UMSHA Press

JECH
Journal of Education and Community Health

J Educ Community Health. 2025;12(1):42-49. doi:10.34172/jech.3276

http://jech.umsha.ac.ir

Original Article

Effectiveness of a Mobile App (*Hhoung Pha-tum*) on Breast Health Literacy Among At-Risk Women in Rural Community in Southern Thailand

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Article history:
Received: November 14, 2024
Revised: February 26, 2025
Accepted: March 14, 2025
ePublished: March 31, 2025

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Abstract

Background: Mobile applications provide an accessible platform for health interventions, improving knowledge and awareness of early breast cancer (BC) detection. This study evaluated the effectiveness of a BC education and prevention app in enhancing health literacy (HL), confidence in self-examination, and preventive practices among women in southern Thailand.

Methods: A quasi-experimental study with a pre-test and post-test design was conducted among 90 randomly assigned women in a rural Thai community from May 14 to August 6, 2022. Baseline data on participants' general information and BC HL were collected. The content validity of HL and prevention practice questionnaires ranged from 0.7 to 1.0, with reliability scores of 0.89 and 0.74, respectively. The intervention group accessed *Hhoung Pha-tum*, an app featuring BC education, self-assessment tools, educational videos, and healthcare resources. A post-test was conducted three months later. Independent and paired t-tests were used to analyze changes in HL and preventive practices within and between groups.

Results: Baseline HL scores showed no significant difference between the control (84.47 ± 2.69) and intervention (86.73 ± 1.63) groups ($P = 0.47$). However, post-test scores significantly improved, with the intervention group scoring 95.98 ± 1.19 compared to 88.38 ± 2.47 in the control group ($P < 0.01$).

Conclusion: The app effectively enhanced HL and engagement in BC prevention. Accordingly, healthcare providers should promote *Hhoung Pha-tum* among at-risk women to increase knowledge and awareness, thus supporting early detection efforts at the primary healthcare level.

Keywords: Mobile application, Health literacy, Breast health promotion and prevention

Please cite this article as follows: Simla W, Thanapop S, Khunpol S, Boonrod T, Liamputtong P, Suwankhong D. Effectiveness of a mobile app (*Hhoung Pha-tum*) on breast health literacy among at-risk women in rural community in Southern Thailand. J Educ Community Health. 2025; 12(1):42-49. doi:10.34172/jech.3276

Introduction

Breast cancer (BC) is the primary cause of mortality among women. There have been over two million new cases of BC in 2020, resulting in nearly 700 000 cancer deaths globally (1). BC is also ranked as the most frequently diagnosed cancer among women in Thailand. According to the National Cancer Institute of Thailand (2), the mean annual age-standardized incidence rate per 100 000 between 2016 and 2018 was 25.2, 46.4, and 62.2 for women aged 30 years, 35 years, and 40 years, respectively. The incidence rate increased significantly to 93.4 per 100 000 among women aged > 45 years. These findings indicate that BC is more prevalent in women over 40 years. In 2021, BC diagnosis was detected at stages I–IV and unknown stage (23.4%, 28.4%, 23.2%, 23.7%, and 1.3%, respectively). A significant portion occurred among individuals in their thirties and older. The mortality rate attributed to BC has become an increased public health problem (3). This increase in fatality is associated with less awareness of screening practices (4,5) and the limitations of healthcare services within the country (4). Delayed early detection often results in diagnoses at advanced stages of the disease (6,7).

The Thai healthcare system has initiated numerous

campaigns aimed at enhancing knowledge and promoting awareness of BC prevention among women, focusing on diminishing the incidence and fatality rates associated with BC (7). However, the incidence of BC remains high. The rate of diagnosed BC across the country increases by 3%–7% per year (8). The National Cancer Institute (3) creates a service plan to strengthen BC promotion and prevention by encouraging healthcare practitioners in local health centers to provide BC knowledge and enhance screening services to the target group once a year and encourage women to follow breast self-examination (BSE) monthly to detect early abnormal signs and symptoms. Promoting yearly screening programs and providing knowledge to at-risk women through different kinds of media and innovation are important strategies to reduce the risk factors of BC (9).

Since 2010, the use of mobile apps for health promotion and prevention has increased, thereby raising many mobile health-related apps, including breast health. This process aims to provide information and support to prevent women from BC and encourage them to adopt healthier practices (10,11). The use of mobile technologies has become a common approach for delivering healthcare services and health-related facilities in BC (6). Yusuf et al (12) suggest that nowadays, mobile applications have impacted the health behaviors of individuals and can bring about positive health outcomes. Mobile applications have been utilized by people to increase health literacy (HL) and management more than relying on conventional healthcare techniques.

HL is a primary focus of research within the health promotion approach and is recognized as a crucial factor influencing individuals' ability to manage health risks, access essential BC information, and make informed healthcare decisions (13). Enhancing HL can reduce women's risk of developing BC. It is also regarded as an effective indicator for disease prevention interventions, particularly in BC (14). This is because HL encompasses an individual's ability to acquire, communicate, and comprehend fundamental health information and services necessary for making appropriate healthcare decisions (15).

However, there is little knowledge about the effectiveness of a mobile application for breast HL among women in the rural communities of southern Thailand. Thus, this study seeks to investigate the effectiveness of a mobile application designed for BC education and prevention programs, aiming to boost HL and confidence in BSE and encourage preventive practices among women in southern Thailand.

Materials and Methods

Study Design

A quasi-experimental study with a pre-test and post-test design and intervention and control groups was conducted on at-risk women (i.e., age-related risk, family history, and lack of BC screening) living in a district of Kong Ra, Phatthalung province, Thailand, from May 14 to August 6, 2022.

Participants

The study participant included at-risk women living in a rural community in southern Thailand. The inclusion criteria were being in the age range of 30–59 years, owning a smart mobile phone, residing in the study area at least one year, and having no history of BC diagnosis. On the other hand, exclusion criteria included having family members diagnosed with BC and leaving the community during data collection.

The sample size (n) was calculated based on hypothesis testing to compare the means of two populations. The sample size necessary in this situation is computed as follows (16):

$$n / group = 2\sigma^2 \left(Z_{1-\alpha/2} + Z_{1-\beta}\right)^2 / \left(\mu_1 - \mu_2\right)^2$$

Where n and $Z_{\alpha/2}$ represent the sample size per group and the significance level (1.96 for $\alpha = 0.05$), respectively. Further, Z_{β} is the desired power (0.84 for 80% power). In addition, μ_1 and μ_2 denote the mean scores for BSE behavior in the experimental (28.03) (17) and comparison (26.10) groups, respectively (17). Moreover, σ_1 and σ_2 are the standard deviations of the experimental (2.97) and comparison (3.29) groups, respectively, and (17) σ^2 is the pooled variances = 9.79.

Initially, a maximum sample size of 41 participants per group was calculated. After accounting for a 10% attrition rate ($n_{adjust} = 41 / (1\text{-}0.10) = 45$), the final adjusted sample size was rounded up to 90 participants in total, with 45 participants being systematic random sampling into each group.

Hhoung Pha-tum App and Feature

The research teams and technological experts initially developed a health mobile application based on five steps of the ADDIE model, including analysis, design, development, implementation, and evaluation (18). Data on the needs and benefits of breast health media were gathered in the analysis stage. Group conversations were conducted with 15 volunteer women in the at-risk group. Approximately half of the participants expressed concerns about early breast self-screening, mentioning uncertainty about when it might occur to them. On the other hand, they tended to follow self-care practices by consuming fresh vegetables, avoiding chemical-laden foods, adhering to religious practices, and maintaining happiness. However, they irregularly received essential information about BC from healthcare professionals. Although some expressed a desire to perform self-screening, they lacked the required confidence to do so. This is primarily due to the perceived embarrassment if they seek breast examinations from healthcare practitioners.

This typical feedback from women at risk of BC prompted the development of technology aimed at enhancing

breast HL and enabling early breast detection. The platform provides easy access for women to communicate knowledge about BC with friends and neighbors. The technology ensures easy access to information and allows users to revisit key details as necessary. The tool offers information about experts whom women can contact for more in-depth insights into breast-related issues of interest.

The gathered information was incorporated into the design concept, and the participation of these individuals (they named the application "Caring for Breast") was considered a mobile health media identity. They were encouraged to engage in discussions about the utility of the information in the tool, its accessibility, the attractiveness of the mobile health media's image, and other relevant factors. Following the discussion, the mobile application was further refined based on their feedback in order to suit their context. Subsequently, we reconvened with these participants, inviting them to test the app before deploying it in the intervention group.

The content within the app concerning BC education encompasses information on understanding BC, breast anatomy, signs and symptoms of BC, risk factors, treatment modalities, BSE, screening examinations and techniques, doctor examinations, survival rates, and BC prevention. The other data were related to the sources of information related to BC, a list of support groups and community healthcare provisions, hotline numbers, screening reminders, dispelling myths, and presenting facts based on Thai cultural beliefs.

This study was based on Nutbeam's theory of HL (19). Interventions that addressed the functional, interactive, and critical levels of HL were designed and implemented in our study. For functional HL, easily understandable and culturally sensitive educational materials about BC, its risk factors, and preventive measures were developed, ensuring that the information was presented in clear and simple language. In this respect, the local dialect was used to help participants better understand that information. Workshops and training sessions were conducted to target groups, focusing on basic breast health information and emphasizing the importance of early detection through BSE. For the step of **interactive HL**, discussions and community events were facilitated for open conversations about the breast health world. This process provided a platform for women to share their experiences, concerns, and questions related to BC and their needs, utilizing interactive technologies (e.g., mobile applications or online platforms) to engage individuals in learning about BC and its prevention. Such applications included features that allowed for questions, discussions, and real-time interaction.

In addition, workshops were conducted to help individuals analyze health information related to BC and prevention and teach them how to evaluate the reliability of sources and make informed decisions about their breast health. Then, they were encouraged to advocate for their health and the health of their community. Encouraging community-based initiatives addressed individual health and advocated for policy changes related to BC screening, treatment, and support for the primary healthcare level. Further, it ensured that healthcare professionals were trained to communicate effectively with their clients. This included providing clear information, answering questions, and supporting patients in making informed decisions about their health. Healthcare professionals were trained to communicate effectively with participants. Furthermore, mechanisms were established for feedback from the community to continually improve educational materials and interventions, ensuring that the provided information was relevant, understandable, and effective enough. Thus, by incorporating Nutbeam's theory into BC prevention efforts, the goal was to create a comprehensive and empowering approach that addresses the diverse HL needs of individuals and communities. This could result in increasing health awareness, paying more attention to early detection, and actively participating in BC prevention strategies.

Data Collection Tool and Technique

A questionnaire for gathering information was developed by the researchers that included socio-demographics, family history of BC, abnormal symptoms, BSE, HL, and practices of BC promotion and prevention based on Nutbeam's theory (19). The HL assessment included six aspects (24 questions), namely, cognitive skills, access skills, communication skills, decision skills, self-management skills, and media literacy skills. The participants self-reported 'the truth about themselves for BC promotion and prevention'. The five-point response scale scores ranging from 5 to 1 (extremely, quite a bit, somewhat, sometime, to not at all, respectively) were applied for the five skill assessments. Examples of these questions involve *'I sought information about BC promotion and prevention from the community healthcare center'* and *'You notice abnormalities in the breast and nearby organs'*. Ten questions were related to BC promotion and prevention practices (general personal BC promotion and prevention practices), which were scored 4 (practicing 6–7 days/week), 3 (practicing 4–5 days/week), 2 (practicing 3 days/week), 1 (practicing 1–2 days/week), to 0 (no practicing). The content validity measured by the index of an item's objective congruence was 0.90. Cronbach's alpha coefficients of HL and BC promotion and prevention practice questions were 0.86 and 0.74, respectively. The required data were collected by the research team using a self-administered questionnaire. The concern and response format were modified to make it more culturally relevant for the women living in the local community. Two measurements were employed to assess the overall quality of the questionnaire.

To invite the target participants into intervention and control groups, we initially contacted a healthcare professional who was responsible for the BC prevention

campaign for the target group. The inclusion criteria were women aged between 30 years and 59 years, women who owned a smart mobile, and women who had never been diagnosed with BC. However, the participants were excluded if they were leaving the community during the data collection period.

Simple random sampling was used to invite women who met the study criteria. The village public center was a common place to meet with participants of each group separately to inform them about the study background, objectives, and activity for the participation. Before distributing pre-test questionnaires, women were asked to give consent. Moreover, they were provided with the instructions and guidelines before completing the questionnaires. Questionnaire completion took about 15 minutes. Then, the researchers rechecked once whether each of the questionnaires was completed by each participant. The intervention group was allowed to take a break for five minutes. Next, they were presented with the breast mobile app and taught how to download it, how to register, and how to access the information inside the mobile app. They were invited to discuss, ask questions, and play around with the mobile app until they became familiar with the app and felt comfortable using it in daily life.

The intervention group was prompted once a week (12 in total) through the LINE group application (a communication app commonly used in Thailand) we had created using questions such as *Today, have you accessed the app? How are you going with the app? Is the mobile app running okay? Have you found any benefits to women's breast health?* and *What are its benefits?*. This process requires the researchers to regularly remind the participants to access and use the app. With the exception of the control group, the researchers met them twice (pre-test and post-test assessment). However, the participants of both groups were reminded to complete the post-test three months after the pre-test day. To complete the post-test, the researchers met them at village public centers. The questionnaires (the same instrument as the pre-test) were then given to each of the individuals to complete. Finally, the researchers rechecked once if the questionnaire of each participant's questionnaire was completed.

Statistical Analysis

The data were entered into Epi-data (version 3.1) for cross-checking and exported to SPSS (version 23.0) for analysis. Responses on HL skills were grouped into very good, good, fair, and poor levels (80–100%, 70–79.99%, 60–69.99%, and < 60%, respectively). The means and standard deviations (SDs) were calculated for quantitative variables, and frequencies were computed for categorical variables to obtain proportions. Then, the data were analyzed by an independent t-test and paired t-test, and the level of significance was set at 5%.

Results

In general, 90 women completed the self-administered questionnaire. The means (SDs) of age in the intervention and control groups were 48.31 (6.04) and 45.36 (6.78). Based on the quasi-experimental design, significant differences were discovered between intervention and control groups in terms of the mean age and religion. However, there were no significant differences in education, marital status, occupation, BC family history, abnormal symptoms of the breast, and breast examination. The characteristics of the participants are presented in Table 1.

There were differences between the pre-test and post-test of BC HL and health promotion practices between groups. Both the intervention and control groups obtained inadequate BC HL scores. Conversely, no statistically significant differences were found in participants' HL pre-test scores (baseline HL: 84.47 ± 2.69 and 86.73 ± 1.63 for the control and intervention groups, respectively, $P = 0.473$). Regarding the HL of the study participants and the use of the app, a statistically significant difference was noted post-intervention (post-test: 88.38 ± 2.47 and 95.98 ± 1.19

Table 1. Socio-Demographic Characteristics and Cancer History of Participants (N = 90)

Variables	Intervention (n = 45)	Control (n = 45)	*P* Value
Age (years)	Mean ± SD (48.31 ± 6.04)	Mean ± SD (45.36 ± 6.78)	0.032
Education, n (%)			
Primary school	17 (37.78)	23 (51.11)	
Secondary school	23 (51.11)	13 (28.89)	0.090
Bachelor's degree	5 (11.11)	9 (20.00)	
Religion, n (%)			
Buddhist	27 (60.00)	44 (97.78)	< 0.001
Muslim	18 (40.00)	1 (2.22)	
Marital status, n (%)			
Single	3 (6.67)	1 (2.22)	
Married	37 (82.22)	33 (73.33)	0.357
Widowed/divorced	5 (11.11)	11 (24.44)	
Occupation, n (%)			
Private/government working	11 (24.45)	5 (11.11)	
Agriculturist/self-employed	30 (66.67)	34 (75.56)	0.136
Unemployed/housewife	4 (8.88)	6 (13.33)	
BC family history, n (%)			
Yes	9 (20.00)	10 (22.22)	0.193
No	36 (80.00)	35 (77.78)	
Abnormal symptoms of breast, n (%)			
Yes	4 (8.88)	3 (6.67)	0.694
No	41 (91.12)	42 (93.33)	
Breast examination, n (%)			
Never examined	41 (91.12)	42 (93.34)	
Breast self-examination	2 (4.44)	1 (2.22)	0.227
Health personal	0 (0.00)	2 (4.44)	
Mammogram	2 (4.44)	0 (0.00)	

Note. SD: Standard deviation; BC: Breast cancer.

for the control and intervention groups, respectively, $P=0.003$). These results were in accordance with the scores of BC promotion and prevention practices. There were no statistically significant differences in participants' practices at the pre-test score (baseline score: 19.71 ± 0.78 and 21.31 ± 0.68 for the control and intervention groups, respectively, $P=0.125$). Concerning the participants' post-intervention app promotion and prevention practices, a statistically significant difference was observed in the scores (post-test: 20.24 ± 0.88 and 30.02 ± 0.31 for the control and intervention groups, respectively, $P<0.001$). The promotion and prevention practices were stable at an inadequate level (Table 2).

Based on the pre-test and post-test comparisons of the BC HL scores of the intervention group after applying the app, the paired t-test revealed a statistically significant difference between the pre-test and post-test of the participants' HL in all dimensions. As regards cognitive and access skills, the participants' scores were 14.24 ± 0.32 and 15.91 ± 0.23 ($P<0.001$), as well as 15.58 ± 0.36 and 16.27 ± 0.25 ($P=0.020$) in the pre-test and post-test, respectively. In addition, their scores were 14.82 ± 0.36 and 16.22 ± 0.25 ($P<0.001$), as well as 143.93 ± 0.3 and 15.96 ± 0.22 ($P<0.001$) in terms of media literacy and communication skills, in the pre-test and post-test, respectively. Concerning self-management and decision skills, the pre-test and post-test scores of the participants were 14.04 ± 0.31 and 15.86 ± 0.21 ($P<0.001$), as well as 14.11 ± 0.34 and 15.76 ± 0.21 ($P<0.001$), respectively. However, there was no statistically significant difference in the six dimensions of HL literacy scores of the control group between the pre-test and post-test, except for media literacy skills. Regarding cognitive and access skills, the pre-test and post-test scores of the participants were 15.15 ± 2.68 and 15.37 ± 2.41 ($P=0.548$), as well as 15.04 ± 3.28 and 15.75 ± 2.80 ($P=0.082$). Further, their pre-test and post-test scores were 13.73 ± 3.01 and 14.48 ± 3.10 ($P=0.031$), as well as 13.22 ± 3.95 and 13.62 ± 3.77 ($P=0.348$) with respect to media literacy and communication skills, respectively. Eventually, the participants received scores of 13.84 ± 3.38 and 14.60 ± 3.46 ($P=0.091$), as well as 13.73 ± 3.82 and 14.71 ± 3.66 ($P=0.064$) in the pre-test and post-test concerning self-management and decision skills, respectively (Table 3).

Discussion

This study evaluated the effectiveness of a mobile app in improving HL and behavior change in at-risk women in rural southern Thailand. The results of the pre-test and post-test showed increased BC knowledge after using the app. Studies by Yusuf et al (12) and Osei and Mashamba-Thompson (20) highlighted mobile apps as valuable tools in healthcare, providing easy access to health information and self-care. Anderson et al (21) and Nasution et al (22) also emphasized their role in promoting health and preventing illness through personalized support. Our findings align with those of Fitzgerald and McClelland (23), reporting that mobile apps effectively promote BSE in Korean women.

Mobile phone apps increase HL and positive health outcomes. It is accepted as a modern tool used to promote health communication to change individual health risk behavior (24). Yusuf et al (12) found that the knowledge of BC among Malaysian women in the northeast peninsular

Table 2. Differences Between Pre-Test and Post-Test of BC Health Literacy and Promotion and Prevention Practices Within and Between Groups (N = 90)

Health Literacy and BSE Acceptance	Control Group (n = 45)			Intervention Group (n = 45)			T test	*P* Value
	Mean	SD	Level	Mean	SD	Level		
BC Health Literacy (Total Score = 120)								
Pre-test	84.47	2.69	Inadequate	86.73	1.63	Inadequate	0.72	0.473
Post-test	88.38	2.47	Inadequate	95.98	1.19	Adequate	2.77	0.003
BC Promotion and Prevention Practices (Total Score = 40)								
Pre-test	19.71	0.78	Inadequate	21.31	0.68	Inadequate	1.55	0.125
Post-test	20.24	0.88	Inadequate	30.02	0.31	Inadequate	10.43	<0.001

Note. BC: Breast cancer; SD: Standard deviation; BSE: Breast self-examination.

Table 3. The Comparison of Pre-test and Post-Test in BC Health Literacy Scores of the Intervention and Control Groups (N = 90)

Health Literacy Dimensions	Intervention Group				Control Group			
	Pre-Test Mean (SD)	Post-Test Mean (SD)	Paired *T* test	*P* Value	Pre-Test Mean (SD)	Post-Test Mean (SD)	Paired *T* test	*P* Value
Cognitive skill	14.24 (0.32)	15.91 (0.23)	5.00	<0.001	15.15 (2.68)	15.37 (2.41)	0.60	0.548
Access skill	15.58 (0.36)	16.27 (0.25)	2.15	0.020	15.04 (3.28)	15.75 (2.80)	1.77	0.082
Media literacy skill	14.82 (0.36)	16.22 (0.25)	4.25	<0.001	13.73 (3.01)	14.48 (3.10)	2.22	0.031
Communication skill	13.93 (0.3)	15.96 (0.22)	6.62	<0.001	13.22 (3.95)	13.62 (3.77)	0.94	0.348
Self-management skill	14.04 (0.31)	15.86 (0.21)	5.81	<0.001	13.84 (3.38)	14.60 (3.46)	1.72	0.091
Decision skill	14.11 (0.34)	15.76 (0.21)	4.95	<0.001	13.73 (3.82)	14.71 (3.66)	1.89	0.064

Note. BC: Breast cancer; SD: Standard deviation.

region was significantly improved after using mobile breast health education and promotion applications. The design, language, and content included in the application are suited to the participant's contexts, and it is recognized as a user-friendly implementing tool. This can be useful for people with limited access to healthcare services. Houghton et al (6) and Nasution et al (22) supported that the breast mobile app has increased interest in technology for breast health delivery because it has the potential to increase people's knowledge of BC and encourage them to early BSE behavior uptake. The difference in literacy scores between the pre-test and post-test may be because the mobile app was developed based on the participation of volunteers who were at-risk women living in this culture and context before displaying it for the study intervention.

In the process of mobile app development, the researchers obtained the necessary information about BC from reliable sources and created a mobile application. Later, they introduced the application to the participants so that they could create a preferred name for it, provide an opinion, and shape information. This process facilitated the transfer of knowledge and enabled women to understand the BC-related data contained in the application. This process was proceeded and rechecked by volunteers twice, and the researchers brought up unclear issues and information the women were concerned about to discuss in a group and then modified those concerned issues according to the comments and advice of these volunteers. Nasution et al (22) concluded that the acceptance of mobile apps with the purpose of health promotion should be designed in such a way as to meet the needs or requirements of the end-user. To increase user accessibility to mobile apps, developers should not only focus more on tailored content, pattern creation, user friendliness, and effectiveness of the app and features but also on the cultural aspect of the target group. Yusuf et al (12) agreed that the mobile app is a feasible tool for participants and can support them in performing BSE with correct skills because the feature and design increase better memorization. In addition, women who participated in this study completed secondary school education so they could understand points in the app more easily.

Our study implemented an application based on the combination of local languages to help facilitate the knowledge, attitude, and practice of BSE to the user with a clear message without using difficult educational content. The unique feature utilization in digital technology applications may appear better among the women who participated in our study, which is congruent with the findings of a study conducted by Yusuf et al in Malaysia (12). They created a mobile app with a focus on incorporating appropriate language to facilitate knowledge transfer to users after the intervention so that it appeals to users and is accepted as a friendly tool for BC promotion and prevention. By doing so, they attempted to achieve the cancer prevention goal stated by Davis and Oakley-Girvan, implying that mobile applications provide an interesting and challenging chance to change behavior and enhance education in the field of cancer, from prevention to survivorship.

Our findings revealed an increase in all dimensions of HL between the pre-test and post-test, implying that the mobile app developed for BC prevention combined different features and approaches to increase the attention of participants to BSE and screening. The application was revised after receiving pieces of advice and comments from the study volunteers mentioned above, and the researchers reorganized the consequence of lessons in the form of concise words, colored images, and tables, with the cooperation of VDO clips and animation by technicians and electronic production professionals. According to Houghton et al (6), the mobile app created in this study was suitable for primary health prevention and could result in effective HL of BC because of its client-centered nature and the participation of individuals in the developing process. The results of this study match those of a study performed in Iran (25), indicating that the health education package plays a salient part in improving the knowledge, beliefs, and practices of individuals. In the mentioned study, a BSE mobile application was developed using various forms concerned with the more realistic and practical performance of BSE. Based on their results, access to this typical platform could enhance the regular BSE of those intervention participants. Delva et al (26) supported that having access to a mobile app improved the intervention group members' perception of disease susceptibility, perceived barriers to practice, self-efficacy, and health motivation. These improvements are recognized as possible factors to make a positive change in the health behavior of individuals.

Although the app increased HL and prevention practices among the intervention sample, it is important to recognize that health behaviors are complex and influenced by various factors, and simply having adequate HL may not be enough to ensure healthy practices (27,28). The results demonstrated inadequate prevention practices in the intervention group despite a significant increase in the HL score. It is essential to address the underlying factors that may prevent people from engaging in healthy practices and to provide resources and support to help people overcome these barriers. However, it is important to recognize that personal behavior is influenced by cultural and social factors, as well as social norms and peer pressure. Thus, providing only smartphone application information and an easily accessible platform may not be sufficient to motivate healthy practices, making it difficult to conclude that knowledge of BSE would be maintained at last.

Study Limitations

With advancements in communication and digital technology, the mobile app offers a promising tool for health promotion and education, particularly in BC prevention and early detection. However, this study

had certain limitations. First, the findings may not be entirely applicable to all women in rural southern Thailand, as the research was limited to a single area. To improve representativeness, future studies should include participants from urbanized regions across southern Thailand. Additionally, given that the study evaluated outcomes only over three months, the long-term retention of BC awareness remains uncertain. Further research is needed to assess the app's effectiveness over an extended period. The study's longitudinal design, incorporating pre-test and post-test assessments, enabled the evaluation of the educational intervention's impact over time.

Conclusion

The mobile app is a practical means for BC HL programs to prevent and promote BC early detection. Based on easy access to health information, the activation of assistance from community healthcare personnel, and suitability for demand, the results indicated a notable increase in BC HL and prevention practices among participants following the use of the app. The findings suggest that the mobile app could serve as an effective tool for promoting BC prevention engagement among at-risk women at the primary healthcare level.

Acknowledgements

The authors gratefully thank participants who took part in this study. Without their involvement, it was impossible for us to conduct this study.

Authors' Contribution

Conceptualization: Dusanee Suwankhong, Tum Boonrod, and Sasithorn Thanapop.
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Competing Interests

The authors have no conflict of interests associated with the material presented in this paper.

Ethical Approval

This study was approved by the Human Research Ethics Committee of Thaksin University (COA No. TSU 2021-013 REC. No. 0252). Written informed consent was obtained from all participants before they took part in the study. They were informed that their participation was voluntary and confidential, and the results would remain anonymous.

Funding

This study was funded by Thailand Science Research and Innovation (TSRI); TSU-65A105000022.

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