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Exploring User Experiences with a Persuasive mHealth App for Breastfeeding: An Empirical Investigation

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ABSTRACT

Women are increasingly turning to mHealth apps as primary sources for breastfeeding education and support. The rising prevalence of mHealth apps presents a unique opportunity to explore their impact on women's breastfeeding experiences. Understanding user perspectives of these apps, especially focusing on their persuasive design aspects, can offer valuable insights for enhancing maternal and child health outcomes. These insights can optimize these technologies to align with user values and promote sustained healthy behaviors. This study aimed to undertake an empirical exploration of users' experiences with the persuasive design features employed in the Milky Way mHealth app and align the findings with human values within the value-sensitive design (VSD) framework. Semi-structured interviews were conducted with a group of women who had used the Milky Way app. Interview data were analyzed using an inductive thematic approach. To provide insight into users' values mediated by the app, a deductive analysis complemented by a data-driven inductive approach was performed. Data analysis was supported by NVivo data-management software. Findings from the study demonstrate that the persuasive design elements in the Milky Way app significantly influence users' experiences. The analysis provided four primary themes: Informative, Easy to use, Credible, and Social connection. Overall, participants praised the app's trustworthy educational content and support features as valuable resources for addressing breastfeeding challenges and obtaining reliable support. Participants expressed concerns about information overload and emphasized the importance of personalized support and evidence-based tailored recommendations. The results demonstrated that users' values were expressed and embedded within the app. The analysis indicated an alignment between the app design features and the values and opinions of the users within the VSD framework. This study interprets women's perspectives utilizing the Milky Way app and highlights the significance of its evidenced-based educational and support features. Further investigation into potential user values like privacy, remains crucial for a comprehensive user-centered app design. The empirical insights gained from this study contribute to future research, informing the development and design of ethically considerate persuasive mHealth apps to maintain their relevance in promoting positive user experiences and facilitating meaningful behavior change.

KEYWORDS

Breastfeeding; mHealth; persuasive strategy; persuasive technology; persuasion; behavior change; ethical design

1. Introduction

Breastfeeding is a health behavior that holds immense significance for the health and well-being of mothers and infants. It is recognized as a complex behavior with well-established benefits, making it a vital component of maternal and infant health promotion (Gallegos et al., 2020). Mobile health (mHealth) apps have shown feasibility in promoting behavior change related to breastfeeding practices. These apps have been found to enhance modifiable factors related to breastfeeding behavior, including increasing knowledge and facilitating access to support (Demirci et al., 2018; Diniz et al., 2019; Mieso et al., 2022). However, the efficacy and quality of breastfeeding apps without a theoretical foundation may be limited (A. A. Almohanna et al., 2020). Although incorporating behavioral theories has shown promise (Kassianos et al., 2019), a recent review found a lack of adequate implementation of behavior change techniques indicating insufficient utilization of evidence-based strategies (Musgrave et al., 2020). Women need breastfeeding apps with enhanced functionality and interactive engagement for optimal support (Cheng et al., 2020). Therefore, breastfeeding apps should extend beyond providing reliable information and incorporate persuasive design elements to support women in adopting appropriate breastfeeding behaviors without coercion or force (Meedya et al., 2019).

Persuasive technology (PT) is an interdisciplinary field that has the potential to influence user behavior and engagement. The Persuasive Systems Design (PSD) model represents a key framework in PT and provides a structured approach for the

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design of systems that aim to influence user behavior in desired manners (Oinas-Kukkonen & Harjumaa, 2009; Wenker, 2022). The model consists of 28 persuasive design features that focus on incorporating relevant system design elements to motivate and persuade users toward desired behaviors, including making informed decisions, ultimately promoting positive behavior change (Oinas-Kukkonen, 2013).

The current study utilizes the Milky Way breastfeeding mHealth app as a research medium (Meedya et al., 2021). The PSD model was employed as a systematic approach to guide the design and development of the Milky Way app (Oinas-Kukkonen & Harjumaa, 2009). The app aims to offer accurate and current breastfeeding information and support breastfeeding women (see details in Textbox 1). Previous research conducted by the authors thoroughly discusses the persuasive features of the app, its categories, and its implementation (A. A. S. Almohanna et al., 2022).

Textbox 1. Overview of the study context: the Milky Way mHealth app

The Milky Way mHealth app represents an innovative evidenced-based approach in the field of mHealth breastfeeding apps. The app was designed building on a successful educational intervention known as the Milky Way program and was informed by comprehensive formative research involving women, health professionals, and information technology experts (Meedya et al., 2014, 2021).

The app is a product of the collaborative effort of a multidisciplinary team of health professionals, researchers, information technology experts, and end-users. Developed and presented by the University of Wollongong in Australia, the app is freely available for download on the Apple store and Google Play. In addition, it has been utilized as a routine breastfeeding educational resource in some Australian hospitals (Illawarra Shoalhaven Local Health District, 2022).

The PSD model has captured significant research interest in recent years. Diverse stakeholders, including health researchers, practitioners, technology designers, and public health officials, are exploring the potential of PT to promote health (Aldenaini et al., 2023; Shi et al., 2024). A growing body of evidence demonstrates that well-designed persuasion systems can yield positive outcomes in healthcare settings (Shi et al., 2024). This recognition arises from the increasing acknowledgment of the PSD model's efficacy in influencing health behavior change (Geirhos et al., 2022; Oyebode et al., 2020). Persuasive technology designers draw from various fields like social psychology and human–computer interaction (HCI) for designing user-friendly interfaces that encourage desired behaviors (Oyibo, 2024). Numerous apps and studies have emerged, demonstrating their diverse applicability across various health domains and incorporating persuasive design elements to facilitate behavioral change (Matthews et al., 2016; Oyebode et al., 2020; Win et al., 2019) including apps related to maternal health (Mbanusi et al., 2020). However, the model implementation in breastfeeding apps has not been widely studied from the user's perspective (A. A. S. Almohanna et al., 2022). Further research is needed to gain a better understanding of these design features and inform the development of evidence-based apps that effectively support women in their breastfeeding journey. Understanding the user's perspective is crucial for developing breastfeeding apps that are tailored to the needs of breastfeeding women, ultimately enhancing their engagement and experience.

Technological advancements, particularly persuasive systems, have transformed Information Systems (IS) into powerful tools for behavior change (Ekpezu et al., 2023). As such, persuasive mHealth apps have shown promise in improving users' health behaviors. However, a limited understanding of user interaction and engagement presents a challenge in designing health informatics systems (Karppinen et al., 2018). Although user perception of system interactions and persuasive strategies can be context and time-dependent, an understanding of the user experience remains crucial for optimal design (Segerståhl & Oinas-Kukkonen, 2007). Research suggests that a positive user experience which involves ease of use, attractive aesthetics, and engagement, enhances the effectiveness of persuasion (Segerståhl et al., 2010). Additionally, effective persuasion depends on successful communication between the system and the user (Cemiloglu et al., 2023). Thus, exploring the implementation and design of persuasive strategies in mHealth is crucial, as these strategies can significantly impact user experience and system usability (Hamid et al., 2024; Sporrel et al., 2021). The utilization of digital health technologies, including persuasive systems, inevitably poses risks and ethical considerations. These primarily come from potential breaches of users' values that should inform the design and implementation of such technologies (Nebeker et al., 2019). While IS research excels at explaining user technologies adoption, understanding user resistance requires further exploration (Laumer & Eckhardt, 2012). In this modern digital landscape, users are increasingly selective about the technologies they integrate into their lives. Ethical considerations have become a key role in user decision-making, affecting technology adoption and prompting critical examination of the ethical dimensions embedded within these technologies (Gram-Hansen & Kight, 2019). Nonetheless, empirical research on user experiences and values related to persuasive systems continues to be scarce. There is limited research exploring what users find important or meaningful (e.g., their values) when interacting with persuasive systems (Gram-Hansen & Kight, 2019).

A noteworthy development in the field of ethics and values within HCI is the research on value-sensitive design (VSD) (Grossova, 2023). This research has been particularly impactful in the domain of PT, as it enables designers to address and incorporate user values in the design and implementation process (Gram-Hansen & Ryberg, 2015). The VSD is a theoretically grounded design framework within IS design that aims to ensure that technology aligns with human values and needs (Friedman & Kahn, 2002; Spence, 2011). This approach has been widely applied in technology design, including in HCI research (Mithun et al., 2019). Empirical explorations within the VSD framework help understand not only the usability but also users' perspectives on human values associated with the technology (Davis, 2009).

Despite the growing popularity of mHealth apps for breastfeeding education and support, limited research explores users' perspectives on the persuasive design features employed within these apps and how these features align with their values. Furthermore, potential ethical considerations embedded in PT design have not been adequately explored in the context of breastfeeding apps. The relationship between persuasion, the system features, and user values is essential to the overall user experience. The persuasive potential of a system design is largely determined by understanding the user's interaction with it. Previous research has indicated a need for further exploration at the level of system features (Oinas-Kukkonen, 2010). Empirical research can provide insights into how these features mediate user experiences and respect their values (Smits et al., 2022). While qualitative methods have been commonly used in previous research (Asbjørnsen et al., 2020; Lucero et al., 2022; Mohadis et al., 2016; Thach & Phan, 2019), semi-structured interviews offer distinct advantages by allowing for personalized and adaptable exploration of diverse viewpoints, providing valuable insights for enhancing the user experience of persuasive technologies. Thus, this article reports the results of an exploratory study that investigates users' experiences with the persuasive design features of the Milky Way mHealth app and aligns these findings with human values using the VSD framework.

2. Methods

2.1. Study design

In-depth semi-structured interviews were conducted to (1) explore the user experience of the Milky Way mHealth app, focusing on the impact of its persuasive design features and engagement with breastfeeding support and (2) align the findings from these user experiences with human values using the VSD framework. Convenience sampling was employed to recruit participants for individual semi-structured interviews. The study protocol was approved by the Human Research Ethics Committee (HREC) at the University of Wollongong (Approval No. 2021/009) before data collection began and consent was obtained prior to conducting the interviews. The Consolidated Criteria for Reporting Qualitative Research (COREQ) (Tong et al., 2007) was used to design and conduct this research (Appendix 1).

2.2. Participants

The study recruited the target participants anonymously using online recruitment techniques. Following ethical approval, postings were placed on various social media platforms such as Facebook pages, WhatsApp, Instagram, and Twitter. Participants received a $20 online gift card as compensation for their time spent on the interview. Inclusion criteria included being at least 18 years old, currently pregnant or breastfeeding, and having prior experience with the Milky Way app. Before the interview, participants were asked to thoroughly explore the app on their mobile devices. The app's sections and functionalities are presented in Textbox 2.

Textbox 2. The Milky Way mHealth app sections and functionalities
The Milky Way app is structured into distinct sections, each assisting a particular purpose and providing support to various aspects of breastfeeding.

1. The "Preparation" section is built around the benefits of breastfeeding. It lists various advantages, intending to encourage and persuade women toward breastfeeding by providing them with well-researched, reliable information.
2. The "Milk Supply" section is dedicated to addressing concerns of women who perceive their milk supply as insufficient. The app provides these women with supportive suggestions and targeted information, effectively addressing a potential barrier to breastfeeding and reassuring them about their capability to breastfeed.
3. The "Forum" section offers links to a social media-based community of breastfeeding women. This helps as an interactive platform for users to connect with others in similar situations, share information, seek support, and share their experiences, thus creating a strong sense of community.
4. The "Support" section provides valuable links to a collection of reliable websites and pages operated by trusted government authorities. By offering access to external resources for additional information and support, it not only enhances the app's functionality but also reinforces its credibility, due to its affiliation with reputable organizations.
5. The "FAQ" section addresses common questions and concerns related to breastfeeding. It is a source of useful information and resources, providing links to credible websites, and facilitating answers to the women's most pressing breastfeeding queries.

2.3. Data collection

The semi-structured interviews were conducted via phone or online platforms and lasted approximately 24 minutes on average. Prior to the interviews, participants were asked to indicate their preferred method of conducting the interview, whether it be through phone or online communication platforms such as Zoom or FaceTime. The flexibility to schedule online interviews at a convenient time for mothers is important to effectively reach and engage with mothers with infants. In addition, the semi-structured nature of the interviews enabled participants to elaborate on the outlined topics and offered a comprehensive view of their perspectives. Participants consented to audio recording, and notes were taken during the interviews to capture additional insights. The research team developed and reviewed the interview guide (Appendix 2), with questions aimed at gathering insights into participants' experiences and opinions of the app, its various sections, aesthetics, usability, and the credibility of its information.

2.4. Data analysis

In this study, Braun and Clarke's guidelines (Braun & Clarke, 2006) were applied to conduct a thematic analysis of the verbatim transcripts using NVivo data-management software (QSR International Pty Ltd, 2020). The initial analysis

was performed manually by AA, who reviewed the transcripts multiple times to gain a comprehensive understanding of the data, followed by line-by-line NVivo coding and then organizing the codes into data tables to identify descriptive themes. The validity of this analysis was ensured by two authors' collaborative coding to ensure that the coding was reliable and consistent (Barbour, 2001). This entailed refining emergent themes through an iterative process of collaborative discussions with the research team. The sample size was considered adequate in terms of data saturation as consistent recurring ideas emerged across multiple participants, indicating that further data collection was unlikely to yield new significant insights (Saldana, 2021). Data saturation was achieved as recurring explicit ideas emerged consistently across different participants (Saldana, 2021). Ongoing discussions were held throughout the data analysis process to increase the traceability and verification of the analysis (Nowell et al., 2017). These common themes or patterns were confirmed by all authors, indicating that saturation was reached, and further data collection was unlikely to yield new insights (Hennink & Kaiser, 2022). The quotes that best represented the themes were selected for reporting while maintaining confidentiality through pseudonyms. A further deductive approach, complemented by a data-driven inductive thematic analysis, was employed. Interview-derived quotes, themes, and subthemes were examined through the lens of VSD to identify values important to the participants and align them with the represented user values. This approach offered empirical insights into user experiences and their perceptions of values as presented through the app.

3. Results

3.1. Description of participants

The participants in this study were 12 women with ages ranging from 25 to 41 years old. In terms of education, five participants (41.7%) held a Master's degree, four (33.3%) had a Bachelor's degree, and three had educational qualifications below a Bachelor's degree. Among them, only one woman (8.3%) was pregnant with previous breastfeeding experience, while the rest were currently breastfeeding. Most women were first-time mothers (n = 9.75%). All but two initiated breastfeeding within a few hours of birth. Nearly, all (91.6%) exclusively breastfed at home, with one woman combining breast milk with formula.

3.2. Thematic analysis

Participants' experiences using the Milky Way app and their opinions of its features yielded four key themes through thematic analysis: (1) Informative; (2) Easy to use; (3) Credible; and (4) Social connection. These themes, further elaborated below with sub-themes and participant quotes, provide a greater understanding of user experiences. A visual thematic map was generated (Braun & Clarke, 2013) to illustrate the relationships between themes and subthemes, see Figure 1.

3.2.1. Theme 1: Informative

This theme revolves around the Milky Way app's ability to provide comprehensive guidance on breastfeeding topics, act as a troubleshooting tool, and offer practical visual materials. This theme highlights the app's effectiveness in delivering valuable information to mothers, addressing their concerns, and enhancing their breastfeeding experiences. Table 1 presents an overview of Theme 1, subthemes, and exemplary quotes.

3.2.1.1. Comprehensive and efficient information. Participants praised the app's comprehensive guidance on breastfeeding topics and how it addressed challenges. Participants mentioned that the app covered all the necessary information needed for breastfeeding issues, which could help reduce stress (quote 1). They found the concise and targeted information particularly beneficial for their current breastfeeding stage (quotes 2 and 3).

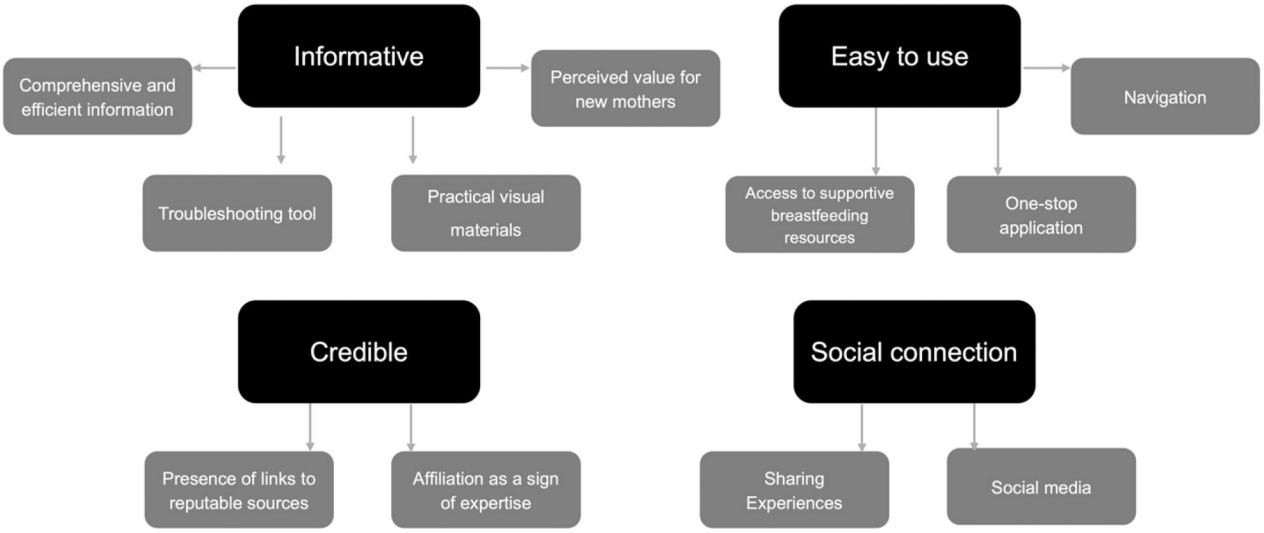

Figure 1. Thematic map of participants' experience with the Milky Way mHealth app. Single-directional solid arrows demonstrate hierarchical relationships between themes and subthemes.

Table 1. Overview of Theme 1: subthemes, codes, and exemplary quotes.

Theme and subthemes	Codes	Exemplary quotes
Theme 1: Informative		
Subtheme 1: Comprehensive and efficient information	Comprehensive coverage and reduced stress	Quote 1: "I think the app covered all needed information for the breastfeeding issues I think if you have a bit more information, you're less stressed." (P4).
	Importance of exposing to right information	Quote 2: "I like the content. it's more just making sure that they're exposing themselves to the right information at the right stage." (P10).
	Divided sections and plentiful information	Quote 3: "I like how the app is divided in many sections, every section has lots of information to read. Whatever I want to ask I find the answers." (P10).
	Increased confidence and self-resolutions for breastfeeding challenges	Quote 4: "Actually, in the beginning, as I told you, I had some problems with latching and low milk supply. So when I checked the milk supply section, I use the results they gave me and I tried to improve myself. So actually, it worked perfectly. So I tried to solve my problem." (P6).
	Value of the information in the milk supply section	Quote 5: "I love the milk supply part because I've had some problems. And it was immediately giving me some of the causes that could cause this problem." (P4).
	Avoiding information overload and appreciating the targeted information	Quote 6: "I think that's really good for mothers. Because, you know, you can go in and get a little bit of information without being too overloaded with information, which you can be when you're looking online, you can get too much information and it can overwhelm you. Yeah, so I think the milk supply is a good section." (P1).
	Benefits of the preparation section	Quote 7: "Preparation section was the most beneficial section especially prevention of possible challenges." (P9).
	Practical advice on various breastfeeding-related issues	Quote 8: "The preparation is good, because it answers some questions about different areas that you could be concerned about before you get there." (P12).
		Quote 9: "It has lots of really good advice. Like say baby don't gain weight or something that tells you how to deal with that. I think that's really good section." (P10).
		Quote 10: "I like how it's got like the main points of what you were looking for especially the benefits those first few days and normal baby behavior." (P4).
		Quote 11: "I was happy with that you've mentioned a fair bit in there about high risk pregnancy." (P3).
Subtheme 2: Troubleshooting tool	Milk supply section as a troubleshooting tool	Quote 12: "The app also sort of like troubleshoot in a way like, for whatever reason, you are feeling like you have a low supply, it's got the main sort of issues and you can click on it and then it gives you some like support and some reasons." (P5).
	Act as an assistance and reassurance breastfeeding tool	Quote 13: "For example, my breasts are definitely, like, smaller than they were. So I just the other day just clicked on the soft and empty breasts one and it has the information about it like. " (P12).
	Quick reference utility	Quote 14: "I think that is like that topic itself is something that a lot of women was wanting assistance on or reassuring, I think to have that as its own separate kind of page on the app is very helpful in sort of trying to find a frequently asked question about what's happening there would be an easy go to for someone who had a question about that, which I think is good." (P11).
	Motivational and comprehensive support	Quote 15: "It gives you a quick break down which I think is easy in the fact that it's a small amount of information not having to read pages of it. So you can get a quick answer, which is quite good." (P7).
		Quote 16: "I liked the milk supply when I sometimes want the motivations to continue breastfeeding. There was many information, this section helped me to continue breastfeeding." (P8).
		Quote 17: "I thought also the frequently asked questions was really good, like there are really good questions that people might ask." (P11).
Subtheme 3: Perceived value for new mothers	Preparation for new mothers	Quote 18: "I think it'd be great for new moms." (P3)
	Support for first-time mothers	Quote 19: "if like someone new to breastfeeding the app will help them to find any answer they want … especially the new mom." (P7).
	App recommendations and sharing with first-time mothers	Quote 20: "I felt like I want to be more prepared so I had the Milky Way app before I had my son. And then now as well. "I've used that a couple of times as well, when I have a quick question to ask or just something basic I want to find information on." (P10).
		Quote 21: "I think a lot of new mums prepare for labor and birth, but then the breastfeeding it ends up being like you're asking questions, because you're in the middle of breastfeeding and you you're not sure if you're doing it right or whatever. So I think that tab is would be very helpful for First mum." (P5).
		Quote 22: "I think for some of my friends, I have four people I know who are due in July and three of them are first time mums. I think I would recommend it to other people who are going to be going through it for the first time." (P4)
		Quote 23: "I have been sharing the app to my friends they have just had babies. It's a form of like finding information and support and going from there." (P1).
Subtheme 4: Practical visual materials	Clear and helpful visual information	Quote 24: "Pictures are good because it gives you a clearer understanding of like what positions you can put the baby in and how to get good latch and that kind of stuff. So yeah, those who have been helpful." (P3).
	Enhanced understanding	Quote 25: "the preparation of it was very helpful, especially the pictures and layout of it along with description of each breastfeeding position, it's easy to remember the navigate." (P1).

The milk supply section, providing tailored information and solutions for common problems like low milk supply and latching, was highly valued (quotes 4 and 5). Participants noted that it could improve their breastfeeding experience and prevent information overload (quote 6).

On the other hand, the preparation section, offering tailored insights into potential breastfeeding challenges, was considered most advantageous. That's because it addressed common concerns, helping participants prepare for and prevent potential issues (quotes 7 and 8). Generally, participants valued the app's provision of advice on various breastfeeding-related issues (quotes 9–11).

3.2.1.2. Troubleshooting tool. The app was perceived as a valuable tool for troubleshooting for resolving common breastfeeding issues (quote 12), with participants giving examples of its use for troubleshooting specific breastfeeding problems (quote 13). In particular, the milk supply section was perceived as a beneficial tool for addressing breastfeeding problems and motivating continued breastfeeding due to its practical troubleshooting abilities (quote 14). Participants constantly expressed appreciation for the milk supply section's ability to provide quick solutions, which saved them from extensive reading time (quote 15). Furthermore, they appreciated the app's inclusion of relevant and useful questions, which reflect the common breastfeeding concerns many mothers may have (quotes 16 and 17).

3.2.1.3. Perceived value for new mothers. Participants positively regarded the app as a helpful resource for new and expectant mothers to address common breastfeeding queries (quotes 18 and 19). They valued its ability to prepare them with accurate and essential knowledge prior to birth. They emphasized the importance of being prepared, especially for first-time mothers who may be unsure of what to expect (quote 20).

Participants highlighted the challenges new breastfeeding mothers face and recognized the potential of the app to help overcome them. The preparation section was perceived as particularly beneficial in helping new mothers feel confident and prepared for the breastfeeding experience (quote 21).

Participants expressed their intention to continue using and recommending the app, considering it beneficial for their breastfeeding journey and for other first-time mothers (quotes 22 and 23).

3.2.1.4. Practical visual materials. The visual materials in the Milky Way app were found useful for their clarity, meaningfulness, and ability to convey core breastfeeding messages. Participants highlighted the potency of these materials, specifically the clear presentation of images and informative visual content (quote 24).

The app's emphasis on providing practical visual materials in a clear and accessible manner was appreciated by participants. Descriptive images illustrating different breastfeeding positions, techniques, and tips for achieving a proper latch were considered helpful and easily memorable, facilitating practical access during breastfeeding sessions (quote 25).

3.2.2. Theme 2: Easy to use

The theme of ease of use emphasizes the app's accessibility, intuitive design, and user-friendly features. Participants appreciated the app's clear layout, engaging interface, and one-stop access to breastfeeding resources. Table 2 presents an overview of Theme 2, subtheme, and exemplary quotes.

3.2.2.1. Navigation. Participants frequently mentioned the app's ease of navigation and user-friendliness (quotes 26 and 27). Participants found the app to be well-organized with clear and concise breakdowns of information which indicated that the app's user interface and navigation design were successful in meeting the needs and expectations of its users (quote 28).

Participants found the app to be engaging and visually appealing and called it fun and engaging (quote 29). Furthermore, they appreciated the interactivity and ease of use of certain features, such as the drop-down list feature (quote 30).

3.2.2.2. Access to supportive breastfeeding resources. Participants appreciated the accessibility and variety of support resources available through the app. They consistently mentioned the support page as a key feature of the app, highlighting its helpfulness in providing access to relevant resources (quotes 31 and 32).

Participants appreciated not having to remember multiple websites for breastfeeding support, as the app combined this information for them. The ability to access a variety of resources, and to have them readily available on phones, was seen as a likable feature (quotes 33 and 34). Additionally, they identified the links to the well-known government website or local resources as a helpful resource for mothers seeking support as they provide relevant and up-to-date information (quotes 35 and 36).

3.2.2.3. One-stop application. The app was perceived as a "one-stop application" that contained all mother's breastfeeding-related inquiries (quotes 37 and 38). The app's convenience was valued by the participants, who appreciated having all the necessary resources accessible in one platform (quote 39).

Participants appreciated having a centralized location where they could find answers to common questions related to breastfeeding as it can help to relieve potential difficulties that may arise. They expressed their appreciation toward the convenience provided by the app, which allowed them to access all the relevant information in one place without the need to check multiple sources (quotes 40 and 41). The convenience of having everything in one place was particularly helpful for busy mothers who may not have the time to search on multiple platforms (quotes 42 and 43).

3.2.3. Theme 3: Credible

This theme focuses on the app's trustworthiness, reliability, and affiliation with reputable sources. Participants emphasized the importance of having access to credible

Table 2. Overview of Theme 2: subthemes, codes, and exemplary quotes.

Theme and subthemes	Codes	Exemplary quotes
Theme 2. Easy to use		
Subtheme 1: Navigation	User-friendly navigation	*Quote 26: "the box like sections on the home page as well as on the side there makes it easy to navigate."(P5).* *Quote 27: "super easy to navigate."(P4).* *Quote 28: It's cool. It gives you the information like, you can just click and send about your issue. You can click on it and it will give you what do you need to know, just make sense on why there might be an issue."(P9).*
	Interactive and engaging features	*Quote 29: "fun and engaging." (P6).* *Quote 30: "I think the milk supply was really helpful, because it's sort of interactive, and you can look at it. You know, it gives us a drop down list for the queries."(P3).*
Subtheme 2: Access to supportive breastfeeding resources	Supportive resource page	*Quote 31: "I thought support page that most helpful."(P11).* *Quote 32: "I really liked all of the links that it had for the support in terms of where to get information from."(P5).*
	Well-known breastfeeding support websites	*Quote 33: "I like this section so I don't have to remember all those websites. So if I click on one that I liked, and I got information from, they're all kind of stored there on that little page, so I can keep the app on my phone. And if I need to re access those websites, then I don't have to remember what they were all, you know, the what the website was. So I liked that." (P1)*
	Accessible support links	*Quote 34: "I like the support section where it take you to the links of a bunch of different other links and websites and things you can access, again, that was helpful, and I like that I have that on my app on my phone." (P3).*
	Local relevance support	*Quote 35: "My best section definitely the support page. Especially because it's got the Illawarra Shoalhaven so obviously is relevant for anyone living in the Illawarra."(P12).*
	Up-to-date information access	*Quote 36: "I think the links the ABA website helpful I would say that their website was probably the best with up to date information with kids."(P7).*
Subtheme 3: One-stop application	Comprehensive information in one place	*Quote 37: "It's like a one stop application for people in Australia."(P1)*
	Centralized location	*Quote 38: "the frequently asked questions, I think that that's handy because I don't have to, you know, Google or anything, I can just scroll through those questions and see if I could find an answer."(P10).*
	Readily available on mothers' phones	*Quote 39: It has the Australian breastfeeding association, all that stuff there. I definitely think it's really handy to have their direct phone number too, the links the websites are all in one spot. I think that's very handy. "(P3).*
	All-in-one breastfeeding resource	*Quote 40: "I love the frequently asked questions, because I love to see how people will have like some problems and the answer to this problem in same spot, of course, because it's often so a lot of people will struggle to the same points."(P9).*
	Immediate answers with streamlined design	*Quote 41: "I think using the Milky Way, kind of has everything that you need, that you would usually Google right there. "(P12).*
	At-hand breastfeeding resource	*Quote 42: " it's very easy to navigate in the app, it's easy to find answers. Especially for a busy mom, you're looking for an answer not goanna wait for to ask someone a question, and wait for an answer. So you're just browse with the questions and look for the answer that you're looking for. Yeah, so it's very easy."(P1).* *Quote 43: " I like to have the app sitting on my phone."(P6).*

information and sources within the app, which enhanced their confidence in the app's reliability. This was considered a crucial element in establishing the app's credibility. Table 3 presents an overview of Theme 3, subtheme, and exemplary quotes.

3.2.3.1. Presence of links to reputable sources. Participants consistently emphasized the importance of credible information and sources in the app, considering them as crucial for overall reliability and trustworthiness (quote 44).

Several participants echoed this sentiment, emphasizing that the inclusion of links to credible sources, such as the Australian Breastfeeding Association (ABA) and Raising Children Network, was crucial in increasing participants' trust in the app's provided information (quotes 45–47). The presence of links to local health district websites was also viewed positively especially by participants residing in those areas (quote 48).

Participants found the feature of having links after each information section helpful for verifying credibility (quote 49). The feature of providing additional reading material as evidence for the presented information was perceived as unique as it was not commonly found in other breastfeeding apps, thus making the app stand out as a credible app (quotes 50–52). Participants' feedback reinforces the positive impact of the app's credibility, as demonstrated by their positive experiences and intention to continue using it. This, in turn, strengthens their reliance on the app as a trustworthy source of breastfeeding information (quote 52).

3.2.3.2. Affiliation as a sign of expertise. Participants expressed their trust in the credibility of the app due to its association with the University of Wollongong. Many participants noted that the app's connection with the university made them view the information provided as more credible and they considered the app to have a high level of credibility (quotes 53–55).

Participants' perception of the app's credibility was further reinforced by the presence of the University of Wollongong logo on the app page on the app store, which they viewed as a symbol of professionalism and expertise (quote 56).

This finding was evident among participants who had a connection with the university, emphasizing the importance

Table 3. Overview of Theme 3: subthemes, codes, and exemplary quotes.

Theme and subthemes	Codes	Exemplary quotes
Theme 3: Credible		
Subtheme 1: Presence of links to reputable sources	Recognition of reputable websites	Quote 44: "For me, personally, it would be more of the reliability in the links and the references." (P12).
	Confidence in information accuracy	Quote 45: "Also when you go in links and see that you're linking to the Australian breastfeeding Association and raising children. They're both known websites. I know that they have credible information. That's handy. And the right information." (P3).
	Links to evidence-based sources	Quote 46: "When you go in links and see that you're linking to the Australian breastfeeding Association and raising children. They're both known websites. I know that have credible information. That's handy. And the right information. So, yeah, I feel that the information on there is the right information to be given." (P4).
	Reliable linked resources	Quote 47: "It's got it's got all the links to, you know, the information that I'm just looking at one of them, for instance, one of the links. linking back to raising children. That's the website I tend to look at already." (P9).
	Trusted local health authority	Quote 48: "…the fact that it has the Illawarra Shoalhaven Local Health District website as well as makes it even more credible for someone who's living in the Illawarra." (P10).
	Perceived credibility	Quote 49: "If anyone wanted to do further reading, you have that evidence as to be able to do it, and I think that's sort of made me think it was quite credible." (P10).
	Unique credibility-assurance feature	Quote 50: "There's already a link mentioned after each information in the app. So I feel that's not any some information from any website, can refer to that reference. If I need to make sure that this information is credible or not. This feature I didn't think that it's available in any available app now. So it's certainly make me take any information from this app. As a credible information." (P1).
	Credibility through further reading	Quote 51: "So it's showing that it's not just random stuff that you've got, if you've actually got, you know, if anyone wanted to do further reading, you have that evidence as to be able to do it, and I think that's sort of made me think it was quite credible." (P4).
	Positive credibility experience	Quote 52: "I had very good experience using this app, And I think it's going to be a good app for many years now because of the credibility in it." (P11).
Subtheme 2: Affiliation as a sign of expertise	University affiliation trust	Quote 53: "Knowing that it's from the university really makes it more credible in my eyes." (P7)
	Confidence in information quality as its university-developed app	Quote 54: "The app is credible because I know this app is developed by a university. So I took their information as credible as it is." (P10).
	Expertise-based credibility	Quote 55: "It is credible it's from the university belonging to people scientists or researchers who have put the information there and they know how to check whether a reference is credible or not." (P8).
	Professional affiliation	Quote 56: "I like the credibility of the information because when I've checked the app in app store says that it was developed by a university as shown. So there must be experts developing this app." (P3).
	Local recognition of credibility	Quote 57: "I think like for me, it is credible because I'm a local here, and I know about Wollongong University. It's where I do my degree." (P6)

of personal familiarity in shaping their perceptions of credibility (quote 57).

3.2.4. Theme 4: Social connections

This theme highlights the app's role in promoting a sense of community and support among users. Participants appreciated the opportunity to share their experiences, connect with other mothers, and access support resources through social media platforms. Table 4 presents an overview of Theme 4, subtheme, and exemplary quotes.

3.2.4.1. Sharing experiences. The app was viewed positively by the participants in terms of its supportive features and resources. One of the primary reasons for their positive perception of the app was the availability of other mothers' stories and journeys in the app, which allowed them to relate to others and feel less isolated in their breastfeeding journeys (quote 58). The participants frequently mentioned the importance of social support to mothers, highlighting the crucial role it plays in providing reassurance and a sense of community during the breastfeeding journey (quote 59).

3.2.4.2. Social media. Participants found the app's embedded external links to support resources to be a valuable feature. Considering the widespread usage and ease of accessibility of Facebook, external links to this social networking site were incorporated as the primary sharing platform. Participants highlighted the efficacy of the link to the ABA Facebook page within the app, highlighting that it provided a valuable platform for connecting with a supportive community (quote 60). They mentioned that the Facebook page was particularly beneficial for first-time mothers, as it allowed them to seek advice and share experiences from a greater network of breastfeeding mothers (quote 61).

Table 4. Overview of Theme 4: subthemes, codes, and exemplary quotes.

Theme and subthemes	Codes	Exemplary quotes
Theme 4: Social connections		
Subtheme 1: Sharing Experiences	Relatability through stories	Quote 58: "I think the stories in the app are really good, like hearing other people's stories and other people's journeys and being able to relate to the people." (P5).
	Shared breastfeeding journeys connection	Quote 59: "I Like that there was a support group for further talking about our daily issue for breastfeeding." (P4).
Subtheme 2: Social media	Positive view of social media connection	Quote 60: "the Facebook group was really helpful. So I've had a lot of help from Australian breastfeeding Association. ABA as well, that was really helpful for me as new mom." (P9).
	Appreciation for integrated social media linking	Quote 61: "The Facebook link is good. Because if they didn't link through they should, and the Australian breastfeeding Association has really good support. I think that's good to be able to link to it." (P10).

3.3. Theme inter-relationships

The thematic analysis shows a cohesive interplay among the identified themes. Rather than presented independently, these themes interact to enhance the overall user experience for breastfeeding mothers. The app's *informative* content plays a crucial role in establishing its *credibility*. By providing comprehensive, evidence-based information presented in a clear format, the app was perceived as a reliable source. This is further reinforced by the *easy-to-use* interface that allows mothers to quickly access the information they need during their breastfeeding journey. The app's intuitive interface and clear layout reinforce accessibility, minimizing frustration, and enhancing trust in its reliability, thereby strengthening both the "Informative" and "Credible" themes. Further enhancing credibility, the app's affiliation with the University of Wollongong and links to reputable sources enable users to navigate breastfeeding challenges confidently. This credibility, in turn, promotes a sense of confidence which would encourage users to engage with others via linked social media platforms, supporting the *social connection* theme. These inter-relationships underscore the collaborative effects of the app's features which emphasize the importance of integrating reliable information with user-friendly design and community engagement to enhance user experience and support.

3.4. Empirical insights related to users' value experiences

In this analysis, the VSD was utilized to investigate the alignment of the app design with users' values. It was observed that all participants perceived the app as reflecting and respecting their values as the resulting themes were in alignment with various values related to the VSD. In the context of the Milky Way app, incorporating ethical considerations and human values into the system design was evident in the resulting themes. For instance, the theme "Informative" highlights the importance of providing efficient information to mothers which aligns with the values of "Beneficence" and "Human welfare", which emphasizes the importance of promoting the well-being of users. The theme "Easy to use" also aligns with the values of "Ease of use" and "Unobtrusiveness" (Kuonanoja et al., 2018). The app's navigation, access to resources, and one-stop-shop approach all prioritize making the app user-friendly and accessible to mothers. These values reflect the importance of designing apps that are intuitive and straightforward that provides relevant experiences to users. The third theme "Credible" demonstrates the values of "Evidence-based knowledge", "non-maleficence" and "Trust". By including links to reputable sources, the app ensures that the information provided to users is accurate, which prevents harm. Also, the theme "Social connection" aligns with the values of "Social responsibility" and "user participation". More identified values are presented in Table 5.

4. Discussion

4.1. Main findings

A qualitative analysis was conducted through semi-structured interviews to explore women's perspectives on the design features of the Milky Way mHealth app and align their perceptions with human values within the VSD framework. Participants highly valued the app's persuasive design which provided convenient access to evidence-based and comprehensive breastfeeding information. They also valued the app's interactive nature as it provided easy access to useful resources and prompt responses to queries, efficiently meeting the diverse needs of breastfeeding women. Markedly, key features that participants found important included the app's credibility, provision of tailored solutions, and focused approach. These features included integration of evidence-based information, direct links to trusted websites and hotlines, incorporation of social media links, and seamless navigation to external support resources. The analysis provided an enriched understanding of users' values and demonstrated the app's thoughtful design in alignment with those values.

4.2. Users' perspectives on persuasive design principles and feature preferences

According to the PSD model, the effectiveness and generalizability of persuasive strategy implementations are influenced by the context in which the PT is used. The thematic analysis showed that users highly appreciated the persuasive design features employed in the Milky Way app. There was an alignment between users' perspectives and persuasive principles in the PSD model. Participants praised the app's

Table 5. The identified values, their description and representation in the Milky Way app and examples of relevant participants' quotes.

Identified values	Values description and representation in the Milky Way app	Relevant participants' quotes
Trust	Trust refers to the user's confidence in the system and its reliability. The Milky Way app features such as Trustworthiness, Expertise, and Third-party endorsements offer credible and trustworthy information from reputable sources to build trust with the user.	"I feel that the information on the app is the right information to be given." (P3). "It has University of Wollongong Australia logo and like, you know that it's developed by professional bodies." (P7).
Transparency	Transparency refers to the level of openness and honesty in the system. The Milky Way app features such as Surface credibility and Trustworthiness offer clear and credible information to the user about the source of information and expertise behind the app.	"it's not Nothing really hidden. It's very straightforward." (P9). "I actually like the fact that everything that you've posted had the links to where you got the information from." (P4).
Social responsibility	Social responsibility refers to the system's impact on society and individuals. The Milky Way app features such as Social connection offer opportunities for users to connect with others, compare their experiences, and feel like they are part of a community with a common goal of having a positive breastfeeding experience.	"I like hearing other people's stories and other people's journeys and being able to relate to the people, other people's journeys, because that's always the thing with breastfeeding. They make it seem very easy, but it's actually one of the hardest." (P10).
Accessibility	Accessibility refers to the system's availability, adaptability, and portability. The Milky Way app enables users to utilize all features of the app, explore its available content, and retrieve information regardless of their internet connectivity.	"so that way, I don't have to worry about trying to find any information at all just their on my phone all the time." (P6). "it's very easy to reach it's very clear actually and easy to get information from." (P12).
Usability	Usability refers to the ease with which users can effectively interact with and navigate through the app. The Milky Way app organizes information efficiently, presenting information in portions, thus facilitating ease of use. The app also offers sustained usability over time as it would remain easy to use and navigate throughout different breastfeeding stages, encouraging continuous engagement.	"I think it's got a good breakdown, and it's easy to follow." (P1). "I'll keep using it until I stop breastfeeding for this pregnancy." (P2).
Satisfaction	Satisfaction refers to whether a user's interaction with a system fulfills their needs, wants, and expectations. The Milky Way app offer an engaging, intuitive app experience that aligns effectively with users' informational needs and expectations.	"just in general the app I think it's an enjoyable tool and easy navigate all these information." (P10). "I think that it looks engaging when you first open it and clicking on things. I don't think it's boring at all." (P5).
Ability	Ability refers to users' ability to take control of their own health and well-being. The Milky Way app features such as Information, Resources, and Support provide users with the knowledge, tools, and support they need to make informed decisions about their breastfeeding choices and able to seek out the support they need.	"I think it's covered all needed information for the breastfeeding issues and give me more confidence about what I'm doing. Give me solutions for maybe like breastfeeding outside the home." (P1).
Inclusivity	Inclusivity involves designing systems that are accessible and usable for a wide range of users. The Milky Way app displays inclusivity by catering to different user needs and preferences, including visual learners. The app also features pictures that represent cultural diversity which offers a platform that is inclusive and respectful of various cultural backgrounds and practices related to breastfeeding.	"I like the images it's easy to reach has helpful visual information it's very clear actually." (P2).

simplified layout (Reduction) and its emphasis on the benefits of breastfeeding, which persuaded them to continue breastfeeding (Tunnelling). The section tailored to address concerns related to low milk supply was highly appreciated, especially by first-time mothers (Tailoring). The provided interactive resolutions increased their confidence in breastfeeding. This aligns with literature emphasizing personalized breastfeeding support for first-time mothers, as they value tailored guidance (Theodorah & Mc'Deline, 2021). Evidence suggests that perceived sufficient milk supply (breastfeeding self-efficacy (Dennis, 1999) can be enhanced through the ability to learn about milk production (Sidhu et al., 2019). Self-efficacy is a focal determinant of behavior (Sutton, 2001), and both self-efficacy theory and the PSD principles are crucial in understanding user behavior. Both highlight the importance of understanding users' perspectives and offering the necessary resources and skills to assist them in achieving their goals (Oyibo, 2016). By utilizing the PSD model, designers can effectively enhance users' self-efficacy in performing desired behaviors.

The Milky Way app proved valuable for participants, particularly in addressing low milk supply concerns (Suggestion). The app effectively motivated women to overcome breastfeeding misinformation and feel confident in their abilities. This finding is consistent with research suggesting that implementing in-app suggestions list could enhance users' confidence in behavior change (Oyebode & Orji, 2022). As the pre-written suggestions are impersonal responses, new mothers experiencing time constraints may be more inclined to seek out impersonal sources of information such as the information provided in the app. This aligns with previous research indicating that under time constraints, users may find impersonal information sources to be more accessible, especially for sensitive topics (Wang et al., 2017).

Considering the study results, it is evident that the Milky Way app aligns with recent research trends indicating a

strong preference among breastfeeding women for mobile apps after hospital discharge (Griffin et al., 2021). Specifically, the app's low milk supply section addresses a common reason reported for discontinuing breastfeeding which is perceived low milk supply (Rozga et al., 2015; Sidhu et al., 2019) by offering tailored support to this concern. Participants' appreciation of the app's provision of relevant and easily accessible information was highlighted in a previous study by the authors (A. A. S. Almohanna et al., 2023). This emphasizes the importance of delivering meaningful information in a simplified, user-friendly design for health-related app users (Alqahtani et al., 2019; Hamid et al., 2022; Vlahu-Gjorgievska et al., 2023). Additionally, establishing a sense of similarity within the app enhances users' likability (Ruijten, 2021). Users reported that the presented pictures and topics in the app reflected their interests and felt approachable (Similarity). Participants also noted that reading about mothers experiencing similar concerns may reduce feelings of loneliness. Likewise, the incorporation of simple and realistic pictures (Liking) and the forum section (Social role) increased user engagement. Previous studies have consistently identified the significance of social support for breastfeeding and the ease of use of breastfeeding apps (Quifer-Rada et al., 2023; Syam et al., 2024). Although feature such as ease of use is frequently reported in previous studies (Demirci et al., 2019; Syam et al., 2024), its recurrence underscores its fundamental importance in the design and functionality of breastfeeding mHealth apps. Additionally, integrating computer-human interaction features, including suggestions, similarity, liking, and social role, supports goal achievement (Shevchuk et al., 2019).

The study results demonstrated a strong correlation between users' positive experiences with the Milky Way app and their perceptions of its credibility. Credibility plays a crucial role in shaping users' opinions of persuasive systems as evidenced by previous studies (Asbjørnsen et al., 2019; Koranteng et al., 2021, 2023). Such positive evaluations are closely related to users' intention to continue using the system (Lehto & Oinas-Kukkonen, 2015; Merz & Steinherr, 2022). Participants indicated that incorporating trusted sources and referencing them in the app (Trustworthiness) positively influenced their perception of its credibility. They also trusted the app's content, which showed knowledge and expertise (Expertise), and they accepted the app's advice based on its association with professional identities (Surface credibility). This trust was further enhanced by highlighting the credentials of the developers within the app (Real-world feel). Clear information about the sources of the app's content is vital for establishing credibility, as it enhances "believability" and promotes behavioral change (Ritterband et al., 2009). The app's believability was reinforced by users reporting their appreciation for the ability to verify the accuracy of information through external sources (Verifiability). Participants also perceived the app as credible due to the inclusion of well-known sources such as government websites (Authority) and third-party endorsements from influential local health organizations (Third-party endorsements). These findings underscore the significance of design features that prioritize credibility in enhancing the user experience of health-related apps, ultimately increasing user trust and persuasive impact (Matthews et al., 2016).

The study participants identified various social influence strategies as motivational and engaging. Connection to social media was particularly beneficial in providing access to information about other mothers and increasing users' confidence in their own breastfeeding experience (Social learning and Social comparison). Moreover, participants appreciated the opportunity to connect and interact with others who shared similar experiences through the app's social media link (Cooperation). These qualities were seen to have a normative influence by increasing users' motivation to continue breastfeeding and improving their breastfeeding capability (Normative influence). These findings highlight the significance of promoting a supportive and inclusive community within the app, as it can positively impact users' motivation to adopt or continue a target behavior. This aligns with previous research that highlights the potential of normative influence strategy in promoting behavior change and user engagement (Pintar & Erjavec, 2021).

The authors' previous study on the Milky Way app (A. A. S. Almohanna et al., 2023) demonstrated the significance of tunneling, credibility, expertise, and social support features as they were highly valued by participants. Similarly, in this study, participants reported positive experiences with the app, perceiving it as informative, credible, and practical in promoting and supporting breastfeeding. Both studies highlight the importance of user feedback in improving the design of persuasive systems and maintaining their relevance, engagement, and effectiveness in promoting behavior. These findings highlight the role of users' favorable impressions in facilitating desired behavior change, particularly in the context of persuasive systems aimed at influencing users' perceptions and behavior toward a specific purpose.

4.3. Ethical considerations in persuasive technology design

Persuasive technologies are deliberately designed to change users' behavior; hence, the issue of complacency regarding ethics in PT is a pressing concern. Adhering to appropriate guiding principles aligned with ethical analysis is essential to ensure the ethical design of PT (Karppinen & Oinas-Kukkonen, 2013). This study findings demonstrated that the design of the Milky Way app incorporated principles of VSD to ensure functional benefits and alignment with users' ethical values. Davis (2009) advocates for the integration of VSD methods to address the ethical implications of persuasive systems. An important aspect of VSD is determining which values should be considered. In this regard, Friedman et al. (2006) proposed a comprehensive human values list to assist designers and researchers in incorporating ethical considerations into system designs. However, other researchers presented an opposing viewpoint to using a predefined set-list of values in VSD as they argue that a bottom-up approach, involving the elicitation of values directly from

stakeholders, can be a more effective approach (Borning & Muller, 2012; Le Dantec et al., 2009).

The study focused on the immediate user's interaction with the Milky Way app. Notably, privacy concerns did not emerge as an issue, likely because the app does not collect personal data. While privacy was not a concern in this study, it does not deny its importance for app users (Friedman et al., 2015). Instead, it highlights the context-specific nature of values in technology use. Moreover, it emphasizes the idea that values are shaped by both the design of the technology and its context (Spence, 2011).

Human values, such as Trust and Autonomy, are increasingly essential in ubiquitous technologies, including mHealth apps (Mithun et al., 2019). These technologies play a significant role, but there are instances where these values may be compromised or violated. Thus, prioritizing these fundamental human values in the design of such technologies is crucial to ensure user trust and sustained engagement.

Furthermore, these findings contribute to the broader discussion on the significance of user-centered design in developing technology tools. Research has shown that involving users in the design process leads to highly effective persuasive systems aligned with users' primary goals (Oduor & Oinas-Kukkonen, 2019). This user-centered approach, combined with ethical considerations, promotes a deeper understanding of user requirements, resulting in a more tailored app that effectively meets users' needs while maintaining ethical principles, ensuring a sustainable positive user experience.

4.4. Strengths, limitations, and future directions

The key strength of this study lies in its proactive response to insights gathered from the persuasive literature regarding the misalignment between end-users and digital technologies (Keizer et al., 2020). While recognizing the acknowledged benefits of personalized persuasive systems, it is apparent that the field is still in its nascent stages, characterized by a limited understanding of the most effective ways to tailor these technologies (McGowan et al., 2022). In this study, a dynamic, data-centered approach was adopted to bridge the gap between user needs and technological solutions. By considering factors such as user preferences and health perception, the study aimed to enhance the perceived persuasiveness of digital health technologies.

This study's limitations primarily relate to sampling. This empirical study employed the data saturation concept for thematic analysis and sample size. While this approach captures the breadth and depth of the participants' experiences and mitigates redundancy in further data collection, it is important to acknowledge that this study sample size was relatively small (Mwita, 2022). However, recent research has indicated that qualitative studies can reach saturation even with small sample sizes (Hennink & Kaiser, 2022; Rahimi & khatooni, 2024). Although this exploratory study provides valuable insights into user experiences and potential design improvements, further research with a larger diverse sample is recommended to confirm and refine these findings.

4.5. Implications for future design, research, and implementation

Recent studies have identified challenges in the development of health-related apps, including the lack of theory-grounded and evidence-based persuasive systems and the unclear effects of individual persuasive strategies and their interrelations (Pintar & Erjavec, 2021; Taj et al., 2019). This highlights the importance of an empirical approach in exploring persuasive systems in healthcare. This study helps to fill these gaps by providing valuable insights into the persuasive design elements in promoting breastfeeding behaviors through the Milky Way app.

Recent research indicated that only a few studies evaluating health-related persuasive apps have been conducted in real-world settings (Qasim et al., 2018; Staehelin et al., 2023). This study enhances the validation of the PSD model by aligning its principles with real-world data, offering insights into how the persuasive design features of the app can effectively meet the diverse needs of users thus enhancing the persuasiveness of its content and functionality. User perspectives play an essential role in informing design decisions as they provide insights into their desired behavior and enable accurate predictions of actual behaviors (Ndulue et al., 2022; Oyebode & Orji, 2022). By involving users and considering their perspectives, designers can enhance the persuasive system's effectiveness, leading to positive behavior change outcomes.

There is a strong consensus among researchers that successful behavior change technologies require a user-centered development process involving iterative improvements (Yardley et al., 2016). This approach involves employing a combination of quantitative methods and in-depth qualitative research to continuously refine the technology, ensuring it meets user requirements and preferences.

5. Conclusions

In this study, an mHealth app designed and developed following the PSD model was used as a research medium. Women were interviewed to gain insight into their experiences with the embedded persuasive design features of the Milky Way mHealth app. The findings revealed a strong user appreciation for the app's functionalities, particularly its personalized evidence-based recommendations, user-friendly interface, and supportive community features. These findings highlight user values of autonomy (personalized recommendations), ease of use (user-friendly features), and social connection (supportive community). Furthermore, the study provides evidence supporting the integration of user values into mHealth app design. This approach can enhance both app efficacy and user experience by resonating with the diverse needs and values of different user groups. Looking forward, these insights can guide the development of future mHealth apps that prioritize user-centered design principles

and promote sustainable behavior change. Additionally, the discussion on ethical considerations for persuasive mHealth apps should continue.

Statement of significance

Problem. Addressing the limited understanding of user interaction and engagement in the design of health informatics systems, this research focuses on the challenges may raise by this gap, specifically within the context of breastfeeding support through mHealth apps.

What is Already Known? The efficacy of breastfeeding apps may be limited by the absence of theory-grounded approaches and effective behavior change techniques. User-focused design in mHealth and is considered essential. Additionally, the value of interdisciplinary collaboration is recognized for enhancing the development of effective mHealth apps. However, there is a notable gap in empirical research on user experiences and values within persuasive systems.

What This Article Adds? This article highlights the impactful role of informative, user-friendly, credible, and socially connected apps in promoting healthier behaviors. The study showed that content transparency can improve user trust, engagement, and overall experience. Moreover, it highlights the significance of tailored and real-time feedback in mHealth apps to enhance user adherence and motivation. Importantly, ethical design principles are considered essential for increasing user trust and optimizing the effectiveness of persuasive mHealth applications.

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Ethics statement

Ethical approval was obtained for this study from the University of Wollongong, the Human Research Ethics Committee (Approval No. 2021/009).

Informed consent

All participants provided informed consent prior to participation in the study.

Disclosure statement

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Appendix 1. COREQ-Qualitative study

32-item Consolidated criteria for reporting qualitative studies (COREQ)

No. of items	Guide questions/description	Reported on manuscript
Domain 1: Research team and reflexivity		
Personal characteristics		
1. Interviewer/facilitator	Which author/s conducted the interview or focus group?	The first author conducted all interviews
2. Credentials	What were the researcher's credentials? E.g., PhD, MD	The interviewer held MSc in software engineering.
3. Occupation	What was their occupation at the time of the study?	The interviewer was PhD candidate.
4. Gender	Was the researcher male or female?	Female
5. Experience and training	What experience or training did the researcher have?	Bachelor's in computer science Master in software engineering Academic training in qualitative research methods.
Relationship with participants		
6. Relationship established	Was a relationship established prior to study commencement?	No prior relationship.
7. Participant knowledge of the interviewer	What did the participants know about the researcher? E.g., personal goals, reasons for doing the research	In the study, it was made known to all participants that the interviewer was a PhD student, and they were informed about the research objectives. All participants were provided with additional details about the study through the Participant Information Statement.
8. Interviewer characteristics	What characteristics were reported about the interviewer/facilitator? E.g., Bias, assumptions, reasons and interests in the research topic	The author had a positive attitude toward the Milky Way mHealth app, but she made a conscious effort to remain impartial and neutral during her conversations with the participants.
Domain 2: Study design		
Theoretical framework		
9. Methodological orientation and theory	What methodological orientation was stated to underpin the study? E.g., grounded theory, discourse analysis, ethnography, phenomenology, and content analysis	Thematic analysis.
Participant selection		
10. Sampling	How were participants selected? E.g., and purposive, convenience, consecutive, snowball	Convenience sampling
11. Method of approach	How were participants approached? E.g., face-to-face, telephone, mail, and email	Participants were recruited for interviews through an invitation embedded in the end of an online survey.
12. Sample size	How many participants were in the study?	12 participants
13. Non-participation	How many people refused to participate or dropped out? Reasons?	All participants who provided consent, either in written or verbal form, completed the study.
Setting		
14. Setting of data collection	Where was the data collected? E.g., home, clinic, and workplace	All semi-structured, in-depth interviews were conducted remotely using mobile phone or online platforms such as FaceTime or Zoom.
15. Presence of non-participants	Was anyone else present besides the participants and researchers?	Only the researcher was present during data collection with the participants.
16. Description of sample	What are the important characteristics of the sample? E.g., demographic data and date	Participants were women who were pregnant or mothers who were breastfeeding or had experiences of breastfeeding, being 18 years or older, and, had an Apple/Android-based smartphone. Demographic data is reported in Table 1 in Section 3.
Data collection		
17. Interview guide	Were questions, prompts, guides provided by the authors? Was it pilot tested?	The research team developed the questions, prompts, and guides jointly. The interview guide was pilot tested.
18. Repeat interviews	Were repeat interviews carried out? If yes, how many?	No.
19. Audio/visual recording	Did the research use audio or visual recording to collect the data?	All interviews were audio-recorded.
20. Field notes	Were field notes made during and/or after the interview or focus group?	The first author facilitated all interviews and maintained detailed notes, documenting ideas from each interview in an ongoing iterative process.
21. Duration	What was the duration of the inter views or focus group?	The interviews lasted between 11 and 45 minutes (24 minutes on average).
22. Data saturation	Was data saturation discussed?	Final sample size was determined by thematic saturation
23. Transcripts returned	Were transcripts returned to participants for comment and/or correction?	No.
Domain 3: Analysis and findings		
Data analysis		
24. Number of data coders	How many data coders coded the data?	Two authors conducted the analysis and all authors discussed and agreed on identified themes and subthemes for the final analysis.
25. Description of the coding tree	Did authors provide a description of the coding tree?	No.
26. Derivation of themes	Were themes identified in advance or derived from the data?	Themes were derived from the data.

(*continued*)

Continued.

No. of items	Guide questions/description	Reported on manuscript
27. Software	What software, if applicable, was used to manage the data?	QSR NVivo 11. Microsoft word.
28. Participant checking	Did participants provide feedback on the findings?	No.
Reporting		
29. Quotations presented	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? E.g., participant number	Yes. Selected quotations were presented to illustrate the themes and findings of the research.
30. Data and findings consistent	Was there consistency between the data presented and the findings?	Yes.
31. Clarity of major themes	Were major themes clearly presented in the findings?	Yes. Major themes are summarized in the results section and Figure 1
32. Clarity of minor themes	Is there a description of diverse cases or discussion of minor themes?	Yes, e.g., subthemes of the themes derived from the collected data.

See Tong et al. (2007).

Appendix 2. Interview guide

(Start by greeting the participant and introducing myself using my full name. Briefly explain the study, ensuring the participant is informed and verbal consent obtained for the interview and audio recording. Ask the participant how she is doing today, then, invite her to share some general information about herself.)
How old are you?
What is the highest level of education that you have achieved?
Are you currently pregnant or breastfeeding?
How old is your youngest child?
How soon after birth did you initiate BF?
Tell me about your breastfeeding experience in general.
Could you please describe to me what have been your sources of breastfeeding information?
What are the top two technology-based options that you used for breastfeeding support and information? (Prompts: for example, Facebook. Mobile apps Or Websites?)
To start with, I wonder if you could tell me a little bit about your experience of exploring and using the Milky Way app? What did you think of the app?
(Prompts: tell me more about …)
How do you think the app influenced your BF experience?
(Prompts: give one example …)
What new things (if any) did you learn from the app?
Can you please tell me what do you think about the preparation section and how useful you think it is? (Prompts: what did you like? Dislike?)
Can you please tell me what do you think about the milk supply section and how useful you think it is? (Prompts: what did you like? Dislike?)
How about the rest of the sections, the Forum that links to the Australian Breastfeeding Association Facebook page, the support section and the frequently asked question section? (Prompts: anything you like? Dislike?)
(Prompts: tell me more about what you just said regarding …)
Was there any particular information in any section that helped you or supported you during breastfeeding? (Prompts: any part you think it was the most helpful part)
Can you please tell me what you liked the least about the App?
tell me more about that? (Prompts: for example, information, images, navigation, a specific section?
What did you think of the look of the app?
(Prompts: give one example …)
Do you think we can improve the look of the app in any way? (Prompt: for example, app looks such as font, colors, and images)
What new things (if any) did you learn from the app?
(Prompts: give one example …)
What do you think about the credibility of the information in the Milky Way app?
How did insure its credible and trustworthy?
(Prompts: give one specific example on why …)
Was there anything you thought should be in the app that was not in there?
(Prompts: do you have any suggestions that can improve the app? any additional sections or features?
Do you see yourself using the App for a longer period of time? Y/N
Why?
Do you have any further comments or anything to add about the Milky Way app and your experience using it?