

Assessing the Impact of a Mobile App Exposure on Breast Self-Examination Knowledge, Self-Efficacy, and Behavioural Intention Among Housewives in Thiruvananthapuram, Kerala

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Abstract—

Purpose — This study aims to assess whether structured exposure to the *Know Your Lemons* mobile application improves Breast Self-Examination (BSE) knowledge, self-efficacy, and behavioural intention among housewives in Thiruvananthapuram, Kerala, where breast cancer screening participation remains critically low.

Design/methodology/approach — A pre-post intervention design was employed using purposive sampling among housewives aged 30–60 years. Participants completed pre- and post-intervention questionnaires measuring BSE awareness, technique knowledge, practice frequency, and barriers. The study was grounded in Champion's Health Belief Model and the Technology Acceptance Model.

Findings — Despite a majority of participants having heard of BSE, very few practised it regularly. The key barrier was insufficient technique knowledge rather than lack of general awareness. Following app exposure, participants reported significantly increased BSE confidence, improved understanding of breast cancer symptoms, and stronger intention to seek medical consultation upon detecting a change. The app was rated highly usable, and a notable preference for Malayalam-language content was identified among a substantial portion of participants.

Originality/value — This study provides empirical support for mHealth-based BSE interventions targeting urban homemakers in South India. It demonstrates that skill-focused, reminder-integrated digital tools are more effective than conventional awareness campaigns alone, and advocates for culturally and linguistically localised app adaptations to strengthen community-level breast cancer prevention in Kerala.

Keywords - Breast Self-Examination, mHealth, Know Your Lemons®, Health Belief Model, self-efficacy, breast cancer screening, Kerala, housewives, Technology Acceptance Model.

Relevance to design practice - This study shows that thoughtful visual design can make complex health information more accessible and drive real behavioural change. It also highlights that cultural and linguistic localisation are essential design decisions, not afterthoughts, when creating health tools for diverse communities.

I. INTRODUCTION

Breast cancer is the most common malignancy among women worldwide and within India, where it stands as a leading cause of cancer-related mortality (Nur Indaha, 2024). Globally, incidence rates are rising rapidly, particularly among younger women, suggesting that modifiable health behaviours and early detection of breast cancer are more critical than ever.

(Lauren Houghton, 2019) Participation in breast cancer screening in India remain extremely adequate, with national survey data indicating that only 0.9% of women have ever undergone a breast examination. (Gopika M. G, 2022) Even in Kerala, which ranks among the top states for screening participation, overall coverage is strikingly low, and many women are still diagnosed at late stages (Stage III or IV) due to poor awareness and social taboos (Gopika M. G, 2022)

For populations such as housewives in urban centres, traditional barriers to screening include language barriers, and a fear of unnecessarily consulting a doctor (Rehana Sarwat, 2026) Breast Self-Examination (BSE) offers a simple, rapid, and cost-free screening method that empowers women to become familiar with their own breast tissue and detect abnormalities early. (Aygöl Kissal, 2019)

Since mammography is typically not performed on younger women, BSE serves as a vital primary line of defence in the home. (Aygül Kıssal, 2019)

The emergence of mobile health technologies, provides a unique opportunity to bridge the gap between knowledge and practice. Smartphone applications can overcome common barriers by providing step-by-step video guides, automated monthly reminders, and infographic risk factors (Nur Indaha, 2024)According to Know Your Lemons Foundation (2025), developed by the Worldwide Breast Cancer organization, uses visual metaphors like different appearances of a lemon to illustrate 12 possible signs of breast cancer helps to make health information accessible, non-threatening, and memorable. The app additionally includes BSE instructional videos, early screening information, a symptom tracker, and reminder tools.

The research indicates that interventions grounded in the Health Belief Model (HBM) which addresses a user's perceived susceptibility, severity, and barriers are particularly effective at increasing the frequency and quality of BSE performance (Arryana Nasution, 2021) While urban residents are statistically more likely to possess knowledge of breast cancer, the actual practice of monthly self-assessment remains minimal. (Rehana Sarwat, 2026)

This study utilised Know Your Lemons, a third-party mobile health application developed by the Know Your Lemons Foundation (2025), which provides guided breast self-examination instructions, symptom education, and reminder-based screening support.

The research was designed to assess whether an exposure to the Know Your Lemons® application could improve BSE awareness, knowledge, confidence, and behavioural intention among housewives aged 30-60 years in Thiruvananthapuram, Kerala. The study employs a pre-post intervention design and uses quantitative survey instruments to measure change at the individual level.

II. LITERATURE REVIEW

Introduction and Burden of Breast Cancer

Breast cancer remains the most frequently diagnosed cancer among women globally and continues to exact

a significant public health toll. Breast cancer is a non-communicable and chronic disease that is highly prevalent among females, and with 2.3 million new cases and nearly 685 thousand deaths, it was the most common cancer diagnosed and the fourth leading cause of cancer death in 2020(Mitra Shakery, 2021).In resource-limited settings, late-stage diagnosis is a persistent challenge.

Theoretical Foundations: The Health Belief Model

The theoretical underpinnings of most BSE mobile interventions draw heavily on two frameworks. The Health Belief Model (HBM) is one of the most popular models used for prevention of diseases and identification of the effective factors in screening behaviours. It assumes that preventive behaviours are based on individuals' beliefs and was designed to predict which groups of people use preventive measures and which do not. (Mitra Shakery, 2021). Key constructs of the HBM include perceived susceptibility, perceived severity, perceived benefits, perceived barriers, health motivation, and self-efficacy.

Qualitative Needs Assessment for App Development

Before developing BSE-focused apps, several researchers conducted formative qualitative studies to understand user requirements. (Arryana Nasution, 2021), using a qualitative approach with semi-structured in-depth interviews among 37 participants including public women, software experts, and content experts, identified themes of vulnerability, forecasting, reactive, influence, outcome, and obstacles, and found that app requirements based on HBM components included infographic risk factors, video demonstrations of symptoms and self-examination, information on metastasis, survival, screening, and treatment, and features such as screening reminders, sharing buttons, and prompts. Similarly, (Soonhee Roh, 2023)conducted focus groups with 22 Yankton Sioux Tribe women and found that participants were favourable toward mobile web app education, particularly for women in their 40s to 60s, and that interactive multimedia messages and visual materials, such as videos and pictures, were more likely to capture attention and motivate engagement. Participants also desired culturally tailored information, including statistics relevant to their community, the Indigenous holistic wellness approach, and early education for younger generations.

Impact of Mobile Applications on BSE Frequency

A growing body of interventional evidence confirms that smartphone applications can substantially increase how often women perform BSE. (Mitra Shakery, 2021) conducted a quasi-experimental study on 150 women in Iran and found that after the intervention, the largest number of BSEs was four times among 60% of participants in the intervention group versus once among 24% of the control group over four months ($p = 0.001$); they concluded that the smartphone application, which included a BSE reminder, training, alarm, and feedback to the therapist, enhanced the participants' performance of BSE.

Impact on BSE Self-Efficacy

Self-efficacy emerges consistently as one of the most pivotal outcomes improved by app-based BSE interventions. In (Mitra Shakery, 2021) quasi-experimental study, the mean difference of self-efficacy scores was significantly higher in the smartphone application group compared to the control group (10.75 ± 7.63 vs. -2.75 ± 2.44 , $p = 0.001$), indicating that the application had assured the participants of their ability to perform BSE.

Culturally Tailored Mobile Interventions

Cultural adaptation is increasingly recognized as critical to the success of mHealth interventions for BSE and broader breast cancer screening. (Soonhee Roh, 2023) emphasized that findings highlighted the importance of creating effective, culturally tailored educational interventions built into programs specific to American Indian women to increase understanding about breast cancer screening, with particular attention to how culture, beliefs, and barriers are implicated in screening behaviours.

Gaps and Future Directions

Despite the growing evidence base, important gaps remain (Maryam Kucheki, 2024) noted that virtual training using social networks alone is relatively effective in improving BSE skills; however, since accurate breast self-examinations are very important for early detection of breast cancers, it seems essential to investigate the effectiveness of combining face-to-face and virtual training to achieve the goal of performing a correct BSE. Self-efficacy component coverage is also incomplete in many apps.

Conclusion

The collective literature demonstrates that mobile applications are a promising, scalable, and theory-grounded mechanism for enhancing both BSE frequency and self-efficacy among women. Evidence from Iran, Malaysia, Poland, India, the United States, and Indonesia shows consistent improvements in BSE performance, self-efficacy, and health beliefs when app-based interventions incorporate HBM constructs, personalized education, reminders, and culturally tailored content. Future research should focus on combining digital and face-to-face components, integrating self-efficacy-specific features, validating skill quality (not just frequency), and adapting interventions to diverse cultural and socioeconomic contexts to maximize impact on breast cancer early detection outcomes.

III. THEORETICAL FRAMEWORK

Champion's Health Belief Model

Champion's Health Belief Model Scale is the primary theoretical framework guiding this study. Originally developed by Victoria L. Champion in 1984 and subsequently revised in 1993 and 1999, the CHBMS is a breast cancer-specific adaptation of Rosenstock's (1966) original Health Belief Model. It was designed to measure the psychosocial determinants of breast cancer screening behaviours including BSE, clinical breast examination, and mammography and making it uniquely suited to the aims of this study. The CHBMS operationalises six core constructs: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, health motivation, and self-efficacy, each of which corresponds directly to measurable dimensions of BSE behaviour in this study population.

Perceived susceptibility refers to a woman's subjective belief about her personal risk of developing breast cancer. Perceived severity refers to a woman's belief about the seriousness of breast cancer and its consequences for her life, health, and social functioning. Perceived benefits refer to a woman's belief that performing BSE will result in positive outcomes and most critically, the early detection of breast cancer at a stage when treatment is most effective. Perceived barriers constitute the most influential construct within the CHBMS in predicting BSE non-practice. Health motivation, a construct added by Champion to distinguish the CHBMS from the original HBM, refers to a general orientation toward health-seeking behaviour. Women

with high health motivation are more likely to engage in preventive actions regardless of specific disease beliefs. Self-efficacy refers to a woman's confidence

in her ability to successfully perform BSE correctly and consistently.

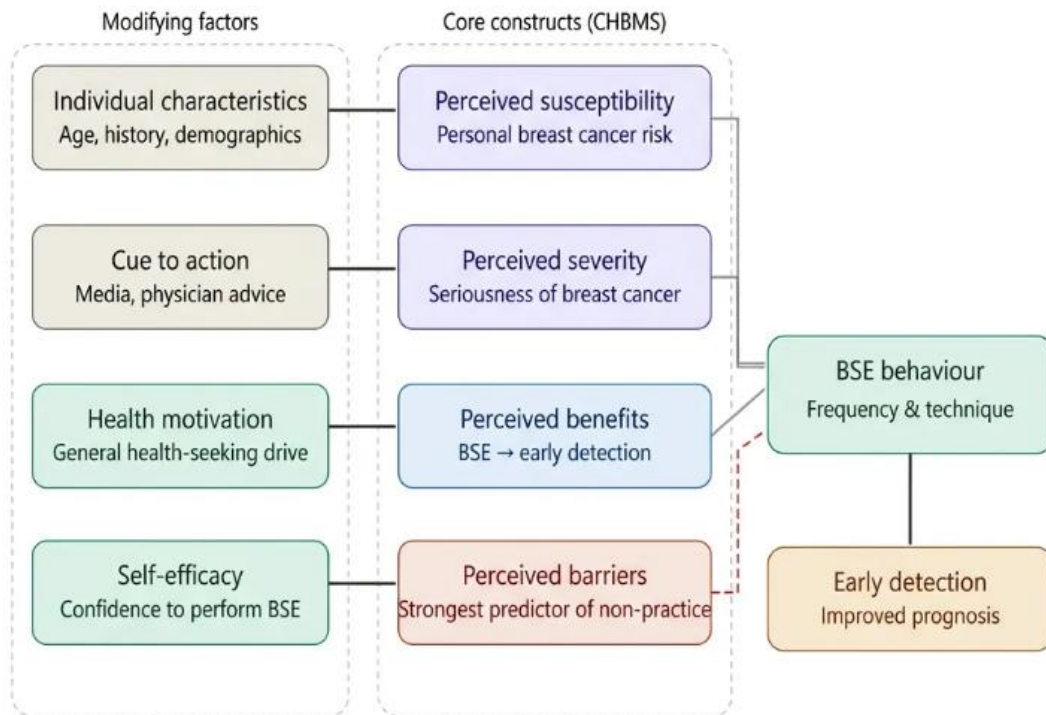


Figure 1. Champions Health Belief Model

Technology Acceptance Model (TAM)

The Technology Acceptance Model (Davis, 1989) explains the adoption and use of information technology systems through two primary constructs: perceived ease of use and perceived usefulness. In the context of this study, the TAM provides a lens for evaluating whether the Know Your Lemons app was acceptable and usable enough to be adopted as a self-care tool by the target population. The post-intervention questionnaire specifically measures ease-of-use ratings, clarity of language, and intention to continue using the app all of which are TAM-aligned outcomes. The integration of HBM and TAM allows for a comprehensive understanding of both the health behaviour change dimensions and the technology adoption dimensions of the intervention's effectiveness.

Hypothesis of the study

Exposure to the Know Your Lemons® mobile application will significantly increase BSE self-efficacy (confidence in performing BSE correctly) among housewives aged 30–60 years in Thiruvananthapuram.

There will be no significant difference in BSE self-efficacy scores before and after exposure to the Know Your Lemons® application.

Variables

Independent variables include Know Your Lemons® app exposure, awareness, perceived barriers, and app usability. While dependent variables are BSE self-efficacy, practice frequency, behavioural intention to consult a doctor, symptom knowledge gained, and app acceptability. The confounding variables are pre-existing BSE knowledge, age, household income, family history of breast cancer, digital literacy, and language preference.



Figure 2. Variables

Research Question

Does the use of the Know Your Lemons® mobile application as an educational intervention bring about a significant improvement in breast self-examination (BSE) awareness, knowledge, confidence, and behavioural intent among housewives aged 30 to 60 years in Thiruvananthapuram, Kerala?

Constructs and Items Used

The study employed two structured questionnaires: a pre-intervention instrument and a post-intervention instrument. After pre- intervention the app Know Your Lemons® was send to the participants for trying BSE.

Pre-Intervention Instrument

The pre-intervention questionnaire contained 7 items (excluding name and timestamp) designed to capture baseline sociodemographic characteristics and BSE-related knowledge and behaviour. The constructs and corresponding items were:

1. Sociodemographic Profile: Age (continuous), monthly household income (ordinal: <10,000; 10,000-25,000; 25,000-50,000; >50,000; Prefer not to say)

2. BSE Awareness: 'Have you heard of BSE before?' (dichotomous: Yes/No)
3. BSE Knowledge: 'Do you know how to perform BSE?' (dichotomous: Yes/No)
4. BSE Practice: Frequency of BSE practice (ordinal, 5 levels: from 'Never practiced' to 'Monthly at optimal time')
5. Barriers to BSE: 'Why don't you practice BSE?' (categorical: lack of knowledge, fear, never heard, not worried, bothersome)
6. Family History: 'Do you have a family history of breast cancer?' (dichotomous: Yes/No)

Post-Intervention Instrument

The post-intervention questionnaire contained 19 substantive items organised around five constructs:

1. App Usability (TAM - Ease of Use): Ability to download, ease-of-use rating (1-5 Likert), language clarity
2. Cognitive Effectiveness (HBM - Perceived Benefit): Whether visual lemons aided symptom understanding, whether the app added new knowledge

3. Behavioural Self-Efficacy (HBM - Perceived Barriers): Confidence in performing BSE post-app use, whether BSE felt less intimidating
4. Behavioural Intention (HBM - Cue to Action): Intention to use app independently, intention to consult a doctor upon noticing a change
5. Acceptability and Recommendation: Willingness to recommend the app; preferences for localisation (Malayalam version, culturally relatable visuals)

Sample Details

The study targeted housewives residing in Thiruvananthapuram, Kerala, aged between 30 and

60 years. Participants were recruited through purposive sampling via personal and community networks of the research team. Inclusion criteria were: (a) female gender, (b) age 30-60 years, (c) residing in Thiruvananthapuram district, (d) self-identified as a homemaker, and (e) ownership of a smartphone capable of running the Know Your Lemons® application.

A total of 63 participants completed the pre-intervention questionnaire. Of these, 22 participants completed the full intervention cycle of downloading and using the Know Your Lemons® app for a minimum of two days and completed the post-intervention questionnaire.

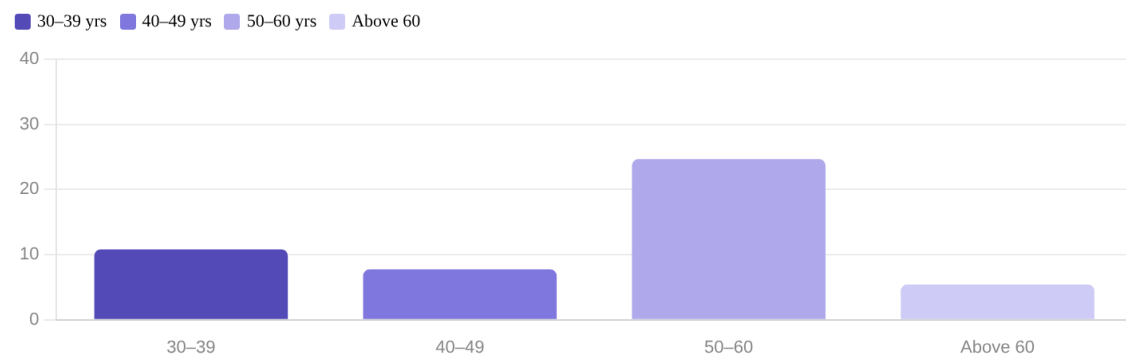


Figure 3. Age Group Distribution

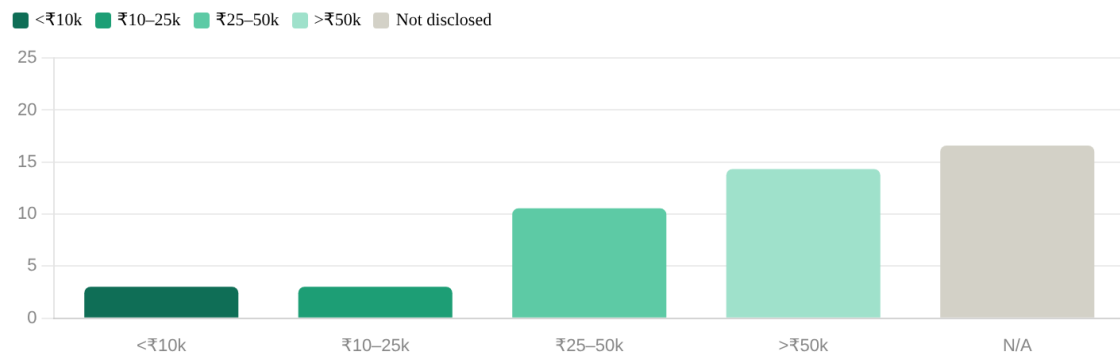


Figure 4. Monthly Household Income

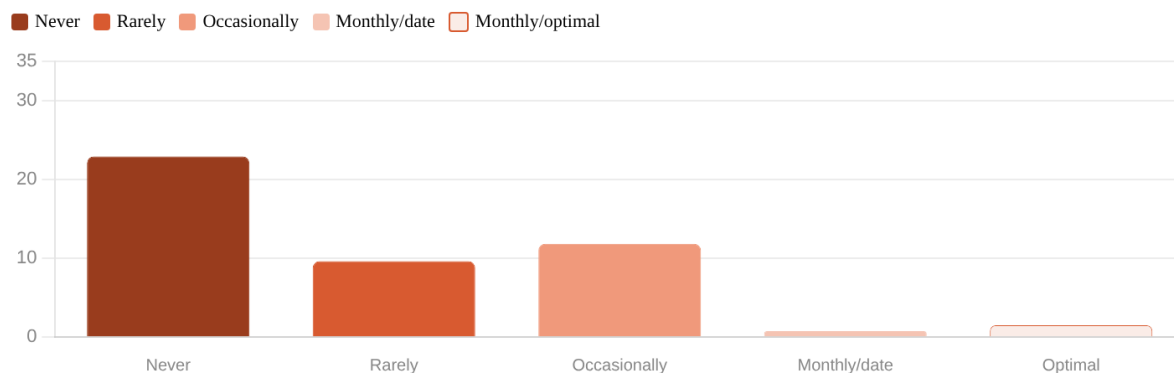


Figure 5. BSE Practice Frequency

Variable	Category	Number
Age Group	30-39 years	14
	40-49 years	10
	50-60 years	32
	Above 60 (excl.)	7*
Monthly Income	< ₹10,000	4
	₹10,000 - ₹25,000	4
	₹25,000 - ₹50,000	14
	> ₹50,000	19
	Prefer not to say	22
Family History of Breast Cancer	Yes	10
	No	53

Table 1. Sample details

Descriptive Statistics

Pre-Intervention Descriptive

The mean age of pre-intervention participants was 44.98 years (SD = 9.71, range: 25-62). The majority of participants (50.8%) were in the 50-60 age group, reflecting the sample's angle towards older homemakers. A large proportion (34.9%) preferred not to disclose income, among those who did, 30.2% reported monthly household income exceeding ₹50,000.

In terms of BSE awareness, 79.4% (n=50) of participants had heard of BSE prior to the study. However, knowledge of the correct technique was lower, with only 54.0% (n=34) reporting they knew how to perform BSE. Only 3 participants (4.8%) practised BSE monthly at the optimal time (seven days after the start of menses), while 49.2% (n=31) had never practised BSE at all.

BSE Practice Level	Number	Percentage
Never practiced BSE	31	49.2%
Rarely practice BSE	13	20.6%
Occasionally, but not regularly	16	25.4%
Monthly on a specific date	1	1.6%
Monthly at optimal time (7 days post-menses)	2	3.2%
Total	63	100%

Table 2. Pre- intervention

The most commonly cited barriers to BSE practice were: 'I know how to do BSE but miss the optimal time' (44.4%, n=28) and 'I don't know how to do it and accurately distinguish an abnormal lump' (38.1%, n=24). Seven participants (11.1%) stated they had never heard of BSE. Only 2 participants cited lack of worry about breast cancer as a reason for non-practice.

Post-Intervention Descriptive

Among the 22 post-intervention participants, 86.4% (n=19) reported downloading and opening the app 'very easily', and a further 13.6% (n=3) did so with minor difficulty, suggesting high accessibility. The mean ease-of-use rating was 4.27 out of 5.0 (SD = 0.88), with 54.5% (n=12) rating the app 5/5.

Post –Intervention Outcome	Most Favourable Response	Number	Percentage
App ease of use (rated 4 or 5)	High usability	17	77.3%
Visual lemons helped understanding	Yes, much better than text alone	11	50.0%
Increased BSE confidence	Yes, much more confident / Somewhat	20	90.9%
BSE felt less intimidating	Yes, a lot / Somewhat	18	81.8%
Added to breast cancer knowledge	Learned a few / a lot of new things	18	81.8%
Surprised by symptoms shown	One or two / Several surprised me	17	77.3%
Would recommend the app	Yes, definitely	13	59.1%
Would consult a doctor if change noticed	Yes, immediately	17	77.3%

Visual design aided understanding	Yes, very much	13	59.1%
Language simple and easy	Very simple / Mostly simple	19	86.4%
App ease of use (rated 4 or 5)	High usability	17	77.3%

Table 3. Post Intervention

Statistical Analysis

Wilcoxon Signed-Rank Test

Prior to selecting statistical tests, the distribution of key continuous variables was assessed for normality using the Shapiro-Wilk test, which is appropriate for small sample sizes such as those used in this study. For the pre-intervention sample ($n = 63$), the BSE practice score was found to be non-normally distributed ($W = 0.812$, $p < 0.001$), with a strong positive skew reflecting the high concentration of participants who had never practised BSE.

For the post-intervention sample ($n = 22$), the BSE confidence score also departed significantly from normality ($W = 0.834$, $p = 0.002$), with scores clustering toward the higher end of the scale following app exposure.

The Shapiro-Wilk statistic (W) ranges from 0 to 1, where a value close to 1 indicates that the data closely follows a normal distribution. A statistically significant p -value ($p < 0.05$) indicates that the null hypothesis of normality is rejected, meaning the data is not normally distributed. the robustness of the t -test under moderate non-normality with sufficient directional skew.

Chi-Square Tests of Association

Chi-square tests were used to examine associations between pre-intervention categorical variables. The association between BSE awareness ('Have you heard of BSE?') and BSE practice level was not statistically significant at the conventional threshold ($\chi^2(4) = 8.305$, $p = 0.081$). However, the association between BSE knowledge ('Do you know how to perform BSE?') and practice level was highly statistically significant ($\chi^2(4) = 20.916$, $p < 0.001$), indicating that women who knew how to perform BSE were substantially more likely to practise it with some regularity.

Spearman Correlation

Spearman's rank-order correlation was computed between participants' age and BSE practice score in the pre-intervention sample. The correlation was

negligible and non-significant ($r = 0.084$, $p = 0.511$), indicating that age alone was not a determinant of BSE practice frequency in this sample. Among post-intervention outcomes, Spearman correlations among the four numeric constructs (confidence, ease of use, knowledge gained, recommendation likelihood) were moderate to strong and positive, ranging from $r = 0.217$ (ease of use and knowledge gained) to $r = 0.773$ (confidence and recommendation likelihood).

IV. INFERENCE AND FINDING

Pre-Intervention Baseline

The pre-intervention data reveal a significant and concerning gap between BSE awareness and BSE practice in the study population. While 79.4% of participants had heard of BSE, fewer than 5% practised it regularly at the clinically recommended time. The most prevalent barrier was not lack of awareness, but rather insufficient knowledge of the correct technique combined with practical forgetfulness. While 44.4% of participants knew about BSE but missed the optimal time. This suggests that informational awareness campaigns alone are insufficient. What is needed are skill-building and reminder-integrated interventions, precisely the kind the Know Your Lemons app provides.

Post-Intervention Impact

The post-intervention results strongly support the effectiveness of the Know Your Lemons app as a health behaviour change intervention. The mean BSE confidence score of 3.23 out of 4.0, indicates that the app substantially enhanced self-efficacy for BSE. This is particularly noteworthy because the participants were exposed to the app for a relatively short period (minimum two days), suggesting that even brief, guided exposure can produce meaningful changes in self-efficacy.

The visual lemons metaphor was found to be either 'much better than text alone' or 'somewhat helpful' for 95.5% of participants, confirming the theoretical premise of pictorial superiority in health communication. The self-examination video was the most valued feature (cited by 86.4%), consistent with

the finding that technique knowledge — rather than general awareness is the key driver of BSE practice. Regarding intention to act: all 22 post-intervention participants indicated they would consult a doctor if they noticed a change, with 77.3% (n=17) stating they would act immediately. This represents a qualitatively important shift in health-seeking behaviour intention, reflecting a successful cue-to-action mobilisation consistent with the HBM.

However, the data also surface important nuances. One participant found the navigation confusing and reported no learning benefit. Three participants reported that BSE did not feel less intimidating. These outliers suggest that the app, while effective for most, is not universally suitable without supplementary support, particularly for participants who are less digitally literate or who have health anxiety.

The null hypothesis, “There is no significant difference in BSE self-efficacy scores after exposure to the Know Your Lemons[®], is rejected as the post intervention confidence scores have been significantly elevated, also supporting the study's primary hypothesis that app exposure significantly improves BSE self-efficacy.

Localisation Needs

A significant finding is the expressed preference for Malayalam-language content. While 54.5% were comfortable with either English or Malayalam, 22.7% preferred a Malayalam-only version and 18.2% preferred a bilingual version. Additionally, culturally relatable visuals were identified as a desirable enhancement by a subset of participants. These findings indicate that the app's effectiveness could be substantially amplified through linguistic and cultural adaptation for the Kerala context.

V. MANAGERIAL IMPLICATIONS

The findings carry several practical implications for public health practitioners, NGOs, and policymakers working in the domain of women's health and cancer prevention in Kerala.

1. App-based BSE interventions should be integrated into community health programmes: The Know Your Lemons app demonstrated strong usability (mean ease-of-use = 4.27/5.0) and acceptability in this population. ASHA workers, Kudumbashree

networks, and Primary Health Centres in Thiruvananthapuram district could incorporate structured app-guided BSE sessions into their existing women's health outreach programmes.

2. A Malayalam-language version of the app is a priority: Given that 40.9% of participants expressed some preference for Malayalam content, the developers of the Know Your Lemons app should be engaged to develop a localised Malayalam version. State health agencies and NGOs in Kerala could potentially partner with Worldwide Breast Cancer to facilitate this localisation, which would also support other Malayalam-speaking regions across India.
3. Technique-focused interventions are more effective than awareness campaigns alone: The finding that technique knowledge drives practice has direct implications for how health communication programmes are designed. Investment in instructional content (videos, step-by-step guides) rather than mere awareness messaging will yield higher returns in BSE practice behaviour change.
4. Reminder functionality should be emphasised: A significant proportion of pre-intervention participants (44.4%) knew about BSE but missed the optimal time. The Know Your Lemons app's built-in reminder tool directly addresses this barrier and should be promoted as a key feature during app orientation sessions.
5. Supplementary in-person support for low digital literacy users: For a minority of users who found the app navigation confusing, a blended approach such as combining app-based content with a brief facilitated session by a health worker would be more appropriate. This is consistent with differentiated instruction principles in health education.

CRedit Author Contribution Statement

Aparna H: Data curation, Writing original draft preparation, Investigation, Visualization
 Anakha Ajith: Data curation, Writing original draft preparation, Investigation, Visualization
 Prashanth Cherian Kochuveetil: Conceptualization, Supervision, Methodology guidance

BIBLIOGRAPHY

- [1] Arryana Nasution, A. Y. (2021). Development of Mobile App for Breast Examination Awareness Using Health Belief Model: A Qualitative Study. *Asian Pacific Journal of Cancer Prevention*, 3151 - 3163. DOI: 10.31557/APJCP.2021.22.10.3151
- [2] Ayg l K ssal, B. K. (2019). Effects of Health Belief Model-Based Education on Health Beliefs and Breast Self-Examination in Nursing Students. *Asia-Pacific Journal of Oncology Nursing*, 403 - 410. DOI: 10.4103/apjon.apjon_17_19
- [3] Gopika M. G, P. R. (2022). Status of cancer screening in India: An alarm signal from the National Family Health Survey (NFHS-5). *Journal of Family Medicine and Primary Care*, 7303-7307. DOI: 10.4103/jfmpc.jfmpc_1140_22
- [4] Lauren Houghton, R. H. (2019, November 6). Mobilizing Breast Cancer Prevention Research Through Smartphone Apps: A Systematic Review of the Literature. *Frontiers in Public Health*, pp. 1-15. DOI: 10.3389/fpubh.2019.00298
- [5] Maryam Kucheki, M. N. (2024). The effect of a virtual educational intervention based on self-efficacy theory on women's skills of breast self- examination. *BMC Women's Health*, 1-7. DOI: 10.1186/s12905-024-03471-8
- [6] Mitra Shakery, M. M. (2021, August 24). The effect of a smartphone application on women's performance and health beliefs about breast self-examination: a quasi-experimental study. *BMC Medical Informatics and Decision Making*, pp. 1-10. DOI: 10.1186/s12911-021-01609-4
- [7] Nur Indaha, A. N. (2024). Early detection of self-breast examination using smartphone breast application. *IOS Press*, 135-144. doi: 10.3233/BD-249004
- [8] Rehana Sarwat, A. A. (2026). Exploring awareness, practices and barriers to breast cancer screening among females in Rawalpindi and Islamabad: a cross-sectional study. *Discover Public Health*, 1-15. DOI: 10.1186/s12982-026-01381-8
- [9] Soonhee Roh, Y.-S. L. (2023). Developing Culturally Tailored Mobile Web App Education to Promote Breast Cancer Screening: Knowledge, Barriers, and Needs Among American Indian Women. *Journal of Cancer Education*, 1224-1233. doi: 10.1007/s13187-022-02252-x
- [10] Know Your Lemons Foundation. (2025). *Know Your Lemons* [Mobile application]. <https://knowyourlemons.org/app>
- [11] SBI Life. (2024). *SBI Life extends 'Thanks a Dot' breast cancer awareness initiative*. <https://www.sbilife.co.in/documents/d/sbil/sbi-life-extends-thanks-a-dot-breast-cancer-awareness>
- [12] EH News Bureau. (2025, May 26). *Zydus Lifesciences campaign drives breast cancer awareness through self-examination initiative*. Express Healthcare. <https://www.expresshealthcare.in/news/zydus-lifesciences-campaign-drives-breast-cancer-awareness-through-self-examination-initiative/449253/>
- [13] <https://www.campaignindia.in/search?Terms=BREAST>
- [14] <https://www.fujifilm.com/in/en/news/fujifilm-india-partners-with-pinkathon>
- [15] The Hindu. (2015, April 1). Sharp rise in breast cancer cases in Kerala in past 20 years. *The Hindu*. <https://www.thehindu.com/news/national/kerala/sharp-rise-in-breast-cancer-cases-in-kerala-in-past-20-years/article70588076.ece>
- [16] The Times of India. (2024, October 22). India saw rise in breast cancer cases in past 5 yrs. *The Times of India*. <https://timesofindia.indiatimes.com/city/allahabad/india-saw-rise-in-breast-cancer-cases-in-past-5-yrs/articleshow/124878247.cms>
- [17] Economic Times. (2026, April 23). *Nearly 500 per cent increase in breast cancer cases in India since 1990: Study*. The Economic Times. <https://economictimes.indiatimes.com/news/india/nearly-500-per-cent-increase-in-breast-cancer-cases-in-india-since-1990-study/articleshow/128973204.cms>
- [18] Roth MY, Elmore JG, Yi-Frazier JP, Reisch LM, Oster NV, Miglioretti DL: Self-detection remains a key method of breast cancer detection for U.S.women. *J Women's Health* (2002) 2011, 20(8):1135–1139 doi: 10.1089/jwh.2010.2493
- [19] Absavaran M, Niknami S, Zareban I. Effect of training through lecture and mobile phone on breast self-examination among nurses of Zabol Hospitals. *Payesh*. 2015;14(3):363–73.

- [20] Pengpid S, Peltzer K. Knowledge, attitude and practice of breast selfexamination among female university students from 24 low, middle income and emerging economy countries. APJCP. 2014;15(20):8637–40. doi: 10.7314/apjcp.2014.15.20.8637