

# Maternal health applications: Qualitative findings of user needs

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## Abstract

**Objective:** This study sought to understand the current experiences and subsequent needs of digital maternal health application users based on an interdisciplinary analysis of features currently available in the digital marketplace (including mobile applications and mobile-friendly websites).

**Methods:** Following secondary analysis of previously collected interview and focus group data, we used qualitative thematic analysis to observe recurring themes within current maternal health applications and prospective augmentation of related technology for future development.

**Results:** Study findings suggested tailored features would best serve the target population, and eleven unique themes comprising additions and improvements to maternal health applications emerged. These included seven major areas: improved mental health support, need for forums and support groups, lack of lactation and breastfeeding support, lack of quality food and nutrition access and product finders, minimal financial literacy information, tailored culturally competent information, and need for localized information and resources. Findings also suggested four main improvements for digital offerings in the current maternal health space: increased emphasis on resources available for postpartum care, importance of minimizing the number of hubs used, need for making information more digestible by ensuring it is written, edited, and provided at appropriate reading levels by more coordinated interaction of words and graphics, and ensuring the trust and credibility of such applications.

**Conclusions:** Maternal health applications are improving; however, more features can be added in a localized manner. Additional improvements could be made to current offerings, maximizing the utility of applications, especially in hard-to-reach areas such as maternity care deserts. With the advent of artificial intelligence, developers are poised with the ability to make platforms more focused and tailored for their users.

## Keywords

Maternal health, pregnancy, digital applications, qualitative

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## Background and significance

Pregnancy can be an exciting time for families. However, barriers to conception and maintaining a healthy pregnancy may stand in the way. From conception obstacles to prenatal care, many women are unaware of the standard of care they need for pregnancy.<sup>1</sup> Not only is the time preceding pregnancy daunting, but once pregnant, women are among the most vulnerable populations for adverse health outcomes.<sup>2</sup> A multitude of health complications can arise

from pregnancy, including, but not limited to, gestational diabetes, hypertension, and mental health problems.<sup>3</sup> It is

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critical to be aware of the conditions under which pregnancy can occur, the care needed by mother and baby, and how to navigate the uncharted seas of pregnancy. Easy-to-use and convenient technology platforms for expectant mothers can be highly beneficial by providing direct access to resources, grouping similar topics of concern, and directing toward the next steps.<sup>4</sup> With most of the world going digital, access to information about pregnancy is readily available. However, having comprehensible information in a trusted and secure environment is hard to come by the study.<sup>5</sup> Misconceptions and fear can arise from unreliable medical sources on the internet and popular media.<sup>6</sup>

Digital health has been on the rise, especially with the advent of artificial intelligence (AI).<sup>7</sup> In regard to maternal health, AI presents a plethora of opportunities to improve patient populations at the local level in a cost-efficient manner.<sup>8</sup> Due to a lack of focus and improvements in maternal health, having locally available resources in underserved areas is an issue that calls for our attention.<sup>9</sup> While this persists in many communities throughout the United States, rural areas are especially vulnerable.<sup>10</sup> With the lack of resources in maternal health care for mothers and their families, the digital space is poised to reach those in rural and underserved areas due to the ease of implementation and providing resources from areas that might be far to reach from quality healthcare resources. However, it is important to keep in mind whether these populations have access to reliable internet and technology and, if not, how to provide better access to such technology.

Understanding the needs and wants of users can help to curate a safe and secure outlet for mothers and families. Key target demographics of users for such technology include younger mothers and their families, those on federal and state-supported insurance such as Medicaid, and those in need of supportive resources and guidance, fostering a community of belonging. With pregnancy and postpartum having many unknowns and complexities, the journey may be challenging for mothers of all levels of experience, and especially intimidating for new mothers.<sup>11</sup> A technology platform that provides localized resources and serves as a “one-stop shop” would be beneficial to these patients and their loved ones. Therefore, the presented research aims to investigate what new features of maternal health applications would be beneficial and what improvements could be made, from both potential users’ and healthcare providers’ perspectives.

While the field of AI is relatively new, efforts have been made over time to improve maternal health through technological means.<sup>4</sup> Some examples of current applications on the market are Philip’s Pregnancy+, Flo Pregnancy Tracker, and Pregnancy and Baby Tracker: What to Expect (WTE). These applications are primarily used for receiving week-by-week pregnancy information and tracking the development of the baby. This study makes recommendations for additions and improvements to maternal

health-focused applications, based on perspectives of potential end users and healthcare providers.

## Methods

### Context

To conduct the research, a team of three coders analyzed secondary data generated by senior-level undergraduate healthcare technology students in the business school of a large public institution, where they conducted a market analysis of pregnancy and maternal-related applications. Data analyzed included individual interviews and focus groups to gain an understanding of the community’s needs and desires for maternal health resources, particularly in the realm of digital technology. The research team evaluated this data as secondary data analysis. The institution’s IRB approved the study prior to commencement of data analysis. Written informed consent from study participants was not possible, as this was secondary data analysis.

### Thematic approach

From the interview transcripts and notes from focus groups, thematic analysis was employed, breaking down the data, organizing it by classification, and identifying themes.<sup>12</sup> All the interviews were coded together (both healthcare providers and individual users), and the team individually coded the compiled data into two response classifications: “What features should be added to digital maternal health applications?” and “How can one improve preexisting features of digital maternal health applications?” The data were then exported into Dedoose, a qualitative software, where data was individually coded using a combination of inductive and deductive analysis to find common themes from the written materials and interview transcripts.<sup>13</sup> Once the coding process was concluded, excerpts from the material were exported, and then sorted to observe recurring themes. The emergent themes were organized based on the research questions, and the research team subsequently gathered and contrasted interpretations of the themes, reaching a consensus to reveal the most important themes. This consensus was achieved by acknowledging themes that the coders found recurring.

### Participant population

A diverse group of senior business students collected qualitative data from specific local communities around the college campus from where the study was advertised. The study was conducted among potential application end users and healthcare providers who may refer patients to a pregnancy content application for more health education. The research is about secondary use of information, and the identity of the participants could not readily be ascertained.

Furthermore, the investigators did not have the ability to contact the subjects or the ability to reidentify the subjects through any means to obtain consent.

The providers represented both clinic and hospital settings, and the potential users represented a split between rural, suburban, and urban residents who were currently pregnant, prospective mothers, and significant others involved in the mother's pregnancy journey. For the users, individual interviews and focus groups were primarily focused on those without access to maternal health resources. For the health-care providers, individual interviews were focused primarily on those who work in maternal care or have an interest in the field. Participants were recruited by the students conducting the class project via purposive sampling, flyers with a QR code posted around campus, and word-of-mouth.

Overall, 66 individual user interviews, 13 individual provider interviews, and two focus groups were conducted, all either in-person on campus or virtually, based on the availability of interviewees. Video interviews were recorded and transcripts were generated. Students created sample questions ahead of time, including, but not limited to: "Where do you get access to good resources?," "How effective were these resources?," "What are some of the biggest/most common issues with patients that you have seen relating to pregnancy," and "What resources do you typically give to your patients?"

This broad scope of feedback from a diverse set of respondents presented us with rich data leading to new takeaways on maternal health resources from a digital space.

## Results

From our analysis, eleven total unique themes emerged for recommendations for maternal health applications. These themes were distinguished by additions—or new features, and improvements to existing features. Of the eleven total themes, seven were classified as recommendations for future additions to maternal health applications: improved mental health resources, need for forums and support groups, lack of lactation and breastfeeding resources, lack of quality food and nutrition access and product finders, minimal financial literacy information, tailored culturally relevant information, and need for localized resources. Additionally, four themes were classified as recommendations for enhancements within existing maternal health applications: increased postpartum care emphasis, importance of one-stop shopping, need for easily digestible information, and ensuring trust and credibility (Figure 1).

### *Recommended additions to maternal health applications*

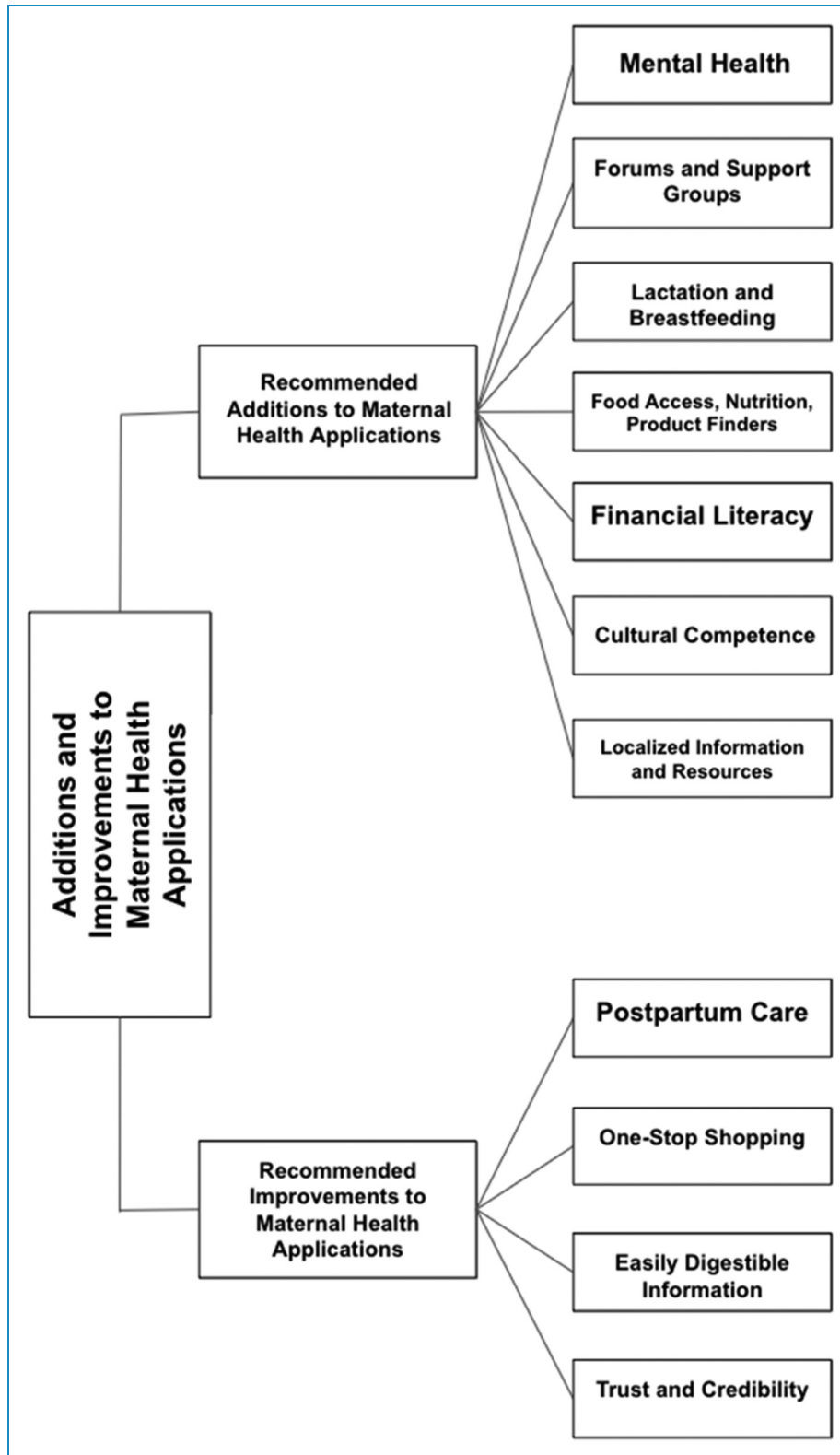
**Improved mental health resources.** Mental health resources emerged as an essential addition to maternal health

applications by the frequency of the related codes and discussion of the feature's necessity. When asked if any issues need more awareness, a 19-year-old mother mentioned "definitely about mental health" as "they don't really talk about what ... to expect," and "I want to be able to care for my baby in a healthy mental state." Users interviewed stressed the need for a better approach but were unsure of specific strategies to take. They also described a current lack of knowledge surrounding postpartum depression and postpartum psychosis. Many mothers were unaware of how to detect and treat mental health disorders that may occur postbirth. Providers stressed the need to go to their primary care physician for mental health care and that they can connect patients to important resources, such as digital applications.

**Need for forums and support groups.** The sense of loneliness and/or lack of community that can come with pregnancy is reflected in the following statement by a 25-year-old mother from a rural border area: "To this day, I still rely a lot on Facebook Groups, just because it's a lot of moms with their own personal opinion." Having a dedicated inclusive community forum and specialized support groups allows mothers to connect with and encourage other mothers in their local area in similar situations. By connecting mothers, this community forum can allow them to share about their pregnancy journey in a focused space. Parents in a similar stage of life with babies of similar age or with due dates around the same time can provide advice to each other. Having a moderator to mediate the forum would ensure accurate and relevant information, and a moderated question board with answers provided by medical experts provides a reputable source of information.<sup>14</sup>

**Lack of lactation and breastfeeding information.** A substantial portion of the mothers interviewed felt that they were unprepared for breastfeeding and that "more localized information would help..." as they "had to do a lot of research for a local lactation consultant." They reported receiving lactation support and education only after having the baby, which caused panic and anxiety. A recurring theme present was the use of lactation consultants to help navigate handling lactation. An additional advantage of maternal health applications is the ability to bring awareness to breastfeeding classes and resources, as noted by a pediatric NICU nurse from an urban city: "A lot of moms do not get education on breastfeeding until they have the baby themselves."

**Lack of quality food access, nutrition, and product finders.** Respondents stated that they want to be better informed of programs available to them, such as the Woman Infants Children program, which works "...kind of like food stamps, but it's specifically for pregnant women ..." and provides "...a certain amount of money to buy



**Figure 1.** Recommended additions and improvements to digital maternal health applications.

formula and a bunch of vegetables and fruits for your baby.” Those from certain demographics also mentioned a lack of access to organic healthy food, which was not

as much of a concern brought up by suburban and urban participants. Participants also expressed concerns about food access for their babies, such as formula, and one

participant suggested a feature that allows parents to determine the cost and locations to get formula.

**Minimal financial literacy resources.** Financial literacy and budgeting were expressed by respondents as concerns about preparing for an affordable pregnancy, birth, and parenthood.<sup>15</sup> For example, a 29-year-old mother from a small town in proximity to an urban city noted the need for an improved understanding of their insurance policies, suggesting another opportunity for maternal health applications to provide support and resources for new parents navigating the demands of parenthood.

**Tailored cultural relevance.** As a reflection of the need for information to serve a diverse population, the 29-year-old mother mentioned that she wished there was “more knowledge and access to less traditional routes: birthing centers, midwives, doulas.” Additionally, a healthcare provider emphasized that there are “tons of resources in English” and that there is a need to “look into Spanish options.”

**Need for localized information and resources.** Local resources need to be accessible both logistically and financially. Participants noted that maternal health applications can work with local agencies to provide transportation, such as collaborating with local transportation services to provide bus passes for mothers unable to travel independently. Respondents also noted a mechanism is needed to connect with local classes on topics such as putting on diapers and showering the baby, especially before giving birth.

### **Recommended improvements to maternal health applications**

**Increased postpartum care emphasis.** As maternal health encompasses postpartum care, some digital maternal care applications have postpartum care attributes; however, the focus groups and interviews revealed that some services offered are inadequate. Many respondents were unprepared or informed on how to care for themselves after birth. When asked if there was a lack of information from providers regarding the aftercare of the baby and themselves, a mother mentioned “yes, a lot” and that she had to find most of her information from “Facebook Groups, Reddit, and Google.” This trend appeared in numerous instances, and mothers felt as though they could have been more prepared if more online resources highlighted the importance of postpartum care.

One specific aspect of postpartum care that respondents felt was not as developed is the proper care of a newborn. Essential tasks such as swaddling a baby, giving them their first bath, or even changing diapers were not included in numerous digital applications. Additionally, participants

did not have any information about what to do with over-produced milk or how to obtain colostrum.

**Importance of one-stop shopping.** For the technical features of an application, an important aspect is the potential of having a single application serve as one resource hub for users. Many women had to use multiple digital applications during their pregnancy. For instance, a 37-year-old suburban mother “because of [her] gestational diabetes, had to use ... two [applications] ... MyFitnessPal and [Pregnancy +].” Having more than one online maternal care application can become confusing and impractical for users, creating the potential for convolution with repetitive and nonrelevant information.

Users also explained how they feared becoming overwhelmed with information due to the need for multiple applications with relevant offerings. Participants reported a preference for having one resource that encompasses all their needs.

**Need for easily digestible information.** Following this feature, several respondents noted that they preferred “TikTok style” videos compared to articles and other longer videos. The presence of short, snappable content seemed easier for the users to absorb and did not leave them with an overwhelming feeling of information, as timely information that is easy to access and read is critical to better provide accessible knowledge.

**Ensuring trust and credibility.** As reflected in several participants’ comments, with the rise in the usage of digital means for healthcare, it becomes harder to find and rely on credible sources providing quality information. A large number of the mothers interviewed mainly turned to Facebook Groups as a trusted source of information, and as one mother mentioned, which was constantly reemphasized, “It’s a lot of moms with their own personal experiences, and I can trust it more than looking it up online.”

### **Discussion and limitations**

The findings from the interviews and focus groups showed a strong lack of certain features from the current products available in the maternal digital health space. Features ranging from community-based and mental health support to more dynamic ones, such as product finders, indicate the wide range of untapped benefits that could serve to benefit mothers and their families before, during, and after the pregnancy. Warning signs and easily accessible information regarding mental health to better prepare mothers would be greatly beneficial, such as online and in-person support groups coordinated by a maternal health application, providing support to those experiencing similar mental health disorders. Breastfeeding and lactation support is also a place where maternal health applications

can step in and provide essential information for mothers before and after birth. A resource that can provide access to healthy and affordable food options is often necessary for proper maternal health.<sup>16</sup> Feeding America provides access to local food banks nationwide for low-income families. Collaborations between maternal health applications and organizations that work on the distribution of food to low-income individuals can benefit mothers. Better access to healthy and affordable foods is not well utilized without proper nutrition guidance, such as information on appropriate weight gain, exercise safety, and a healthy diet.<sup>17</sup> Infant nutrition and formula availability are also concerns expressed by mothers. An AI-based product finder can assist mothers with finding local healthy and affordable food options as well as other necessities such as baby formula and diapers. The application could also serve to compare prices and help to find baby products that are in stock.

Financial literacy is another prime opportunity for maternal health applications to provide support for families. A budgeting calculator and financial plans inclusive of prenatal and postnatal needs are effective tools. AI may be especially useful in providing each patient with the most relevant financial information based on their desired procedures/state of pregnancy and budget. An abundance of helpful information can be developed through partnerships with organizations such as Operation Hope, a nonprofit working to accelerate access to financial literacy, to create tailored and relevant financial assistance content.

The need for culturally relevant information can prevent mothers from being overwhelmed by providing only relevant and curated information based on lifestyle and period of pregnancy.<sup>18</sup> This includes the knowledge that different regions in the United States may require alternative and less traditional delivery methods, that certain diseases and disorders change the nutrition or feeding requirements, and that some areas have large populations with different languages.<sup>19</sup>

The potential utilization of an AI-based, local search engine could also prove valuable. The system can schedule appointments and reminders to go to certain appointments during varying points of time of pregnancy for larger healthcare systems with more developed infrastructure. For smaller clinics, where digital infrastructure might be more limited, the system can have direct phone numbers. Mothers can also be assisted in finding hospitals and clinics with the necessary resources in the local area. Such a system could also effectively assist mothers in finding area-based resources, provider availabilities, insurance policies that are accepted in local hospitals/clinics, where to get baby products, access to local mom groups, and support groups such as faith-based organizations.

Overall, there is a general sense of a lack of information, and the postpartum care sections of digital applications need to be further developed to answer the concerns of

patients and users. The impact of postpartum depression is vast and impacts nearly 600,000 women annually in the United States.<sup>20</sup> This shows the high prevalence of postpartum depression; by giving women more social support, their well-being and mental health can be supported.<sup>21</sup> Another example noted in our findings—being able to find breast milk donation centers—can be vital in having successful postpartum care for mothers and their babies.

A threat posed to users is the constant repetition of information across applications, as users can get into the habit of ignoring important information due to unnecessary additional stress and worries that can arise when managing guidance from multiple locations.<sup>22</sup> This can result in users becoming overinformed, potentially leading to increased anxiety.<sup>23</sup>

Furthermore, maternal health application content must be given in a fast and easily digestible fashion. Recent data shows that attention spans have measurably shrunk over the past few decades.<sup>24</sup> By providing content that conveys valuable information in a shorter time frame, women will be able to receive the information that is essential for benefitting their specific maternal health. Trust in digital maternal health applications must also be established to maximize target audience usage and engagement.

Certain features were found to be more beneficial for those from certain demographics than others, reemphasizing the need for applications to be tailored to not overwhelm users who are already stressed from other aspects of their pregnancy journey.<sup>25</sup> To our interest, many of the prospective features that were commonly emphasized were nontangible support, such as mental health and community support, the two most common recurring themes. This shows that not only should applications serve to gain access to other physical resources, but they should also be utilized to provide platforms for direct support, where users can connect with each other to encourage nontangible support. Moving forward, leveraging these results will allow us to have a better understanding of the future of the digital health space in relation to maternal health.

In addition to these features, clear themes were observed from both users and healthcare providers, such as the need to have more unified platforms and minimize convoluted and nonrelevant information presented to the user. This extra information, plus the hassle of juggling between multiple platforms of resources and figuring out which platform to use, creates anxiety and dissuades users from following guidance. This is why quick and easily digestible information focused on critical information would prove better with the fast-moving nature of today's lifestyle and shorter attention spans.<sup>24</sup> With this in mind, it is important to take into account changing demographics and keep the information targeted and specific to better serve the user's needs.<sup>26</sup> To ensure this, trust should be promoted between the users, patients, providers, and developers of the application by directly bringing in feedback from mothers and maternal

health organizations, in addition to restructuring methods of marketing to be more patient-centered.

Throughout the study, during which a formula shortage was occurring, families consistently voiced the need for better ease of finding items relating to maternal health and a fair way to compare prices. This was most strongly emphasized in the context of items that were in short supply at the time. With the constantly changing nature of supply and demand, future shortages are inevitable, and different items will present challenges to acquire in a cost-effective manner, highlighting the critical need to provide timely support in real-time based on what is currently in shortage.<sup>27</sup> This combined with various key strategies and public health guidance and interventions, would serve to benefit the population.<sup>28</sup>

With the broad impact of AI in our daily lives and the publication of the AI Open Letter, where concerns are brought up on potential harmful implications of the usage of AI in day-to-day applications, developers must consider the advantages and drawbacks of using AI in many aspects and ensure the benefits outweigh the disadvantages.<sup>29</sup> A way to avoid false claims made by AI would be utilizing an AI-based system that fact-checks information related to pregnancy with direct verification from medical professionals. Implementing such steps would put a foot forward for medical providers recommending digital maternal care applications to their patients. It would be ideal to provide all these benefits that would greatly help digital maternal health applications; however, it is understood that although hypothetically, such features would greatly help, the feasibility of implementing all of them is difficult due to numerous constraints. The implementation of credibility should be established by partnering with organizations such as the American College of Obstetricians and Gynecology. These reputable organizations will be able to legitimize resources provided in the online application, and having a highly regarded institution at the forefront of a digital maternal application will lower the number of people who are skeptical of the advice and knowledge provided. Some participants even described the "... information and resources ... [as] ... outdated and misleading."

Overall, a more localized resource providing guidance on a regional basis was suggested by potential users to be beneficial, especially those in hard-to-reach areas. By identifying essential resources that could benefit specific patient populations, one can have a better foundation of how to utilize digital health to improve maternal health outcomes in underserved areas. This research will enable a deeper understanding of the needs and resources that are currently unmet, as well as the ability to supply them more broadly across communities.

Since the authors did not collect the data, there were some limitations in ascertaining full contextual factors for some of the quotes. Furthermore, with the given information on the scope of maternal health disparities and the

current state of technology, it was recognized that there are limitations to the practicality of implementing such resources in a timely and cost-efficient manner. However, the research showed promising opportunities to serve patient populations with resources beyond what is currently available.

## Conclusion and future recommendations

From our findings, maternal health platform developers are encouraged to foster interdisciplinary work with providers, patients, users, and other stakeholders to ensure that platforms are designed with a unified front. While designing such applications, the localized nature of maternal health is important to keep in mind, while also presenting comprehensive resources under one hub. The future of utilizing AI for this is promising, but more guidelines should be devised and implemented to provide security, protection, and comfort. This ensures that resources are tailored to the target population to encourage continued engagement in the maternal care journey.

**Contributorship:** SB, NG, WP, and RP researched literature and conceived the study. SB, NP, and GW were involved in data analysis and wrote the first draft of the manuscript. All authors made major contributions to the write-up of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript.

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