

Exploring the Needs and Perceptions of Women of Reproductive Age Toward a Digital System for Early Breast Cancer Detection: A Qualitative Study

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Abstract: Breast cancer is the most common malignancy among women worldwide, and early detection remains the most effective strategy for reducing mortality. Digital technologies, including artificial intelligence and mobile applications, are increasingly proposed to support early detection, yet perspectives of women of childbearing age toward such systems remain poorly understood. **Objective:** This study explored the needs and perceptions of women of childbearing age (15–49 years) regarding a digital breast cancer early detection system. A qualitative descriptive design was used. Twenty participants were purposively selected and engaged through in-depth interviews and two focus group discussions. Data were analyzed using Braun and Clarke's thematic analysis, and trustworthiness followed Lincoln and Guba's criteria. Four themes emerged: perceived benefits of digital early detection, perceived barriers and concerns, contextual needs for adoption, and preference for a human technology hybrid model of care. Participants valued convenience, privacy, and empowerment but expressed concerns regarding digital literacy, trust in algorithmic accuracy, cost, and data security. Women of childbearing age hold generally positive yet conditional perceptions toward digital breast cancer early detection systems. Successful implementation requires digital literacy support, transparent communication about accuracy and privacy, affordability, and integration with trusted human healthcare providers.

Keywords: breast cancer; early detection; digital health; women of childbearing age; qualitative study; perception

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INTRODUCTION

Breast cancer remains the most frequently diagnosed malignancy and the leading cause of cancer-related death among women worldwide. Global estimates indicate that breast cancer accounted for roughly 2.3 million new cases and more than 665,000 deaths in a single recent year, with the burden disproportionately affecting low- and middle-income countries where diagnosis often occurs at advanced stages. In Indonesia, breast cancer similarly ranks first in both



incidence and mortality among women, and a substantial proportion of cases are still detected at stage III or IV, when curative treatment options are limited and survival is markedly reduced. Because prognosis is strongly associated with the stage at diagnosis, early detection continues to be recognized as the single most cost-effective strategy for reducing breast cancer mortality, particularly in settings where population-based mammography screening is not yet universally accessible or affordable.

Early detection efforts have traditionally relied on breast self-examination, clinical breast examination, and mammography. However, uptake of these conventional methods among women of childbearing age, generally defined as women aged 15 to 49 years, remains suboptimal. Evidence from multiple qualitative studies conducted across diverse settings, including Malaysia, Tanzania, Ghana, Kenya, Burkina Faso, and India, consistently shows that women in this age group face overlapping barriers such as low risk perception because breast cancer is often mistakenly viewed as a disease of older women, competing domestic and reproductive responsibilities, embarrassment associated with breast examination, fear of a cancer diagnosis, limited health literacy, and structural obstacles including distance to health facilities, cost, and shortages of trained personnel. These barriers are compounded for women of reproductive age because breast changes are frequently attributed to pregnancy, lactation, or hormonal fluctuation, which further delays symptom recognition and health-seeking behavior.

Against this backdrop, digital health technologies have emerged as a promising complement to conventional early detection pathways. Artificial intelligence-assisted mammography reading, mobile health applications for breast self-examination reminders and education, chatbot-based symptom triage, wearable thermal sensors, and web-based risk assessment or screening-navigation platforms are increasingly being piloted and implemented in both high-income and resource-limited settings. Studies from Sweden, Serbia, and Australia have documented that women generally hold cautiously positive attitudes toward the use of artificial intelligence in mammography, valuing its potential to improve diagnostic accuracy and efficiency, while simultaneously expressing concerns about the loss of human contact, algorithmic transparency, and accountability when errors occur. Similarly, digitally delivered interventions such as mobile applications supporting perioperative care, stakeholder-driven web applications for cancer screening promotion, and app-based behavior change programs for young women at increased hereditary risk have shown encouraging acceptability, provided that the content is personalized, interactive, and embedded within trusted clinical relationships rather than offered as a fully autonomous replacement for human care.

Despite this expanding body of evidence, a clear gap persists in the literature. First, the large majority of qualitative studies examining perceptions of artificial intelligence and digital tools in breast cancer detection have concentrated on women within the conventional mammography screening age range, typically 40 years and above, or on women already diagnosed with breast cancer. Comparatively little is known about how women of childbearing age, a group characterized by distinct life-stage priorities such as pregnancy planning, contraception, breastfeeding, and simultaneous engagement with maternal and child health services, perceive and evaluate a digital breast cancer early detection system. Second, existing digital health literature on reproductive-age women has predominantly addressed maternal and reproductive health applications rather than breast cancer detection specifically, leaving the intersection between

digital early detection technology and reproductive-age women's needs largely unexplored. Third, most available qualitative evidence originates from either high-income countries with mature digital health infrastructure or from studies emphasizing barriers to conventional screening, rather than directly eliciting the perceived needs, expectations, trust concerns, and design preferences that reproductive-age women hold toward a digital early detection system that they might realistically use within their own health-seeking context. Fourth, few studies have examined how digital literacy, smartphone ownership, and internet access, which vary considerably by socioeconomic status and geographic location, shape not only the willingness to use such systems but also the specific features that women consider necessary, such as privacy safeguards, local language content, integration with existing midwifery or primary care services, and the balance between automated feedback and human reassurance.

This study therefore addresses an important and previously underexamined gap by qualitatively exploring the needs and perceptions of women of childbearing age regarding a digital breast cancer early detection system. The novelty of this research lies in three main contributions. First, it shifts the analytical focus away from the conventional screening-age population toward reproductive-age women, whose life-stage circumstances, digital habits, and health priorities differ substantively from those of older women who dominate the existing literature. Second, rather than evaluating a single pre-existing application or artificial intelligence tool, this study takes a needs-assessment approach that captures women's expectations, concerns, and design preferences prior to or independent of exposure to any specific platform, thereby generating findings that are directly translatable into the user-centered design of future digital early detection systems. Third, by synthesizing insights across culturally and economically diverse settings represented in the recent international literature, alongside locally grounded evidence on breast examination behavior among Indonesian women of reproductive age, this study offers a contextually nuanced understanding that can inform the development of digital early detection interventions that are not only technologically feasible but also socioculturally acceptable, trustworthy, and equitable.

Theoretically, the perceptions and needs explored in this study can be situated within two complementary frameworks that have long informed cancer prevention research. The Health Belief Model explains health-seeking behavior through constructs such as perceived susceptibility, perceived severity, perceived benefits, and perceived barriers, all of which have been shown to shape breast examination practices among women of reproductive age in community health settings. Meanwhile, the Technology Acceptance Model and its extensions emphasize that perceived usefulness and perceived ease of use are central determinants of whether individuals adopt a new digital tool, alongside trust, social influence, and facilitating conditions. Integrating these two frameworks allows this study to examine not only whether women of childbearing age perceive themselves to be at risk and believe early detection to be beneficial, but also whether a digital system is perceived as usable, trustworthy, and worth adopting within their daily lives. This dual theoretical lens is particularly relevant because a digital early detection system introduces an additional layer of decision-making, namely the acceptance of the technology itself, on top of the pre-existing psychosocial determinants of screening behavior.

The global digital divide further underscores the urgency and complexity of this inquiry. While smartphone penetration and internet access have expanded rapidly even in low- and middle-income countries, disparities in digital literacy, connectivity, and affordability persist along lines

of income, education, and rurality. Recent population-based analyses from Cambodia and secondary survey data from Ghana demonstrate that although mobile phone ownership is positively associated with breast examination uptake, a considerable proportion of reproductive-age women, especially those in rural or low-income households, remain digitally underserved. This suggests that a digital breast cancer early detection system designed without attention to equity may inadvertently widen existing disparities in early detection rather than closing them. Consequently, understanding women's needs must extend beyond technological preferences to encompass structural enablers and constraints, including affordability, language accessibility, offline functionality, and integration with community health worker networks, all of which are essential considerations for equitable implementation.

Understanding these needs and perceptions is timely and practically significant. As health systems in many countries move toward integrating artificial intelligence and mobile-based tools into cancer control programs, ensuring that such systems are designed around the lived realities, values, and concerns of the women who will use them is essential for achieving meaningful uptake, sustained engagement, and ultimately, earlier detection and improved survival outcomes. The findings of this study are expected to provide evidence-based recommendations for policymakers, digital health developers, and healthcare providers seeking to design and implement breast cancer early detection technologies that genuinely respond to the needs of women of childbearing age..

METHODOLOGY

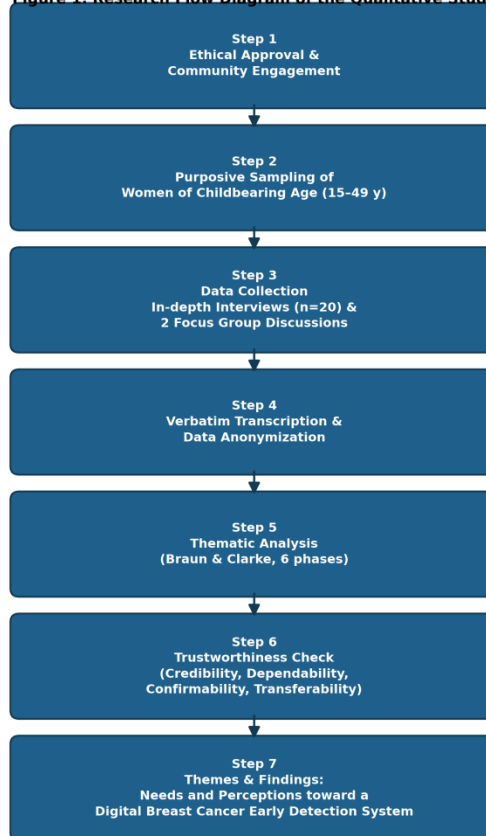
This study employed a qualitative descriptive design, chosen for its suitability in producing a straightforward, data-near summary of participants' needs and perceptions without imposing a highly interpretive theoretical lens, while still allowing thematic depth. The study was conducted in a primary healthcare and community setting where maternal and reproductive health services are routinely provided, positioning it as a realistic entry point for women of childbearing age to encounter a digital breast cancer early detection initiative.

Participants were women of childbearing age, defined as 15 to 49 years, who were free of a prior breast cancer diagnosis and who attended routine maternal, reproductive, or general health services at the study site. Purposive sampling was used to ensure variation in age, parity, educational background, occupation, and prior experience with digital health tools, with recruitment continuing until data saturation was achieved, that is, until no new themes emerged from successive interviews. Twenty participants were included, consisting of women engaged through semi-structured in-depth interviews and two focus group discussions of five to six participants each, allowing triangulation between individual and group-level perspectives.

Data were collected using a semi-structured interview guide developed from the Health Belief Model and Technology Acceptance Model constructs described in the background section, covering perceived risk of breast cancer, prior early detection practices, awareness and expectations of digital health tools, perceived benefits and barriers of a digital breast cancer early detection system, and specific needs regarding features, privacy, and support. Interviews and focus group discussions were audio-recorded with consent, transcribed verbatim, and anonymized prior to analysis.

Data analysis followed the six-phase thematic analysis framework: familiarization with the data, generation of initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the final analytic narrative. Coding was performed independently by two researchers and discrepancies were resolved through discussion to enhance analytic rigor. Trustworthiness was addressed through credibility (member checking and prolonged engagement), dependability and confirmability (audit trail and peer debriefing), and transferability (thick description of context and participant characteristics), following the criteria proposed by Lincoln and Guba. Ethical approval was obtained from the relevant institutional research ethics committee, and written informed consent was secured from all participants prior to data collection. The overall research flow is summarized in Figure 1.

Figure 1. Research Flow Diagram of the Qualitative Study



RESULTS AND DISCUSSION

Twenty women of childbearing age participated in this study, with ages ranging from 19 to 48 years. Participants represented a range of educational backgrounds, from junior secondary school to postgraduate education, and occupations spanning homemakers, informal workers, and salaried employees. Fourteen participants owned a smartphone with regular internet access, while

six had limited or shared access. Thematic analysis generated four major themes: (1) perceived benefits of a digital breast cancer early detection system, (2) perceived barriers and concerns, (3) contextual needs for adoption, and (4) preference for a human–technology hybrid model of care. A summary of these themes, subthemes, and illustrative participant statements is presented in Table 1.

Table 1. Themes, Subthemes, and Illustrative Findings

Theme	Subtheme	Illustrative Description	Supporting Literature
1. Perceived Benefits	Convenience & time efficiency	Fits into daily caregiving routine; reduces need for clinic visits	Adams et al. (2024); Hawkes et al. (2024)
	Privacy & reduced embarrassment	Allows preliminary self-assessment without immediate face-to-face examination	Ali et al. (2022); Naidu et al. (2024)
	Empowerment	Enables an active role in self-monitoring and health decision-making	Nasrudin et al. (2025)
2. Perceived Barriers & Concerns	Trust in algorithmic accuracy	Doubt that AI can reliably replace human clinical judgment	Jovanovic et al. (2026); Johansson et al. (2024)
	Digital literacy	Unfamiliarity with apps, especially among older or less-educated women	Jonayed et al. (2024)
	Cost & connectivity	Data charges and unstable internet access limit consistent use	Nyamhanga et al. (2024); Okyere et al. (2025)
	Data privacy concerns	Fear of misuse or exposure of sensitive health information	Schmeising-Barnes et al. (2024)
3. Contextual Needs for Adoption	Local language & simple interface	Culturally familiar content with low-bandwidth functionality	Nasrudin et al. (2025); Altmannshofer et al. (2024)
	Integration with existing services	Linkage to midwives/primary care for confirmatory follow-up	Srinath et al. (2025); Tognon et al. (2025)
	Transparency on accuracy & data use	Clear explanation of system limitations builds trust	Ng et al. (2023)
4. Human-Technology Hybrid Model	Digital for education/reminders, human for diagnosis	Combines efficiency and accessibility with human reassurance	Pang et al. (2025); Woode et al. (2025)

The first theme, perceived benefits, reflects participants' generally favorable orientation toward digital early detection tools. Many participants described convenience and time efficiency as primary advantages, noting that a mobile application offering breast self-examination reminders or symptom-checking features would fit more easily into their daily routines, which are often dominated by childcare and domestic responsibilities, than scheduling a clinic visit. This finding

is consistent with evidence from Australia and Serbia showing that women perceive artificial intelligence-assisted screening as reducing waiting times and improving diagnostic efficiency, while echoing feasibility findings from an app-based behavior change intervention for young women at increased breast cancer risk in the United Kingdom, which similarly reported that digital tools help translate risk-reduction intentions into sustained action when integrated into daily life. Participants also frequently described a sense of privacy and reduced embarrassment as an important benefit, since a digital tool allows preliminary self-assessment without immediate face-to-face examination, a concern that resonates with qualitative findings from Egypt and Fiji in which embarrassment and modesty were identified as substantial deterrents to conventional clinical breast examination. Several participants further described a sense of empowerment, feeling that access to accessible information and self-monitoring tools allowed them to take a more active role in their own health, aligning with stakeholder-driven digital intervention research from Malaysia demonstrating that user-centered design enhances perceived ownership of screening behavior.

The second theme, perceived barriers and concerns, captured a more cautious and, at times, skeptical undercurrent. Concerns about trust in algorithmic accuracy were prominent, with several participants questioning whether an artificial intelligence system could reliably detect abnormalities without human oversight, a hesitation that mirrors dual-perspective findings from Serbia and interview-based findings from Sweden in which women valued the efficiency of artificial intelligence but insisted that a radiologist should remain the final decision-maker. Digital literacy and unfamiliarity with technology emerged as a further barrier, especially among older participants and those with limited formal education, corroborating survey-based evidence from Bangladesh indicating that unfamiliarity and low technological competence constrain the adoption of reproductive digital health services among women. Cost and access limitations, including smartphone ownership, data charges, and unreliable internet connectivity, were also raised, particularly by participants from lower-income households, echoing population-based findings from rural Tanzania and Ghana in which structural and economic barriers continue to hinder both conventional and digitally mediated early detection efforts. Data privacy was another salient concern, with participants expressing unease about how personal health information, particularly related to a sensitive condition such as breast cancer, would be stored, shared, or potentially exposed, reflecting broader apprehensions documented in studies examining attitudes toward multi-cancer early detection blood tests in Great Britain.

The third theme, contextual needs for adoption, synthesizes the specific conditions participants indicated were necessary before they would trust and consistently use a digital breast cancer early detection system. Participants emphasized the need for content and instructions delivered in local language and culturally familiar terms, alongside simple, low-bandwidth interfaces that could function with limited connectivity, needs that parallel design recommendations emerging from stakeholder engagement research in Malaysia and content-quality reviews of existing breast cancer prevention applications in Germany, both of which identified a lack of personalization and contextual relevance as key shortcomings of current mHealth tools. Several participants also articulated a need for the system to be linked with existing maternal and community health services, such as midwives, community health workers, or primary care clinics, so that any concerning result could be followed up promptly by a trusted human

provider rather than leaving women to interpret results alone, a preference consistent with findings from India and Burkina Faso emphasizing the socioecological embeddedness of screening decisions within family and community networks. Clear, transparent communication regarding the system's accuracy, limitations, and the handling of personal data was repeatedly requested as a precondition for trust, in line with recommendations from research on AI-assisted screen reading implementation.

The fourth theme, preference for a human–technology hybrid model, emerged as an integrative thread running through nearly all interviews. Rather than viewing digital tools as a replacement for existing services, participants consistently described an ideal model in which a digital system would perform initial education, reminders, and preliminary self-assessment, while human healthcare providers retained responsibility for confirmatory examination, diagnosis, and emotional support. This hybrid preference closely mirrors findings from mobile perioperative care and app-based support programs, which found that digital tools were most valued when they complemented, rather than substituted for, human clinical relationships. Taken together, these findings suggest that the successful design and implementation of a digital breast cancer early detection system for women of childbearing age depends not merely on technological sophistication, but on deliberate attention to trust-building, digital equity, cultural relevance, and continued integration with the human healthcare workforce that women in this life stage already rely upon for reproductive and maternal care.

Beyond the four core themes, participants' narratives revealed important nuances tied specifically to their reproductive life stage that distinguish their perspectives from those of older, post-reproductive women who dominate the existing literature on digital breast cancer screening. Several participants who were pregnant or breastfeeding at the time of interview described uncertainty about whether breast changes they experienced were related to pregnancy and lactation or warranted further evaluation, and they expressed a specific need for a digital early detection tool to clearly differentiate between normal reproductive-related breast changes and potential warning signs. This concern echoes survey evidence from Ghana showing a substantial unmet need for breast cancer screening specifically among women of reproductive age, many of whom are simultaneously navigating antenatal, postnatal, and family planning services, and it suggests that a digital early detection system targeted at this population must be explicitly designed to account for the physiological overlap between reproductive processes and breast symptomatology, rather than being a generic adaptation of tools designed for older screening-age women. Participants also noted that their household and caregiving responsibilities meant that any digital tool requiring lengthy registration processes, frequent manual data entry, or non-intuitive navigation was unlikely to be used consistently, reinforcing the convenience-oriented benefit theme and aligning with findings on mobile breast screening services among rural and remote women in Australia, which similarly identified logistical simplicity as a decisive factor in sustained engagement.

The comparison between this study's findings and prior Indonesian evidence further strengthens the contextual relevance of the results. Local qualitative and cross-sectional studies conducted among women of reproductive age attending community health centers in Indonesia have shown that understanding of breast self-examination remains inconsistent and that constructs from the Health Belief Model, particularly perceived susceptibility and perceived barriers, strongly

predict clinical breast examination uptake. The present findings extend this evidence by demonstrating that when a digital layer is introduced, these same psychosocial determinants interact with technology-specific factors such as perceived usefulness and trust, producing a more complex decision-making process than either framework alone would predict. In other words, a woman who perceives herself to be at low risk of breast cancer is unlikely to adopt a digital early detection tool regardless of how well designed or trustworthy that tool is, indicating that digital health interventions for this population must be paired with continued community-based health education addressing fundamental risk awareness, rather than being deployed as a stand-alone technological solution.

Comparing findings across age groups also illuminates how the needs of women of childbearing age diverge from those of women closer to or within the conventional screening age range. Research on breast cancer risk assessment delivery among women aged 30 to 39 years in the United Kingdom found that this slightly older subgroup was more receptive to structured, clinic-initiated digital risk communication, whereas participants in the present study, who included a wider and generally younger age range, more strongly emphasized informal, self-directed engagement through mobile applications integrated into everyday routines rather than clinic-based digital risk calculators. This divergence suggests that digital early detection strategies cannot be designed uniformly across the entire span of reproductive and midlife years but should instead be tailored to the specific digital habits, life circumstances, and health system touchpoints relevant to narrower age bands within the broader childbearing-age population.

The findings also carry direct implications for the design and governance of future digital breast cancer early detection systems. First, developers should prioritize transparent, plain-language explanations of how artificial intelligence or algorithmic components function, what their accuracy limitations are, and how a positive or ambiguous result will be followed up, since perceived transparency was repeatedly linked to trust in this study and in prior evaluations of AI-assisted screen reading implementation. Second, health system planners should ensure that any digital early detection initiative is embedded within, rather than parallel to, existing maternal, reproductive, and primary healthcare touchpoints, allowing community health workers and midwives to serve as trusted intermediaries who can support digital literacy, interpret ambiguous results, and facilitate referral. Third, equity-focused strategies such as offline-capable application design, subsidized data access, and multilingual content are necessary to prevent digital early detection initiatives from disproportionately benefiting already digitally advantaged women, consistent with population-level evidence from Cambodia linking mobile phone ownership to breast examination uptake. Fourth, robust and clearly communicated data governance policies are essential, given that concerns about the storage and potential misuse of sensitive health information were raised spontaneously and consistently across participants, mirroring apprehensions documented in research on multi-cancer early detection blood testing in Great Britain.

Several limitations should be considered when interpreting these findings. The study was conducted within a single community and primary healthcare setting, which may limit the transferability of findings to women of childbearing age in markedly different sociocultural, economic, or health system contexts. Because participation required willingness to discuss a sensitive health topic and, for the focus group component, comfort speaking in a group setting, self-selection bias cannot be entirely ruled out, and the perspectives of women with very limited

digital access may be underrepresented despite deliberate efforts to include participants with varying levels of digital literacy. Additionally, because participants were describing perceptions of a digital early detection system in the abstract rather than reacting to a fully developed and deployed application, some expressed needs and concerns may shift once women gain hands-on experience with an actual tool, underscoring the importance of future usability testing and longitudinal evaluation following any prototype development informed by these findings.

CONCLUSIONS

This study demonstrates that women of childbearing age hold generally positive yet carefully conditional perceptions toward digital breast cancer early detection systems. While participants recognized clear benefits in convenience, privacy, and empowerment, they simultaneously articulated meaningful concerns regarding trust in algorithmic accuracy, digital literacy, cost, connectivity, and data privacy. Their expressed needs, including local-language content, low-bandwidth functionality, integration with trusted human providers, and transparent communication about system accuracy and data handling, provide a practical foundation for the user-centered design of future digital early detection interventions. Rather than positioning artificial intelligence or mobile applications as autonomous replacements for existing services, the findings support a hybrid model that combines the efficiency and accessibility of digital tools with the trust and reassurance afforded by human healthcare providers. Policymakers, digital health developers, and healthcare institutions seeking to introduce digital breast cancer early detection technologies among reproductive-age women should therefore prioritize digital literacy support, equitable access, transparent data governance, and seamless integration with existing maternal and community health services to achieve meaningful and sustained uptake.

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