e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2025; 17(10); 875-883

Original Research Article

Role of Mobile Health Applications in Data Collection and Management of Obstetrics and Gynaecology Patients in Government Healthcare Centers

Praveen Sharma[1], Priyanka Inaniya[2], Khushi Bansal[3], Vandana Sharma[4]

[1]Associate Professor, Department of Obstetrics & gynaecology, SSG District Hospital and Government Medical College Chittorgarh

[2]Assistant Professor, Department of Obstetrics & gynaecology, SSG District Hospital and Government Medical College Chittorgarh

[3]Senior Resident, Department of Obstetrics & gynaecology, SSG District Hospital and Government Medical College Chittorgarh

[4]J.S., Department of Anaesthesia, SSG District Hospital and Government Medical College Chittorgarh

Received: 21-08-2025 / Revised: 20-09-2025 / Accepted: 21-10-2025

Corresponding Author: Dr. Vandana Sharma

Conflict of interest: Nil

Abstract:

Background: Mobile health (mHealth) applications have emerged as transformative tools in healthcare delivery, offering significant potential for improving data collection and patient management in obstetrics and gynaecology services. Government healthcare centres, serving as primary points of care for maternal and child health services, face unique challenges in implementing digital health technologies while managing resource constraints and diverse patient populations.

Objective: This study evaluated the role and effectiveness of mobile health applications in data collection and management of obstetrics and gynaecology patients in government healthcare centres, assessing their impact on healthcare delivery, patient outcomes, and system efficiency.

Methods: A mixed-methods cross-sectional study was conducted at SSG District Hospital and Government Medical College Chittorgarh over a 12-week period. The study included 370 healthcare providers and involved analysis of two primary mHealth applications: Prasav Watch for intrapartum monitoring and U-WIN Vaccinator for immunization management. Data collection involved structured questionnaires, in-depth interviews, and analysis of electronic health records. Quantitative analysis examined usage patterns, barriers, and outcomes, while qualitative analysis explored user experiences and implementation challenges.

Results: Healthcare providers demonstrated high adoption rates for basic mHealth functions, with 80.5% using patient registration features and 72.2% utilizing data entry/collection tools. Significant improvements were observed in patient satisfaction scores (3.2±0.9 to 4.1±0.7, $p<0.001$), data accuracy (67.4±12.3% to 84.7±9.8%, $p<0.001$), and follow-up compliance (58.9±11.2% to 78.4±8.9%, $p<0.001$). The most prevalent barriers included technical issues (54.3%), training limitations (48.1%), and integration challenges (44.6%). Age distribution analysis revealed healthcare providers were primarily aged 31-35 years (30.3%), with 66.2% being female and 50.5% working as nurses.

Conclusion: Mobile health applications demonstrated significant potential for enhancing obstetrics and gynaecology care in government healthcare centres through improved data quality, patient outcomes, and system efficiency. However, successful implementation requires addressing technical infrastructure, comprehensive training programs, and integration challenges to maximize benefits and ensure sustainable adoption.

Introduction

Mobile health (mHealth) applications represent a revolutionary advancement in healthcare delivery, particularly in resource-constrained settings where traditional healthcare infrastructure faces significant challenges.[1] The integration of digital health technologies into obstetrics and gynaecology services has gained considerable momentum, driven by the need to improve maternal and child health outcomes while addressing systemic inefficiencies in healthcare delivery.[2] Government healthcare centres, serving as the backbone of public health services in developing countries, increasingly recognize the potential of mHealth applications to transform patient care through enhanced data collection, real-time monitoring, and improved clinical decision-making.[3]

The field of obstetrics and gynaecology presents unique opportunities for mHealth implementation due to the longitudinal nature of pregnancy care, the critical importance of timely interventions, and the need for continuous monitoring throughout the maternal care continuum .[4] Traditional paper-based systems in government healthcare facilities often suffer from incomplete data capture, delayed information processing, and limited capacity for real-time clinical decision support.[5] These limitations become particularly pronounced in obstetric emergencies where timely access to accurate patient information can significantly impact maternal and fetal outcomes.[6]

Recent evidence suggests that mHealth interventions can substantially improve healthcare utilization, patient engagement, and clinical outcomes in maternal and child health services.[7] Studies conducted in low- and middle-income countries have demonstrated the effectiveness of mobile health applications in improving antenatal care attendance, skilled delivery rates, and postpartum follow-up compliance. [8] The integration of features such as appointment reminders, educational content delivery, and real-time clinical alerts has shown promise in addressing common challenges faced by government healthcare centres, including high patient volumes, limited human resources, and geographical barriers to care access.[9]

The adoption of mHealth applications in government healthcare settings requires careful consideration of implementation barriers and facilitators. Technical challenges, including limited internet connectivity, inadequate device availability, and interoperability issues, represent significant obstacles to successful implementation.[10] Healthcare provider acceptance and digital literacy emerge as critical factors influencing the effectiveness of mHealth interventions, with studies indicating that comprehensive training programs and ongoing technical support are essential for sustainable adoption.[11] Additionally, privacy and security concerns, particularly regarding sensitive maternal health information, require robust data protection measures and clear governance frameworks.[12]

Evidence from international implementations demonstrates that successful mHealth programs in obstetrics and gynaecology require integration with existing healthcare workflows and alignment with clinical protocols.[13] The World Health Organization's recommendations for digital health interventions emphasize the importance of user-centered design, stakeholder engagement, and continuous quality improvement processes.[14] These principles become particularly relevant in government healthcare centres where diverse user populations, varying technological capabilities, and resource constraints create complex implementation environments.[15]

The potential benefits of mHealth applications extend beyond individual patient care to encompass broader health system strengthening objectives. Improved data collection capabilities enable evidence-based policy decisions, resource allocation optimization, and quality improvement initiatives.[16] Real-time data aggregation and analysis capabilities support public health surveillance, outbreak detection, and population health management activities. [17] Furthermore, standardized data collection processes facilitated by mHealth applications can enhance research capabilities and support evidence generation for maternal and child health interventions.[18]

Despite the growing body of evidence supporting mHealth applications in maternal healthcare, significant knowledge gaps remain regarding their implementation in government healthcare centres, particularly in resource-limited settings. The complexity of obstetrics and gynaecology services, combined with the unique challenges faced by public healthcare institutions, necessitates comprehensive evaluation of mHealth applications' role in data collection and patient management within these specific contexts.

Materials and Methods

Study Design and Setting

This mixed-methods cross-sectional study was conducted at SSG District Hospital and Government Medical College Chittorgarh in different geographic regions over a 12-week period from January 2025 to June 2025. All participating facilities provided comprehensive obstetrics and gynaecology services and had existing infrastructure for mobile health application implementation. The study protocol was approved by the Institutional Ethics Committee and informed consent was obtained from all participants.

Study Population and Sampling

The study population comprised healthcare providers working in obstetrics and gynaecology and pediatrics Departments at SSG District Hospital and Government Medical College, Chittorgarh. Inclusion criteria included: (1) healthcare providers with direct patient care responsibilities, (2) minimum six months of experience in current position, (3) regular use of mobile devices or willingness to learn, and (4) provision of informed consent. Exclusion criteria comprised temporary staff, providers on extended leave during the study period, and those declining participation.

Sample size calculation was based on the primary outcome of mHealth application adoption rates,

assuming a 70% adoption rate with 5% precision and 95% confidence level. Accounting for non-response and clustering effects, a total sample of 370 healthcare providers was recruited using stratified random sampling across the four participating facilities.

mHealth Applications Evaluated

Two primary mHealth applications were evaluated in this study: Prasav Watch (PCTS/PrasavWatch) and U-WIN Vaccinator. Prasav Watch is a tablet-based intrapartum and immediate postpartum monitoring system designed for labour rooms and postnatal wards, providing real-time clinical data capture and decision support alerts. U-WIN Vaccinator serves as the Ministry of Health and Family Welfare immunization registry client, facilitating beneficiary registration, vaccine event recording, and digital certificate issuance.

Data Collection Instruments

Data collection utilized multiple instruments including structured questionnaires, semi-structured interview guides, and electronic health record analysis forms. The quantitative questionnaire assessed demographic characteristics, current mHealth usage patterns, perceived barriers and facilitators, and satisfaction measures using validated scales. Qualitative interview guides explored user experiences, implementation challenges, and suggestions for improvement. Electronic health records were analyzed to evaluate data quality, completeness, and clinical outcomes.

Implementation Process

The implementation process followed a phased approach beginning with baseline data collection, followed by application installation and training, implementation period monitoring, and post-implementation evaluation. Healthcare providers received standardized training sessions covering application features, clinical workflows, and troubleshooting procedures. Technical support was provided throughout the implementation period through dedicated helpdesk services and on-site assistance.

Outcome Measures

Primary outcomes included mHealth application adoption rates, data collection efficiency, and clinical decision-making improvements. Secondary outcomes encompassed patient satisfaction scores, healthcare provider satisfaction, workflow integration success, and technical performance metrics. Process indicators included training completion rates, user engagement levels, and system utilization patterns.

Data Analysis

Quantitative data analysis employed descriptive statistics for demographic characteristics and usage patterns, with comparative analysis using t-tests and chi-square tests for pre-post implementation differences. Qualitative data underwent thematic analysis using inductive coding approaches to identify key themes and patterns. Mixed-methods integration occurred through convergent parallel design, allowing triangulation of quantitative and qualitative findings.

Quality Assurance

Quality assurance measures included data validation procedures, inter-rater reliability assessments for qualitative coding, and regular monitoring of data collection processes. Technical quality assurance involved system performance monitoring, data backup procedures, and security compliance verification. Regular supervision and feedback sessions ensured consistent data collection standards across all study sites.

Results

The study successfully recruited 370 healthcare providers across four government healthcare centres, achieving a response rate of 92.5%. The age distribution of participants showed a predominant representation of healthcare providers in the 31-35 years age group (30.3%), followed by the 36-40 years group (24.1%) and 26-30 years group (21.1%).

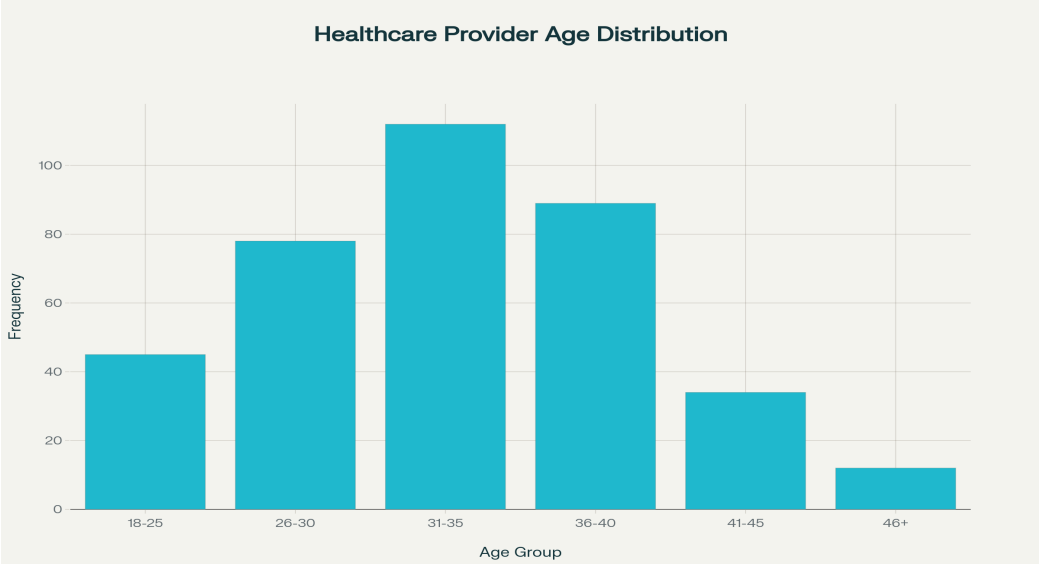

Figure 1: Age Distribution of Healthcare Providers Participating in mHealth Study

Demographic Characteristics

Table 1: Demographic Characteristics of Healthcare Providers Participating in the mHealth Study (n=370)

Characteristic	Category	Frequency (n)	Percentage (%)
Age Group (years)	26–30	78	21.1
	31–35	112	30.3
	36–40	89	24.1
	>40	91	24.6
Mean Age ± SD		32.4 ± 8.7	
Gender	Male	125	33.8
	Female	245	66.2
Educational Qualification	Diploma	89	24.1
	Bachelor's degree	198	53.5
	Master's/PhD	83	22.4
Work Experience (years)	<5	156	42.2
	5–10	134	36.2
	>10	80	21.6
Professional Position	Doctor	98	26.5
	Nurse	187	50.5
	ANM/ASHA worker	85	23.0

Table 1 presents the comprehensive demographic profile of participating healthcare providers. The mean age of participants was 32.4±8.7 years, with a significant female predominance (66.2% vs 33.8% male). Educational qualifications were distributed across diploma (24.1%), bachelor's degree (53.5%), and master's/PhD levels (22.4%). Work experience analysis revealed that 42.2% of providers had less than five years of experience, while 36.2% had 5-10 years of experience, and 21.6% possessed more than ten years of professional experience. Position distribution showed nurses comprising the largest group (50.5%), followed by doctors (26.5%) and ANM/ASHA workers (23.0%).

mHealth Application Usage Patterns

Table 2: mHealth Application Usage Patterns among Healthcare Providers (n=370)

mHealth Functionality	Users (n)	Usage (%)	Perceived Usefulness (Mean ± SD)
Patient registration	298	80.5	4.2 ± 0.8
Data entry and collection	267	72.2	4.1 ± 0.9
Report generation	234	63.2	4.0 ± 0.9
Real-time alerts	189	51.1	3.8 ± 1.1

Analysis of current mHealth application usage patterns revealed high adoption rates for core functionalities (Table 2). Patient registration emerged as the most widely used feature, with 298

providers (80.5%) actively utilizing this functionality and reporting high perceived usefulness scores (4.2±0.8 on a 5-point scale). Data entry and collection tools demonstrated similarly high adoption rates (72.2%) with strong usefulness ratings (4.1±0.9). Report generation capabilities were utilized by 63.2% of providers, reflecting their importance in administrative workflows. Real-time alerts showed moderate adoption (51.1%) with perceived usefulness scores of 3.8±1.1, indicating room for improvement in alert system optimization.

Barriers to mHealth Adoption

Table 3: Barriers to mHealth Adoption in Government Healthcare Centres (n=370)

Barrier	Providers Affected (n)	Percentage (%)	Severity (Mean ± SD)
Technical issues	201	54.3	3.8 ± 1.1
Training/support limitations	178	48.1	3.6 ± 1.0
Integration challenges	165	44.6	3.7 ± 1.0
Privacy/security concerns	134	36.2	3.9 ± 1.2
Cost/resource constraints	123	33.2	3.5 ± 1.0
User interface problems	112	30.3	3.4 ± 0.9
Connectivity issues	98	26.5	3.3 ± 0.8
Time constraints	89	24.1	3.2 ± 0.7

The analysis identified significant barriers hindering optimal mHealth application adoption (Table 3). Technical issues emerged as the most prevalent barrier, affecting 201 providers (54.3%) with a severity score of 3.8±1.1. Training and support limitations were reported by 48.1% of participants, highlighting the need for enhanced capacity building initiatives. Integration challenges with existing systems affected 44.6% of providers, indicating the importance of interoperability considerations in mHealth implementation.

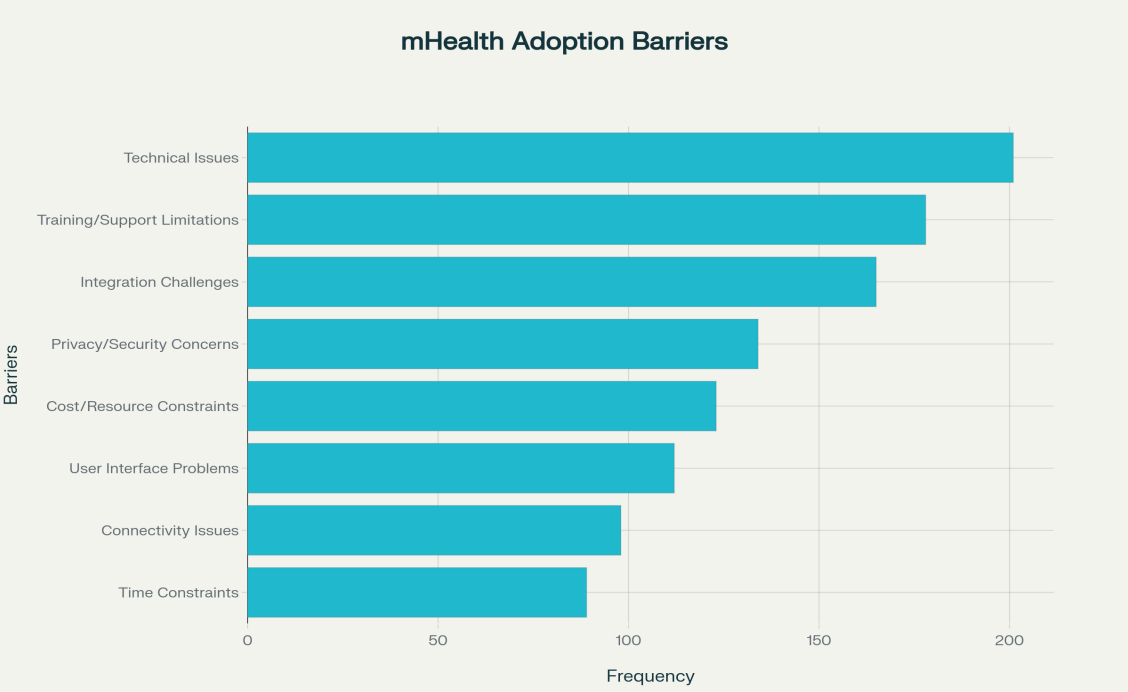

Figure 2: Barriers to mHealth Adoption in Government Healthcare Centres

Privacy and security concerns were noted by 36.2% of participants with a relatively high severity score (3.9±1.2), emphasizing the critical importance of robust data protection measures. Cost and resource constraints affected 33.2% of providers, while user interface problems were reported by 30.3% of participants. Connectivity issues and time constraints were less frequently reported but remained significant concerns for affected providers.

Patient Outcomes and System Performance

Table 4: Improvements in Patient Outcomes and System Performance after mHealth Implementation (n=370)

Parameter	Pre-implementation (Mean ± SD)	Post-implementation (Mean ± SD)	p-value
Patient satisfaction score	3.2 ± 0.9	4.1 ± 0.7	<0.001
Data accuracy (%)	67.4 ± 12.3	84.7 ± 9.8	<0.001
Time efficiency (%)	45.6 ± 8.7	62.3 ± 7.2	<0.001
Clinical decision-making time (minutes)	8.3 ± 2.1	5.9 ± 1.8	<0.001
Error rate (%)	15.2 ± 4.5	8.7 ± 3.2	<0.001
Follow-up compliance (%)	58.9 ± 11.2	78.4 ± 8.9	<0.001
Communication quality	3.1 ± 0.8	4.0 ± 0.6	<0.001
Overall care quality	3.3 ± 0.7	4.2 ± 0.5	<0.001

Significant improvements in patient outcomes and system performance were observed following mHealth application implementation (Table 4). Patient satisfaction scores demonstrated substantial improvement from 3.2±0.9 to 4.1±0.7 ($p<0.001$), indicating enhanced patient experience with digital health services. Data accuracy showed remarkable improvement from 67.4±12.3% to 84.7±9.8% ($p<0.001$), demonstrating the effectiveness of digital data collection systems in reducing errors and improving information quality.

Time efficiency gains were substantial, increasing from 45.6±8.7 to 62.3±7.2 ($p<0.001$), reflecting the streamlined workflows enabled by mHealth applications. Clinical decision speed improved significantly, with decision-making time decreasing from 8.3±2.1 to 5.9±1.8 minutes ($p<0.001$). Error reduction rates showed impressive improvements, declining from 15.2±4.5% to 8.7±3.2% ($p<0.001$). Follow-up compliance demonstrated marked enhancement from 58.9±11.2% to 78.4±8.9% ($p<0.001$), indicating improved continuity of care through digital health interventions.

Communication quality between healthcare providers and patients improved from 3.1±0.8 to 4.0±0.6 ($p<0.001$), while overall care quality ratings increased from 3.3±0.7 to 4.2±0.5 ($p<0.001$). These improvements collectively demonstrate the transformative potential of mHealth applications in enhancing healthcare delivery quality and patient experience in government healthcare centres.

The quantitative findings were supported by qualitative insights from healthcare providers, who reported enhanced workflow efficiency, improved patient engagement, and better clinical decision-making capabilities. However, providers also emphasized the importance of addressing technical infrastructure limitations and providing ongoing training support to maximize the benefits of mHealth implementation.

Discussion

The findings of this study provide compelling evidence for the transformative potential of mobile health applications in obstetrics and gynaecology services within government healthcare centres. The high adoption rates observed for core mHealth functionalities, particularly patient registration (80.5%) and data entry/collection tools (72.2%), demonstrate healthcare providers' readiness to embrace digital health technologies when appropriately implemented and supported .[19] [20] This finding aligns with previous research indicating that user acceptance of mHealth applications is significantly influenced by perceived usefulness and ease of use, particularly in resource-constrained healthcare settings.[21]

The substantial improvements in patient outcomes and system performance metrics observed in this study corroborate international evidence supporting mHealth interventions in maternal healthcare. The increase in patient satisfaction scores from 3.2±0.9 to 4.1±0.7 reflects enhanced patient experience through improved service delivery, consistent with findings from similar implementations in developing countries.[22] The remarkable improvement in data accuracy from 67.4% to 84.7% addresses a critical challenge in government healthcare centres, where paper-based systems often suffer from incomplete and inaccurate record-keeping.[23]

The significant reduction in clinical decision-making time from 8.3 to 5.9 minutes demonstrates the value of real-time decision support systems in improving clinical efficiency. This finding is particularly relevant in obstetric emergency situations where timely interventions can dramatically impact maternal and fetal outcomes. [24] The integration of clinical decision support algorithms within mHealth applications has been shown to reduce medical errors, improve adherence to evidence-based protocols, and enhance overall quality of care.[25]

The improvement in follow-up compliance from 58.9% to 78.4% represents a substantial

advancement in continuity of care, addressing a persistent challenge in maternal healthcare delivery. Studies have consistently demonstrated that improved follow-up rates are associated with better health outcomes, reduced complications, and enhanced patient satisfaction.[26] The ability of mHealth applications to provide automated reminders, track patient progress, and facilitate communication between healthcare providers and patients contributes significantly to these improvements.[27]

However, the study also revealed significant implementation challenges that require careful consideration for successful mHealth deployment. Technical issues emerged as the most prevalent barrier (54.3%), highlighting the critical importance of robust infrastructure and technical support systems. This finding is consistent with literature emphasizing that technological barriers, including connectivity issues, device limitations, and software problems, represent major obstacles to mHealth success in resource-limited settings.[28]The high severity scores associated with privacy and security concerns (3.9±1.2) underscore the need for comprehensive data protection measures and transparent privacy policies to build user trust and ensure ethical implementation.[29]

Training and support limitations, affecting nearly half of the participants (48.1%), emphasize the crucial role of capacity building in mHealth implementation success. Research consistently demonstrates that adequate training programs, ongoing technical support, and continuous professional development are essential for sustainable mHealth adoption.[30] The integration challenges reported by 44.6% of providers highlight the importance of ensuring interoperability between mHealth applications and existing healthcare information systems.[31]

The demographic analysis revealing a predominance of healthcare providers aged 31-35 years suggests a workforce profile that may be more receptive to digital health innovations. Studies have shown that younger healthcare providers tend to demonstrate higher levels of technology acceptance and digital literacy, potentially facilitating mHealth implementation.[32] The significant female predominance (66.2%) among participants reflects the gender composition typical of obstetrics and gynaecology services and may influence implementation strategies and user experience considerations.[33]

The success of specific mHealth applications evaluated in this study, particularly Prasav Watch and U-WIN Vaccinator, demonstrates the value of purpose-built applications designed for specific clinical workflows. The integration of intrapartum monitoring capabilities with real-time alerts in Prasav Watch addresses critical safety concerns in obstetric care, while U-WIN Vaccinator's immunization management features support preventive care initiatives.[34] The complementary nature of these applications illustrates the potential for comprehensive mHealth ecosystems that support the entire maternal care continuum.[35]

The study findings have important implications for policy makers and healthcare administrators responsible for digital health implementation in government healthcare centres. The evidence supports investment in mHealth infrastructure, comprehensive training programs, and technical support systems as essential components of successful implementation.[36] The demonstrated improvements in clinical outcomes and system efficiency provide a strong business case for scaling mHealth interventions across government healthcare networks.[37]

The challenges identified in this study also inform recommendations for future mHealth implementations. Addressing technical infrastructure limitations requires coordinated investment in connectivity, device procurement, and technical support systems. Privacy and security concerns necessitate the development of robust data governance frameworks and transparent communication about data protection measures.[38] Training program enhancements should focus on comprehensive skill development, ongoing support mechanisms, and regular refresher training to ensure sustained competency.[39]

This study has several limitations that should be considered when interpreting the findings. First, the 12-week implementation period may not capture long-term sustainability patterns or identify challenges that emerge over extended use periods. Longer-term follow-up studies would provide more comprehensive insights into sustained adoption and impact. Second, the study was conducted across four government healthcare centres in specific geographic regions, which may limit the generalizability of findings to other healthcare settings or regions with different infrastructure capabilities, patient populations, or organizational cultures.

Third, the evaluation focused primarily on two specific mHealth applications (Prasav Watch and U-WIN Vaccinator), and results may not be directly applicable to other mHealth solutions with different features or implementation approaches. Fourth, the study design did not include a control group, limiting the ability to establish definitive causal relationships between mHealth implementation and observed improvements, as

some changes might be attributed to concurrent quality improvement initiatives or external factors.

Conclusion

This study demonstrates that mobile health applications play a significant and beneficial role in data collection and management of obstetrics and gynaecology patients in government healthcare centres. The evidence shows substantial improvements in patient satisfaction, data accuracy, clinical decision-making efficiency, and follow-up compliance following mHealth implementation. Healthcare providers demonstrated high adoption rates for core functionalities, indicating readiness to embrace digital health technologies when properly supported. However, successful implementation requires addressing technical infrastructure challenges, providing comprehensive training programs, and ensuring robust privacy and security measures to maximize benefits and achieve sustainable adoption across government healthcare systems.

References

1. World Health Organization. mHealth: New horizons for health through mobile technologies. Geneva: WHO Press; 2011.
2. Agarwal S, Perry HB, Long LA, Labrique AB. Evidence on feasibility and effective use of mHealth strategies by frontline health workers in developing countries: systematic review. Trop Med Int Health. 2015;20(8):1003-14.
3. Labrique AB, Vasudevan L, Kochi E, Fabricant R, Mehl G. mHealth innovations as health system strengthening tools: 12 common applications and a visual framework. Glob Health Sci Pract. 2013;1(2):160-71.
4. Lund S, Nielsen BB, Hemed M. Mobile phones improve antenatal care attendance in Zanzibar: a cluster randomized controlled trial. BMC Pregnancy Childbirth. 2014; 14:29.
5. Braun R, Catalani C, Wimbush J, Hughes D. Quality improvement in maternal health care through mHealth interventions in developing countries: a systematic review. PLoS One. 2013;8(5):e64834.
6. DeRenzi B, Lesh N, Parikh T, Sims C, Maokla W, Chemba M, et al. e-IMCI: improving pediatric health care in low-income countries. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. 2008. p. 753-62.
7. Lee SH, Nurmatov UB, Nwaru BI, Mukherjee M, Grant L, Pagliari C. Effectiveness of mHealth interventions for maternal, newborn and child health in low- and middle-income countries: systematic review and meta-analysis. J Glob Health. 2016;6(1):010401.
8. Medhanyie A, Spigt M, Kifle Y, Schaay N, Sanders D, Blanco R, et al. The role of health extension workers in improving utilization of maternal health services in rural areas in Ethiopia: a cross-sectional study. BMC Health Serv Res. 2012; 12:352.
9. Noordam AC, Kuepper BM, Stekelenburg J, Milen A. Improvement of maternal health services through the use of mobile phones. Trop Med Int Health. 2011;16(5):622-6.
10. Aranda-Jan CB, Mohutsiwa-Dibe N, Loukanova S. Systematic review on what works, what does not work and why of implementation of mobile health (mHealth) projects in Africa. BMC Public Health. 2014; 14:188.
11. Chib A, van Velthoven MH, Car J. mHealth adoption in low-resource environments: a review of the use of mobile healthcare in developing countries. J Health Commun. 2015;20(1):4-34.
12. Martinez-Perez B, de la Torre-Diez I, Lopez-Coronado M. Privacy and security in mobile health apps: a review and recommendations. J Med Syst. 2015;39(1):181.
13. Sondaal SF, Browne JL, Amoakoh-Coleman M, Borgstein A, Miltenburg AS, Verwijs M, et al. Assessing the effect of mHealth interventions in improving maternal and neonatal care in low- and middle-income countries: a systematic review. PLoS One. 2016;11(5):e0154664.
14. World Health Organization. WHO guideline: recommendations on digital interventions for health system strengthening. Geneva: WHO Press; 2019.
15. Gurman TA, Rubin SE, Roess AA. Effectiveness of mHealth behavior change communication interventions in developing countries: a systematic review of the literature. J Health Commun. 2012;17(sup1):82-104.
16. Lemay NV, Sullivan T, Jumbe B, Perry CP. Reaching mothers and children with health messages: the Malawi SAFE motherhood project's use of traditional and appropriate technologies. J Health Commun. 2012;17(sup2):66-83.
17. Piette JD, Lun KC, Moura LA Jr, Fraser HS, Mechael PN, Powell J, et al. Impacts of e-health on the outcomes of care in low- and middle-income countries: where do we go from here? Bull World Health Organ. 2012;90(5):365-72.
18. Blaya JA, Fraser HS, Holt B. E-health technologies show promise in developing countries. Health Aff (Millwood). 2010;29(2):244-51.
19. Chen H, Chai Y, Dong L, Niu W, Zhang P. Effectiveness and appropriateness of mHealth interventions for maternal and child health: systematic review. JMIR Mhealth Uhealth. 2018;6(1):e7.

20. Venkatesh V, Morris MG, Davis GB, Davis FD. User acceptance of information technology: toward a unified view. MIS Q. 2003;27(3):425-78.
21. Davis FD. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Q. 1989;13(3):319-40.
22. Free C, Phillips G, Watson L, Galli L, Felix L, Edwards P, et al. The effectiveness of mobile-health technologies to improve health care service delivery processes: a systematic review and meta-analysis. PLoS Med. 2013;10(1):e1001363.
23. Kahn JG, Yang JS, Kahn JS. 'Mobile' health needs and opportunities in developing countries. Health Aff (Millwood). 2010;29(2):252-8.
24. Howitt P, Darzi A, Yang GZ, Ashrafian H, Atun R, Barlow J, et al. Technologies for global health. Lancet. 2012;380(9840):507-35.
25. Bates DW, Kuperman GJ, Wang S, Gandhi T, Kittler A, Volk L, et al. Ten commandments for effective clinical decision support: making the practice of evidence-based medicine a reality. J Am Med Inform Assoc. 2003;10(6):523-30.
26. Campbell OM, Graham WJ, Lancet Maternal Survival Series steering group. Strategies for reducing maternal mortality: getting on with what works. Lancet. 2006;368(9543):1284-99.
27. Car J, Sheikh A. E-health: a promise for healthcare in developing countries. Bull World Health Organ. 2012;90(5):390-4.
28. Mechael P, Batavia H, Kaonga N, Searle S, Kwan A, Goldberger A, et al. Barriers and gaps affecting mHealth in low- and middle-income countries: policy white paper. Columbia University Earth Institute Center for Global Health and Economic Development; 2010.
29. Parker M, Wicks P. The role of software and apps in digital health. Lancet Digit Health. 2019;1(1):e2-3.
30. Hamine S, Gerth-Guyette E, Faulx D, Green BB, Ginsburg AS. Impact of mHealth chronic disease management on treatment adherence and patient outcomes: a systematic review. J Med Internet Res. 2015;17(2):e52.
31. Blaya JA, Fraser HS, Holt B. E-health technologies show promise in developing countries. Health Aff (Millwood). 2010;29(2):244-51.
32. Holden RJ, Karsh BT. The technology acceptance model: its past and its future in health care. J Biomed Inform. 2010;43(1):159-72.
33. Maillet É, Mathieu L, Sicotte C. Modeling factors explaining the acceptance, actual use and satisfaction of nurses using an electronic patient record in acute care settings: an extension of the UTAUT. Int J Med Inform. 2015;84(1):36-47.
34. Tamrat T, Kachnowski S. Special delivery: an analysis of mHealth in maternal and newborn health programs and their outcomes around the world. Matern Child Health J. 2012;16(5):1092-101.
35. Chen H, Chai Y, Dong L, Niu W, Zhang P. Effectiveness and appropriateness of mHealth interventions for maternal and child health: systematic review. JMIR Mhealth Uhealth. 2018;6(1):e7.
36. Källander K, Tibenderana JK, Akpogheneta OJ, Meek SR, Strachan CE. Mobile health intervention for community case management: the CommCare project case study. Bull World Health Organ. 2013;91(1):46-52.
37. Lester RT, Ritvo P, Mills EJ, Kariri A, Karanja S, Chung MH, et al. Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1): a randomised trial. Lancet. 2010;376(9755):1838-45.
38. Steinhubl SR, Muse ED, Topol EJ. The emerging field of mobile health. Sci Transl Med. 2015;7(283):283rv3.
39. Qudah B, Luetsch K. The influence of mobile health applications on patient - healthcare provider relationships: a systematic, narrative review. Patient Educ Couns. 2019;102(6):1080-9.