Women's Perspectives and Challenges in Adopting Perinatal Mental Health Technologies

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Perinatal mental illness is a prevalent global concern impacting pregnant women and new mothers. Women frequently utilize technology for perinatal mental health (PMH) assistance, including smartphone applications, web-based platforms, social media, and online support groups. This study aims to understand mothers' perceived acceptability and effectiveness of mental health technologies and the challenges they face while adopting those technologies to navigate their PMH journey. We conducted in-depth semi-structured interviews with mothers (n=15) who were either pregnant or in their postpartum. Additionally, we gathered data (1600 posts and corresponding 10,000 comments) from online perinatal support communities to explore the discussions concerning mothers' utilization of technology during the perinatal period. Our findings elucidate the diverse experiences of women around professional help, social support, anonymity, and misinformation when adopting and using perinatal technologies and how these experiences shape how they envision future PMH technologies and their aspects. Based on these findings, we recommend developing future evidence-based technologies that continuously support mothers throughout pregnancy and postpartum while advocating for existing technologies to prioritize transparency, empowering mothers to make informed decisions and enhance their digital literacy regarding PMH resources.

CCS Concepts: • **Human-centered computing → Empirical studies in collaborative and social computing**.

Additional Key Words and Phrases: Perinatal Mental Health, Perinatal Technology, Evolving Support System

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1 Introduction

Perinatal mental health (PMH) problems are those that occur during pregnancy or in the first year following the birth of a child. Perinatal mental illness affects up to 27% of new and expectant mothers and covers a wide range of conditions [8]. These illnesses, often referred to as prenatal and postnatal mental disorders, are widely reported and have considerable adverse effects on neonatal and child outcomes as well as maternal mortality [53]. Statistically, perinatal mood and anxiety disorders (PMADs) affect 1 in 5 pregnant mothers [44, 71], and postpartum depression (PPD) affects 1 in 7 new mothers [1] in the United States. Among these conditions, postpartum psychosis, though less common with a prevalence of approximately 0.1-0.2%, is a particularly severe mental health disorder that can have devastating consequences if left untreated [39]. It affects about 1 to 2 in 1,000 new mothers and is often highly stigmatized, which can further impede women from seeking help [53]. Despite the growing awareness of these conditions, many mothers do not obtain the necessary

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medical care or social support due to barriers such as overburdened public healthcare systems, a lack of nearby treatment facilities, difficulties accessing treatments, and the stigma associated with mental health disorders [53].

In recent years, HCI, CSCW, and health informatics communities have explored how digital platforms can support maternal well-being. Studies in this context cover a wide range of topics, from investigating and designing mHealth interventions to diagnose and screen anxiety and depression [12, 25, 26, 28, 80, 93] to evaluating online therapy as an alternative to in-person counseling sessions [10, 59]. Furthermore, research has focused on the role of social media and online support groups in promoting conversations about crucial topics like childbirth and miscarriage [62, 84, 111]. These studies emphasize the benefits of digital interventions for pregnant women and new mothers to cope with depression, anxiety, PTSD, stress[49, 62, 75, 111], alcoholism [30], and eating disorders [81]. These technological innovations, being affordable and easy to avail, allow women to get help, who might not have access to mental health services otherwise [9, 26, 48, 84]. However, while digital technologies offer significant benefits, it is equally important to consider the potential drawbacks and challenges associated with their use. Issues such as technological surveillance, misinformation, and the impact of constant monitoring on mental health warrant careful examination to provide a balanced understanding of these tools' effectiveness [23, 57].

Although there is a considerable body of literature in the field of HCI devoted to designing and evaluating technologies that address various PMH concerns, there is a need to pay greater attention to the human and societal impact of PMH technology design while encouraging a more holistic view of user experience that looks beyond the purposefulness of technologies [20, 49, 76]. Typically, research within this field has focused on developing technology tailored to address particular mental health or wellbeing concerns, followed by assessing the efficacy of the technology and its features through quantitative or qualitative means [49, 55, 63, 74]. Despite this, there is still a gap in understanding the comprehensive perceptions, including challenges, benefits, and drawbacks, of using technology for managing PMADs, beyond specific solutions. Pregnant women and new mothers often navigate a complex landscape of marginalization, where the intersections of their various identities can exacerbate the challenges they face [7, 41], and therefore, this understanding bears more significance in guiding technology design for this vulnerable population. In this research, we aim to gain a nuanced understanding of pregnant women and new mothers' experience, perspectives, and challenges of their naturalistic use of PMH technologies and gauge their acceptance of these technologies in various stages of the perinatal period by answering the following research questions:

- **RQ1:** What are the perspectives of women in their pregnancy or postpartum regarding the utilization of technology for managing PMH concerns?
- **RQ2:** What are the challenges to effectively utilizing technology for PMH concerns? (Here, "effectively" considers how well these technologies align with the needs and expectations of mothers in managing their mental health, including accessibility, usability, relevance, and the ability to provide meaningful support throughout the perinatal period.)

We approached these questions by conducting semi-structured interviews with fifteen mothers who were either pregnant or in the postpartum period. These participants encompassed diverse racial backgrounds, including African-American, Caucasian, and Latino, spanning different trimesters of pregnancy and various postpartum phases (within the 24 months of childbirth). The participants in our study primarily represented young cisgender women residing in the United States. We conducted an additional analysis of online perinatal support groups to strengthen our interview findings. We examined 1,600 posts and 10,000 comments, allowing us to triangulate interview data, validate insights, and identify recurring themes across diverse sources. This multi-method

approach enhanced the research's rigor and depth. Our findings shed light on the complex array of reasons behind the varied preferences and priorities related to technology use during pregnancy and postpartum. Our qualitative analysis illustrates how mothers in their pregnancy and postpartum necessitated PMH technologies but continually experienced being under-served and less empathized due to contemplating misinformation, a lack of availability, and difficulty accessing mundane resources regarding their PMH concerns. An adaptable framework such as Evolving Prenatal and Postnatal Technology (EPPT) is suggested to address recurring challenges. The outcome of this research will assist future developers and researchers of HCI and health informatics to enable them to align current technologies with mothers' perspectives and meet mothers' expectations for future advancements in PMH care.

2 Related Work

In this section, we outline the current research landscape in HCI concerning perinatal period, taking a close look at perinatal technologies, and discussing aspects such as their effectiveness, the support dynamics they offer, participation trends, and the challenges they present.

2.1 Pregnancy and Postpartum in HCI

In recent years, HCI research has increasingly focused on the pregnancy and postpartum phases, delving into the design and evaluation of technological interventions such as mobile apps and wearables to aid perinatal health, maternity care, and postpartum tracking. These interventions assess maternal health, including monitoring fetal development, diet, and exercise during pregnancy and advising pregnant mothers [24, 81, 106]. The research extends to exploring self-tracking programs to enhance the emotional and psychological well-being of prenatal women [17, 31, 61, 66, 97]. Killas Ida et al. elucidated the emotional body of pregnancy, thus introducing a multi-sensorial environment and using affirmations derived from self-affirmation theory to enhance the embodied experience of pregnancy [58]. Similar to other vulnerable mental health context, emphasis has been given to co-designing technologies, such as the "Milk Matters" mobile application with breastfeeding mothers to promote breast milk donation and empower them with positive reinforcements [107]. Emerging wearable devices like my.Flow and LOONCUP [38] use embedded sensors to measure menstrual flow parameters automatically and encourage data sharing [51]. Findings from prior research also highlights the importance of strategic training for midwives and caregivers, so that they can provide better support to patients during these critical periods [22, 111].

HCI researchers are paying more attention in comprehending the challenges that new mothers encounter during and after childbirth, and the strategies they adopt in addressing those challenges. For example, recent research studies attempted to identify the behavioral changes that moms experience after childbirth, detect PPD, baby blues, and corresponding risk factors from different types of behavior traces or naturally occurring conversations on social media or online social support groups [25, 26], and to characterize the types of online social support [84, 86, 106]. A growing body of work has put an emphasis on fostering the development and recommendation of innovative technological solutions and systems designed to enhance the social support network during the postpartum period [27, 40, 82].

Research on prenatal care and education in resource-limited environments, such as low-income nations in the global south [11] and regions like Ecuador [103], underscores the pressing need to confront the substantial challenge of reducing healthcare disparities and ensuring universal access to vital maternal health resources and support. While exploring the intersectional nature of healthcare needs for women in the perinatal period, Smith et al. focused on designing a bilingual app to support the clinical care of pregnant women with diverse background [98]. Studies on marginalized women investigated the usage and satisfaction with digital mental health platforms among perinatal

Black women, revealing disparities influenced by intersectional factors like income and education level [16, 76]. Sensitive topics, such as birth trauma [6], dynamics of pregnancy loss disclosures on specific social network sites [5, 7], the effects of online spaces and algorithmic symbolic annihilation on pregnancy loss experiences, the difficulties LGBTQ people face when navigating pregnancy [85] and loss in online spaces have been discussed through lenses of critical, feminist, and intersectional theories. Together, these studies have provided a comprehensive understanding of how women navigate the complex topics of pregnancy related disclosures online.

2.2 Perinatal Mental Health Technologies

In the past decade, development of various mobile and web-based interventions transformed therapy, advice, and social support for PMH illnesses. Preventing and treating perinatal mood and anxiety disorders (PMADs) is one area where mobile health (mHealth) technology has proven vital in addressing perinatal wellbeing [18, 54]. For mothers in their perinatal period, these technologies—generally offered through mobile apps and devices—offer a variety of advantages [35, 36, 55]. For instance, many pregnant mothers regularly utilize mobile applications such as MyHealthyPregnancy [63], Pregnancy+ [55], bump2bump [74], and Babyscripts [55], Pregnant+ [14] to acquire appropriate health information, such as pregnancy development and potential risk identification while expecting [15, 81]. Mothers have typically reported to gain benefits from using these self-management applications [63, 91, 109]. On the other hand, mHealth interventions such as MUMentum [67], Be a Mom [37], and Happy Mom [113] provided online sessions for postpartum care through psychoeducational, physical, and self-care strategies centered on cognitive behavioral therapy (CBT), frequently integrating storytelling, animations, interactive exercises, summary videos, and homework assignments. On the contrary, wearable technology for PMH is frequently a commercial product that is easily accessible and that many people already use, such as cell phones and fitness trackers [92]. These gadgets help measure metrics related to mental health since they may monitor various factors, including physical activity, GPS location, and usage habits [90].

In the postnatal period, mothers often turn to online peer support groups and social media networks [19, 32], mirroring trends seen in other mental health domains [19, 21, 81, 88, 99]. A variety of online health communities and support groups, such as subreddits, What to Expect communities, and BabyCenter communities, Daily Strength communities [45, 83, 84, 112] have arisen allowing mothers to communicate with each other regarding their circumstances or experiences, which reportedly [32, 84] provide mothers with a sense of belonging and boost their self-esteem [29, 52]. Teaford et al. [101] noticed that online support forums could facilitate information sharing while also providing participants with entertainment, fostering a sense of community, and reassuring them that they are not alone in their struggles if they were to feel isolated. Despite the stigma surrounding PMH issues, often causing mothers to keep their concerns concealed from healthcare providers and their family members, these online support groups provided a platform for mothers to share their stories sincerely, offering anonymity as an essential feature [21, 46, 83]. However, there is limited exploration of how to facilitate these platforms to meet mothers' diverse and unique needs throughout the prenatal and postnatal period, including the effectiveness of different communication technologies.

Despite the growing adoption of technologies in perinatal mental health, it is essential to consider their potential drawbacks. Privacy concerns arise as these technologies collect sensitive data, potentially leading to security issues if confidentiality is not adequately protected [90, 92]. Additionally, while online health communities provide valuable support, they can also spread misinformation, which may impact users' mental health negatively [19, 21]. These technologies' constant monitoring and idealized representations can increase stress and anxiety, as users might feel pressured to conform to specific standards or compare themselves to unrealistic portrayals

[32, 90]. Addressing these concerns is essential to ensure that technological interventions in perinatal mental health are beneficial and do not inadvertently cause harm.

2.3 Women's Perception Towards Technology Use during Pregnancy and Postpartum

Lately, understanding women's perceptions of technology use during pregnancy and postpartum has become a critical area of investigation in the field of HCI and women's health. A significant portion of literature in this area, for instance, has added to our understanding of how women evaluate mHealth interventions [65, 87, 110] targeted towards their physical health. For example, in order to understand the engagement of mothers using mHealth interventions (associated with wearable technology), Jane Li et al. conducted interviews with eight women showing that, although tracking health and behavior changes during pregnancy could facilitate mothers' engagement, women fail to address pregnancy risk factors and symptoms, or even information about the baby through the system [65]. Another study by Kumar et al. using a Feminist HCI approach while exploring mothers' perception in a marginalized context discovered that the success of their mobile-based intervention for disseminating maternal health information to pregnant women in India depended on the involvement of household men (e.g., husbands) and the technical skills and assistance of children in helping new mothers use the app [27]. On the contrary, Uma D. et al. described mixed feelings of mothers using telehealth as video-conference therapy by categorizing their perceptions as positive experiences, negative experiences, suggestions and ideas, and screening and communication [77]. Gui et al. cited that mothers have been utilizing online health communities to reciprocate informational support by sharing experiential and traditional medical information, advice from peers, and exchange emotional support [46].

However, while research has contributed to apprehending the needs of mothers [81] and marginalized groups regarding various prototype systems [69], there has been a somewhat limited exploration of women's experience of technology use in their day-to day lives as a tool to bolster their PMH and navigate the associated challenges they encounter.

3 Methods

We conducted semi-structured interviews and analyzed online perinatal support community data to explore how various technological interventions support pregnant women and new mothers in enhancing their mental health. This multi-method qualitative approach allowed us to thoroughly comprehend the naturalistic observations of technology usage in this context. In this study, naturalistic observation refers to observing and analyzing discussions and interactions within online perinatal support groups, such as subreddits, without influencing or altering the conversations. This approach allows the researchers to capture genuine insights into mothers' experiences, challenges and needs as they naturally occur in these digital communities. This approach contrasts with clinical trials, which involve controlled conditions and structured measurements to evaluate interventions, whereas our methods focus on real-life usage patterns and perspectives in their natural context.

Interpretation of Technology in this Study

Drawing from previous research [43, 46, 65, 70], in the perinatal context, technology is perceived as a valuable resource that offers expectant and new mothers access to a wealth of information, support, and resources at their fingertips—following that our conceptualization of "technology" confines a broad range of tools and communication mediums utilized within the perinatal wellbeing context. This includes text messaging, phone calls, computer-based interfaces, online resources like websites and articles, applications tailored for perinatal health, online forums for peer communication, and popular social media platforms such as Facebook, Instagram, or TikTok. These tools serve diverse purposes, such as obtaining information, connecting with others, and accessing support and resources throughout pregnancy, childbirth, and postpartum.

3.1 Data Collection

For this study, we gathered data by conducting individual interviews with mothers who utilize technology for perinatal health and mental well-being, followed by collecting data from online perinatal well-being communities.

3.1.1 Semi-Structured Interviews. To gain a better understanding on how different technological interventions support pregnant women and new mothers in improving their mental health, we conducted in-depth semi-structured interview study with fifteen mothers.

Recruitment and Participants:

To recruit eligible participants, we employed a multi-channel approach. We distributed a flyer at local daycare facilities containing study details and a QR code linked to an eligibility survey. Additionally, we posted the same flyer on the subreddit r/postpartum_depression on Reddit, leveraging insights from prior research indicating the rapid utilization of online support communities by mothers facing perinatal depression. While initially planning to target other online communities dedicated to perinatal depression, such as BabyCenter and WhatToExpect, we discovered restrictions on participant recruitment through post-seeking [83, 84]. Our eligibility criteria included individuals pregnant or within 24 months postpartum, experiencing PMH concerns or diagnosed with a PMH illness, and utilizing technological interventions for mental health support. We used snowball sampling [79] with initial respondents and our network to interview 15 women, comprising eight pregnant and seven postpartum participants, until data saturation was reached. Data saturation was determined when recurring themes consistently emerged across interviews, and no new themes were identified in subsequent ones. While we recognize that achieving true saturation with a sample size of 15 participants is challenging, especially given the diversity of experiences and the complexities of PMH, this threshold was reached based on the consistency of the data.

The distribution of expectant mothers included four in their second trimester and four in their third trimester. Among those who were postpartum, four were within the first year after childbirth, with the rest falling within a 24-month postpartum period. A total of ten participants were already mothers, with eight reporting they had toddlers and two having infants. The group was ethnically diverse, comprising African-American, Caucasian, and Hispanic women, and were residents of the United States. All participants had been diagnosed with PMH issues, such as depression, anxiety, bipolar disorder, PTSD, and postpartum depression, through either self-assessment or clinical evaluation.

The age distribution of the participants primarily fell between 25 and 34 years (14 participants), with one participant in the 35 to 44 age group. Given that the 25-34 age range is the primary demographic affected by Perinatal Mood and Anxiety Disorders (PMADs) [3], and considering the heightened risk of perinatal depression among African-American women [42], the sample is expected to represent a significant portion of the at-risk population. This demographic focus is crucial for understanding and addressing the unique challenges faced by women in this age group from diverse races.

Regarding mental health assessment, the median score of the participants on the Edinburgh Perinatal/Postnatal Depression Scale (EPDS) was 15, with a standard deviation of 3.63. This score indicates a moderate level of depression among the participants, underlining the critical need to address mental health concerns within this demographic, aligning with the study's focus [64].

Furthermore, every participant reported utilizing at least one form of technology, such as mobile apps or websites, to manage their PMH issues.

Study Procedure:

We conducted all the interviews within a ten-month period, from July 2022 to April 2023. Due to the prevalent stigma associated with this context, the participant recruitment process proved

to be a little time-intensive. Mothers were hesitant to share their perinatal experiences through interview-based approaches. Participants received a $30 Amazon gift card as a token of appreciation for participating in the study. The presence of an incentive might have influenced participants' openness and willingness to share their experiences, potentially affecting the richness of the data.

The interviews were semi-structured and lasted, on average, 50 minutes. The duration ranged from a minimum of 40 minutes to a maximum of 1 hour and 15 minutes. Questions were focused on the following areas: background (introduction; current estate of the perinatal period), mothers' perceptions (incorporating social support, encountered obstacles, and individual PMH concerns), technology usage (confining the utilization of technological interventions and perceptions thereof), prospective interventions (entailing coveted features aligned with individual needs).

3.1.2 Online Perinatal Support Communities. Online perinatal support groups are a valuable source of insights into mothers' experiences seeking mental health during the perinatal period. Prior research has shown that women extensively discuss technological resources and interventions and their challenges on these platforms [46, 84, 100], and therefore, these platforms may be utilized as a rich source of real-world conversations about these issues. We extended our data collection to four subreddit communities dedicated to perinatal well-being, namely r/postpartum_depression, r/BabyBumps, r/beyondthebump, and r/postpartumprogress. Selection criteria included platforms known for their active participation by mothers seeking support and information regarding technology during the perinatal period. We chose these specific subreddits due to their high activity levels, relevance to perinatal mental health, and diverse user base in the United States, providing a broad spectrum of experiences and perspectives. To address potential biases in subreddit selection, we ensured that the chosen communities represented the broader landscape of online perinatal support groups, considering the variety of topics discussed and the diverse participation. We leveraged Reddit for our study due to its popularity as a platform for mental health discussions, highlighting its valuable role in providing support, advice, and resources related to mental health issues [13, 21]. Studies [21, 26, 78] show that Reddit cultivates supportive communities ideal for openly sharing experiences and accessing information, making it well-suited to investigate perinatal mental health support. The selected subreddits host vibrant daily discussions among perinatal women, covering various topics and frequently mentioning technologies to support mental health. We extracted approximately 1,600 posts and 10,000 comments from four subreddits: r/postpartum_depression (600 posts, 4,000 comments), r/BabyBumps (400 posts, 3,000 comments), r/beyondthebump (300 posts, 2,000 comments), and r/postpartumprogress (300 posts, 1,000 comments). The six-month timeframe was selected to capture a broad range of experiences while maintaining a manageable dataset for in-depth qualitative analysis. While this period does not account for potential seasonal trends, it was chosen to ensure the relevance and timeliness of the data, reflecting current discussions and experiences within these communities. Future research could extend the timeframe to explore seasonal variations in perinatal mental health discussions. This integrated approach allowed us to triangulate our interview findings, validate insights, and identify common themes and patterns across different data sources, eventually enhancing the rigor and depth of the research findings.

3.2 Data Analysis

After combining the collected online community data and interview transcripts, we conducted an in-depth thematic analysis of the collected online community data and interview transcripts, employing an iterative inductive approach [33]. All analysts were involved in reviewing the entire dataset, including all posts, comments, and interview transcripts, to ensure comprehensive coverage and consistency in theme identification. Initially, each researcher independently reviewed

the online community data and interview transcriptions, generating an initial list of themes. The themes were identified through a process of open coding, where segments of the data were labeled with descriptive tags. These initial codes were then grouped into broader themes through constant comparison, where emerging themes were continuously refined and adjusted based on ongoing analysis. Subsequently, the researchers collaborated to examine and merge the themes' similarities and differences. Given the semi-structured format of the interviews, the coding process primarily organized responses around specific topics or groups of related questions. For example, prominent themes emerged regarding mothers' perspectives on PMH technologies and their preferred technological interventions. Other themes and sub-themes also surrounded recurring topics that frequently arose, even when not explicitly addressed. Throughout the coding process, any concerns or uncertainties were addressed through discussions between the researchers. Consensus was reached on a few exceptional cases of doubt, ensuring the accuracy and reliability of the analysis. This thorough and collaborative approach facilitated a nuanced exploration of the data, capturing the mothers' experiences and perspectives on technology use during the perinatal period. The following sections will specify references derived from interview data by the notation P1, P2, and subsequent numerical sequence. References to posts from online perinatal support communities (SR) will be designated SR_P1, SR_P2, and onwards, while comments will be referenced as SR_C1, SR_C2, and forth.

3.3 Ethical Consideration

Throughout the study, researchers followed ethical guidelines by obtaining approval from our university's Institutional Review Board (IRB), ensuring participants' rights were maintained. Participants provided verbal consent, and their anonymity was preserved. Besides, data collection from the online communities adhered to Reddit's terms of service, with identifiable information withheld to maintain confidentiality. Reddit's content policy permits research use as long as user privacy is respected and data is anonymized. While the terms of use did not prohibit research, we followed ethical best practices, including anonymization and data protection, to safeguard community privacy. Original posts and comments were modified to protect anonymity while retaining the meaning of the contents.

3.4 Positionality

The authors of this paper brings a range of personal and professional experiences related to perinatal mental health challenges. One of the authors has connections to these topics, that provides us with unique perspective and a deep empathy for the struggles faced by the study population. The familiarity with mental health challenges allowed us to approach participants' experiences with greater sensitivity and understanding, and to foster a research environment that is respectful and responsive to the complexities of these experiences. The authors have expertise in intersectional stigma, online social support, and working with marginalized and vulnerable populations. This background shaped our approach to data interpretation. We sought to acknowledge and respect the nuanced ways in which stigma and social support intersect with perinatal mental health and to consider diverse perspectives and lived experiences that may otherwise have been overlooked. Throughout the research process, we engaged in reflexivity practices to recognize and mitigate potential biases arising from our own experiences. These reflexivity practices helped ensure that our empathy and connection to the study population did not unintentionally shape the findings but instead enriched our understanding in a thoughtful and transparent way. By including this positionality statement, we seek to provide transparency and trustworthiness in our research. It provides a better understanding of the lens through which we approached this study, while

reinforcing our commitment to conducting rigorous and respectful research with populations facing mental health challenges.

4 Findings

The interviews were designed to capture mothers' perspectives on PMH technologies, which shed light on the challenges mothers face while navigating those technologies and how mothers anticipate future technological interventions in this context.

4.1 Understanding the Perspectives on Technology-based Perinatal Support

This study explored mothers' convoluted, often contrasting perceptions concerning technology-based perinatal support. Our interview participants varied in their use of digital resources during the perinatal period. Although their engagement with technology for mental health concerns was not consistently frequent, they acknowledged turning to technologies for precise information or guidance when needed, whether through mobile apps, web-based platforms, or internet browsers. We describe our findings on mothers' perceptions of their daily technology usage under four themes: **enhanced accessibility and ease of use**, **perceived effectiveness of PMH technologies**, **social support and community engagement**, and **perceived benefits of anonymity**.

4.1.1 Enhanced Convenience and Ease of Use. The mothers' perceptions of perinatal technology were inherently interconnected with their awareness of and receptiveness to technology utilization during the prenatal and postpartum periods. They emphasized the convenience it offers and their overall user experience when engaging with these technologies.

When asked about technology solutions for resolving prenatal mental health concerns, our study's pregnant participants in their second or third trimester tended them over traditional healthcare services due to their enhanced accessibility and flexibility, allowing them to access information from any location. This preference originated from time restrictions, poor mental healthcare for expectant mothers, and logistical challenges. This trend persisted prominently within online prenatal communities (r/babybumps and r/beyondthebump). Here, mothers exchanged insights on how digital platforms streamlined their pregnancy journey, discussing the convenience and accessibility these tools provided in managing various aspects of their prenatal experience, from tracking pregnancy to seeking support and information for mental health. Due to their limited mobility during pregnancy, individuals depended heavily on technology; they reported experiencing abrupt and severe mental health problems, including anxiety and mood swings, saying,

> *"Navigating pregnancy is tough enough, especially when mental health issues arise, but tech offers a lifeline when traditional sources fall short as I could just Google my symptoms and get to know immediately what issues or what reliefs I should get you know!."* (SR_P113)

While our interviews, mothers stated they usually search for relevant information or symptom monitoring through online searches, predominantly via Google and YouTube, to address their concerns. However, three participants pointed out that there is a significant lack of mental health services for pregnant women, and many mental health illnesses are overlooked or left untreated until they are in crisis. Participant 2 noted:

> *"You go to the hospital, but the doctor isn't available, probably is dealing with other people, especially concerning mental health, services, maybe they're dealing with other people with other mental issues, like maybe depression, PTSD, or bipolar. And sometimes they are extreme, and the doctor will be like, let me first serve them, or the doctor, maybe a clinician, is busy elsewhere. So they don't get the time to attend to you. Or even sometimes, we don't get the time to see the doctor."* (P02)

In contrast, during our interviews with mothers in their postpartum phase, it became apparent that despite being aware of the technological advancements available for managing postnatal mental health, a significant number leaned towards human-centered care. A recurring theme in their narratives was a profound sense of loneliness, depression, fatigue, and feeling overwhelmed during this period. This sentiment accentuated mothers' deep value on direct interpersonal connections and the emotional resonance derived from in-person assistance from mental health professionals and peer support groups. They cherished the human touch, empathy, and nuanced understanding facilitated by non-verbal cues in face-to-face interactions, highlighting the irreplaceable nature of human connection during a crucial life transition period. As Participant 5 mentioned,

> *"I need the most is someone who can listen to me kindly in a place, someone who can give me the time, and place with no distractions, not online but face to face."* (P05)

While sharing the experience of online therapy sessions, one of them mentioned,

> *" I've tried to do a call and video therapy before. I did not really stick with it because I didn't feel like it was doing anything for me."* (P13)

These insights reveal the limitations of digital interventions in addressing deeper emotional needs. Although technology provides convenience, as highlighted by participants, it often fails to deliver the empathy and nuanced understanding required during postpartum challenges.

However, it's essential to acknowledge that not all participants shared this perspective. Many preferred utilizing digital media for social and professional support regarding mental health and well-being. The interview participants revealed that their reliance on technology extended beyond addressing major mental health concerns to confine underlying mundane issues causing emotional distress. For instance, many frequently turned to online platforms like Google browsing and YouTube for guidance on their babies' dietary and sleep patterns. Post-delivery challenges, such as difficulties in breastfeeding, often caused their anxiety to worsen, and to alleviate these concerns, they sought insights on effective breastfeeding techniques available across various digital platforms. Echoing to that one of the mothers from the communities commented,

> *"I find it much more convenient to use technology-based interventions as it simplifies the process of seeking help. It saves time and effort compared to going to the hospital or searching for information otherwise."* (SR_C278)

Furthermore, to illustrate their navigation experience with technology, mothers often expressed frustration with websites, citing challenges such as overwhelming amounts of information, technical glitches, and difficulty in navigation. They mentioned the lack of user-friendly interfaces and the inability to find precise details efficiently make their web browsing overwhelming. For instance, a participant stated, *"I found it hard to go through websites. There was too much chaos, and I couldn't find what I was looking for easily; instead, it gets diverted through some random ads or broken links,"* whereas another mom noted, *"not even a website provides actual information about pregnant mothers' mental health."* On the other hand, mobile apps were frequently favored for their intuitive navigation, streamlined interfaces, and convenience to the interview participants. As one of them said, *"Sometimes logging into a website is hard and technical problems could come in, an app is much more effective."* Others noted the simplicity of mobile apps, which offer easy access to relevant information and resources with fewer clicks; however, they still cited concerns about the lack of correct details to get the required information. Some even noted downloading the application versions of multiple web-based platforms like *Reddit, BabyCenter, What to Expect* because they could access those from mobile. Related to that, P03 mentioned,

> *"I found myself relying more on mobile app versions of BabyCenter rather than web versions (of those platforms) during my pregnancy. The convenience of having these*

	Preconception	Pregnancy			Postpartum
	Before Conception	1st Trimester	2nd Trimester	3rd Trimester	Within 2 Years of Childbirth
Technology Category	Information gathering, ovulation cycle tracking, health monitoring, mental health recommandations, social support	Pregnancy tracking, prenatal exercise, social support, prenatal wellbeing care recommendation, consultation			Postpartum self care, wellness, social support, postpartum exercise, consultation, mental health symptoms tracking
mHealth Technologies	Ovia, Flo, Premom	HiMommy, Expectful	HiMommy, Pregnancy+, Pregnancy Yoga App	Expectful, Pregnancy+, Pregnancy Yoga App	TalkSpace, Happify, Calm, Peanut
Web-Based Platforms	WebMD, What to Expect, BabyCenter, The Bump				
Online Communities and Social Media	Online perinatal wellbeing communities (What to Expect, BabyCenter, Reddit), Social Media (Facebook, TikTok, Instagram)				

Table 1. Taxonomy of technology utilization through different trimesters of pregnancy and within two years of childbirth

> *resources at my fingertips, accessible anytime and anywhere, made my pregnancy more manageable.*" (P03)

In summary, pregnant participants favored technology due to time constraints and limited traditional care access, finding it accessible and flexible, while postpartum mothers valued human support but also used digital platforms for convenience. Also, despite common frustrations with websites, mobile apps were praised for intuitive navigation, though accuracy about the information concerns remained.

4.1.2 Perceived Effectiveness of Perinatal Wellbeing Technologies. Participant mothers affirmed the benefits of digital interventions like apps, online platforms, and telehealth for perinatal support, aligning with our findings that online community discussions frequently highlight the effectiveness of these technologies for managing mental health during pregnancy and postpartum. Table 1 presents the taxonomy of technology (mHealth technologies, web-based platforms, and online communities) utilization throughout their preconception period, different trimesters of conceiving, and within two years postpartum. Our research revealed a correlation between maternal mental health during the perinatal period and their health-related concerns, a finding supported by prior studies [35, 36, 55]. Participants referenced occurrences wherein particular health concerns induced stress and anxiety, elucidating the role of perinatal wellbeing technologies in facilitating the assessment and management of such circumstances. Although our interview study did not include participants from the preconception stage or the first trimester, insights gained from mothers in their second or third trimesters and online discussions offer valuable perspectives on their utilization of technology during the initial phases of pregnancy. Additionally, some discussions also touched on the use of technology in the preconception phase. Mothers planning for conception mentioned apps like Flo, Ovia, and Premom for tracking cycles and overall health, providing insights that supported their mental well-being during this stage. While these observations are noteworthy, the primary focus of our study remains on the perinatal period, ensuring that the core discussion stays centered on perinatal support technologies.

Preconception Technologies:

The interview study and online communities showed that mothers planning for conception increasingly leverage technology to track their cycles, fertility, and overall health, including mental health. They mentioned using apps to monitor menstrual patterns, ovulation, and basal body temperature, which provide insights into their fertile windows and hormonal changes. In online communities, mothers frequently mentioned that preconception apps like Flo, Ovia, and Premom can help identify fertile windows and provide insights into hormonal patterns. Flo, Ovia, and Premom are popular apps that employ data tracking, personalized insights, community support, and educational resources to guide women through preconception planning, fertility tracking, pregnancy journeys, and parenthood. One of the moms in the online community noted,

> *"As someone with irregular cycles, Flo's cycle predictions have provided insights I couldn't get from just charting manually. It's giving me more confidence in timing for conception."* (SR_P756)

Mothers mentioned these apps also offered them tips on preconception nutrition, exercise, and lifestyle factors - leading mothers to recommend these apps to other mothers who are also going through the same situation in the online communities. Mothers also emphasized that monitoring their hormonal fluctuations and engaging in tailored meditation practices played a pivotal role in preserving their mental well-being during this time. Overall, technology allows mothers-to-be to make informed decisions about their fertility, potentially improving their chances of a healthy conception while maintaining their mental wellness.

Pregnancy Technologies:

Traversing the emotional ups and downs of pregnancy can be challenging, making mental wellbeing a top priority for pregnant mothers. In our interviews, mothers elaborated on the interconnected nature of tracking pregnancy health progress and their mental health concerns. They highlighted how monitoring physical health indicators, such as fetal development and maternal well-being, significantly influenced their emotional and psychological states throughout the perinatal period. The analysis of both online communities and interview data provided valuable insights into the prevalent utilization of technology among pregnant mothers seeking mental health wellness resources and recommendations through apps like Pregnancy+, WebMD Pregnancy, and Expectant. Pregnancy+ is an app for pregnant mothers that offers a user-friendly experience for tracking fetal movements, monitoring weight gain, and visualizing the baby's growth, including detailed charts and images, while Expectful is a comprehensive pregnancy app offering traditional week-by-week updates and articles along with standout features like daily pregnancy meditations and a diverse library of mindful pregnancy workouts, including a notable prenatal stress-relief class [4, 68]. WebMD Pregnancy application provides doctor-approved content and tools like checklists, doctor's visit questions, a weekly bump photo album, and specialized content for those expecting twins [4]. Regarding the use of Pregnancy+, one of the mothers mentioned from the community,

> *"Every time I become pregnant, this is my to-go app. It's perfect for getting the ideal weight and height and comparing it to the weight and height I get from my appointments. It's great to keep track of weight gain or loss while pregnant... I also appreciate the self-care tips and relaxation techniques that helped me prioritize my well-being pregnancy"* (SR_P516)

They also voiced that while these health apps offer valuable information, they fall short in addressing mental health concerns and providing guidance on managing anxieties during pregnancy thoughtfully. About using WebMD Pregnancy, Participant 4 stated,

> *I really like that it gives advice, and again, it gives our daily articles so that you can read about pregnancy and it's related mental health issues as well...But it doesn't really talk intensively or get intensively into the pregnant mother's mental health.* (P04)

Pregnant women in their second or third trimester reported utilizing yoga applications to help them relax and regain mental tranquility using the Pregnancy Yoga App. Through guided meditation, breathing techniques, and gentle stretches, pregnant women mentioned alleviating stress, reducing anxiety, and cultivating a sense of inner calm. However, they noted, "Not everyone is EXACTLY the same," illustrating how these apps are not tailoring enough for individuals. Within online communities, mothers have highlighted using apps like HiMommy to bridge their pregnancy journey with their partners. As one mom commented,

> *"The Himommy one is more fun and can be linked to the father (Hidaddy), and he gets different updates every day. There's an option to make it "naughty," lol, but I like it because it lets him in, on the everyday discomforts you are going through too."* (SR_C1367)

By utilizing these technological tools, expectant mothers have placed equal importance on their emotional wellbeing and physical health, adopting a more comprehensive approach to prenatal care.

Postpartum Technologies:

On the other hand, postpartum mothers repeatedly use self-assessment and mood-tracking tools to determine whether they are facing mental health concerns as they emphasize that mental health concerns become a pressing issue following childbirth, prompting them to monitor their emotional state using such tools actively. They often used web-based systems like *BabyCenter, What to Expect* and text messages and platforms like *Talkspace, Calm* and *Happify* for telehealth recommendations of medication, online therapies, and cognitive behavioral therapy. Talkspace is an online therapy service that connects users to a licensed provider in their respective state for personalized therapy through private messaging or live sessions based on the user's plan [2]. On the other hand, Calm is an adaptable app for meditation, sleep, and relaxation, offering a range of features, including meditations, stories, music, and soundscapes to promote mindfulness and tranquility [73]. Although these applications are not specifically designed for postpartum mothers, they provide general solutions to mental health concerns such as depression, anxiety, irregular sleep cycles, and more, offering support and resources for overall well-being. One mother shared that she incorporates the app Happify into her routine to bolster positive thinking by engaging in mindfulness games and assessments. Mothers noted that the flexibility of these technologies was beneficial during the stressful postpartum period when time restrictions and *baby-related responsibilities* were seen as significant obstacles. One of the participants mentioned,

> *"During my postpartum depression, I relied on technology a lot. I used it to research counselors and to attend virtual counseling sessions. Texting was also a way to communicate with my counselor, especially during difficult days."* (P09)

In the online discussions, mothers noted that while they appreciate the specialized focus of certain apps, they find their utility to be limited over time. They expressed a preference for apps designed to cater to a broader spectrum of their needs.

> *"There was an app with only one feature, and that was to connect with a Lactation Consultant, and that was cool. But there was no other feature."* (SR_P68)

Although these technologies show potential in enhancing access to mental health resources, there are apprehensions surrounding the accuracy of resources specifically to address the mental health needs of postpartum mothers. Many existing apps and tools cater to general mental health needs, which does not adequately address the unique challenges faced by new mothers.

4.1.3 Social Support and Community Engagement. Online perinatal support groups, including forums like subreddits, BabyCenter communities, What to Expect communities, Daily Strength communities, and Facebook groups, have benefited participant mothers' perinatal experiences.

Nowadays, even perinatal apps such as Peanut and Mamma Mia [102, 105] allow mothers to connect and form support groups. During the interview, many mothers indicated that *exchanging advice, encouragement, and emotional support* in those support groups formed an insightful network for them that is not geographically confined.

> *"The major resource I used was community message boards, especially on platforms like 'What To Expect.' It allowed me to post updates, ask questions, and share concerns."* (P03)

In answer to what type of information she availed from the community, she noted,

> *"I look for everything from 'why is not my baby turning over yet or rolling yet' to 'is it normal for me to have leg cramps in the middle of the night? Is anybody else experiencing brain fog?' You know, it is a wide range of everything, but I'm not often the one posing a question, but I am often reading about somebody else who's posing a similar question to something I am experiencing, and that is helpful."* (P03)

In those communities, mothers often voiced that by fostering connections, providing information and advice, and offering a supportive space for expression, these communities empower them to navigate the journey of pregnancy and motherhood with confidence and resilience. Expressing gratitude for the support received, one mother in the community wrote,

> *"Being part of an online perinatal support group has made me feel less alone during this journey. It's incredible how strangers can become such a source of strength and encouragement."* (SR_P123)

Mothers regarded these platforms as more reliable and easy to follow than arbitrary perinatal websites; P03 emphasized *"Online forums felt more real and authentic compared to some alarming and scary information that I found on other websites."* Through the mothers' lens, online support groups primarily facilitated the exchange of informational and emotional support, while the availability of instrumental support remained notably lacking. Few mothers mentioned they require immense instrumental support during postpartum, but they failed to obtain any through any support groups, P11 said,

> *"Hell yeah, I need instrumental support from my surrounding or any source for maintaining my wellbeing!! But through technology or even online communities couldn't be possible!"* (P11)

On the contrary, whilst not all mothers posted or commented on those platforms, they certainly went through other stories to learn how to deal with their situation or to check *if the feelings (concerns) were normal or similar*. They repeatedly stated, *"It feels good to feel like you're not alone."* During our interviews, we had the opportunity to interact with a healthcare provider (nurse) mother. She shared that she found reassurance in perusing TikTok videos wherein fellow mothers openly engage in discourse and organize their lifestyles around the intricacies of postpartum mental health issues. However, in contrast to that other participant mothers opposed, P10 stated,

> *"You can actually talk to somebody who's going through the same thing as you, you know, instead of like your Instagram or Facebook or whatever, as they are random thoughts out there. But on Reddit (subreddit: r/postpartum_depression), it's, like, people are actually going to respond to you and others are going through the same situation like you, which is nice."* (P10)

Although many found comfort and support online, there was concern about the pressure and unrealistic portrayals often encountered on social media platforms like Instagram. P08 highlighted,

> *"On the other side of the point of Instagram, there's always, you know, the people who are super happy and perfect-looking, so that's sometimes kind of rough on us."* (P08)

Furthermore, a couple of mothers (n=3) mentioned they did not belong to any online group during their perinatal period. Conversely, a small segment of mothers believe that, at times, women divulge excessive personal information about their experiences, leading to discomfort among fellow moms; they said, *"Sometimes people share too much personal information or express themselves inappropriately, which I find uncomfortable."* (P07) Overall, participant mothers regarded online perinatal support groups as an effective means of exchanging social support.

4.1.4 Perceived Benefits of Anonymity. Anonymity in online platforms presents a nuanced role in the context of seeking mental health assistance [89], a trend that holds true for individuals addressing PMH concerns. Our interviews revealed that a substantial number of mothers (n=8) derived comfort from the anonymity afforded by mHealth interventions, often opting to use pseudonyms to maintain confidentiality. This approach enabled them to find "comfort" in sharing their experiences and emotions candidly without the fear of judgment or stigma.

Online communities, where anonymity is preserved, fostered environments conducive to open discussions, allowing mothers to connect with a broader support network that transcends geographical boundaries. However, this preference for anonymity also stemmed from skepticism of sharing mental health struggles on platforms like Facebook and Instagram, where their family could potentially become aware of their challenges. Consequently, many chose to share on platforms such as Reddit and BabyCenter, where they could seek advice and express themselves either anonymously or under a pseudonym, thereby safeguarding their privacy while accessing support. P06 mentioned,

> *"On Reddit, I talked to a lot of people. You know, you can make a comment or post, and then they will comment on that, and we can talk back, or you can privately message, and it's anonymous. So, you know, you don't have to picture and stuff about you like that necessarily, so that's a big one, anonymity when you're venting is a big ONE to connsider."* (P06)

Two participants expressed discomfort with sharing personal experiences on social media, regardless of the level of anonymity, citing privacy concerns regarding the information they might divulge. Despite their reservations about posting, they valued the contributions of others who openly shared their perinatal journeys online. However, the element of anonymity introduced a layer of complexity and apprehension for some users. Four participants raised concerns about *"the veracity of information provided by people whose names are concealed"* in online forums and tools, a sentiment encapsulated in the statement, "If I become anonymous, that means I do not even trust myself." This highlights an inherent tension in the mental health sphere between the desire for anonymity and the necessity for trust and authenticity in self-disclosure, a dichotomy mirrored in other mental health domains.

4.2 Challenges Encountered in Adopting Perinatal Wellbeing Technologies

While our participants mostly have a positive attitude toward technology use for PMH concerns, they delineated several substantial challenges hindering their effective access and use of these resources, which we themed as: **lack of comprehensive perinatal care, navigating contradictory information and misinformation, concerns about the use of sensitive data, and financial constraints.**

4.2.1 Lack of Comprehensive Perinatal Care through Technology. While technology shows promise in increasing access and engagement for PMH support, the online discussion of mothers revealed that many current digital offerings fail to provide truly comprehensive care. Most apps and online platforms tend to take a fragmented approach - focusing solely on one element like maternal education, peer support forums, mood tracking, or meditation practices. For example, one of the mothers in the communities mentioned,

> *I used an app that provides information about postpartum depression and postpartum care but does not offer validated screening tools or pathways to professional counseling services, as well as opportunities for social support.* (SR_C378)

Besides, throughout the interview, mothers mentioned encountering various accessibility and availability constraints when pondering technology to get help during the prenatal and postnatal phases. Interview participant mothers said they needed *more comprehensive, specialized solutions or platforms* for their mental health concerns as timely support. Highlighting the absence of evidence-based resources, a mother shared her distressing experience of sudden bleeding after exercising in her second trimester, expressing a need for credible information to feel reassured and normalize the situation - the lack of such resources and the prevalence of misinformation left her disheartened. Due to a lack of evidence-based services, especially targeting PMH concerns, moms felt underserved and struggled to find helpful strategies that were appropriate for their circumstances in time; as one of them mentioned,

> *"Initially, I searched for symptoms online to confirm if I had postpartum depression. I found it challenging to find information or even any app about what to do once I realized I had it. There was a lack of guidance on handling the situation."* (P14)

During their pregnancies, two mothers highlighted the absence of specific interventions addressing prenatal mental health concerns, including irritations, mood swings, and sudden emotional bursts. Conversely, two mothers who were in their first year of postpartum mentioned resorting to more general mental health interventions such as Calm and Talkspace, stressing the lack of technologies specifically concentrated on postpartum mental health. This trend persisted as postpartum mothers consistently faced challenges in finding interventions that assisted seamlessly with both prenatal and postpartum needs. For example, a mother using a pregnancy application during her prenatal period found the app lacking in addressing postpartum issues like recovery, birth trauma management, and sleep disturbances. This prompted mothers to navigate between multiple applications to meet their specific needs. Similarly, in online communities, mothers often noted the difficulty of identifying interventions that could be utilized throughout pregnancy and after delivery. Without combining these stages, digital solutions run the risk of missing critical needs or perpetuating gaps in care. These experiences emphasize the demand for more comprehensive and continuous support solutions in the context of perinatal care.

> *"I had an app during my pregnancy, which connected me with others in the same stage. However, it was not as helpful after the baby arrived; you couldn't post there anymore, you know, the community goes away."* (P05)

> *"Apps like Pregnancy+ was my go-to app during pregnancy, but I found myself searching for a new app to help me navigate the challenges of postpartum life. It would be wonderful if its features to support new moms beyond pregnancy."* (SR_P30)

Accessibility issues were prominent as well. Mothers noted that most platforms or programs they utilized only functioned while they were online. They emphasized, *"limited internet access has made finding online mental health information difficult."* Few mothers shared that there were instances when they required immediate support during the perinatal period for their impulsive depression and extensive weariness for their children but encountered difficulties gaining access to this crucial help because of problems with internet connectivity. The *lengthy login processes* of some particular apps made it difficult for them to get the timely assistance they required. Many mothers also pointed out not receiving immediate support from medical services through technology; *'Getting timely online counseling was difficult too. I was in crisis, but many counselors had availability issues or couldn't provide immediate referrals. They ended up giving me appointments on next month instead."*

This issue was also evident in online communities, where mothers faced challenges in quickly finding crisis hotline information during urgent situations. This struggle highlights a notable obstacle in accessing timely assistance -

> *"So I had a panic attack last night while in the bath. I had a thought about what would happen to me if I ended up in crisis or died or whatever, and what would happen to my baby? Where would he go...After searching crisis hotline, I tried crisis, I everything I could think of while in this state of mind.I had to use breathing techniques to calm down and function properly enough to use my phone. By the time I was able to find that 988 was the place to call I was no longer in crisis and came to the conclusion that the person on the other end would probably call cps and take my kid and send them to who has been playing dad this whole time which is why I was freaking out to begin with.* ***"Google, if I were suicidal, I would be dead. Google, if I were homicidal, my baby would be dead. Google, this is unacceptable. Why is it when someone types in a crisis hotline that it's seven lines down and hidden? Why is it not at the top big numbers 988.*** *Fuck your gd sponsored bullshit. Someone needs to fix that shit right now."* (SR_P76)

This digital gap isolates individuals from possible sources of assistance and exacerbates their difficulties when they require immediate attention.

Moreover, the significance of interpersonal relationships emerged as a crucial factor in maternal support, with many mothers highlighting that face-to-face interactions with family, friends, and healthcare professionals offer irreplaceable emotional resonance, practical assistance, and personalized guidance. While online support groups provide valuable emotional and informational support, they often fall short in offering the depth and immediacy of in-person connections. Overall, integrating both online and direct support systems is essential for a comprehensive approach to maternal well-being.

4.2.2 Cultural Sensitivity. Four interview participants noted that as they were from marginalized backgrounds, they felt that their applications did not adequately represent or resonate with their unique experiences and cultural contexts. In their words, *"The app does not look like they are talking about us."* In the online communities, mothers from diverse cultural backgrounds discussed their experiences with traditional apps like Pregnancy+ and Expectful. They pointed out that these apps typically focus on gathering information about partners or their involvement throughout the pregnancy journey. However, they noted that such features were not applicable to them due to the unique dynamics within their families. Assumptions embedded in such digital tools are not resonate with diverse family structures, traditional beliefs about pregnancy and childbirth, or communication styles. Additionally, one of the mothers mentioned her friends often faced *language barrier* while navigating the applications as the applications did not always support other languages (such as Spanish) than English.

4.2.3 Navigating Contradictory Information and Misinformation. The participants frequently relied on online resources, websites, forums, and social media groups to seek support and information. While search engines like Google and platforms like WebMD and Providence could offer general or perhaps unclear health information, perinatal health and mental health technologies are designed to provide moms with focused, trustworthy help during this crucial time - they are supposed to go beyond general search results. Many mothers highlighted the absence of evidence-based support in those technologies, prompting them to turn to online communities to address their PMH concerns. Notably, online PMH communities and subreddits emerged as significant mediums for them to access valuable insights and support. However, this approach was not without its challenges; nine mothers reported encountering "conflicting perspectives," "varied treatment suggestions," and

"groundless tales," which fostered a sense of uncertainty and hesitancy towards utilizing these platforms for guidance. As participant P06 noted, differing personal experiences often led to a divergence in the advice and perspectives shared, stating,

> *"It happened several times, not once, where someone says something, someone tries to explain something, and someone also has different experiences over the same problem, they have different stories."* (P06)

When faced with false information online, mothers often engage in discussions to navigate it by verifying facts, sharing credible sources, and offering personal insights to clarify misconceptions in online communities. This collaborative effort helps ensure that accurate and reliable information prevails within the community, empowering mothers to make informed decisions about their pregnancy and childbirth journey. Two participants noted that they opted to keep their queries and opinions to themselves to avoid potential conflicts or disagreements, a strategy that somewhat curtailed their engagement with technological solutions for managing PMH concerns. Despite these reservations, many still turned to platforms like Google or YouTube for urgent advice, albeit with a critical eye towards the reliability of the sources and the prevalence of misleading information and irrelevant advertisements. One individual highlighted the inadequacy of search results specific to PMH, illustrating the complex landscape of online resources that mothers navigate in seeking support for PMH issues: *"Google doesn't always offer specific information regarding PMH. You search for something and the results are vague or confusing."*

4.2.4 Concerns about the Use of Sensitive Data. Through our study, we discovered, similar to other sensitive mental health contexts, women with perinatal depression contemplating using technology to help their journey sometimes become intensely aware of the private and sensitive nature of their perinatal experiences when interacting with digital tools and platforms, leading to concerns about data security and personal information. Revealing personal health data or emotional issues via technology created a sense of vulnerability for most of our participants. All of our participants expressed anxiety about the secrecy of their information, fearing that their private information would be revealed to unwanted parties. Mothers frequently noted in online support communities that after inputting health-related data into apps like WebMD and Providence, they often received targeted advertisements directly related to the information they had previously provided. This experience led them to the realization that their activities within the apps were being monitored and tracked. The threat of *data breaches* or illegal access to their perinatal health-related data adds to their confusion and anxiety. They solely believe *"Personal data should be kept confidential and only accessible to necessary individuals, like doctors or healthcare providers."* Furthermore, two individuals raised doubts about the HIPAA (Health Insurance Portability and Accountability Act) compliance of certain apps and web platforms, adding another layer of skepticism to their perception of online tools. When prompted by apps, the participants did not want to share personal details such as their location, contact number, or address, leading to careful consideration of the pros and cons of divulging such information. This deliberative process involved evaluating whether the support and benefits derived from technology superseded the perceived risks to their privacy.

4.2.5 Financial Constraints. The financial difficulties connected with childbirth and early parenthood aggravated when evaluating the expense of PMH concerns through technological solutions. Investing in digital tools or platforms overwhelmed the participant mothers navigating perinatal depressive symptoms. Mothers (n=7) mentioned *subscription fees*, *app purchases*, and the cost of necessary gadgets added to the strain, especially since financial resources were already stretched low. Mothers in communities also mentioned that most applications do not even provide an actual overview of the functionalities on the free trial. Four of our participants also stated that their *insurance coverage*

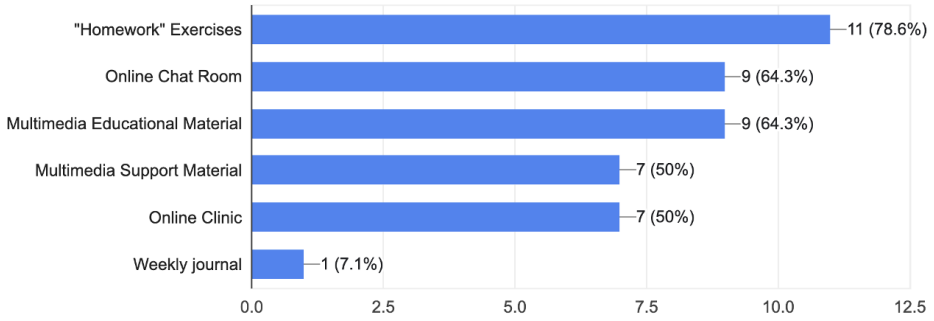

Fig. 1. Desired features of preferred perinatal technology as reported by the mothers

did not allow mobile applications other than the basic apps like *Providence App*, which failed to address their needs for PMH issues. One of them said, *"Virtual visits were more expensive under my insurance, which was an extra cost. It was hard to manage when already dealing with depression and anxiety. Cost and access to appropriate care were significant challenges."* Mothers said even apps like *Talkspace*, which provided online therapy sessions, are not affordable for the mothers as those are not *insurance covered*. They were divided between finding quality perinatal help and managing the practicality of their budget. One of them mentioned,

> *"Initially, it was a free app. I accessed it freely, so at some point, I couldn't log into it. I had problems logging into it. The system was slow, or I don't know, it's how the app was set or something. Then suddenly, it keeps asking me to pay for further usage. That is what I didn't like about it, and I canceled to use it."* (P04)

For the mothers, affordability affected not just access to technology but also the perceived value of these solutions. As our participant mothers were based in the United States, it is crucial to acknowledge that insurance-related aspects may vary compared to other countries. However, the generalized observation remains consistent across diverse settings, indicating that the affordability of these technologies is a common concern.

4.3 Suggested Features for Future Technology Design

4.3.1 Poorly Addressed Concerns in Existing PMH Technologies. The interview participants highlighted a range of limitations of the existing technological solutions, including lack of facilitation of remote therapy sessions, personalized health education, and timely reminders for medication. Four participants mentioned that they were not prepared for *birth trauma* and *breastfeeding discomfort*, and the sudden stresses these traumas bring, and failed to find resources around those topics. The participants unanimously agreed on the importance of maintaining a physical exercise routine during the perinatal period to support mental health, and they expressed that the PMH technologies they use lacked tailored, personalized healthcare routines. The mothers advocated for the inclusion of features that allow for the *easy tracking of health metrics* such as weight gain, food intake, sleep, and exercise, emphasizing the importance of monitoring maternal health parameters alongside those of their babies to foster a balanced PMH. In online communities, on the other hand, the mothers have implicitly mentioned that perinatal technologies, though abundant, often lack personalization. They present information and recommendations that are universally applicable, overlooking individual medical histories, risk factors, and cultural preferences. Limited tailoring, like generic prenatal yoga suggestions, postpartum mental care, and a focus on averages in risk assessments, can cause

confusion, anxiety, or a false sense of security. These technologies need to evolve to consider the unique needs of each user.

4.3.2 Desired Features in Future Mental Health Technology. In our interviews, we solicited mothers' perspectives on the desirable features and functionalities for future perinatal technology interventions. The open dialogues facilitated a deep understanding of their anticipations and needs for technology that supports them throughout their perinatal journey. A prominent request, voiced by several participants, was the incorporation of personalized content tailored to the various stages of the prenatal and postpartum phases. Mothers repetitively stated there should be an option in the technological interventions for immediate support, mentioning that *"PPD is an absolute emergency; they (developers, researchers) should consider the suicide hot line kind of thing for mothers as well."* Another participant described how she unexpectedly started bleeding during her third trimester, which caused her fear and anxiety. If she had access to *personalized healthcare technology* that allowed her to identify medical professionals, it would have been beneficial for her. They stressed the importance of having access to reliable information backed by *credible sources and medical experts*, especially when dealing with urgent and sensitive issues such as *handling birth trauma* or *breastfeeding discomforts.* To illustrate, one of the mothers mentioned, *"Nobody prepares you for how difficult and stressful breastfeeding can be! I wish I had access to breastfeeding educational resources to talk to other mothers about them."* Additionally, mothers highlighted the potential usefulness of participating in online chat rooms for receiving social support and validation of their feelings. Regarding the types of resources for gaining education and information, they mentioned that webinars, online clinics, and homework exercises (for physical and mental health) would benefit them in coping with their situations. In Figure 1, we have outlined the activities that mothers expressed their willingness to engage with in a technological intervention targeting PMH. Our findings revealed that mothers primarily favored features such as homework exercises, an online chat room for connecting with other mothers sharing similar experiences, and multimedia educational resources supplemented with illustrations.

5 Discussion

In this section, we discuss the implications drawn from our findings and identify potential areas for envisioned technologies and improvement in existing technologies.

5.1 Implications for Developing User-Centric PMH Technologies

Our analysis reveals expectations for personalized, technology-assisted care during pregnancy and postpartum. Postpartum mothers noted a decrease in the effectiveness of specific applications used during pregnancy, indicating the need for a supportive dynamic solution across both motherhood phases. A framework should be designed to understand the recurring challenges associated with the adoption of PMH technology and to create comprehensive and evolving prenatal and postnatal technological (EPPT) solutions. Unlike prior socio-technical ecology frameworks [81, 82], EPPT should be tailored to meet individualized needs, providing sustained support throughout the prenatal and postnatal periods. We outline the following feature design strategies within EPPT for systems adapting progressively across the pregnancy-motherhood continuum. While this vision builds on prior research, it also introduces new insights into the challenges mothers face with current applications. By emphasizing the importance of adaptable, personalized support and culturally diverse content, our findings contribute to a deeper understanding of how PMH technologies can more effectively serve mothers throughout their perinatal journey. These feature designs could be adapted by developers, researchers, healthcare providers, and policymakers to create and implement technology solutions that evolve alongside mothers' changing needs.

5.1.1 Access to Evidence-based Support Material. In our study, mothers emphasized the importance of having access to evidence-based support materials for dealing with challenging situations, as these often lead to mental health issues like stress, anxiety, and PTSD. However, they also face difficulties finding authentic information in websites or mobile health technologies and ended up getting misinformation instead-they even highlighted, *"Getting info from readings and by attending classes for managing mental health are so boring"*. In contrast to all these concerns, providing mothers with evidence-based multimedia educational and support materials designed within the technology for the perinatal period is highly desirable for mothers. Mothers affirmed that these multimedia resources could encompass diverse content to assist with perinatal wellbeing concerns, including videos, interactive tutorials, webinars, and informative articles. These multimedia educational resources can be seamlessly integrated into the EPPT framework, leveraging compelling **storytelling videos** and ensuring **diverse cultural representation**, enhancing their *effectiveness and accessibility* for mothers.

***Video Storytelling*:** Our findings enlightened that mothers constantly look for other mothers' stories on online support groups to get to know how other mothers in the same condition are handling their perinatal concerns; asserting on that one of the mothers mentioned, *"I enjoy going through the experiences shared by other mothers as evidence-based stories, the advice given by the doctor, and the resources shared by the members often helped me to deal with my situation."* (P08) The EPPT framework could employ "storytelling" to effectively engage mothers at this intersection. These intersect with other research studies in HCI [34, 47, 83, 94] on the effectiveness of online storytelling in the context of mental health, including postpartum depression. These video stories can cover various topics, from pregnancy and childbirth experiences to postpartum mental health journeys, breastfeeding advice, and the suggestions on online therapies, medications. These videos offer a rich source of peer support, encouragement, and evidence-based information by incorporating real-life narratives and insights from mothers who have navigated the perinatal period.

***Diverse Cultural Representation*:** Reciprocating our findings with prior research [76, 108], diverse cultural representation in online storytelling videos featuring mothers is a compelling and essential aspect of PMH-related content creation. These videos would have the potential to offer a unique opportunity to celebrate the rich arrays of cultures that shape the perinatal experiences of women worldwide. By showcasing narratives from mothers of diverse cultural backgrounds, these videos would not only honor the traditions, beliefs, and practices unique to each culture but also would promote inclusivity and empathy, which identifies a crucial point in HCI research [16, 76].

5.1.2 Access to Individualized Care. Echoing previous research [95], all mothers we interviewed also voiced the importance of physical exercises while navigating their mental health concerns such as *mood swings, stress, and abrupt thoughts*. They also noted that illustrating a variety of individual self-reflective and self-care activities aimed at promoting emotional and physical wellbeing during the perinatal period would be helpful to them. It is essential to create a segment to assign mothers personalized homework exercises to engage in mindfulness and relaxation techniques, tailoring physical exercises recommended by healthcare experts to promote mental wellbeing during this critical period. It is essential to maintain an evolving cycle from healthcare experts' recommendations on individual mothers' physical conditions and, thereof, make suggestions on the physical activity exercises through the EPPT framework.

5.1.3 Integration of Family-Centered Care. Integrating family members, particularly partners, as they are recognized as the primary support source [96], into the framework holds significant implications for designing technology solutions that cater to the holistic needs of mothers during the perinatal period. This family-centered approach enhances communication and collaboration between partners, enabling shared decision-making and goal-setting. The EPPT framework can

also leverage educational resources through storytelling targeted at spouses to enhance their understanding of PMH and wellbeing. Additionally, by incorporating feedback mechanisms and considering privacy and security features, designers can ensure that technology solutions within the framework adapt and improve continuously, promoting active digital participation and support for husbands, even in remote scenarios. Cultural sensitivity in design is vital, recognizing that different cultural dynamics influence family involvement in maternal care, necessitating flexibility within the framework to accommodate diverse expectations.

5.2 Implication for Improving Existing Technologies

5.2.1 Leveraging Technology for Immediate and Effective Support. One key implication of leveraging existing technology for PMH support is the ability to provide immediate assistance and interventions during acute distress. Our analysis has identified that mothers often seek immediate support through technology - while dealing with their PMH concerns. These technologies could even leverage inputted data to detect warning signs and patterns, triggering outreach from providers or facilitating urgent telehealth sessions when intervention is critically needed. Unlike traditional support channels with potential delays, technology can shrink the gap between a mother's need for care and access to personalized strategies, psychoeducation, and professional resources. By offering this immediate availability of supportive interventions, maternal mental health crises could be de-escalated more rapidly, adverse outcomes reduced, and resilience fostered during the perinatal period's most vulnerable moments.

Additionally, integrating technology with in-person support can enhance the effectiveness of counseling by offering complementary resources and continuous care. Technologies can be designed to extend the reach of face-to-face counseling, providing mothers with holistic care that combines the personal touch of human interaction with the convenience and personalization of digital tools. This dual approach is crucial in addressing the diverse and evolving needs of mothers throughout the perinatal period.

5.2.2 Integrating Cultural and Contextualized Sensitivity. Contrasting our findings to prior research [76], cultural sensitivity remains a persistent concern for mothers from diverse and underrepresented cultural backgrounds. Integrating cultural and contextualized sensitivity in developing and deploying healthcare technologies, particularly in the field of PMH, holds profound implications for improving both the accessibility and effectiveness of these tools. PMH technologies should prioritize the inclusion of multiple languages, such as Spanish, and comprise diverse cultural representations to ensure broader accessibility. Furthermore, research in this context is needed; an emphasis on cultural and contextual sensitivity facilitates the co-creation of technologies, involving users as partners in the design process, which can lead to more meaningful and user-centered solutions.

5.2.3 Designing Towards Data Transparency. While users are genuinely concerned about the collection and handling of their data, striking a balance between user expectations and the complex landscape of regulations and policies is challenging. Participants often did not provide private information, such as contacts, locations, etc. as asked by the apps, because they were unsure of how and why these information would be used. However, lately, it has been identified that data transparency is indispensable for instilling trust among patients within health-related systems [56], especially in mental health domains [50] - because of rules, regulations, and internal policies on information sharing [60]. The situation is particularly delicate when it comes to PMH difficulties since women frequently worry about possible information disclosure to family members or midwives out of the fear that their child would be taken away from them or they could be judged by others [72, 104]. To address this challenge, designers and developers should prioritize collaboration among stakeholders, including users, healthcare providers, and policymakers, comprehensively

assessing their values and data transparency needs. This approach ensures that future technologies align with user expectations, comply with legal and ethical standards, and enhance user trust, ultimately leading to more effective and ethically sound PMH solutions in an increasingly data-driven healthcare environment.

5.2.4 Transparency Towards Technology Pricing for the Stakeholders. Our findings revealed instances where participants downloaded apps while experiencing emotional distress, and as they started replying on the app for support, they discovered that features eventually got locked behind a paywall they could not afford. Mothers emphasized the importance of free trials to evaluate whether the app meets their needs, such as reviewing online therapies or consultants before committing to payment. Designers should prioritize creating interfaces that give explicit price information while taking into account the expenses involved in app creation and maintenance. It may be helpful to use visual tools to break down costs and determine whether insurance would be able to cover them. Hence, developers and policymakers must work together to create cost-effective solutions catering to insured and uninsured individuals, promoting equitable access to PMH support.

6 Limitations

While adhering to HCI norms in sample size, our study has several limitations. The research is primarily US-based, with participants drawn from US communities and online perinatal support groups, which may skew findings toward US perspectives. This focus may limit the generalizability of our findings to other countries with different healthcare systems and cultural contexts. Additionally, although we employed a naturalistic approach by observing user interactions on Reddit, it is important to note that this differs from observing users in a physical, real-world environment. Instead, our study focuses on digital ethnography, observing and analyzing behaviors within the online environment where users naturally interact. Finally, our study centers on maternal perceptions, which may not fully capture the influences of healthcare providers, partners, and other support networks in adopting PMH technologies. As such, while our insights are valuable, they should be considered within the context of both a US healthcare system and an online setting. Future research could expand to include diverse cultural and healthcare settings and real-world observations for a more comprehensive understanding.

7 Conclusion

Through the semi-structured interview with fifteen mothers and analysis of discussions from online perinatal communities, we explored a comprehensive understanding of mothers' nuanced experiences, perspectives, and challenges while adopting PMH technologies, which have expressed varying acceptability and effectiveness associated with these interventions. Mothers have highlighted essential factors such as professional help, social support, anonymity, and the pervasive issue of misinformation that influence their adoption and usage of these technologies. In light of our findings, we have introduced the Evolving Prenatal and Postnatal TechCare (EPPT) framework to address the dynamic nature of the PMH journey and suggest a tailored approach to accessing personalized evidence-based assessment while considering the evolving stages of pregnancy and postpartum.

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