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Original Research Article

Assessing the acceptability and usability of digital interventions for pregnancy health

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ABSTRACT

Background: Despite the promising potential of digital interventions to enhance maternal health outcomes, there is a lack of comprehensive exploration into their real-world acceptability, usability, and effectiveness among pregnant women. This study was conducted to evaluate the acceptance and usability of digital interventions among pregnant women to gain insights into real-world applications.
Methods: The study enrolled fifteen pregnant women (ages 20 to 40 years) using an online application between November 2022 and May 2023. Data collection comprised a usability survey, and statistical analysis employed descriptive statistics and Chi-square tests.
Results: Significant variations in age (mean 29.33 years) and gestational age (mean 13.80 weeks) were observed ($p<0.001$). Ease of use received positive ratings (73.3% found it easy; $p=0.071$), with no participants finding it difficult ($p<0.001$). The introduction to the application was well-received ($p=0.004$). Monitoring utilities were deemed helpful by 73.3% ($p=0.071$), with strong agreement from 26.7%. App engagement was high, with 86.7% disagreeing it was boring and 13.3% strongly disagreeing with the same ($p=0.020$). Motivational impact for a healthy diet was endorsed by 80% ($p=0.091$), and medication adherence support by 93.3% ($p=0.015$). Recordkeeping ease was significant (80% agreement; $p=0.247$). Notably, 86.7% remained active users after 30 days, with no dropouts ($p<0.001$).
Conclusions: This pilot study suggests that digital interventions can positively influence maternal health, offering valuable insights for their integration into healthcare strategies.

Keywords: Digital intervention, Pregnancy management, Acceptability, Usability, User experience, Mobile health

INTRODUCTION

In the field of public health, securing optimal maternal and neonatal outcomes is of paramount importance. Unwarranted pregnancy complications like miscarriages, stillbirths, and preeclampsia, are stark indicators of poor maternal health. Effective interventions, including prenatal care and promoting hospital deliveries, are crucial in minimizing the risks and lowering mortality. However, it is important to understand that maternal and neonatal mortality, resulting from pregnancy and delivery problems occur much more frequently in low-middle-income countries.[1]

India, with nearly 25 million annual childbirths, accounts for almost one-fifth of the world's total yearly births.[2] This underscores the importance of care during pregnancy in the country, as it not only improves a woman's overall health but also enhances the probability that the mother and her unborn child will survive, ultimately supporting the child's long-term development.[3] In 1990, India had an alarmingly high maternal mortality ratio (MMR) of 556 women per hundred thousand live births, while the global MMR stood at 385 per hundred thousand live births. However, by 2015, India had made significant progress, reducing its MMR to 167 per hundred thousand live births, which surpassed the global MMR of 216 per hundred thousand live births. This represents a remarkable 70%

reduction in India's MMR between 1990 and 2015, in contrast to the global decline of 44%. Despite significant progress in lowering maternal and newborn mortality rates in India, over 44,000 women die each year as a result of pregnancy-related conditions, and approximately 6.6 lakh infants die during the first 28 days of life.[4] The National Family Health Survey (NFHS) data from the fourth (2015-16) and fifth (2019-21) rounds were studied to determine changes in birth outcomes over five years in the country. Using data from 195,470 women in NFHS-4 and 255,549 women in NFHS-5, it was identified that nearly half of the Indian states/union territories (n=17/36) reported lower livebirth rates during 2019–21 than the national average (88.9%). Also, a livebirth decline of 1.3 percentage points (90.2% versus 88.9%) was observed. In particular, miscarriages increased in both urban (6.4% versus 8.5%) and rural areas (5.3% versus 6.9%), while stillbirths increased by 28.6% (0.7% versus 0.9%).[5] A significant fraction of these pregnancy complications can be prevented by providing appropriate prenatal care and quick detection and management of high-risk conditions such as severe anaemia and pregnancy-induced hypertension.[4]

In response to these ongoing challenges in maternal and neonatal health, the application of technology to healthcare, or "digital health", has drawn considerable attention. It is based on eHealth, which is the use of technology to assist with health-related activities. Mobile connectivity, particularly in low- and middle-income nations, has opened up new avenues for improving healthcare access, making digital health an increasingly important area of practice.[6] Significant results have been obtained through digital interventions during pregnancy, including reduced insomnia symptoms, improved clinical management of gestational diabetes mellitus (GDM), and promotion of healthy dietary behaviours and weight control in women who are overweight or obese.[7-9] Remarkable promise has been shown by digital intervention for improving infection surveillance and detection during pregnancy, resulting in better maternal care.[10] Predicting the likelihood of poor maternal health outcomes, monitoring high-risk pregnancies for preeclampsia and eclampsia, and enabling early detection of the same are other ways that digital treatments have shown tremendous promise in helping pregnant women.[11] Considering these promising benefits, we conducted an observational and prospective pilot study with the primary aim of assessing the acceptability and usability of digital interventions among pregnant women visiting doctors outpatient department in Nagpur, Maharashtra to gain significant insights into their practical application within real-world settings.

METHODS

Study design

This observational and prospective pilot study was conducted at Deshmukh Hospital, Surendra Nagar, Nagpur, 440015, between July 2023 and September 2023. The study aimed to assess the demographic characteristics and gather user feedback on a pregnancy management application over 30 days. All participants provided informed consent before being enrolled into the programme.

Inclusion and exclusion criteria

Inclusion criteria comprised individuals aged 18 years or older, pregnant women in their first, second, or third trimester, possessing access to a smartphone or tablet with internet connectivity, and the ability to communicate in the language(s) supported by the digital platform (English/Hindi/Marathi). Participants needed to agree to programme participation, adhere to its guidelines and provide informed consent for engagement in the digital antenatal care programme. Additionally, inclusion was limited to pregnant individuals with low-risk pregnancies as determined by healthcare providers.

Exclusion criteria included pregnant individuals with high-risk pregnancies requiring specialized medical attention and continuous monitoring. Participants were excluded if they lacked access to necessary digital devices or reliable internet connectivity, couldn't effectively comprehend or communicate in the supported language(s), had limited cognitive abilities or mental health conditions hindering digital resource engagement, concurrently participated in other conflicting research studies or interventions, or had complex medical conditions or comorbidities such as diabetes, hypertension, heart disease, or cancer requiring specialized care beyond the scope of the digital programme.

Enrolment

Fifteen pregnant women visiting the doctor’s outpatient department were enrolled. Participants were suggested about the app by treating gynaecologists and volunteered to get enrolled. The enrolment process utilized an online web application, ensuring accessibility and convenience. The app was available exclusively in the English language; thus, participants were required to have proficiency in English for effective engagement with the app. The study details, including its purpose and procedures, were available online.

Data collection

Participants were invited to share their perspectives on the pregnancy management app by responding to a carefully structured survey. The survey was designed to cover a spectrum of aspects including: assessing the ease of use and navigation within the app; evaluating the overall user experience and goodness of the app; examining the ability of the participants to recall and use the app features, measuring satisfaction with the introductory materials of the app; assessing the effectiveness of the app in tracking vital pregnancy-related parameters; evaluating the app's

engagement level and checking if the app was boring to use; exploring the app's influence on dietary habits; examining the clarity and understanding of the information provided by the app about well-being management; investigating the impact of the app on adherence to prescribed medications; and gathering insights into the app's role in maintaining medical records by the participants.

This survey thoroughly investigated different aspects of the pregnancy management app, offering valuable insights into user experiences, perceptions, and how the app may impact essential aspects of pregnancy care, ranging from usability to wellbeing management and medical record-keeping by the participants.

Statistical analysis

For each patient feedback questionnaire, we computed descriptive statistics encompassing both the number and percentages of responses. To evaluate shifts in percentages or proportions, Chi-square or proportion tests were applied. The calculated p values served to gauge the significance of variations in percentages among participants, with a predetermined threshold of 0.05 (5%) denoting statistical significance. The quantitative analysis of survey responses aimed to ascertain the extent of percentage agreement across diverse dimensions of the pregnancy management tool.

RESULTS

Table 1 depicted demographic characteristics, presenting the mean±standard deviation (SD) and corresponding p values for age and gestational period among study participants. Participants had a mean age of 29.33 years (SD=4.32), with a statistically significant difference (p<0.001). Similarly, the mean gestational period was 13.80 weeks (SD=8.31), also demonstrating a statistically significant difference (p<0.001). These findings suggest variations in age and gestational period within the study population.

Table 1: Demographic metrics - age and gestational period.

Demographic	Mean±SD	P value
Age	29.33±4.32	<0.001*
Gestational period (in weeks)	13.80±8.31	<0.001*

*Statistically significant at p<0.05

Table 2 summarizes user feedback and engagement with the pregnancy management app. The majority of the participants (73.3%) found the app easy to use and good to use, with additional participants strongly agreeing (26.7% and 20%, respectively). However, one participant (6.7%) remained unsure about the app's ease of use. While the p value for ease of use (0.071) did not reach statistical significance, the p value for user-friendliness was significant (0.004).

Table 2: User feedback and engagement overview.

Questions	N (%)	P value
It was easy to use		
Agree	11 (73.3)	0.071
Strongly agree	4 (26.7)	
Agree	11 (73.3)	0.004*
It was good to use		
Can't say	1 (6.7)	
Strongly agree	3 (20.0)	
It has been difficult to remember to use it		
Disagree	12 (80.0)	0.020*
Strongly disagree	3 (20.0)	
The introduction of how to use it was sufficient		
Agree	11 (73.3)	0.004*
Can't say	1 (6.7)	
Strongly agree	3 (20.0)	
Was able to monitor vital parameters		
Agree	11 (73.3)	0.071
Strongly agree	4 (26.7)	
It was boring to use		
Disagree	13 (86.7)	0.020*
Strongly disagree	2 (13.3)	
It has motivated me to consume healthy diet		
Agree	9 (60.0)	0.091
Can't say	3 (20.0)	
Strongly agree	3 (20.0)	
It has helped me to understand how I need to manage my pregnancy		
Agree	11 (73.3)	0.071
Strongly agree	4 (26.7)	
It helped me to take medication on time		
Agree	10 (66.7)	0.015*
Can't say	1 (6.7)	
Strongly agree	4 (26.7)	
Keeping medical record was easy		
Agree	8 (53.3)	0.247
Can't say	3 (20.0)	
Strongly agree	4 (26.7)	
Status (at 30 days)		
Active	13 (86.7)	<0.001*
Delayed	2 (13.3)	
Drop out	0 (0.0)	

*Statistically significant at p<0.05

In terms of participants' ability to recall how to use the app, none of the participants indicated that it was difficult to use (p values of 0.020) (Figure 1).

Regarding the introduction to the app, a substantial proportion of the participants found it sufficient for use, with 73.3% agreeing and 20% strongly agreeing; only 1 participant (6.7%) wasn’t sure about the response (p values of 0.004) (Table 2).

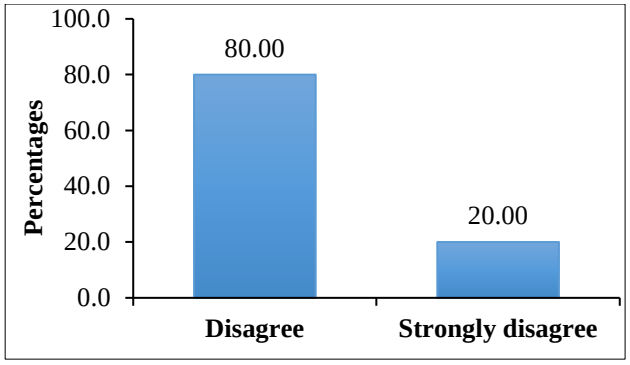

Figure 1: Difficult to use the pregnancy management app.

For monitoring vital parameters and effectively managing pregnancy, 73.3% agreed, while 26.7% strongly agreed that the app was helpful (p=0.071 for each). Furthermore, participants found the app engaging, with 86.7% disagreeing and 13.3% strongly disagreeing that the app was boring to use. The app's engagement demonstrated statistical significance (p=0.020) (Table 2).

The app was reported to be motivational for consuming a healthy diet, with 60% of the participants agreeing and 20% strongly agreeing, while 20% were uncertain (p=0.091). Moreover, the majority of participants (66.7% agreeing and 26.7% strongly agreeing) found the app helpful in adhering to their medication, while only 6.7% were unable to answer, indicating statistical significance (p=0.015). With regards to the ease of maintaining medical records, most of the participants (53.3%) agreed and 26.7% strongly agreed that it was easy to use, while 20% were unable to provide a definitive response (p=0.247) (Table 2).

The status of participants at the 30-day mark revealed that a significant majority of the study participants (86.7%) remained as active users of the app, while a small proportion experienced delays (13.3%), and there were no reported dropouts (0.0%) suggesting a statistical significance (p<0.001) (Figure 2 and Table 2).

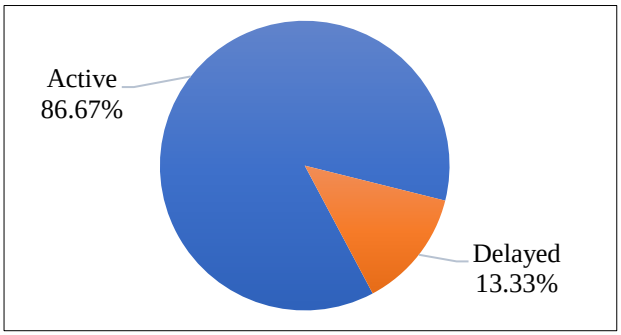

Figure 2: Status of the pregnancy management app at the 30-day mark.

Overall, the results suggest favourable user experiences with the pregnancy management app, as the study participants found it easy to use, engaging, and beneficial for various aspects of pregnancy care, with positive feedback on key features such as monitoring vital parameters, medication adherence, and dietary motivation.

DISCUSSION

Pregnancy apps have become common tools for accessing essential pregnancy-related information globally, surpassing other medical applications in prevalence. Despite their popularity, concerns about their user-friendliness and understanding, especially for pregnant women, persist.[12] We investigated the issue with a focused research, finding some favourable results that contribute significantly to our understanding.

A study was conducted to assess the usability of a mobile assistive app designed for pregnant women. The results revealed an overall satisfaction rate of 65.33%, with a mean score of 3.25, indicating subjective pleasure among participants. The app was deemed relatively easy to remember, with a mean score of 3.84 and a satisfaction rate of 76.66% for memorability. Learnability, representing ease of learning to use the app, had a mean of 3.78, and a satisfaction rate of 73.33%. Efficiency, reflecting how efficient it was to use the app, achieved a mean of 3.86, with participants expressing a satisfaction rate of 77.14%. Furthermore, 73.33% of the participants reported that the app was good to use.[13] Another study focusing on women's experiences with the maternity care app showed an overall acceptance among most women. They appreciated the app for providing an array of information and various tools within the app to be helpful. Over 90% of the women not only found the app to be a useful resource of information, but they also expressed a willingness to recommend it to others. Furthermore, a large majority (>90%) agreed that the app's installation was simple. They also trusted the app's security measures, believed in the content, and appreciated its relevance and ease of use.[14] Consistent with these results, our own findings were also positive. The majority of participants reported that the app was easy and good to use, and wasn’t boring.

'SwasthGarbh' (healthy pregnancy) is an interactive smartphone application designed to provide comprehensive antenatal care and real-time medical support to pregnant women. A randomized controlled trial (RCT) with 150 participants demonstrated the effectiveness of this app in enhancing antenatal care quality, reducing obstetric/medical complications, and providing a positive pregnancy experience. The test group experienced a remarkable decrease in medical (38.0% versus 55.5%, p=0.04) and obstetric (52.1% versus 59.7%, p=0.36) complications during pregnancy. Moreover, there was a significant improvement in mean (± SD) maternal systolic blood pressure (SBP) (118.9±11.8 versus 123.4±14.2 mmHg; p=0.046), diastolic blood pressure (DBP) (76.0±8.4 versus 80.0±10.9 mmHg; p=0.02), and haemoglobin levels (11.5±1.4 versus 10.9±1.4 g/dl; p=0.03) at delivery compared to the control group. The

positive clinical outcomes were a result of the provision of superior prenatal care, rapid identification of complications, prompt medical intervention, and improved medication adherence supported by the app.[15] Similar to these positive findings, a substantial number of our study participants were able to successfully monitor their vital parameters and take their medications on time with the help of the maternity care app.

Furthermore, a two-arm parallel RCT was conducted to assess the impact of a 6-month intervention using the HealthyMoms app on excessive gestational weight gain (GWG), body fatness, dietary habits, moderate-to-vigorous physical activity (MVPA), glycemia, and insulin resistance in comparison to standard maternity care. The findings showed no statistically significant effect on GWG overall (p=0.62). However, interestingly, the intervention's impact varied by pre-pregnancy BMI. Women with overweight and obesity before pregnancy demonstrated a reduction in weight gain in the intervention group compared to the control group, as shown in both imputed analyses (–1.33 kg; 95% CI –2.92 to 0.26; p=0.10) and completers-only analyses (–1.67 kg; 95% CI –3.26 to –0.09; p=0.031). According to Bayesian analyses, there was a 99% probability of some intervention effect on GWG among women who were overweight or obese with an 81% probability that this effect was greater than 1 kg. However, the intervention group strikingly exhibited higher scores on the Swedish Healthy Eating Index at follow-up compared to the control group (0.27; 95% CI 0.05-0.50; p=0.017).[9] Similar findings were observed in the PEARS RCT, where the intervention group, guided by dietary advice through mHealth, showed improved dietary intakes compared to the control group, which received standard care. The improvement was evident in a lowered glycaemic index [mean difference (MD) −1.75], reduced intake of free sugars (%TE) (MD −0.98), lower fat (%TE) (MD −1.80), and decreased sodium intake (MD −183.49).[16] In line with previous research, the majority of participants in our study reported that the maternity app assisted them in maintaining a healthy diet during their pregnancy.

Promoting increased support, education, and care for mothers is imperative to equip them with the knowledge required for a safe and healthy pregnancy and childbirth.[17] A systematic review of mobile app for self-management during pregnancy concluded that these app have positive impacts on taking care of oneself during pregnancy.[18] Also, a meta-analysis examining the effects of mobile health app on pregnancy care, demonstrated their effectiveness in promoting maternal physical health, including weight management, gestational diabetes mellitus control, and asthma control, with a moderate to large effect size (Cohen's d=0.72). Significant improvements were also observed in maternal mental health (d=0.84) and knowledge about pregnancy (d=0.80).[19] Our study aligns with these findings, with a majority of participants finding the maternity app assisted them in understanding how to manage their pregnancy effectively.

A RCT was conducted to evaluate the feasibility, acceptability, and initial effectiveness of an innovative, patient-focused, audio-based SMS text messaging application designed to assist women in accessing maternity care services. The intervention demonstrated high levels of acceptability and feasibility, with more than 90% of participants finding it useful, user-friendly, interesting, appropriate, engaging, and compatible, and expressing a strong inclination to recommend it to others. No participants were lost to follow-up during the study period.[20] As discussed earlier, our study yielded similar results in terms of user acceptability and ease of use. Importantly, in our study a large number of participants remained active throughout the study period with no dropouts dropped out. This enthusiasm and sustained engagement of participants, points toward the transformative impact of this digital approach in enhancing maternity care experiences.

While our study provides valuable insights, certain limitations should be acknowledged. The sample size in our study may limit generalizability, and the self-reported nature of user feedback introduces the possibility of response bias. Moreover, the short-term nature of the study may not capture long-term user experiences. Future research could address these limitations by employing larger, diverse samples and implementing longitudinal study designs for a more comprehensive understanding of digital interventions in pregnancy health.

CONCLUSION

In conclusion, our study highlights the favourable acceptability and usability of digital interventions for pregnancy health. The study participants reported positive experiences with the pregnancy care app, showcasing ease of use, engagement, and effectiveness in supporting various aspects of pregnancy management. The findings align with existing literature on pregnancy app and emphasize the potential of digital interventions in improving maternal health outcomes.

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