

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 gradually becoming a universal template for offering preventive behavior interventions among women who are at risk for breast cancer, although limited methodological procedures on mixing models, documentation, and qualitative studies for their developments are presented. Thus, this study 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 This study explains how intervention progress may be enriched with a theoretical 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. The thematic analysis method was employed for developing themes and subthemes.

Results The ASSISTS model, self-regulation, and the self-control models 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 were 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 features. The mobile app framework 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 a three-phase way of combining models, 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 quickly risen in developing countries (2) and varies in different regions of Iran by age composition of populations and lifestyle behaviors of women. According to a new study conducted in Iran, 6,160 breast malignancies are diagnosed in the country each year, and 1,063 cases cause death. Based on the report, the crude rate of breast cancer incidence is 26.3, the mean age-standardized rate (ASR) is 28.1, and the mortality rate due to breast cancer is 9.9 per 100,000 people/year in Iran (4). Based on a study, the highest and the lowest rates have been reported in Tehran and Chaharmahal-Bakhtiari provinces, respectively (5).

The risk factors that increase the chance of developing breast cancer can be categorized into unchangeable factors, such as sex, age, delay in menarche or menopause, and family history of breast cancer (6, 7), and changeable factors, such as obesity (8), high intake of fatty foods (9), low level of regular exercise (10), alcohol drinking (9, 11), smoking (12), and facing high levels of stress (10). These

changeable lifestyle factors are important risk factors for developing breast cancer (8). As such, changing one's lifestyle may prevent breast cancer and reduce the risk of getting breast cancer to a large extent (11-16). For instance, it is estimated that healthy patterns lowered breast cancer risk by 11% (17) or routine exercises prevent too much weight gain and therefore decrease the risk of developing breast cancer by 11.6% (18).

It has been accepted that the easiest and most effective ways to control and decrease breast cancer development and mortality are prevention and screening programs (19), which are currently in progress in Iran (20). Screening measures, including self-and clinical breast exams and mammography, are also defined as useful for early detection and decreased mortality due to breast cancer (21, 22). However, the procedures for these modalities are not the same in many countries (23-25). There is no national screening program for early diagnosis and control of breast cancer in Iran, despite the fact that early detection of breast cancer is the variable critical to reducing its burden (26). Unfortunately, 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 (25, 26). A study conducted in 2013 in Iran further revealed that 25% of women postponed subsequent check-ups for more than three months (27), and despite having suitable awareness and beliefs, few health staff members applied breast cancer-preventive behaviors (BCPBs) and screening (28). Unfortunately, detailed statistics regarding breast self-examination and clinical breast examination do not exist among Iranian women. Nevertheless, the results of a systematic review in Iran reported that the rate of screening behaviors varied throughout the country. This rate fluctuated between 1.8–19.3% for breast self-examination, between 4–25% for clinical breast examination, and between 3–26% for mammography (29). If women complain about their breasts, doctors typically request women to return with a diagnostic mammogram (30-32).

Because few Iranian women pay attention to breast screening behaviors, focusing and planning on improving healthy lifestyle behaviors is vital to developing beneficial health care approaches and increasing health outcomes (33, 34). These reports reflect the summary of the overall low uptake of breast cancer screening behavior, which justifies the focus on a healthy lifestyle by modifying health promotion. Lifestyle changes can largely help reduce the risk of breast cancer (35). Based on previous studies, lifestyle interventions (36) such as changing dietary habits decreased the risk of breast cancer by 65–82% (37-39), performing adequate physical activity decreased the risk by 20-42% (40-42), not drinking alcohol decreased the risk by 2–12% (37, 38), managing stress decreased the risk by 15–26% (39-42), not smoking decreased the risk by 5–23% (43-45), and losing weight decreased the risk between ages 30 and 49 by 53% (36, 46).

One of the most effective approaches to enhance BCPBs is using media campaigns (e.g., via billboards, radios, and television campaigns) to inform women (47-51). 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 is 27.3 million, and 15.2 million have computers, and 21.6 million access the Internet. However, the rate of mobile users is 85% for men and 76.4% for women. Based on the statistics, 60.4% of women have access to the Internet. About 89.6% of Iranian users who use an

information technology tool (e.g., mobile, computer) are 15–24 years old, and 94.9% are 25–49 years old. Meanwhile, based on the age index of mobile use, the penetration rate of mobile users in the 50–74-year-old age group is about 82.2%, and in the age group of 75 years and older is 50%. These figures show that the 25–49-year-old age group has the highest number of mobile users (52).

Short-term results of using mobile applications include improving a healthy lifestyle (53, 54), doing regular physical activity (55, 56), having the proper weight (57, 58), following a healthy diet (54, 58, 59), rising cancer screenings (53), reducing stress (60), creating an innovative situation for planning regular behavioral goals (61-63), facilitating self-monitoring (64), and self-control of targeted behavior (65). Mobile apps have become progressively related to health maintenance and are effectively combined with interventions that mark healthy food, regular exercise, and weight control (72). The long-term results of using mobile applications include improving the quality of life (66-68), increasing longevity (69), promoting healthy aging (70, 71), reducing treatment costs (67, 72-74), reducing disability (75, 76), and estimating mortality and morbidity (77, 78).

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 include affordability, availability, and appropriate delivery to numerous areas and several people (79, 80). Women at risk 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 (81, 82). However, the bazaar for health care mobile apps is significantly disorganized because many of them are planned for very particular backgrounds, and they fail theoretical content. Literature reviews on quality evaluations for mobile apps report miscellaneous results (81, 83), and most developed apps do not have a theoretical foundation and were not developed using a stepwise, structured approach. Therefore, the design of a high-quality, theoretical foundation-based mobile app with documentation and using a stepwise and structured approach is necessary to enhance BCPBs in women.

Model-based intervention supports planners in recognizing theoretic structures to consider in an intervention to extract behavioral modification (84, 85). Furthermore, the theoretical basis offers an approach to smartphone preventive behavior intervention improvement (86). The Template for Intervention Description and Replication (TIDieR) guideline suggested the application of theoretical frameworks in planning preventive interventions (87). Above all, model-informed design eases the process of an intervention (88, 89). Evidence from the literature review and meta-analysis is applied as a base to generate suggestions for smartphone app design. The literature review is the source standard for integrating data in health care systems (3).

On the other hand, considering the views and experiences of users in designing and developing mobile-based educational software helps increase the effectiveness and practicality of the educational app. Thus, by exploring users' experience with the mobile app, investigators and app designers can well develop future mhealth 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 penetration into users and their context of performance (90). The benefits of the user-centered plan involve the increase of freedom, capability, helpful, sensitive experience, and a feeling of connection for users (91). The user-centered plan emphasizes the target audience via an iterative plan method that employs users in building a concept, design, and improvement of a mobile app (92, 93). User contribution enhances demand and user-friendliness (94). The target group can choose personalized data about their favored method, which is vital to expand the adequacy and efficiency of interventions (91). 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 the possible benefits of reasonable costs, high accessibility, and proper adherence, the current study aimed to develop a mobile app (m-BCPBP) to facilitate BCPBs among at-risk women by applying a model, literature review, and user-based method through a qualitative study.

Methods

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

Step 1: Model-Informed Design

Intervention development by using a theoretical source can considerably advance health behavior. The benefits of models and theories in health education and health-oriented behavioral interventions include the following: helps in discerning measurable program outcomes, specifies methods for behavior change, identifies the timing for interventions, helps choose the right mix of strategies, enhances communication between professionals, improves replication, and improves program efficiency and effectiveness (95). Model-based interventions are more successful than interventions that are not model-based because these programs are built on understanding the mechanism of health behavior changes, and researchers with an accurate understanding of the mechanism or process of behavior change programs are more likely to succeed in planning (96). Therefore, appropriate theoretical support for health needs increases the effectiveness of health education programs. The need to reflect on and address the health problem through an educational intervention based on appropriate patterns of promoting behaviors leading to early detection of breast cancer to reduce its mortality is important (97).

Several studies have been directed on the utilization of patterns and theories of health education to raise awareness, improve attitudes, and/or increase healthy behaviors regarding breast cancer. Numerous methods can be applied to conduct health promotion interventions, especially in the field of breast cancer prevention. The self-regulatory and self-control models related to social cognitive theory form the theoretical base of the m-BCPBP app along with the ASSISTS model. Models and structures related to social cognitive theory address the basic role of social systems related to a person's behavior and consider the importance of both self-efficacy and regulation. Furthermore, these theories reflect the

dynamic interaction among personal, behavioral, and environmental elements, and the key role of observational learning that is created on observing others' results and experience is proven. For instance, numerous results suggested a pivotal and positive role of the self-regulatory and self-control models in breast cancer screening behavior, healthier food choices, exercise behavior, intake of fruit and vegetables, sexual behaviors, substance abuse, and smoking (98-108).

On the other hand, the ASSISTS model is designed exclusively to promote breast cancer prevention behaviors in Iranian women and according to Iranian culture. Therefore, the m-BCPBP app framework design was according to the combination of three models, including the ASSISTS model (109), self-regulation model (110), and self-control model (111). The decision to select these three models was based on their use in similar interventions, using similar modes of interventions, and similar behaviors that could be linked to how the three frameworks were selected. 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 (109).

The self-regulation model emphasizes five phases of self-regulation: goal setting, 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 (110). Self-regulation has four structures, including standards and criteria of desirable behavior, motivation to fulfill standards and criteria, monitoring of situations and thoughts that attain standards and criteria, and willpower internal strength to control desires. This role is an essential key to prosper in life because it changes the person's reactions. Specifically, self-control supports a person with control and standards and aligns the chase of a lasting purpose (111). The theoretical framework (as displayed in Figure 1) demonstrates the associations between m-BCPBP and health results.

In this conceptual model, self-regulation involves self-awareness of the current breast health and lifestyle status, positive attitudes toward preventive behaviors, and motivation to seek correct information regarding BCPBs. Awareness, positive attitudes, and seeking health information can cause a self-assessment reaction, which includes a woman's interpretation of the situation against a goal, standard, or criteria. Furthermore, a series of reactions and replies can be identified after self-assessment due to self-adjustment and self-efficacy (110) to improve self-care and stress management, such as having a healthy diet, increasing regular physical activities, performing regular breast check-ups, controlling daily stress, and finally achieving breast health. As demonstrated in Figure 1, improving self-care will be the focus of the intervention. Therefore, to achieve this goal, the focus will be on behaviors such as having a healthy diet, increasing regular physical activity, performing regular breast check-ups, and controlling

daily stress. As a result, women who use the m-BCPBP app will likely find better outcomes about their breasts' health.

Step 2: Document of literature review

Search Strategy

To achieve the most critical available evidence to develop the m-BCPBP app framework, the current study group completed a literature review to assess the efficacy of mobile and web technology-based interventions for breast cancer prevention and screening in women. An extended bibliographic search was performed using the PubMed, Cochrane Library, Science Direct, ProQuest Dissertations and Theses, and Scopus databases. The keywords were searched based on the research topic, related articles, and mesh thesaurus. The following search string was used: “(((“breast cancer prevention”) OR (“cancer prevention”) OR (“cancer control”) OR (“neoplasms prevention”) OR (“breast neoplasms diagnosis”) OR (“breast cancer diagnosis”) OR (“breast screening”) OR (“early detection of cancer”) OR (mammography) OR (“breast self-examination”)) OR (“breast mammography”) OR (“breast cancer preventive behaviors”) OR (“breast health behaviors”) OR (“breast self-monitoring”) OR (“breast self-regulation”) OR (“breast cancer risk”))) AND (((“mobile applications” “smartphone” “telephones applications” “telephone application” “telephones app” “web-based app”) OR (“mobile application”) OR (“mobile app”) OR (“Smartphones applications”) OR (“Smartphone application”) OR (mobiles) AND (“mobile”) AND (smartphones) AND (“web-based applications”)) OR (“web-based applications”) OR (“health records, personal”) OR (“personal health records”) OR (“online systems app”) OR (“online system applications”) OR (“mHealth”) OR (“ehealth”) OR (“information technology”))). The search was limited to published articles that assessed or reviewed the effectiveness of mobile apps-based or web-based interventions (RCT, pre- and post-test design, or quasi-experimental) from 2007 to 2017.

Criteria for considering studies for this review

Study Selection

Two authors studied the appropriateness of all selected studies and also assessed the risk of bias and the data for selected articles, such as demographic information of participants; the number of participants in each group; the design, aim, and duration of the study; and opposing effect, type, and main results of each intervention were obtained. All detected clinical trials (RCT, pre- and post-test design or quasi-experimental) were screened from 2007 to 2017 according to the following inclusion criteria: original studies, English language, studies that include the use of a mHealth app and web technology-based interventions, studies that include healthy people’s use of a web-based mHealth app without a previous breast cancer diagnosis, and studies that concern breast cancer prevention/breast cancer screening/health behaviors. Additionally, we selected all clinical trials (RCT, pre- and post-test, or quasi-experimental) involving mobile app-based and web-based educational programs versus no intervention or another educational (e.g., emails) or technological intervention (e.g., text messaging, brochure, booklet, and lecture-based approaches). We excluded articles that applied text messaging, emails, or other

technological interventions that did not include mobile apps or web-based technology and articles that applied mobile apps for patients with breast cancer or other cancers or any other chronic disease, studies of apps that were not related to breast cancer prevention or screening, systematic reviews of app or web evaluation studies, studies that reported primarily on the validation of any mobile health app tool, and studies of mobile apps not related to health behaviors regarding breast cancer.

Data Collection and Extraction Process

To assess the quality and bias of the selected studies, the EPHP tool was used. The EPHP offers a total methodological rating of weak, moderate, or strong in eight domains: choice bias, study design, blinding, data gathering methods, confounders, intervention integrity, withdrawals and dropouts, and analysis. Initially, the title and abstracts were evaluated. Then, based on inclusion and exclusion criteria, the full texts of chosen articles were collected for further evaluation for final inclusion. Discrepancies in quality ratings were resolved through discussion between the researchers.

Data were collected and analyzed in December 2017. A total of 1,079 papers were identified in the bibliographic searches. By screening abstracts or full-text articles, 11 randomized controlled trials of the use of mobile phone apps or web-based interventions for breast cancer prevention and screening behaviors were recognized. Table 1 provides a summary of the features of the included studies. This search found that m-based intervention is an appropriate method to perform breast cancer prevention and screening behaviors and can reduce the risk of developing breast cancer. Some mobile-based delivery templates were detected in 11 chosen articles; these templates include mobile app-based (112-116), web-based (117-120), and phone and web-based (121, 122). The majority of the studies (n=8) focused on breast cancer prevention behaviors (112, 115-121), and three studies focused on screening and early detection (113, 114, 122).

Table 1. Description of the characteristics of the studies presented in the review

Year/location	Study Method/sample	Theories/ Models	Most effective mode(s) of Intervention	Outcome measures
al, (2017) / a	RCT/ N=120 (n=60 mMammogram intervention group/ n=60 control group) women aged 40 to 77 years old.	Fogg behavioral model (FBM) and Health Belief Model. Target: To increase knowledge and awareness and promote mammogram screening	The intervention group received educational program (mMammogram mobile app) with an interval of 6 months' follow-up. Each day participants received 8-21 messages covering various topical areas, including breast cancer, screening guidelines, and types of screening; breast cancer risk factors; individual, structural, and cultural barriers to screening; communication strategies; follow-up for test results; and information on local clinics. Messages followed a trajectory from basic knowledge building to specific strategies aimed to enhance motivation for and access to mammography/control group received a printed brochure written in Korean that informs guidelines for breast cancer screening.	In the intervention group, satisfaction with the intervention, effectiveness of the intervention, feasibility and acceptability of the mMammogram intervention, and increase of knowledge on breast cancer and screenings were significantly higher than the control group.
a et al ' Portugal	Pretest, post-test/ N=32 women aged 18 and over.	Fogg Behavior Model	Participants received a smartphone app designed to promote cancer prevention behaviors, based on tailored-messages for 28 consecutive days (4 weeks). Usability, feasibility, message receptivity, and perceived impact of the app were assessed.	This study showed the viability of designing and implementing smartphone-based interventions to promote cancer prevention behaviors. The results suggest that Happy is usable and might help users change their behavior towards healthier choices and thus reduce their personal cancer risk. Collected data showed an increased frequency in several cancer prevention-related behaviors and an increase in the overall putative cancer prevention level.
et al, (2017)/	RCT/ N=1354	Self-	The intervention group	Follow-up at one-year

	(intervention=676, control=653) healthy non-professional audience with mean age of 47.9 years old.	Regulation Theory	received the web-based intervention designed to help women at risk of breast cancer to improve breast health behaviors without any face-to-face support at baseline and after one year/ control group received no any guidelines for breast cancer screening during one year and continued their standard lifestyle.	post-randomization revealed significant improvements in mammography and BSE screening in intervention women compared with control women over the 1-year intervention period (improvement of 13 percentage points). The intervention effects were more powerful in women who increased breast health knowledge and decreased cancer worry during the intervention.
3-Bertram et al, San Diego	RCT N=105 (intervention= 71) and (usual care=34)) Women aged 40-75 years with BMI C27.5 kg/m2.	Self-Monitoring and Self-Regulatory Model	Intervention group received 12-month web-based Smartphone application for lifestyle intervention, versus a usual care group, for weight, diet, and physical activity among middle-aged and older women at elevated risk for developing breast cancer that focused on the development and practice of self-monitoring and self-regulatory skills/ Participants in usual care group received a copy of the US Dietary Guidelines for Americans. To maintain in the study and reduce loss to follow-up, they also received a brief 15-min telephone call every 3 months. These calls did not include in-depth recommendations for diet or physical activity change.	At 6 months, significant weight loss was observed in the intervention group relative to usual care. By 12 months, the intervention group had lost 3.7 % of weight, compared to 1.3 % for usual care. At 12 months, accelerometer-measured moderate-to-vigorous physical activity increased by 12 min/day compared to no change in usual care. In summary, this web- and phone-based approach produced modest but significant improvements in weight and physical activity for women at elevated breast cancer risk.
n et al, San Diego	RCT/ N=54 (weight loss intervention arm (n=36) or a usual care arm (n=18)) with mean age of 59.5 years, BMI of	Self-Monitoring and Self-Regulatory Models	Intervention participants used the Smartphone app and Electronic calorie-counting web (MyFitnessPal) to monitor diet and a Fitbit to monitor physical activity. Participants received 12 phone calls (30	Weight and accelerometer-measured physical activity: Combining technology-based self-monitoring tools with phone counseling

	31.9, and a mean Gail Model score of 2.5.		minutes each) over 6 months; Accelerometer-based activity meter that provides real-time feedback on the number of steps taken and minutes of moderate-intensity activity (Fitbit)/ Usual care participants (control group) received the U.S. Dietary Guidelines for Americans at baseline and two brief calls over the 6 months.	supported women at increased risk for breast cancer to lose weight over 6 months. As, intervention participants had lost significantly more weight and a greater percentage of starting weight than usual care participants. Across arms, greater increases in moderate-to-vigorous physical activity resulted in greater weight loss.
et al (2015)/ d	Before and after use of the app (same day)/ N=75 Women aged 40-49 years, had no mammography during the previous year	Decisional Conflict Scale, Decision Self-Efficacy Scale:	Women used the web-based mobile application Mammopad decision aid included educational modules on breast cancer, mammography, risk assessment, and priority setting about screening to help women in their 40s gain deeper insights into their priorities for screening and prepare them to discuss mammography screening with their health care providers.	Decisional conflict; Decision self-efficacy scale; Intention for screening; Women reported less conflict about their decisions for mammography screening and felt more confident to make decisions after using the mobile application Mammopad decision aid. The decision aid was particularly effective for women who lacked self-efficacy to make screening decisions.
et al (2014)/	RCT two-arm: /N=71 Overweight and obese postmenopausal women at increased risk of developing breast cancer; age >55; BMI (25-30 kg/m ² or >30 kg/m ²)		Walking intervention administered through interactive voice response (IVR) and mobile devices during 12-week. The intervention arms were IVR + coach and IVR + no-coach condition.	Data of postmenopausal women support the concept that long-term (≥12 months) interventions have superior effects on improvements in adipokine concentrations, given that they tend to promote larger losses of body weight as a result of diet- and/or

				exercise. It is plausible that lifestyle interventions that promote these modifications in adipokine concentrations would be beneficial and associated with reduced breast cancer risk.
al (2013)/	Pretest, post-test/ N=45 women aged 19 and over.	To encourage breast self-examination -	A smartphone application, based on the Android OS, was developed with functions including a breast self-examination date alarm, a reminder to encourage mother and daughter to practice breast self-examination together, record keeping, and educational content with video clips.	Survey: increased breast self-examination: After using the application, the number of participants practicing BSE increased from 62.2% to 71.1%. In subgroup analysis (age < 30 years), the number of participants using BSE increased from 36.4% to 81.8%, and the number of those using it at the appropriate time rose from 2.2% to 33.3%.
s-Bertram et al (2013)/ California	RCT/ N=50 (intervention=33, control=17) overweight/obese women 45 and 70 years of age at increased breast cancer risk.	Gail model	Intervention group received Web-based self-monitoring and telephone-based educational interventions at baseline and 12-week to lose weight and increase physical activity / the control group received a randomization call and was mailed a copy of the 2005 UCDA Dietary Guidelines for Americans.	A program to train women to use web-based weight loss tools achieved a substantial short-term weight loss among the majority of participants. Further follow-up is needed to assess weight loss maintenance over time.
s et al Washington	RCT: three study arms/ N=1052 1. Intervention (n=690), 2. Time 1 control (n=160), 3. 3-month control (n=162) / Postmenopausal women, age 46-74, with BCRA 1-5-	Social cognitive theory	Web-based, personally-tailored decision aid designed to inform women's decisions about prophylactic tamoxifen and raloxifene use.	Intervention participants had significantly lower decisional conflict levels at post-test and significantly higher odds of making a decision about whether or not to take prophylactic tamoxifen or

	year risk $\geq 1.66\%$ and no prior history of breast cancer			raloxifene at a 3-month follow-up compared to control participants. GtD lowered decisional conflict and helped women at high risk of breast cancer decide whether to take prophylactic tamoxifen or raloxifene to reduce their cancer risk.
n et al ' California	RCT/N=55 (physical activity intervention= 28; active control arm =28) women ages 21 to 65 years old; body mass index of 27.3kg/m ² .	Self-monitoring theory	Web-based Physical Activity intervention: The efficacy of a Web-based physical activity intervention was tested in a sample of women at an elevated risk for breast cancer during 3-month. Women in intervention group received Physical Activity Intervention 45-60 min of MVPA most days of the week/ The control group received nutritional intervention to encourage participants to increase their intake of fruits and vegetables.	Participants in the intervention had significantly higher self-efficacy for physical activity at 3 months and borderline significantly higher self-efficacy at 5 months. For women with a first-degree relative with breast cancer, an Web-based physical activity intervention that incorporated information about breast cancer was associated with increased engagement in physical activity and increased self-efficacy.

Self-care, a healthy lifestyle, and stress management are essential elements in developing healthy lifestyle interventional programs (117). Hopeful approaches have fundamental effects in improving self-care and healthy lifestyles 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 of health care experts. Intervention begins at a young age and before the age of 30 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 developing breast cancer because parallel interpersonal interactions may help progress the efficiency of the intervention (83, 117). Social media among peer support is fundamental in improving healthy behavior (123). The results of the present review showed that mHealth-based educational intervention increases women's health behaviors

concerning breast cancer prevention and screening behaviors. Table 2 summarizes the proposed advice from our literature review. These suggestions can guide our study in discovering the subsequent stage in developing a mobile app framework for improving BCPBs in at-risk women.

Table 2: Suggestions gathered from reviewing the literature.

Feature	Suggestions
Element	Self-care, stress management, regular breast check-up, and healthy lifestyle
Target age group	Women aged 30 years and older
Template	E-based template combined with a phone call
Approaches	Determining behavioral aims, healthy lifestyle advising or skill teaching, regular self-controlling, and getting support from the response
Outcome processes	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
Interactivity/ Communication	Text messages, email, social media, or phone for a specialized discussion
Performance	Diagrams for development reports, search feature, goal following, and notifications or reminders

Step 3: Carrying out qualitative study to inform user-focused design

A qualitative study with end users, women age 40 and older, in the design process was applied. A qualitative study is important (124) because it offers valuable visions for the first selection to develop the m-BCPBP framework. A user-focused method helps discover the desires for the platform, content, and design of the m-BCPBP app framework among at-risk women (90). The results of this qualitative study may help in tailoring the intervention, thereby increasing its efficiency and acceptance.

Participants and background

To gain a different perspective for a better understanding of the phenomenon being studied, we used a purposive sampling method to ensure that women with varying socioeconomic status, educational levels, age, religiosity, occupations, and marital status were present in the study (125, 126). The study participants comprised 19 Kurdish-speaking women with a minimum age of 40 from two health care centers affiliated with Kurdistan University of Medical Sciences. These health care centers provide comprehensive health care for different demographic and socioeconomic groups in Sanandaj (the capital of Kurdistan, Iran). The participants were selected from among healthy women on the following inclusion criteria: being 40 years old or older; having experience with health care services; and being residents of the Sanandaj, Kurdistan region. Regarding their educational levels, two women were illiterate; four were primary and high school graduates, two with diplomas; and 11 women were college graduates. Exclusion

criteria included women aged less than 40 years, women with a history of breast cancer, acute disease, mental illness, and those who had difficulty understanding and responding to the interview questions.

Data collection

Data collection was completed in 2017 after obtaining approval from the Ethics Committee of Kurdistan University of Medical Sciences (Grant No: IR.MUK.REC.1396/14). The principal researcher met 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 an information sheet was prepared to document the initial information and contact of the participants. This first communication was followed up by a phone conversation to acquire their attention and agreement to participate in the study. Written informed consent was acquired, and the demographic and contact information of the women were received. A skilled study assistant who was qualified to perform all interviews did so to confirm a high level of stability. To accrue more comprehensive information, the data were gathered using two qualitative methods, including a *semi-structured in-depth interview* and FGDs with women. Data collection was done until each concept became saturated and novel themes ceased to emerge. The interviewer followed an interview guide that aimed to encourage participants to explore and discuss their views and experiences on BCPBs. The beginning of the interview guide included the (1) purpose of the study; (2) demographic characteristics of participants; (3) voluntary participation; (4) risk and benefits for interview participation; (5) confidentiality of information; (6) right to refuse or withdraw consent to participate in an interview; and (7) consent form. To start the interview, some broad ice-breaking questions were asked to discuss their knowledge, attitudes, and behaviors toward breast cancer and prevention, such as "Have you ever heard about breast cancer?", "What have you heard about breast cancer and prevention?", and "From where you have heard?" Then, based on each of the stated behaviors, questions were asked, such as "What do you do to prevent breast cancer?", "What behaviors might prevent breast cancer?", "Which factors are associated with behaviors that might prevent breast cancer?", "How do you perform preventive behaviors?", "What is your preferred intervention strategies to receive relevant breast cancer information?", "How do you think about using mobile technology for behavioral interventions regarding breast cancer prevention?", "What are your experiences in achieving data from a mobile-based template?" They were also questioned about social, cultural, and environmental factors that might have influenced their behaviors. After each question, the participants were invited to explain more about what they had reported. For example, they were questioned, "What do you mean?" and "Explain more" for a deeper consideration of women's experiences regarding breast cancer prevention. An interview guide 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. The interview guide is presented in Textbox 1.

Textbox 1: Semi-structured interview guide

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

What is the most relevant content for you in a breast cancer prevention behavior intervention?

What is your attitude toward preventive behaviors of breast cancer?
Do you have any other recommendations about appropriate content for breast cancer-preventive behavior interventions?
What do you think about self-care among women?
What do you think about using mobile technology in a behavioral intervention regarding breast cancer prevention?
What are your experiences in achieving data from a mobile-based template?
How do 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 for interactivity and communication 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 a 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 suggestions that you have not stated in the offered queries?
To conclude, is it OK to contact you for some follow-up queries if needed?

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 (93). All interviews were conducted in a private place at the convenience of the women. The interviews took approximately 40 to 60 min; each interview was audio-recorded, and field memos were received. Participation in the study was voluntary, and the women were compensated with a pool entrance gift card bonus for their participation.

ii. Focus group discussions (FGDs)

After a semi-structured in-depth interview, to gain deeper information, two FGDs, 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 accepted taking 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 FDS session lasted 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 ask any questions, and those who agreed were now requested to sign consent forms. Women mentioned that the researcher would elicit some subjects, and they were requested to explain the accuracy of their answers. Furthermore, the interviewer explained some simple ground principles on how the FGD would carry on: 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 not disturbing discussion between topics. All the themes that emerged from semi-structured in-depth interviews were confirmed, and no new information was achieved; as additional coding was no longer possible, data collection was ended. All women were free to participate in the interviews, and the pool entrance gift card bonus was given as an incentive for their participation and time spent in the interviews. Sessions were performed in places that were convenient and easy to access to participants.

Data analysis

The participants were asked about descriptive characteristics at the launch of each interview. All in-depth interviews and FGDs were audio-recorded and transcribed verbatim in Persian. At the end of each interview, the interviews were replayed several times and then transcribed verbatim. Thereafter, we translated the quotes (statement of translation) into English. Each quote was translated from Persian to English by two independent researchers. Thereafter, the translations of both researchers were compared. In the case where the quotes were not translated similarly, the researchers discussed the translation to reach a consensus and ensure that the translated quotes reflect the meaning of the original quotes. A deductive analysis was conducted on the transcripts by two investigators (MK and TP), directed by Braun and Clarke's six-stage method of coding: (1) acquaintance with information by reading the transcripts several times, (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 themes by establishing the data that may be the greatest fit for subthemes, (5) naming and defining ending key themes, and (6) creating the report (127). This approach was chosen due to its flexibility, release from a particular theoretical structure, facility to discover a rich series of data and determinations, and analysis of sequential themes. The themes recognized on a semantic level were narrowly related to the data performing the deductive method. The sequential proportional analysis was applied to repeat the difference between theme incidences through opposing women (128).

Deductive saturation was reached during the 11th interview as specified by two study group members (MK and TP) throughout the simultaneous analysis. Two researchers (MK and TP) reviewed the transcripts before agreeing that data saturation was reached. For this purpose, the researchers carefully read the transcripts to become familiar with the conversations. Explanatory verbatim quotes were carefully chosen to maintain data validity. Using an open coding procedure, the researchers identified

every answer that was given by the respondents and provided these answers with a code. A final codebook was developed, and data were coded by two investigators (MK and TP). This was done for the transcripts of three semi-structural interviews. Codes were compared for consistency and differences resolved. Then, the researchers connected the different codes that were identified during the coding process according to their thematic similarities. Through discussion, the researchers found common themes that emerged from the data and that were related to the research questions. Codes that were determined as overlapping were merged so that only one overarching code remained. The codes were structured according to several thematic categories to provide an answer to our research question. The transcripts of the remaining interviews were coded based on this tree structure. Afterward, the transcripts of all interviews were reviewed again to ensure that every response was properly coded. Quotations by women were corrected on a partial basis to eliminate content that did not express meaning (frequent words, falters, and stammering) 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. Data were analyzed by two researchers (MK and TP) using NVivo 10 (129) to manage and organize the data according to the themes identified.

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. The text of the interviews was also presented to some specialists as external observers to verify the accuracy of the coding process.

Results

Overview

A total of 19 eligible women aged 40 and over without breast cancer agreed to take part in the study. Table 3 shows a summary of the demographic characteristics of all 19 women.

Table 3: 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		
Primary	6	31.58
Secondary	2	10.53
Higher	11	57.89
Employment status		
Employed	11	57.89
Unemployed or housewife	8	42.11

After a six-phase deductive 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, subthemes, and examples of meaning units are offered in Table 4.

Table 4: Key themes, subthemes, and examples of meaning units

emes	Subthemes	Examples of meaning units
ntent	Tailored to women	<i>Whatever breast cancer prevention-related information I can seek from various sources including social networks or internet is generally recognized from anywhere in this world [...] therefore 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 I should cater my health toward breast cancer and another type of diseases that threaten our health as mothers.</i>
	Multi-element	<i>I am not aware of what range of physical activity I can have. Is the proper exercise several times? [...] How much physical activity per day or week should I perform that is suitable for my body?</i>
	Trustworthiness	<i>In my opinion, if information regarding breast cancer prevention come from physicians, midwives, health care workers, or clinics, reliability is the first thing I would think, and the trustworthiness is now there</i>
	Goal Setting	<i>I have heard that regular exercise and weight loss are effective in preventing breast cancer, but I am always lazy [...] I am not adept at self-care and regular physical activity; therefore, perhaps this goal setting in this new app can encourage me</i>
eractive rformance	Mutual and flexible interaction with experts	<i>I want some doctors and health care workers to offer expert recommendations on suitable healthy lifestyle, 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 peer support	<i>is worthy of having our online conversations with friends and peers, and we can negotiate and argue our opinions or perhaps even acquire some data and assistance via online conversation meetings</i>
	Interactive software	<i>I desire more pictures, cartoons, and charts. I think an online test is an amazing 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 [...] 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."</i>
mplate	Appealing and beautiful features	<i>My first choice is a colorful format and shape, such as light color. I read on social media that the color pink is related to breast cancer, and the sign is a 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 apps	<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 Software. I found the smartphone is precisely useful, and downloading mobile apps is easy and comfortable.</i>
	App charge	<i>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 a day. Consequently, it assists in reminding me 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 declared my free trial version is finished. Thus, if you are designing for those who are economically weak, I believed that we should provide it for free. If we can run that [it would be worthy] due to much in-app buying;</i>

		<i>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</i>
	User-friendly	<i>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.</i>
	Privacy and security	<i>Privacy subjects. Suppose we placed our information into the cloud, 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? [...]</i>
	Notifications	<i>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 some variety of messages, rather than just words; it could arise like maybe [a] picture or perhaps [...] similar to an audiovisual like somebody saying what they require the user to perform</i>
tended ion and tput	Self-care for personal aims setting	<i>Having a mobile application helps me register my health condition data for the physician to see through the chart or the diagram to check how well I control the things to do past to the follow-up appointment so that the physician can appraise</i>
	Checking the Improvement	<i>Hoping to have a fit weight, regular physical activity, healthy food, and breast check-ups, software or appliances [help] to control my progression and a proper automatic message reminds me</i>
	Systematic update	<i>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.</i>
otivational ture	Ability to compete with other methods and apps	<i>Seeing relatives' use, I identify I have to run it. Therefore, it keeps you motivated to perform it</i>
	Features of app components to increase individual motivation	<i>Virtual 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 [...] Be sure to consider virtual and attractive prizes to design your mobile app.</i>
		<i>Concrete awards: I prefer the awards (i.e., symbols) 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 to below 1000, you acquire a free pool card or another thing, or cash is one of the most important motivators [...] things like that, it will be exciting. Awards are significant, but only if you can sense and see them [...]</i>
		<i>Inward commitment: Possibly, they require to be supplied that app, but finally, it is an inner thing. People are excited from the inner out.</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>	

Theme 1: Content

Subtheme 1.1: Tailored to women

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

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

"I would like all delivered evidence to be preventive behavior-based; any recommended actions should be women's 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 supportive only toward 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's favorite is explained in the following declarations:

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

"I do not distinguish 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 am not aware of what range of physical activity I can have. Is the proper exercise several times? [...] How much physical activity per day or week should I 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, [...] 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 regarding breast cancer prevention come from physicians, midwives, health care workers, or clinics, reliability is the first thing I would think, and the trustworthiness is now there.” (Participant 3; age: 51; married; under diploma; housewife)

“To have a healthy life, we need 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 source.” (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 adept at self-care and regular physical activity; therefore, perhaps this goal setting in this new app can encourage me [...]” (Participant 18; age: 45; married; upper diploma; employed)

“For me, the problem is to maintain 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 recommendations regarding BCPBs. 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-ups, 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 a meeting with 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 errors and misinterpretations I can request 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 women reported:

"It is worthy of having our online conversations with friends and peers, and we can negotiate and argue our opinions or perhaps even acquire some data and 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 recommendations for a healthy lifestyle and self-care toward breast cancer [...] Objectively, I want comfort about my health status, and it means a lot to me with 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 nurturing an encouraging connection between the users and the educators or designers, with the users taking it as a symbol that the educator or expert pays particular attention to 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 application of interactive software, including diagrams, pictures, online tests, short clips, and animation to make the mobile app extremely attractive. Some women

mentioned that they seek the choice of utilizing various multimedia to take part in the intervention, as repeated in the following quotes:

"A short clip to advise 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)

"I desire more pictures, cartoons, and charts. I think an 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 application of the smartphone app. Therefore, design and templates in an exciting and beautiful style are necessary. In this case, two women explained:

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

"My first choice is a colorful format and shape, such as light color. 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 behavior 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 to me what the standard time of a breast check-up looks like since I need to know it." (Participant 4; age: 44; married; upper diploma; employed)

Subtheme 3.3: User-friendly and easy-to-use smartphone apps

Almost all women said that the use of a smartphone application is an excellent tool platform. The key benefits of applying smartphone applications are that they are convenient and useful to navigate and can be used 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, all of which are aimed at improving our lifestyle." (Participant 9; age: 41; single; upper diploma; employed)

Another woman said:

"Mobile applications are similar to a one-stop place for everybody, and I can access any place at any time. Mobile 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)

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

"The most important for an appropriate use of mobile-based training software is that it is user-friendly and that people enjoys working with it. User-friendly is important so that we can quickly enter, and catch desired information." (Participant 10; age: 46; divorced; upper diploma; employed)

The other woman believed that:

"Personally, the most important issue for using mobile apps is to be user-friendly ... due to the simple and direct way of finding subjects. The contents provided in the app must remain minimal. 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 3.4: App charges

Implementing the mobile application at a charge would be a due to many people's economic problems and their worse socioeconomic context. Thus, there was consensus that the mobile app should be free of charge. Women also thought that they would not buy the mobile app and run it for free if 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 health care centers or clinics. Women expressed 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 a day. Consequently, it assists in reminding me 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 declared my free trial version is finished. Thus, if you are designing for those who are economically weak, I believed that we should provide it for free. If we can run that [it would be worthy] due to 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. (Participant 18; age: 45; married; upper diploma; employed)

Subtheme 3.5: Privacy and security

There were worries that the user's privacy may be hazarded, since users' data kept in the cloud may be unprotected from hacking. Furthermore, there were worries about privacy locations and if 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 an ID, and users were given IDs specific to the clinic or health care center they visited. This would then prevent other clinics or health care centers from accessing information such as buying history from clinics or health care centers the users visited. One woman expressed her opinions as follows:

"Privacy subjects. Suppose we placed our information into the cloud; 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 3.6: 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 a small problem. Women used WhatsApp or Telegram, for example, and people got a lot of inappropriate notifications during the day. Instead, it was advised to transmit the message in either image or audiovisual form. Additionally, one woman advised a function that routinely dispatches reminders 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 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 some variety of messages, rather than just words; it could arise like maybe [a] picture or perhaps [...] similar to an audiovisual like somebody saying what they require the user 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 challenges and various problems. Most of the women mentioned that they need educational programs regarding healthy lifestyles and self-care tailored to their needs and outlooks. A consensus showed that the program should keep operations that will allow self-care and checking. Two women expressed their opinions as follows:

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

"Having a mobile application helps me register my health condition data for the physician to see through the chart or the diagram to check how well I control the things to do past to the follow-up 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 other speeches from other women, as demonstrated by the quotations below:

"Having a mobile phone program is vital 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 through regular exercise, healthy eating, regular breast check-ups, etc. It is worthy if mobile software can contribute to my follow up." (Participant 11; age: 45; married; upper diploma; employed)

"Hoping to have a fit weight, regular physical activity, healthy food, and breast check-ups, software or appliances [help] to control my progression and a proper automatic message reminds 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 essential. Women demanded a regular update on the smartphone application as a part of the performance of the program. Two women mentioned:

"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 for 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 utilizing 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 in 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 behind their colleagues or relatives. Two women mentioned:

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

"In my idea, it would be a mixture related to your plan. 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: Features of app components to increase individual motivation

Each app must have unique features and specifications to increase the individual motivation of consumers to use it more. This theme refers to three topics in its subcategory, including virtual awards, concrete awards, and inward commitment.

Different mobile apps give users virtual awards and symbols in which they could get or unlock ranks. By integrating rewards and incentives into the system, user interaction with the app will be sustained. These unspecified awards are aimed at motivating 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)

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

"I prefer the awards (i.e., symbols) 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 to below 1000, you acquire a free pool card or another thing, or cash is one of the most important motivators [...] things like 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)

Inward 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)

Subtheme 5.3: Adding a fun element

Attaching a gaming factor or fun to a mobile app was exciting for a specific link of people. However, most of the women did not realize the game factor as 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 some women did not understand the entertainment features of a mobile app and identify it as something they are being trained in. 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)

Integrating the three-step process (model, document, and user desires into intervention):

According to the outcomes from the literature review and qualitative study results with the target group, this section was organized into the three main categories, including content, components, and format/template of the m-BCPBP app that reflect findings from the three data sources. A detailed description of the app is reported in the following section. The user story box and mock-up screenshots of the m-BCPBP app are demonstrated in Figure 2. The drawings and logo depicted in Figure 2 are our own, and its explanation is accessible in Textbox 2.

1The m-BCPBP app content consists of multidimensional, culture-specific, self-care-related, and credible content with four sub-dimensions: educational, expert, and family/friends support and self-controlling/self-monitoring domains. The m-BCPBP app content focuses on understanding the risk factors of breast cancer, knowing the symptoms of breast cancer, positive attitudes toward preventive behaviors, receiving support, receiving motivational advice, seeking correct information, and improving self-efficacy and self-care. It is a user-friendly and interactive app that helps users monitor and track their lifestyle behaviors. Desired behaviors in the m-BCPBP app include regular breast check-ups, suitable

physical activity, weight control, healthy diet recommendations, and stress management that is offered in eight weeks, as presented in Textbox 2.

1. Educational support: Educational support aims to motivate women and users by determining and knowing the importance of changing their lifestyle (e.g., healthy diet, regular physical activity, having a fit weight) and improving their self-care (e.g., regular breast check-ups) to keep their breasts healthy (Figure 2, Textbox 2).

2. Family and friends support: Family and friends support aims to mediate the interaction of women with one another using a pseudonym via online peer-to-peer interactions, which are used to mobilize and increase combined knowledge and attitudes (49). (Figure 2, Textbox 2).

3. Expert support: Expert support aims to reach adherence and improve self-care and healthy lifestyle knowledge of breast cancer prevention through simultaneous and non-synchronous feedback (130). (Figure 2, Textbox 2).

4. Self-monitoring/Self-care: Self-monitoring and self-controlling aim to encourage women to self-regulate and self-care their lifestyle behavior and stress management according to their intentions and strengthen any modifications. If the outcome is below or above the range, the system gives notifications and announcements through the m-BCPBP app (Figure 2, Textbox 2).

II. The m-BCPBP components:

a. Framework/format of m-BCPBP:

A multidisciplinary study group composed of a computer software professional, an expert mobile app designer, two health education and promotion experts, a dietician, content design experts, and a gynecologist was established to design the m-BCPBP app framework. The m-BCPBP app framework aims to improve BCPBs in obese or overweight women 40 years and older. To develop an automated smartphone app with a user-friendly connection line, m-BCPBP's user connection line, framework, and components were developed by a computer technician and a trained mobile app designer. 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 (sister and mother's history with breast cancer, as well as a history of developing cancer [breast, ovarian, and prostate] in first-degree relatives). A visual graphing function was also designed to let the user configure their behaviors, such as physical activity, diet, daily stress, and breast self-examination during the use of the m-BCPBP app. Real-time feedback and automatic notifications were also established in the m-BCPBP app. In terms of format, the m-BCPBP app is an interactive multimedia mobile application, including pictures, animations, short videos about the signs and symptoms of breast cancer, prevention and screening methods, the correct way to perform breast self-examination, external links to reliable sources, and customizable features for the user to change the interface color. In terms of security, the m-BCPBP app also has password protection to ensure online security and a user portal via a privacy-compliant shared record platform. After launching the m-BCPBP

app, the user was directed to a screen where they entered their username and password. After authentication, the user was presented with the functional components of the application in a tab-accessible format.

b. The m-BCPBP app evaluation:

1. Evaluating the usability of the designed application:

Field testing and validation of the app were conducted during the initial phase of development by collecting informal user reviews from 20 women who were referred to health care centers affiliated with Kurdistan University of Medical Sciences. After the final launch of the m-BCPBP app, 30 women over 40 years old who were referred to Sanandaj health centers were invited via a convenience sampling method to use the app. First, the m-BCPBP app was installed on the mobile phones of the selected samples. After two weeks of continuous use of the m-BCPBP app, the participants' opinions about the usability of the m-BCPBP app were evaluated using the standard questionnaire of usability and user satisfaction assessment (QUIS) (131). QUIS is a 30-item questionnaire translated from the original English version into Farsi, which was then validated to assess the usability of a mobile app (132). The QUIS questionnaire has 30 questions and is designed in six parts: the first part is related to identity information of the person completing the questionnaire (three questions), the second part is related to the general application of the program (six questions), the third part is related to display capabilities (four questions), the fourth part is related to the terms and information of the program (six questions), the fifth part is related to the learning capabilities of the program (six questions), and the sixth part is related to the general capabilities of the program (five questions). This questionnaire is designed based on a ten-point Likert scale in which each question has an answer with a zero score. The zero score is classified as three weak levels, 1.3 to 6 at the intermediate level, and 1.6 to 9 at the good level. The internal consistency ($\alpha=.94$) and interrater reliability (.76) for QUIS are acceptable (133, 134).

2. Outcome evaluation of the m-BCPBP app:

Considering that one of the theoretical frameworks in designing the content of the m-BCPBP app was the ASSISTS model (109). Therefore, to evaluate the outcome of the m-BCPBP app, the section about online exams is designed based on the ASSISTS scale. The ASSISTS scale consists of a 33-item self-report scale. Items in the ASSISTS scale map seven constructs: attitude (8 items), efficacy (3 items), stimulation (3 items), supportive systems (5 items), information seeking (4 items), self-care (7 items), and stress management (3 items). The ASSISTS scale has proved to be reliable and valid in the past, with ethnically diverse Iranian women. All items on the ASSISTS scale are rated on a five-point scale, ranging from 1 = never to 5 = always. Possible scores ranged from 33 to 165. Higher item scores are indicative of more encouraging preventive behaviors toward breast cancer. In the present sample ($n=140$), the Cronbach's alpha coefficient for the ASSISTS scale was found to be acceptable ($\alpha = 0.79$), and the Intraclass Correlation Coefficient (ICC) was satisfactory (0.86) (135).

III. Template/platform of the m-BCPBP app:

The m-BCPBP app can be preinstalled on phones and delivered as a web app that can be performed on PCs, tablets, or phone devices via public web browsers and operating systems.

a. User interface:

Due to the nature of the m-BCPBP app, which had a complex user interface, our main goal was to attract users who used their favorite operating system. Whether iOS or Android, we used the Cross-Platform Mobile Applications with React Native framework to build the m-BCPBP app. The m-BCPBP app is a user-friendly app that can be delivered as a web app to provide colorful online features, such as social networking and tracking within a web browser. The software program was used in multiple mobile platforms, such as Android and iOS (iPad and iPhone). In other words, the m-BCPBP app is a responsive web app that can be used on personal computers, tablets, or smartphone devices through common web browsers and operating systems.

b. Interactivity/Social Communication:

The m-BCPBP app allows users to connect to web-based social media platforms and has a built-in chat feature so that the users can share their experiences and advice, which positively impacts users' preventive behavior (136). Users can utilize the built-in social network feature for interaction with other users, share their experiences, and offer valuable information and support. Furthermore, this allows users to become familiar with each other and then outlook each other's improvement, conversation and post photos, and share them on numerous social media platforms, for example, WhatsApp and Telegram. This real-time communication allows users to get answers to several queries immediately, and users can respond to questions by chatting with each other. The decision to comprise this feature was based on usability examination and users' suggestions to design the chat interface to be like other extensively used messenger apps, such as WhatsApp. Users can communicate through email, Short Message Service (SMS), and/or telephone for individual consultation from experts if required. Additionally, messages tailored to the user's favorites are displayed in the m-BCPBP app and sent via SMS.

Textbox 2: The m-BCPBP app explanation:

Technology platform: The m-BCPBP app can be preinstalled on phones and delivered as a Web app that can be performed on PCs, tablets, or phone devices via public Web browsers and operating systems.

User interface: online colorful features and user-friendly

III. **Content:** multidimensional with four sub-dimension.

The first dimension: Educational support

1. Content

I. Content is developed from the Iranian Ministry of Health and Medical Education medical guidelines, documents, experts, behavior change models, and cognitive theories.

- II. Related information and content are continually updated to keep the user's attention and enthusiasm.
- III. Smartphone app is combined with in-person contact via phone session, short message services (SMS), and social media (WhatsApp, Telegram).
- 2. Breast cancer prevention behaviors
 - I. Regular physical activity such as walking, swimming, and yoga
 - II. Eating a healthy diet includes a combination of fruits, vegetables, protein and an emphasis on reducing fat intake.
 - III. Applying relaxation and stress reduction techniques such as meditation, light music, deep breathing, light yoga, imagination, self-massage, and religious techniques such as worship and prayer.
 - IV. Performing breast self-examination and knowledge of other screening methods such as clinical breast examination and mammography.
- 3. Healthy lifestyle behaviors considering both the Islamic-Iranian social and cultural norms
 - I. Appropriated weight gain.
 - II. Healthy diet plan based on Islamic-Iranian styles.
 - III. Introducing varieties of healthy local food tailored to the Iranian culture, their ingredients needed, their providing in an easy way.
 - IV. Responsibility for health, interpersonal relationships, and interaction with other peers.
 - V. Physical exercise advised by the m-BCPBP app matches the social and cultural norms of Iranian and Kurdish users' physical status.
- 4. Format and security
 - I. Interactive multimedia mobile application, including pictures, animations, and short video about the signs and symptoms of breast cancer, prevention and screening methods, and the correct way to perform breast self-examination, online exams based on ASSISTS scale.
 - II. Outward links to reliable, accurate, and reputable sources.
 - III. Adjustable items for the user to control settings and personalize the m-BCPBP app through setup depending on what satisfied them Such as changing colors and themes.
 - IV. Users' consent after creating an account and before actually using the m-BCPBP app to access users' information.
 - V. A comprehensive privacy policy with describing the purposes of study, permissions in simple Farsi language.
 - VI. Creating a user profile to input basic information such as their name and email address and to select a password.
 - VII. Password-protected to guarantee online security
 - VIII. User portal through a shared recording template proportionate with privacy.

The second dimension: Family and friends support

- 1. Content
 - I. Provide a panel for the women to discuss with family members, friends, or one another.
- 2. Interactivity/Social Communication:
 - I. Online peer-focused panel for participating and support.
 - II. Users can apply the built-in social network feature to interact with other women, giving their experiences, and contribute helpful advice and support.

- III. User can observe how other women answered the survey topics about preventive behaviors toward breast cancer and self-monitoring.
- IV. User can read posts by other women; furthermore, they can take part to reply in the online panel.
- V. Using an alias via online peer-to-peer communications, which are utilized to motivate and rise shared awareness and attitudes toward breast cancer preventive behaviors.
- VI. User can share their activities with others in the built-in chat platform which will positively influence users' preventive behavior.
- VII. The m-BCPBP app gives an online platform particularly for the app's users, which enables them to share knowledge, support, and motivate one another.

The third dimension: Expert support

1. Content

- I. Feedback from health care experts (health education and promotion experts, gynecologist, dietician, and nurse) will promote the agreement and awareness about self-care and healthy lifestyle knowledge.

2. Interactivity/Social Communication:

- I. Online consultation panel for group discussion with users.
- II. Users can communicate through email, SMS, and/or telephone for individual consultation from experts if required.
- III. Content-related issues are handled and resolved quickly, and users' questions will be responded appropriately.

The fourth dimension: Self-monitoring/Self-controlling/Self-care

1. Individualized goal setting

- I. Regular exercise: All kinds of favorite sports for the user, provided that they involve in 30 min of moderate to intensive physical activity at least 5 days per week.
- II. Healthy diet: promoting or preserving the quality of foods through the use of all five groups of food pyramid according to body kcal/day necessities by focusing on low consumption of sweets and fats, and more consumption of vegetables and fruits.
- III. Weight: Due to the negative role of obesity in increasing the risk of breast cancer, especially in women over 40 years old - Following the Medical Institute- Recommended to lose weight and control it regularly.
- IV. Reduce Stress and Achieve Emotional Balance: Exercise regularly, keep a positive attitude, let go of negatives, find ways to relax, develop new interests, get enough rest and sleep, eat healthily. These recommended ways reduce stress, improves mood, and boosts overall health and sleep better.
- V. Regular breast check-up: Following Iran's Health Ministry-recommended regular breast check-up. Breast cancer screening services are now running. Regular breast screening is beneficial in identifying breast cancer early. The earlier the condition is found, the better the chances of surviving it.

2- Functionality:

- I. Users regulate tailored behavioral goals, success in the goal causes positive congratulatory feedback to be displayed on the screen. Make a list of personalized goals in the form of a weekly action plan, and then document the target content;
- II. Offer visual tools, such as graphic progress chart and breast self-examination colorful image–assisted breast health counseling or evaluation. Present colorful diagram physical activity, or nutritional advice with appropriate color images.;
- III. The announcement, follow up, and notification regarding all target behaviors;
- IV. Messages tailored to the user's favorites are displayed in the m-BCPBP and sent via SMS;
- V. Continually updating the m-BCPBP with new content.

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 BCPBs in at-risk women. We applied the explanation of a three-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 to develop the m-BCPBP app framework (87). Combined concepts from three models, including the ASSISTS model (109), self-regulation model (110), and self-control model (111), were applied to develop a theoretical framework on the mobile app's design. Our literature review created the most significant document applying 11 RCTs (137) to offer valued advice on the aspects, elements, period, template, approaches, outcome processes, communication, and function of the intervention. Additionally, our qualitative research among at-risk women is based on our earlier literature review (137) 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 (124). This user-centered strategy is tailor-prepared to the end user's viewpoints because it can confirm that the mobile app is desired and appropriate for end users (91) by choosing desirable content, technology template, user interface, communication, and function.

Themes and subthemes 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 make 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 with and favored by Iranian women in a different language, accent, culture, customs, and habits. Users are likely to be actively involved in the m-BCPBP app if they distinguish that the designed interventional program is related to improving their level of health about breast cancer prevention. Multidimensional content offers the initial presentation of educational messages in virtual learning settings to provide educational necessities. Educational support will possibly encourage dynamic learning; furthermore, the general notion is that the users take control of their learning (138).

Attaining real-time support from technology- and phone-based interventions was an important benefit of mobile app interventions reported by a previous study. Those studies emphasized how users in a physical activity intervention app-based had optimistic experiences of sharing progress and attractiveness using their mobile technology (139, 140) and how users were interested in and enjoyed documenting and sharing emotional conditions and users in socially supportive activities through a mobile app (141). Some studies reported negative attitudes, that mobile app users focused on decreasing sedentary behavior were not interested in sharing their advances with social technology (142, 143).

One of the important points in the m-BCPBP app is to design to combine attractive and effective behavior change methods into a phone app while causing the least bother for the user. According to the women's viewpoint, seeing reports or records showing that they succeeded in achieving a goal, as well as receiving positive feedback, would increase their motivation for preventive behavior. Many women had a positive viewpoint about utilizing mobile apps to track lifestyle behaviors, set goals, assess breast health status progress, and get a graphical, virtual, or verbal explanation on success. An earlier study on the outlooks of healthy people as well as at-risk persons also recommended that checking and tracking aspects and images are satisfactory and valuable (144, 145). An earlier study on mobile apps, in general, recommended that ease, efficacy, and preference impact continued use (146). The design structure should contain visual appeal, pictured styles, and collaborative multimedia. Multimedia structures can provide various learning methods (147, 148). Information visualizing enhances the user's power to understand their improvement and control their preventive behaviors and lifestyle (149). Mobile app content should offer correct purposes and applied procedures to start modification in the target activities and behaviors (85).

Most apps target one health behavior. For example, Roberts et al. (2019) emphasized the use of publicly available physical activity mobile apps (150), and Hartman et al. (2016) focused on using the MyFitnessPal website and phone app to monitor diet and physical activity (119). The m-BCPBP app offers a comprehensive program and targets multiple behaviors (healthy lifestyle, self-care, stress management, fitting for women at risk for breast cancer prevention). The key point in the m-BCPBP app is to combine attractive and effective behavior change methods into a phone app while keeping the least bother for the user. Compared to other mobile apps, the m-BCPBP app is different because it applies multiple intervention modalities, such as educational content, peer (family, friends, and expert) support, self-monitoring, and goal setting. Previous studies on mobile app or web-based interventions dealt with

one or two methods, for example, self-monitoring by Cadmus-Bertram in 2013 (118). Motivationally, these aspects also pictures against main behavior modification methods that behavioral science studies have recognized as successful for supporting behavior change, specifically self-monitoring, goal setting, and receiving feedback on performance (151, 152). Online peer-to-peer interactions have produced a public area in which topics and concerns related to their daily lives can be expressed and replaced. Online peer-to-peer interactions can be perceived as an exclusive space for peer-to-peer interaction in daily life with the possibility of delivering rich, exemplified, and established knowledge for people who engage in them. In general, online peer-to-peer interaction supports individuals emotionally, socially, fundamentally, and governmentally (153).

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 (154). Users can acquire information about a healthy lifestyle, self-care, stress management, physical activity, and controlling weight by applying short films, cartoons, games, or tests (154, 155). 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 (53, 79).

Regarding interaction, consumers favored resilient relationships with doctors and other health care experts via the provision of web-based conversation and availability to the tailored expert recommendation. Cloud calculation suggests resilient distribution methods among health environments to health care workers (156). Peer support is an essential component of behavioral change programs, which lets consumers share their awareness, beliefs, attitudes, experiences, emotional, social, or apply for support (49). Additionally, we require updating the device and the content of the smartphone app regularly to confirm that it is informed and reliable. Enhancing and keeping consumer employment remains a significant challenge. These approaches include the comfort of usage, appealing design, feedback performance, ability to modify designs to suit a person's favorite, personalized data, and different smartphone structures (157).

Implications

The m-BCPBP app design method:

We performed a three-phase method to design the m-BCPBP app framework for women at risk of breast cancer. The findings are valuable for designing and developing a culture-particular, multidimensional, and user-friendly smartphone application. The ubiquity of the smartphone app simplifies the distribution and sharing of data, cares for a wide range of people, and lets the tailoring of data and support based on consumers' features and practices (158). The popularity of scientific progress can identify a change concerning women's empowerment within self-care and preventive behaviors (80).

Advertising method of the m-BCPBP app and target group access to it:

Given the price of the dollar and sanctions against Iran, working with Google to promote the app was not in our interest. The SMS system was considered the main method of advertising to people in this specific area and was based on the SMS prefix send ads. Therefore, using the SMS system, a direct link to download the mobile application was sent to the audience. On the other hand, we included links to our app in social media channels and communicated with our circle (friends, family, colleagues, and classmates) by adding a link to the download to our app also in our "bio." Women can access the m-BCPBP app anytime and anywhere. Therefore, the m-BCPBP app can advise women between consultation visits about BCPBs, thus decreasing the number of outpatient hospital or clinic appointments (159).

The privacy and security of users in the m-BCPBP app:

To ensure the m-BCPBP app wasn't being exploited, it was vital for us in Android app development to identify and mitigate security threats, not only to our software but also to our users. Thus, the m-BCPBP was designed as an interactive multimedia mobile application with customizable details and user settings. To this end, the user portal was designed via a privacy-compliant shared record platform and password protected to ensure online security. After launching the m-BCPBP app, the user was directed to a screen where they entered their username and password. After authentication, the user was presented with all the functional components of the application in a tab-accessible format.

Providing free of charge expert consultation in the m-BCPBP app:

Given that the goal in the initial phase was to provide free counseling services on breast cancer prevention, we invited our colleagues and friends who specialize in this field. The most important part of the recent app was communication, and users could receive any communication they wanted. We have created several expert groups on topics related to breast cancer prevention behaviors. Then, we added expert colleagues and friends who wanted to provide free in-app consultations to the users. Users in those groups asked their specialized questions, and the answers were provided by the relevant expert.

Limitations

This is the first study of its kind that 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, although all women were living in urban regions, 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 happen due to the variable user profiles and fast-paced technical progress. Fourth, smartphone app intervention design, including 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. Another limitation of the study is the fact that the literature review was completed in 2017 because the topic covered is very "current" and could benefit from the recent research published on technology-enhanced interventions. It may be necessary to review more recent studies in this field, and if fundamental changes are observed in the review results, corrections may need to be made to the design of the app content based on the feedback.

Future work

This project provides the performance of a three-phase method as evidence of the efficacy of this method. We accommodated the viewpoint of the potential consumer with a 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 the creation of a document about the acceptance, reliability, usability, availability, stability, and affordability of the m-BCPBP app. After m-BCPBP improvement, we will assess its efficiency as excellent and well-planned RCTs in varied backgrounds. Therefore, the m-BCPBP app framework is personalized as culturally related to mobile apps for women to improve BCPBs.

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 a 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 allows the addition 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 three-phase developmental approach 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 will 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 anonymous; there was no personal information that could link the answers to 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 Khazaee-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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