

Design and Development of a Mobile App Framework to Facilitate Breast Cancer-Preventive Behaviors (m-BCPB) in the At-Risk Women: Qualitative Study

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Abstract

Background Smartphone apps are becoming a gradually universal template for an offering of preventive behavior interventions among women who are at risk of getting breast cancer. Although, only limited methodological procedures on mixing model, document, and qualitative study for their developments are presented. Thus, this study was aimed to design and develop a model-based, document-driven, and user-centered mobile app framework to facilitate breast cancer preventive behaviors targeting at-risk women.

Methods The present study explains how intervention progress may be enriched with a theoretic foundation, literature review, and qualitative research. A semi-structural individual interview and focus group dissection (FGD) were accomplished to combine the user's participation in the development. Participants were employed using a purposive sampling method. All interviews were audio-recorded, transcribed verbatim, and coded by applying the software MAXQDA. The thematic analysis method was employed for developing themes and sub-themes.

Results The ASSISTS model, self-regulation model, and the self-control model were chosen to design the app framework. Data from the literature review presented the most influential document for the designing of the programs. Nineteen women were invited to participate in a semi-structured interview and FGDs. The following five main themes revealed: content, interactive performance, template, extended action and output, and motivational nature. Mobile apps are a useful tool for learning self-care tips, suitable and healthy lifestyles, and stress management, due to their user-friendly and easy feature. The mobile app framework that developed in the present study includes culture-appropriate, user-centered, and reliable content. The mobile app design should include beautiful, visualized features, and interactive multimedia.

Conclusions By applying three phases way combining a model basis, the document from the literature review, and qualitative study from the target group can be held as a pattern for the prospective app design.

Background

Cancer is a leading cause of death globally; in this case, breast cancer has been widely considered (1). The incidence rate has slowly risen in advanced countries in current decades; this rate has quickly risen in developing countries (2). The risk factors that increase the chance of developing breast cancer can be categorized in unchangeable factors, like sex, age, delay in menarche or menopause, and family history of breast cancer (3, 4), and changeable factors, like obesity (5), high intake of fat foods (6), low level of regular exercise (7), alcohol drinking (6, 8), smoking (9), and facing a high level of stress (7). These changeable lifestyle factors are important risk factors for developing breast cancer (5). As such, changing one's lifestyle may prevent breast cancer and reduce the risk of getting breast cancer to a large extent (8–13). For instance, it has been detected that routine exercises prevent too much weight gain and therefore decrease the risk of developing breast cancer (14).

It has been accepted that the easiest and effective ways to control and decrease breast cancer development and mortality are prevention and screening programs, which are at this moment in progress in Iran. Screening performances counting self and clinical breast exams and mammography are also defined to be useful for early detection and decreased mortality as a result of breast cancer (15, 16). However, procedures for application these modalities are not the same and differ in many countries (17–19). However, most Iranian women do not perform breast cancer screening behaviors because screening is not refunded by the government, with a risk that women who postpone screening may die earlier (19, 20). A study conducted in 2013 in Iran further revealed that 25% of women postponed the next check-up for more than three months (21), and despite having suitable awareness and beliefs, few health staffs applied breast cancer preventive behaviors and screening (22). Inappropriately the data for clinical breast exams does not record, but it has been expected that at best, 10% of Iranian females existing in the city might perform annual clinical breast check-ups (23).

Additionally, the information for diagnostic mammography between Iranian women differs from 1.3–30% (24, 25). Because only a few Iranian females considered doing breast exams, concentrating on the enhancement of healthy lifestyles might be vital to generate helpful healthcare approaches and increase health results (26, 27). It is essential to develop the subsequent health of women by performing health promotion modifications.

One of the most effective approaches to enhance breast cancer preventive behaviors (BCPBs) are using media campaigns (e.g., via billboards, radios, and television campaigns), while informing the women (28–32). The most important results of household surveys about using information technology by the Statistics Center of Iran show that the number of Iranian women who have a phone in is 27.3 million, and 15.2 million have computers, and 21.6 million of them access the internet. However, the rate of mobile users is 85% for men and 76.4% for women. Based on the statistic, 60.4% of women access to the internet. About 89.6% of Iranian users who use one of the information technology tools (e.g., mobile, computer) rate in the age group of 15–24 years and this amount of use for people in the age group of 25–49 years reported about 94.9%. Meanwhile, based on the age index of mobile use, the penetration rate of mobile users in the age group of 50–74 years is about 82.2%, and in the age group of 75 years and more is 50%. These figures show that the 25-49-year-old age group has the highest mobile users (33).

Mobile apps make innovative chances to regular behavioral aims, deliver healthy lifestyle advising, and enable self-controlling of targeted behavior of women (34). Mobile apps have become progressively related to health maintenance and effectively combined with interventions that mark healthy food, regular exercise, and controlling weight (35). Furthermore, mobile apps apply a tracking system to increase adherence by automated signal or announcement or graphic growth by checking devices for reminders and systematic interplays. The benefits of applying apps contain affordability, availability, and appropriate delivery to numerous areas and several peoples (35, 36). At-risk women of breast cancer look for apps to find breast cancer prevention-related information, discuss subjects with peers, and look for advice from experts to monitor their self-care decision making (37, 38). However, the bazaar for health care mobile apps is significantly disorganized because many of them are planned for very particular

backgrounds, and they fail theoretic content. A literature review on quality evaluation for mobile apps is different (37, 39). Therefore, the design of quality and document-based mobile app to enhance breast cancer preventive behaviors in women is necessary.

Model-based intervention supports planners in recognizing theoretic structures to consider in an intervention to extract behavioral modification (40, 41). Furthermore, the theoretic basis offers an approach to smartphone preventive behavior intervention improvement (42). The Template for Intervention Description and Replication (TIDieR) guideline suggested the applying of theoretic frameworks in planning preventive interventions (43). Above all, model-informed design eases the process of an intervention (44, 45). Evidence from literature review and meta-analysis is applied as a base to generate suggestions for smartphone app design. The literature review is the source standard in integrating data in health care systems (46). Furthermore, a meta-analytic method is recognized as the most influential document due to its methodological precision (47).

On the other hand, considering the views and experiences of users in designing and developing mobile-based educational software helps to increase the effectiveness and practicality of the educational app. So that, by exploring users' experience about the mobile app, investigators and app designers can well develop future m-health interventions to be both practical and admitted by finale-users. The user-focused plan is a well-accepted strategy to improve a smartphone app. This plan is purposefully valuable due to its penetrations on users and their context of performance (48). The benefits of the user-centered plan involve the increase of freedom, capability, helpful, sensitive experience, and a feeling of connection for users (49). The user-centered plan emphasizes on target audience via an iterative plan method that employs users in building a concept, design, and improvement of a mobile app (50, 51). User contribution enhances demand and user-friendliness (52). The target group can choose personalized data about their favored method, which is vital to expand the adequacy and efficiency of interventions (49). User-based design procedures can support identifying the priority of possible users for content, template, and structure on a smartphone app, thus causing in a singularly useful plan. In conclusion, with probable advantages of little cost, high accessibility, and proper adherence, the current study aimed to develop an m-BCPBP app framework to facilitate breast cancer preventive behaviors among at-risk women applying for a model, literature review, and user-based method by the qualitative study.

Methods

Concerning the m-BCPBP app framework design, three phases procedure was used by combining possible sources, the document from a literature review, and results from by qualitative study from the target group (at-risk women).

Step 1: Model-Informed Design

Intervention development by performing a theoretical source can considerably advance health behavior (41). Therefore, the m-BCPBP app framework design was according to the combined of three-model,

including ASSISTS model (53), self-regulation model (54), and self-control model (55). The ASSISTS model focuses on the key mechanism through the seven principal sub-functions, including attitude, motivation, perceived social support, information seeking, self-efficacy, stress management, and self-care. Based on the ASSISTS model, self-care behavior and stress management are affected directly by attitude, self-efficacy, motivation, information seeking, and social support. Furthermore, women try to find more information when they are motivated, have more self-efficacy, have a more positive attitude toward breast cancer prevention, and experience more social support. Self-efficacy is the belief we have in our abilities, especially our skill to run into the contests ahead of us and complete a task effectively (53). The self-regulation model emphasizes on a five phases self-regulation, counting determination of targets, creation of responsibilities to modification, physical and environmental management to comfort achieving one's goals, and performance of self-regulation elements to attain the target (54). The self-control model contains the following elements: wanted behavior criteria, motivation to fulfill criteria, monitoring of conditions that attain the criteria, and internal power to control desires. Self-control plays a significant role in a person. This role is an essential key to prosper in life because it changes the person's reactions. In specific, self-control supports a person with control and standards and aligns the chase of a lasting purpose (55). The theoretical framework (as displayed in Fig. 1) demonstrates the associations between m-BCPBP and health results.

In this theoretical model, self-regulation includes perceived support regarding preventive behaviors. Perceived support can positively have linked to self-efficacy, motivation, and positive attitude, which in turn is positively related to information seeking, self-care, and stress management. Motivation can increase a woman's self-awareness about the current breast health condition, raise positive attitudes, and increases the desire for information seeking breast cancer preventive behaviors. Awareness, positive attitudes, and seeking health information can cause a self-assessment reaction, which includes the explanation of the situation of a woman to some criteria, aim, or a standard. Furthermore, a series of reactions and replies can be identified after self-assessment due to self-adjustment and self-efficacy (54) to improve self-care and stress management like having a healthy diet, rise regular exercise program, regular check-up, and obtain healthy breasts. As a result, women who took part in using them-BCPBP app will most likely find better outcomes about their breasts' health.

Step 2: Document of Literature Review

To achieve the most critical available evidence to develop the m-BCPBP app framework, the current study group accomplished a literature review to assess the efficacy of mobile-based (m-based) interventions for breast cancer prevention and screening in women. Seven-database, containing the Medline, Cochrane Library, PsycINFO, ProQuest Dissertations and Theses, Cumulative Index to Nursing and Allied Health Literature, Scopus, Excerpta Medica Database, and PubMed, was explored from their inception to Feb 11, 2017. The study group chose 11 randomized controlled trials in 15 articles among the 1079 accessible papers. This search found that m-based intervention is an appropriate method to perform breast cancer prevention and screening and reduce the risk of getting developed breast cancer.

Several mobile-based delivery templates were detected in 11 chosen articles; these templates include mobile app-based (34, 35, 37), web-based (56–59), the internet, email (60, 61), short text message (62), and computers (63). Self-care, a healthy lifestyle, and stress management are essential elements in developing healthy lifestyle interventional programs (57). Hopeful approaches have fundamental effects in improving self-care and healthy lifestyle toward breast cancer prevention. Mentioned approaches include defining behavioral aims, undergoing lifestyle advising or skills teaching, ordered self-controlling, and getting support from the response from health care experts. Intervention initiates at a young age and before the age of 30 years old to cover the positive result of the intervention. E-based templates combining in-woman and phone calls for specialized consultation are effective in decreasing the risk of getting developed breast cancer because parallel interpersonal interactions may help progress the efficiency of the intervention (39, 57). Social media amongst peer support is fundamental in improving healthy behavior (64). Table 1 summarizes the proposed advice from our literature review. These suggestions can guide our study in discovering the following stage in developing a mobile app framework for improving breast cancer preventive behaviors in at-risk women.

Table 1
Suggestions gathered from reviewing the literature.

Feature	Suggests
Element	Self-care, stress management, regular breast check-up, and healthy lifestyle
Target group age	At women with 30 years old and younger
Template	E-based template combining with a phone call
Approaches	Determining behavioral aims, having healthy lifestyle advising or skill teaching, regular self-controlling, and getting support by the response
Outcome events	Monitoring method for breast check-up, image-supported lifestyle evaluation (e.g., regular physical activity and healthy dietary intake) for self-care, and breast check-up measures for breast health status.
Communication style	Text messages, email, Social Media, or phone for a specialized discussion
Performance	Diagrams for development report, search feature, goal following, and notification or reminder

Step 3: Carrying out Qualitative Study to Inform User-Focused Design

A qualitative study with end-users, women age 40 and more, in the design process was applied. A qualitative study is important (65) because it offers valuable visions for the first selection to develop the m-BCPBP framework. A user-focused method helps discover the desires and favorites of platform, content, and design of the m-BCPBP app framework among at-risk women (48). The results of this qualitative study may help in tailoring the intervention, so rising its efficiency and acceptance.

Participant and Background

By purposeful sampling method with maximum variation, 19 women age 40 and more employed from two health care centers affiliated by Kurdistan University of Medical Sciences. These health care centers provide comprehensive health care for different demographic and socio-economic groups in Sanandaj (the capital of Kurdistan, Iran).

Data Collection

Data collection was completed from May-August 2017 after getting approval from the Ethics committee of Kurdistan University of Medical Sciences (Grant No: IR.MUK.REC.1396/14). The principal researcher came close to the target women during health care center visits, and eligibility screening was accomplished in a private space. Women were notified about the aim of the study, and the datasheet was set. This first communication was followed up by a phone conversation to create their attention and agreement to take part in the study. Written informed consent was acquired, and women's profiles were finalized. A skilled study assistant, who was qualified to perform all interviews, performed all interviews to confirm a high level of stability. The data were gathered using two qualitative methods, including a semi-structured in-depth interview and focus group discussions with women. An interview guide (Textbox 1) with open-ended queries was used to discover the desires and favorites of women in terms of the content, template, and format for breast cancer prevention behaviors intervention.

i. Semi-structured in-depth interview

At the beginning of the qualitative study, 11 semi-structured interviews were performed with women. The semi-structured in-depth interview method lets participants explain their responses easily in their phrases. Based on a structure for a qualitative semi-structured interview guide, the interview questions were designed (51). All interviews were conducted in a private place at the convenience of the women. The interview took long for approximately 40 to 60 min. Each interview was audio-recorded, and field memos were received. Women were free to participate in the interviews, and the pool card was given as a gift in appreciation of their participation in the interview.

ii. Focus group discussions (FGDs)

After a semi-structured in-depth interview, to gain deeper information, two focus group discussions, each involving seven women, were performed. To do this, the volunteered women who contributed to semi-structured interviews were requested to take part in FGDs. Six of them decided to be joined in FGDs. In the next part, the eight other new volunteered women approved to take part in FGDs. Generally, FGDs among 14 women were accomplished to discover the subject. Before the beginning of the FGD sessions, the explanatory declaration form was allocated to all women. The purposes of the FGD were clarified to the women, and women were informed that: the FGD session might yield 90–120 minutes, their answers would be unknown and audio-recorded, and their participants were voluntary.

On the other hand, to get the main topics, field notes were reserved as well. Women were then set time to request any questions, and those who agreed were now questioned to sign consent forms. Women were mentioned that the main researcher would say some subjects and was requested to explain with accuracy on their answers. Furthermore, they have explained some simple ground principles on how the FGD would carry on, that is: 1) women were stimulated to offer their views as efficiently and as reliably as they could; 2) women were asked to give each other a chance to participate in the discussion, and 3) to respect the lecturer by attending and no disturb discussion between topics. All women were free to participate in the interviews, and the pool card was given as a gift in appreciation of their participation in the interview. Sessions were performed in places that were convenient and easy to get to participants.

Data Analysis

The participants were requested about descriptive characteristics at the launch of each interview. All interviews were audio-recorded. At the end of each interview, the interviews were heard several times and then transcribed verbatim. Thematic analysis was accomplished on the transcripts by two investigators (MK and TP), directed by Braun and Clarke's six-stage method to coding. (1) acquaintance with information by reading several time the transcripts, (2) primary code generation by regularly detecting and specifying units of meaning with codes, (3) theme searching between the primary codes based on data shapes, (4) rereading and reviewing of themes by establishing the data that may be greatest fitting together as subthemes, (5) naming and defining ending key themes, (6) creating the report (66). This approach was chosen due to its flexibility, release from a particular theoretical structure, facility to discover a rich series of data and determination, and analysis of sequential themes. The themes recognized on a semantic level were narrowly related to the data performing an inductive method. The sequential proportional analysis was applied to repeat the difference among theme incidences through opposing women (67). Thematic saturation was reached at the 11th interview as specified by two study group members (MK and TP) throughout the simultaneous analysis. Explanatory verbatim quotes were carefully chosen to keep the data validity. Quotations by women were corrected on a partial basis to eliminate content that did not express meaning (frequent words, falters, and stammer) and to correct for syntax. A circle mark was applied to consider the deletion of such unimportant statements. Rectangle brackets were applied in quotes to provide words deleted by the talker or to exchange sensitive data where names were stated.

Validation

For validation, interview transcripts and the resulting codes from each of the semi-structural interviews and FGDs were presented to the participants and their views about the meaning of the codes were asked; if they indicated opposing views, their helpful declaration was included. Moreover, the text of the interviews was presented to some specialists who were not contributed to the current study as external observers to check the coding process accuracy.

Results

Overview

A total of 19 eligible women aged 40 and over without breast cancer approved to take part in the study. Table 2 shows a summary of the demographics characteristics of all 19-woman.

Table 2
Characteristics of interview women (N = 19).

Characteristics	N	%
Age, in years		
40–45	10	52.63
46–50	5	26.32
≥ 50	4	21.05
Marital status		
Married	14	73.68
Single	3	15.79
Divorced	2	10.53
Educational level		
Under diploma	6	31.58
Diploma	2	10.53
Upper diploma	11	57.89
Employment status		
Employed	11	57.89
Unemployed or housewife	8	42.11

After a six-phase thematic analysis, and according to five main themes related to the app content, interactive performance, template, extended action and output, and motivational nature. These five themes offered the meaning of level proposing contextual visions into the progress of m-BCPBP. Summaries of the Key themes, sub-themes, and examples of meaning units are offered in Table 3.

Themes	Sub-themes	Examples of meaning units
Content	Tailored to women	<i>Whatever I can seek breast cancer prevention-related information from the various sources including social networks, or internet is generally recognized from anywhere in this world...therefore the breast health status, ways to control stress, cancer prevention, my stress level is very high. And my viewpoint on life has become very pessimistic. So I believe possibly I should cater to my health toward breast cancer and another type of diseases that threaten our health as a mother."</i>
	Multi-element	<i>I don't aware of what range I can have physical activity. What is the proper exercise several times?... How much physical activity per day or week that I should perform that is suitable for my body?</i>
	Trustworthiness	<i>In my opinion, if information resources regarding breast cancer prevention come from physicians, midwives, health care workers, or clinic, reliability is the first item I would think and trustworthiness is now there.</i>
	Goal Setting	<i>I've heard that regular exercise and weight loss are effective in preventing breast cancer, but I'm always lazy [...] I'm not able at self-care and regular physical activity, therefore perhaps this goal setting in this new app can encourage me to take my purpose.</i>
Interactive performance	Mutual and flexible interaction with experts	<i>I want some doctors and health care workers to offer expert recommendations on suitable healthy lifestyles, self-care like regular breast check-ups, and stress management. Therefore, smartphone-based consultation should be right useful and supportive of women.</i>
	The decisive role and worth of friends' and peers' support	<i>It is worthy of having our online conversation meetings with friends and peers, and we can negotiate and argue our opinions or perhaps even acquire some data and some assistance via online conversation meetings.</i>
	Interactive software	<i>In my opinion, I desire more pictures, cartoons, and charts. I sense online test is a fantastic section. At first, I acquire the data. Next, I just check whether I have realized it appropriately via tests.</i>
	Relationship-creating	<i>"Well, yes, that is right. As a woman, having this app on my cell phone allows me to communicate well ... with my friends about their interest and efficiency in maintaining their health and self-care ... Of course, that is not all ... but if the app is like that, It's great to be able to connect with all the people who use this app. It is good news having an opportunity to interact more with others in the virtual world."</i>
Template	Appealing and Beautiful feature	<i>My first choice is a colorful format and shape, such as light color. Indeed, I read on social media that the color pink is related to breast cancer, and the sign is the pink ribbon.</i>
	Apparent and graphic aspects	<i>I prefer more images and photographs for knowing my breast health condition.</i>
	Easy to use smartphone application	<i>In my view, I tried out some self-care and lifestyle apps such as Healthcare and Healthy Lifestyle Training Programs, Cancer Prevention Application, My Pillbox Software, Health Measurement</i>

Software. *I found the smartphone is precisely useful, and downloading mobile apps is easy and comfortable.*

App charge *I have experience with a mobile app, in which I have applied for my diabetes drugs [...] because I have to use it 3–5 times during the day. Consequently, it assists in reminding me as and when I require to use the diabetes drugs. My first experience with the mobile app was satisfactory until just because it's been practically 20 days; it declares my free trial version is finished. Thus, if you are designing for those who are so economically weak, I believed that we should provide it for free charge. If we can run that [it would be worthy] due to them being much in-app buying, you see, in light of that, they are uneducated and not so good to perform, if we desire to support them, maybe we can consider this.*

Appropriate and user-friendly *Personally, the essential issue for using mobile apps is user-friendly... due to the direct and straightforward way to find subjects. It is vital for me that the number of contents provided in the software be short that I can quickly go from the top of the page to the bottom of the page or the page before and after the software.*

Privacy and security *Privacy subjects. Suppose we placed our information into the cloud space, others might hack it. Therefore, if I were the client, I may be concerned if my private data may be revealed. For example, suppose I enter my medical history or my breast health status, what guarantee is there that this data will not be disclosed? [...]*

Notifications *Similar to something that appears on your mobile [...], you are required to save and perform your behaviors. I believed that might be respectable. Or perhaps [...] it has something variety of [a] message rather than just words or what; it could arise like maybe [a] picture or perhaps [...] similar to an audiovisual like somebody saying the user what they require to perform.*

Extended action and output

Self-care for personal aims setting *Having a mobile application helps me to register my health condition data for the physician to perceive through the chart or the diagram to check how well do I control, the things to do past to the following appointment so that the physician can appraise.*

Checking the Improvement *Hoping to have fit weight, regular physical activity, healthy food, and breast check-up, software or appliance to control my progression and a proper automatic message aid retell me.*

Systematic update *I would like to read the present study and see the newest breast check-up advice or recommended self-care and stress management regarding breast cancer prevention and behaviors.*

Motivational nature

Ability to compete with other methods and apps *Seeing relatives use, and I identify I have to run it. Therefore, it holds you motivated to perform it.*

Invisible awards *I have a calorie counting and weight loss program on my mobile phone. With each calorie reduction, I am given a star. Although these awards and stars are not real, they give me a good and positive feeling [...] Earning stars was notable when I was doing it*

	<i>[...] Be sure to consider virtual and attractive prizes to design your mobile app.</i>
Visible awards	<i>I prefer the awards (i.e., symbols) on them inside the mobile app, but it's nothing I can touch and feel like a tangible award. Therefore, for me, if this mobile app was telling once you reduce your calorie intake lower than 1000, you acquire a free pool card or another thing, or cash is one of the most important motivators...</i>
Adding fun element	<i>I would like a mobile app that has gaming factor.... it is exhilarating for a specific link ... adding games in the educational app makes learning more comfortable and more appealing. I think it revives the inner child..."</i>
Inner commitment	<i>Possibly, they require to be supplied that app, but finally, it is an inner thing. People are excited from the inner out.</i>

Table 3

Key themes, sub-themes, and examples of meaning units

Textbox 1: Semi-structured interview guide.

What do you think about breast cancer and preventive behaviors for women?

What is the most relevant content you want to know in a breast cancer prevention behavior intervention?

What is your attitude towards preventive behaviors of breast cancer?

Do you have any other recommendations about the appropriate content for breast cancer preventive behavior intervention?

What do you think about self-care in women?

How do you feel about using mobile technology to perform breast cancer prevention behaviors intervention?

What are your experiences in achieving data from the mobile-based template?

Tell me about how you select a desirable technology template to get breast cancer prevention behavior information, and why?

What do you imagine about the preferred method to obtain data about breast cancer prevention behaviors?

What do you imagine about the preferred template for communicating with peers?

What template do you desire in interactivity with health care experts?

What is your favored presentation template by applying multimedia?

What are the necessary features of development that will engage you in the mobile-based intervention?

What do you think about the inhibitors of mobile-based intervention?

What do you think about the facilitators of mobile-based intervention?

How are your smartphone usage habits?

Do you have any further supposed that you have not stated in the offered queries?

To end, is it OK to contact you for some follow-up queries if needed?

Theme 1: Content

Subtheme 1.1: Tailored to women

Almost all women believed that they were extremely tempted to participate in the app-based interventional program if it can offer them with detailed breast cancer preventive strategies. Some women stated their views as follows:

"[...] Perhaps something associated with like a different person. Because I am a very stressful girl [...] perhaps the preventive plan should be modified to the type of personality and intrinsic characteristics of every Iranian woman or other cultures so that I do not want to adapt behavior from other personality and intrinsic characteristics [...]" (Participant 5; age:41; single; diploma; housewife).

"Whatever I can seek breast cancer prevention-related information from the various sources including social networks, or internet is generally recognized from anywhere in this world [...] therefore the breast health status, ways to control stress, cancer prevention, my stress level is very high. Moreover, my viewpoint on life has become very pessimistic. So I believe possibly I should cater to my health toward breast cancer and another type of diseases that threaten our health as a mother." (Participant 1; age:41; married; upper diploma; employed)

Some women desired breast cancer prevention- a specific healthy lifestyle. Ones reported:

"I would like all delivered evidence is preventive behavior-based; any recommended actions should be women' health-friendly [...]" (Participant 9; age:41; single; upper diploma; employed)

"We are women, so it is very different from the men [...] thus; in my opinion, preventive information about Breast Cancer will be very supportive only for the women." (Participant 7; age:43; married; upper diploma; employed).

Subtheme 1.2: Multi-element Content

Furthermore, the women advised that multi-element content possesses a vital role in developing the content of intervention based on various educational requests and necessities. Intervention elements should significantly highlight suitable and regular exercises, healthy diet recommendations, regular breast check-ups, self-care, and stress management. women' favorite is explained in the next declarations:

"Regularly, it is beneficial to identify like which type of methods for controlling daily stress, how many stresses, or what kinds of the method I can apply for controlling my stress. "(Participant 2; age:40; single; upper diploma; employed)

"I do not distinguish to what kind of method I can apply. What is the appropriate stress management method for various times? [...]"(Participant 4; age:44; married; upper diploma; employed)

"I do not become aware of what range I can have physical activity. What is the proper exercise several times? [...] How much physical activity per day or week that I should perform that is suitable for my body?"(Participant 11; age:45; married; upper diploma; employed)

Subtheme 1.3: Trustworthiness

Women proposed the topic regarding the intervention's trustworthiness. They sensed peace with attaining facts from trustworthy sources, such as their gynecologists, physicians, midwives, health care workers, or clinics, instead of from unreliable and unfamiliar sources about the source or organization of origin.

Three women explained their experiences:

"[...] Some cyberspace and social networks such as Telegram, WhatsApp, Instagram, Facebook, and [...] do not afford correct information about breast cancer and its preventive behaviors, and I don't believe them [...] I like information from trustworthy and reliable sources such as gynecologists, physicians, midwives, health care workers, or clinics that I can believe. "(Participant 11; age:45; married; upper diploma; employed)

"In my opinion, if information resources regarding breast cancer prevention come from physicians, midwives, health care workers, or clinic, reliability is the initial item I would think and trustworthiness is now there."(Participant 3; age:51; married; under diploma; housewife)

"To have a healthy life, we need to get the right information about a healthy and cancer-free lifestyle from scientific sources like doctors [...] Despite the growth of new technologies, many websites and social networks have incorrect and unscientific information about breast cancer and its incurability [...] It's my responsibility as a woman to be able to get the right and correct information from scientific and accurate sources."(Participant 12; age:47; married; upper diploma; employed).

Subtheme 1.4: Goal Setting

Besides tailoring and multi-element features for the app, many women wanted the goal-setting characteristic in the content of this app. They believed that goal setting, particularly small daily and weekly aims, could aid them in persuasion themselves and gradually modify their behaviors. Some

women showed that goal setting would work well with immediate feedback and advance reports as well. Two women said:

"I have heard that regular exercise and weight loss are effective in preventing breast cancer, but I am always lazy [...] I am not able at self-care and regular physical activity, therefore perhaps this goal setting in this new app can encourage me to take my purpose [...]" (Participant 18; age:45; married; upper diploma; employed).

"For me, the problem is to keep going to the behaviors. I always have a good start for many behaviors, but I'm not a good follower [...] Perhaps at the start of the week, like you, I can perform it, in the middle of the week, or even at the end of the week, 'I cannot keep it. For example, when I decide to skip sweets from my daily meals [...] I'm very successful for a few days, but I can't go after that, especially if I'm going to a party with my friends". (Participant 16; age:48; divorced; upper diploma; employed)

Theme 2: Interactive performance

Subtheme 2.1: Mutual and flexible interaction with experts

Women accepted that smartphone-based consultation is essential to deliver supportive information and recommendation regarding breast cancer preventive behaviors. Additionally, women favor communicating with health care workers and doctors mutually and flexibly by various methods. Two women explained that:

"I want some doctors and health care workers to offer expert recommendations on suitable healthy lifestyle, self-care like regular breast check-up, and stress management. Therefore, smartphone-based consultation should be right useful and supportive of women." (Participant 8; age:44; married; under diploma; housewife).

"I might be incapable of making the communication in somebody due to traffic problems, and most of all because of my job problems and the responsibility of living and having a small child [...] It's easier for me to ask health care workers or doctors via telephone or social networks (for example WhatsApp, Emo, and Skype) if there are any error and misinterpretation I can request them for explanations." (Participant 12; age:47; married; upper diploma; employed)

Subtheme 2.2: The crucial role and worth of friends' and peers' support

Women felt that intervention could offer expert support and highlighted the crucial role and worth of friends' and peers' support from online conversation meetings. Some of the women reported:

"It is worthy of having our online conversation meetings with friends and peers, and we can negotiate and argue our opinions or perhaps even acquire some data and some assistance via online conversation meetings." (Participant 6; age:52; married; diploma; housewife)

"I would like online conversation and talking with other women and friends, and it can suggest orders and recommendations me for healthy lifestyle and self-care toward breast cancer [...] Objectively, I want comfort about my health status, and it means a lot to me if somebody's support". (Participant 4; age:44; married; upper diploma; employed).

Subtheme 2.3: relationship-creating

Some women sensed that by sending in-app announcements or a private text to the users to tell them again to perform their preventive behaviors and self-care, this could support nurture an encouraging connection between the users and the educators or designers, with the users taking it as a symbol that the educator or expert has particular attention in their health results.

"Well, yes, that is right. As a woman, having this app on my cell phone allows me to communicate well [...] with my friends about their interest and efficiency in maintaining their health and self-care [...] Of course, that is not all [...] However, if the app is like that, it's able to connect with all people who use this app. An opportunity to interact more with others in the virtual world." (Participant 19; age:56; married; under diploma; housewife)

Subtheme 2.4: Interactive software

The overall favorite of the women is the applying of interactive software, counting diagrams, pictures, online tests, short clips, and animation to make the mobile app extremely attractive. Some women mentioned that they gain the choice of utilizing various multimedia to take part in the intervention, as repeated in the following quotes:

"[...] A short clip for advised the process of performing breast self-examination, health instructions, and the suggested self-care would be exciting and suitable." (Participant 11; age:45; married; upper diploma; employed).

"In my opinion, I desire more pictures, cartoons, and charts. I sense online test is an amazing section. At first, I acquire the data; next, I just check whether I have realized it appropriately via tests." (Participant 7; age:43; married; upper diploma; employed).

Theme 3: Template

Subtheme 3.1: Appealing and Beautiful feature

Almost all women said that the appealing and beautiful feature of the intervention is a critical factor in their applying of the smartphone app. Therefore, design and template an exciting and beautiful style is necessary. In this case, two women explained that:

"Beautiful style and colorful as it can interest women to look at it [...] consequently, it is easy to get notice and simplify learning." (Participant 15; age:50; married; under diploma; housewife)

"My first choice is a colorful format and shape, such as light color. Indeed, I read on social media that the color pink is related to breast cancer, and the sign is a pink ribbon." (Participant 11; age:45; married; upper diploma; employed).

Subtheme 3.2: Apparent and graphic aspects

Graphical and apparent messages regarding the quantity and kind of behaviors to prevent breast cancer must also be considered. Apparent and graphic aspects progress the women's self-efficacy to understand their improvement and know their preventive behaviors performance. One woman mentioned:

"I prefer more images and photographs for knowing my breast health condition[...]" (Participant 1; age:41; married; upper diploma; employed).

"It's useful and valuable to display me that the standard time of a breast check-up looks like it since I need to know it." (Participant 4; age:44; married; upper diploma; employed)

Subtheme 3.3: Easy to use smartphone application

Almost all women said that the use of a smartphone application is an excellent tool platform. The key benefit of applying smartphone applications is that it is convenient and useful to navigate; it can be used at any time and place. Women mentioned the following quotations:

"In my view, I tried out some self-care and lifestyle apps such as Healthcare and Healthy Lifestyle Training Programs, Cancer Prevention Application, My Pillbox Software, Health Measurement Software. I found that the smartphone is exactly useful, and downloading mobile apps is easy and comfortable [...]" (Participant 2; age:40; single; upper diploma; employed).

"At present, everyone has a smartphone, and many things can be learned or accessed from mobile phones [...] There are many mobile applications that we can easily and freely download from mobile phones, such as sports training software programs, diet software, health assessment software, WeightCompanion_1.2 weight loss software, and many other programs, of which all of them are aimed at improving our lifestyle." (Participant 9; age:41; single; upper diploma; employed).

Another woman said:

"Mobil applications is similar to a one-stop place for everybody, and I can access anyplace at any time. Mobil applications can deliver communication links that I could click on if I desired. For example, even if I'm traveling, I follow my healthy eating plan because I've installed diet and calorie-consuming software on my phone [...]" (Participant 7; age:43; married; upper diploma; employed)

Subtheme 3.4: App charges

Implementing the mobile application at a charge would be a barrier concerning the desire of the user to buy the mobile app, since many people's economic problems and their worse socio-economic context. Thus, there was a group agreement that the mobile app should be free of charge. Women, although, also thought that they would not buy the mobile app and run it for free to the users except it intended more

advertisements for the health care centers or clinics. Furthermore, it was advised that to conflict the matter of price, the app could be involved as one of the benefits of a link to the health care centers or clinics. Women told concerns that not all people would be ready to provide smartphones. Additionally, they believed that due to the points suggested, cheaper smartphones would not be ready to run the interface suitably. As such, the design of the mobile app should be a balance between simplicity and usability, to confirm even user experience, and that it does not falter. One woman said:

"I have experience with a mobile app, in which I have applied for my diabetes drugs... because I have to use it 3–5 times during the day. Consequently, it assists in reminding me as and when I require to use the diabetes drugs. My first experience with the mobile app was satisfactory until just because it's been practically 20 days; it declares my free trial version is finished. Thus, if you are designing for those who are so economically week, I believed that we should provide it for free charge. If we can run that [it would be worthy] due to being much in-app buying, you see, in light of that, they are uneducated and not so good to perform, if we desire to support them, maybe we can consider about this." (Participant 18; age:45; married; upper diploma; employed).

Subtheme 3.5: Appropriate and User-Friendly

The women stated that the mobile app design should be appropriate, easy, and user-friendly. One woman mentioned that:

"In my mind, the most remarkable point in the appropriate use of mobile-based training software is its easy and simple application. It is important that the user is comfortable and friendly with the software and enjoys working with it. User-friendly is important that we can quickly to work, enter, and catch desired information." (Participant 10; age:46; divorced; upper diploma; employed)

"Personally, the most important issue for using mobile apps is user-friendly... due to the simple and direct way to find subjects. The number of contents provided in the app must stay short. As a result, I can easily go from the top to the bottom of the page or the page before and after the app." (Participant 17; age:42; married; under diploma; housewife).

Subtheme 3.6: Privacy and security

There were worries that the user's privacy may be hazarded, since users' data kept in the Cloud may be unprotected to hacking. Furthermore, there were worries about privacy locations – if other people would be able to view their user information. To deal with this issue, women advised that users be given the choice of whether they desired to reveal private data to a particular clinic or health care center while keeping it hidden from another one. Another offer was that each clinic or health care center had its ID, and users were given IDs specific to the clinic or health care center they visited. This would then prevent other clinic or health care center from having access to information such as buying history, from other clinic or health care center the users visited. One woman expressed her opinions as follows:

"Privacy subjects. Suppose we placed our information into the cloud space, others might hack it. Therefore, if I were the client, I may be concerned if my private data may be revealed. For example,

suppose I enter my medical history or my breast health status, what guarantee is there that this data will not be disclosed? [...] Or are we keeping all private data on the mobile? if you save it in the phone and something occurs to the mobile, then [...] all data will be lost.” (Participant 14; age:48; married; upper diploma; employed).

Subtheme 3.7: Notifications

However, women desired to apply in-app notifications to deliver messages to users for the gathering of medical data; there were worries of women omitting the in-app notifications, assuming it was of a small problem. Women used WhatsApp or Telegram as an example where people got a lot of inappropriate notifications during day, causing in most persons close your eyes and take no notice to them without even seeing at them first. It was advised instead to current the message either in image or audiovisual shape. Additionally, one woman advised a function that routinely dispatches remembrances to alert users to repeat their behaviors. This would decrease the problem on the operator of having to manually send reminders to the user continually, which would be principally challenging when facing to the great mass of users.

“Similar to something that appears on your mobile [...] you are required to save and perform your behaviors. I believed that might be respectable. Or perhaps [...] it has something variety of [a] message rather than just words or what; it could arise like maybe [a] picture or perhaps [...] similar to an audiovisual like somebody saying the user what they require to perform [...]” (Participant 16; age:48; divorced; upper diploma; employed).

Theme 4: Extended action and output

Subtheme 4.1: Self-care for personal aims setting

The women reported that the nature of being a woman has its challenges and various problems. Most of the women mentioned that they need to have educational programs regarding healthy lifestyle and self-care tailored to their needs and outlooks. An over-all agreement by the women showed that the program should keep operations that will let self-care and checking. Two women expressed their opinions as follows:

“I am interested in taking some charts for checking my health statuses, such as my daily physical activities, my daily calorie consumption, regularly breast self-examination, meditation, and weight that is helpful. I feel handy and comfortable if there is a comprehensive software program based on mobile for this evaluation” (Participant 4; age:44; married; upper diploma; employed).

“Having a mobile application helps me to register my health condition data for the physician to perceive through the chart or the diagram to check how well do I control, the things to do past to the following appointment so that the physician can appraise.” (Participant 9; age:41; single; upper diploma; employed)

Subtheme 4.2: Checking the Improvement

Women believed that the smartphone application content should encourage and repeat the users of their improvement. The women stated a demand to check their physical activities, calorie intake, breast self-examination, meditation, and weight. This finding matched to other speeches from other women, as demonstrated by the quotations below:

"Having a mobile phone program is very important for a woman like me who has many responsibilities in life such as housekeeping, babysitting, working outside the home, and caring for a sick mother-in-law. This program reminds us to take care of our health, such as regular exercise, healthy eating, regular breast check-ups, etc. It is worthy if mobile software can contribute to my announcement to follow up." (Participant 11; age:45; married; upper diploma; employed).

"Hoping to have fit weight, regular physical activity, healthy food, and breast check-up, software or appliance to control my progression and a proper automatic message aid retell me." (Participant 6; age:52; married; diploma; housewife).

Subtheme 4.3: Systematic Update

Given the quick modification in information, systematic updating of the content of smartphone software is significantly essential. Women demanded a regular update on the smartphone application as a part of the performance of the program. Two women mentioned as follows:

"I would like to read the present study and see the newest breast check-up advice or recommended self-care and stress management regarding breast cancer prevention and behaviors." (Participant 14; age:48; married; upper diploma; employed)

"It will be worthy of tabloid update from the breast cancer prevention program to acquire more updated information." (Participant 17; age:42; married; under diploma; housewife)

Theme 5: Motivational nature

Motivators are internal and external elements that encourage health mobile app users to either begin or keep to utilize them.

Subtheme 5.1: Ability competition with other methods and apps:

One of the clear motivators was recognizing other persons applying the mobile app and sharing behavioral data that could be compared to others on social and virtual networking. Women recognized this feature as ambiguous nature: it could be practical and encouraging for some people in specific settings, but it may be discouraging and rush in other conditions, particularly when people worry that they are also far behind compared to their colleagues or relatives. Two women mentioned as follows:

"Seeing relatives use, and I identify I have to run it. Therefore, it holds you motivated to perform it." (Participant 9; age:41; single; upper diploma; employed).

"In my idea, it would be a mixture related to your plane. If you see someone use a mobile app for losing weight, they may motivate you or demotivate you. I believe that it just depends on where your plan and targets in your life are [...] I guess it is great on one side, but on the flip side, it could demotivate individuals who decided to get started on that." (Participant 17; age:42; married; under diploma; housewife).

Subtheme 5.2: Unclear and invisible awards

Different mobile apps give users virtual symbols in which they could get or ranks they could unlock. These unspecified awards are aimed to motivate individuals by activating their competitive characteristics.

"I have a calorie counting and weight loss program on my mobile phone. With each calorie reduction, I am given a star. Although these awards and stars are not real, they give me a good and positive feeling [...] Earning stars was important when I was doing it [...] be sure to consider virtual and attractive prizes to design your mobile app." (Participant 13; age:53; married; under diploma; housewife)

Subtheme 5.3: Visible Awards

Although markers and stars, stages, and encouraging statements and notes from a mobile app offer invisible awards, some persons want a visible one. A woman expressed her opinions as follows:

"I prefer the awards (i.e., symbols) on them inside the mobile app, but it's nothing I can touch and feel like a tangible award. Therefore, for me, if this mobile app was telling once you reduce your calorie intake lower than 1000, you acquire a free pool card or another thing or cash is one of the most important motivators [...] things similar that, it will be exciting. Awards are significant, but only if you can sense and see them [...]" (Participant 7; age:43; married; upper diploma; employed)

Subtheme 5.4: Adding a fun element

Attaching a gaming factor or fun to a mobile app was exciting for a specific link of people. Although, most of the women did not realize the game factor important for women applying user-centered mobile health apps. On the other hand, they believed that a health app with game components might be a positive thing for kids given that they did not understand by the entertainment features of a mobile app, and identify it was something being trained to them. One of the participants believed that:

" I would like a mobile app that has gaming factor or fun [...] it is exhilarating for a specific link [...] adding games in the educational app makes learning more comfortable and more appealing. I think it revives the inner child [...]" (Participant 11; age:45; married; upper diploma; employed)

Subtheme 5.5: Inner commitment

Inherent and inner components are not stimuli produced by a mobile app, but elements inside helping a person to utilize the mobile app. Some women showed that a mobile app could only perform so much.

Finally, it is a person's inner commitment and impulse that will define whether they would proceed to do it for health behavior increase or behavior modification. One of the participants said:

"[...] Possibly, they require to be supplied that app, but finally, it is an inner thing. People are excited from the inner out." (Participant 13; age:53; married; under diploma; housewife).

Interpreting Model, Document, and User Desires into Intervention

According to the outcomes from the possible sources and reports of literature review and qualitative study results with the target group, the content, template, and design of the m-BCPBP framework were set. A multidisciplinary study group included a computer software professional, an expert mobile app designer, two health education and promotion experts, content design experts, and a gynecologist was established to design m-BCPBP app framework. M-BCPBP app framework aims to improve breast cancer preventive behaviors in at-risk women. To develop a smartphone application with a user-friendly link, m-BCPBP's user link and aspects were developed by a computer software professional and an expert mobile app designer. The mobile application can be pre-installed on various smartphone types, for example, Android and iPhone. A visual graphing function was designed to let the user arrange their initial factors, such as age, weight, height, and family history of breast cancer (history of developing breast cancer, sister and mother, as well as a history of developing cancer [breast, ovarian and prostate] in first-degree relatives). Additionally, users were asked about their behaviors, such as physical activity, eating fatty foods, and drinking alcohol, as well as their awareness about risk factors for getting breast cancer and symptoms of breast cancer risk.

The m-BCPBP app framework content consists of risk factors of breast cancer, the symptoms of developing breast cancer, positive attitudes toward preventive behaviors, support, motivational advice, seeking of correct information about breast cancer prevention, self-efficacy advice, self-care advice such as regular breast check-up, suitable physical activity, recommendations about healthy diet, and stress management assistance. The m-BCPBP app framework covers educational, expert, family, and friends support, as well as self-controlling areas (e.g., self-efficacy, self-care, stress management). Educational support offers to encourage users by knowing the effect of improving their lifestyle to keep healthy breasts. Family and friends support aims to conciliate the intercommunication of women, which are used to mobilize and promote common knowledge and attitudes (30). Expert support purposes of attaining and improve healthy lifestyle knowledge, attitudes, and behaviors in order to breast cancer prevention (68). Self-controlling intents to encourage women to self-care of their lifestyle behavior and stress management according to their aims and strengthen any reform made. If the outcome is less or more the range, at that time, the system delivers announcements via the m-BCPBP app framework. The user story box of m-BCPB app is offered in Figs. 2. The drawings and logo depicted in Fig. 2 is our own.

Discussion

Overview

To the best of our knowledge, this research is the first to apply a theory-informed, evidence-driven method, and user contribution in designing a smartphone app for an increase in breast cancer preventive behaviors in at-risk women. We applied the explanation of a 3-phase procedure by integrating theoretical sources, the document from our literature review, and study results from at-risk women. Additionally, a multidisciplinary study group was designed to offer expert recommendations and pay applied and scientific considerations in developing m-BCPBP.

Main Results

A model-based intervention resulting in the TIDieR intervention instruction and guide was designed in order to develop the m-BCPBP app framework (43). Combined concepts from three-model, including the ASSISTS model (53), self-regulation model (54), and self-control model (55), were applied to develop a theoretical framework on the mobile app's design. Our literature review created the most significant document applying 11 RCTs (69) to offer valued advice on the aspect, element, period, template, approaches, outcome events, communication, and function of the intervention. Additionally, our qualitative research among at-risk women creates on our earlier literature review (69) to explore the desires and favorites to develop a tailored intervention. The performance of a qualitative method to produce the user's viewpoints throughout intervention design is distinguished as a sound practice (65). This user-centered strategy is tailor-prepared to the final-user viewpoints because it can confirm that the mobile app is wanted and appropriate for final-users (49) by choosing desirable content, technology template, user interface, communication, and function.

Themes and sub-themes that developed from qualitative research recommended that culturally tailored, woman-particular, multidimensional, and trustworthy contents are principally significant. Due to the existence of different cultures in Iran, it is essential to note making the content of the m-BCPBP app framework culturally sensitive by adjusting lifestyle and preventive information to the visible features of target users. This work consists and uses healthy habits and behaviors items acquainted and favored by Iranian women in a different language, accent, culture, customs, and habits. Users are likely to involve actively in the m-BCPBP app if they distinguish that the designed interventional program is related to improve their level of health about breast cancer prevention. Multidimensional contents offer the initial presentation to educational messages in the virtual learning setting to provide educational necessities. Educational support will possibly encourage dynamic learning; furthermore, the general notion is that the users take control of their learning (70). The design structure should contain visual appeal, pictured styles, and collaborative multimedia. Multimedia structures can provide various learning methods (71, 72). Information visualizing enhances the user's power to understand their improvement and control their preventive behaviors and lifestyle (73). Mobile app content should offer correct purposes and applied procedures to start modification in the target activities and behaviors (41).

Among a variety of technology templates, the m-BCPBP app framework provides the demand for general technology emerging from the current qualitative study due to its helpful and user-friendly style. The

extensive use of smartphone technology, accompanied by the accessibility of useful mobile broadband links, suggests a different occasion to design a novel learning technique (74). Users can acquire information about a healthy lifestyle, self-care, stress management, fitting physical activity, and controlling weight by applying short films, cartoons, games, or tests (74, 75). The smartphone app has increased acceptance among women due to its favorable characteristics, simple use, and multi-practical points. Moreover, smartphone apps suggest self-monitoring details, which may improve particular knowledge of preventive behaviors in consumers (34, 35).

Regarding interaction, consumers favored resilient relationships to doctors and other health care experts via the providing of Web-based conversation and availability to the tailored expert recommendation. Cloud calculating suggests resilient distribution ways among health environments to health care workers (59). Peer support is an essential component of the behavioral change programs, which lets consumers share their awareness, beliefs, attitudes, experiences, emotional, social, or applied for support with each other (30). Additionally, we require to update the device and the content of the smartphone app regularly to confirm that it is informed and reliable. Enhancing and keeping consumer employment stay a significant challenge. Therefore, performing approaches are essential to smartphone application plans. These approaches contain the comfort of usage, appealing design, feedback performance, ability to modify designs to suit a person's favorite, personalized data, and different smartphone structures (76).

Implications

We performed that a three phases method can be applied to design the m-BCPBP app framework for at-risk women about breast cancer. Findings are valuable to design and develop a culture-particular, multidimensional, and user-friendly smartphone application. The ubiquity of the smartphone app simplifies the distribution and sharing of data, cares a wide range of people, and lets the tailoring of data and support based on consumers' features and practices (77). The popularity of scientific progress can identify a change concerning women empowerment within the self-care and preventive behaviors (36). Women can get the m-BCPBP app at any time and anywhere. Therefore, the m-BCPBP app can advise assistance for women between consultation visits about breast cancer preventive behaviors, thus decreasing the number of outpatient hospital or clinic appointments (78).

Limitations

This is the first study of its kind, where explored the viewpoints of at-risk women toward the design of a smartphone app intended to improve their self-care and preventive behaviors about breast cancer in women, who would finally be one of the end-users. However, recent research, like other research, has some limitations. First, the small, purposive, and local sample in one city of Kurdistan (Sanandaj) may limit the generalizability of our results. Second, though all women were living in urban regions, therefore this might not present a realistic depiction of the possible concerns associated with the mobile app that might be met by those living in rural regions. Third, the time to design a three-phase procedure is long-lasting, and time delays may too happen due to the variable user-profiles and fast-paced technical progress. Fourth, smartphone app intervention design, counting time, expert workers, capability, tools, and

training, is significantly resource-serious. Therefore, policymakers should note and study preparing information, financial, emotional, expert workers, preserved time, legal, and logical support for app design.

Future Work

This project provides the performance of a 3-phase method as evidence of the efficacy of this method. We accommodated the viewpoint of the potential consumer with hypothetical source and document for m-BCPBP app framework design. Further research is required to achieve a beta test in the possibility of a study before RCT. In beta testing, we will assess the simplicity of screen navigation, technological difficulties, perverse communication links, and typographical mistakes in numerous internet browsers. Furthermore, we will perform a qualitative study to extract the consumers' experiences after RCT.

Further use and modification will support create a document about the acceptance, reliability, usability, availability, stability, and affordable of the m-BCPBP app. After m-BCPBP improvement, we will assess its efficiency is excellent and well-planned RCTs in varied backgrounds. Therefore, the m-BCPBP app framework is personalized as culturally related to mobile app for women to improve breast cancer preventive behaviors.

Conclusions

With the increase of smartphone devices, a range of mobile apps has been produced to provide training, learning, and support about health difficulties. The current study attempts to expand the limited research by applying three methods, including literature review, applying the model and related theories as well as exploring the user perspectives about design the mobile app to enhance breast cancer preventive behavior by conducting qualitative research with a diverse pool of women. Theory, evidence, and user demands are essential in intervention design. The repetitive method lets the adding of finale-consumer feedback, models, and literature reviews to develop the content, template, and construction of the m-BCPBP app framework, which is personalized and tailored to the user's favorites. The present 3-phase developmental way is a valuable and beneficial pattern for investigators or app designers for future app design. Throughout the design of the m-BCPBP app, it is expected that women would be served appropriately with enhanced communication, which will conceivably change to more beneficial health outcomes and increased user satisfaction. From the women's viewpoint, the app will help a better perception and support in performing self-care and preventive behaviors about breast cancer to these populations.

Abbreviations

BCPB: breast cancer-preventive behaviors; FGD: focus group dissection; TIDieR: Template for Intervention Description and Replication; ASSISTS: attitude, social support, motivation, self-efficacy, information seeking, stress management, and self-care; M-based: Mobile-based; RCTs: Randomized control trials.

Declarations

Ethics approval and participation consent

The study procedure was approved by the Medical Ethics Committee of Kurdistan University of Medical Sciences [IR.MUK.REC.1396/14]. The current study included only somebody who supplied their informed consent. For this, verbal informed consent was obtained from all participants before starting this study, and all participants completed an informed consent form after being explained the study's aims. All women's information was as private and nameless; there was no personal information that could link the answers with any of the participants in the present study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets produced and analyzed throughout the present study are not publicly available in order to keep the participants' privacy but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests. Besides, Maryam Khazaei-Pool, as a member of the editorial board (Associate Editor) of BMC Public Health journal, declares that she has no competing interests.

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Authors' contribution

MK designed the project, did the statistical analysis, and wrote the first draft of the manuscript. TP participated in designing the project and collected the data. PT and KP contributed to the statistics. MK and KP critically revised the final article. All Authors read and approved the manuscript and agreed to be 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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Figures

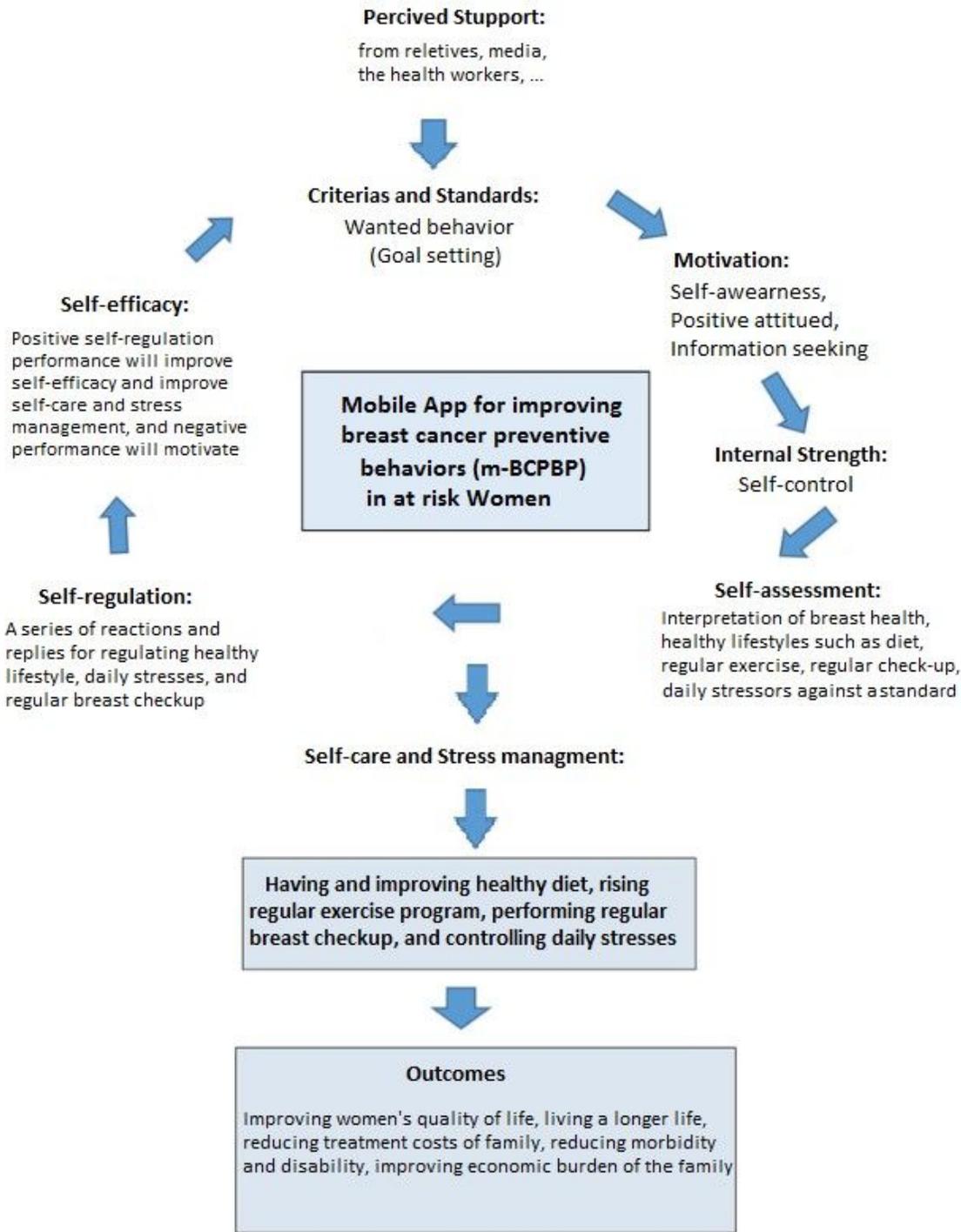


Figure 1

Conceptual framework of m-BCPBP app.

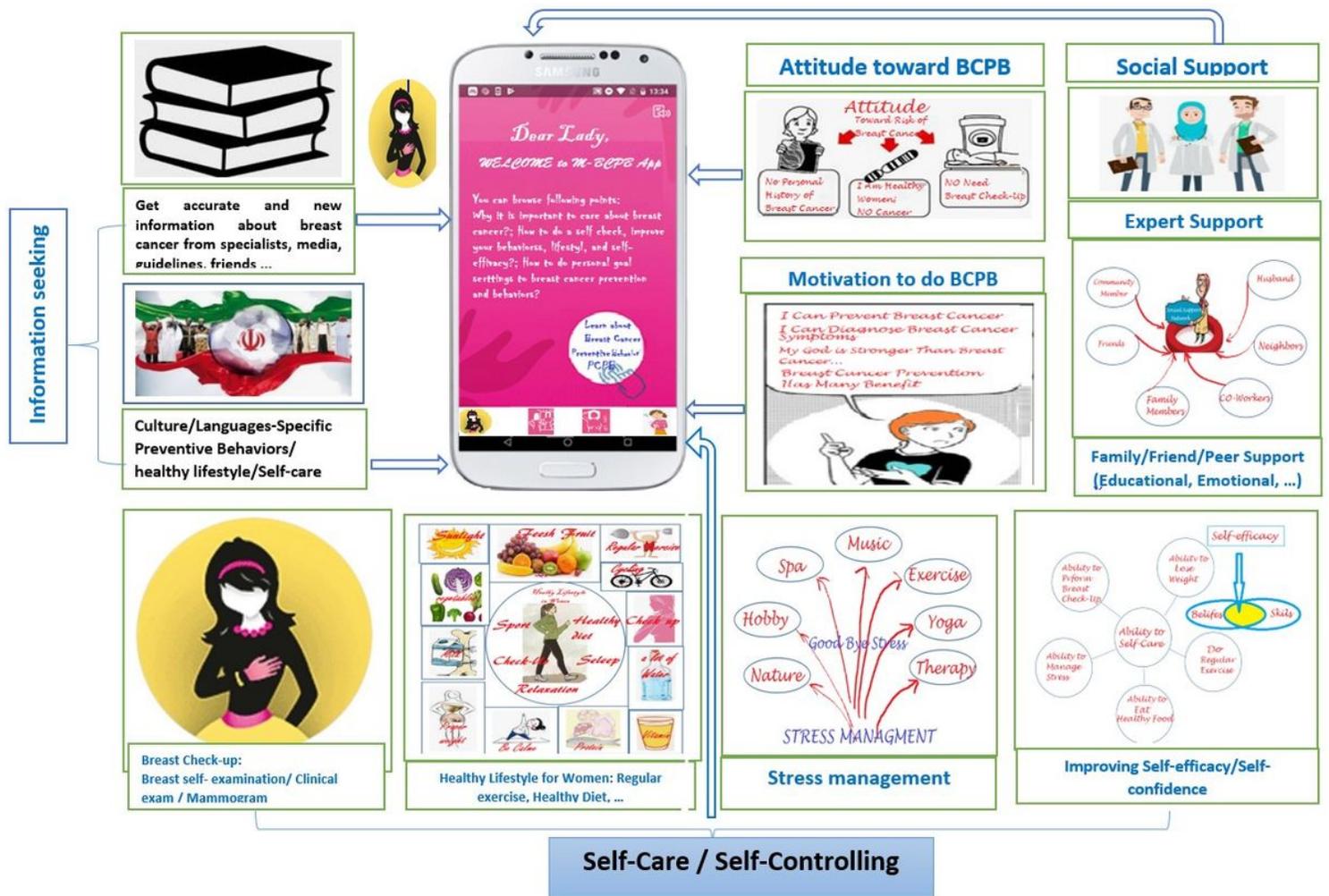


Figure 2

User story box of the m-BCPB App