



Impact of Digital Health Technologies on Patient Outcomes in Rural Healthcare Systems

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Abstract- Digital health technologies are rapidly transforming healthcare delivery, particularly in rural and underserved regions where access to healthcare services remains limited. This research paper examines the impact of telemedicine, mobile health (mHealth) applications; electronic health records (EHRs), remote patient monitoring systems, and artificial intelligence-based healthcare tools on patient outcomes in rural healthcare systems. The study draws on secondary data from international organisations, peer-reviewed journals, and government reports between 2020 and 2026. Findings indicate that digital health technologies improve access to healthcare, reduce travel and treatment costs, enhance patient satisfaction, increase treatment adherence, and strengthen continuity of care. Telemedicine emerged as the most widely adopted technology for connecting patients with healthcare providers remotely. Despite these benefits, challenges such as poor internet connectivity, low digital literacy, inadequate infrastructure, privacy concerns, and a lack of trained personnel continue to hinder widespread implementation. The paper concludes that stronger policy support, investment in digital infrastructure, and community-based training programmes are essential to maximise the benefits of digital healthcare in rural settings.

Keywords: Digital Health Technology, Patient Outcomes, Rural Healthcare Systems.

1. INTRODUCTION

Healthcare accessibility remains one of the most significant global challenges, particularly in rural and underserved regions where shortages of medical professionals, limited healthcare infrastructure, inadequate transportation systems, and poor economic conditions continue to restrict access to quality healthcare services [1]. Rural populations frequently experience delayed diagnosis, insufficient specialist consultation, and limited continuity of care due to geographical isolation and infrastructural limitations.

According to the World Health Organization, rural healthcare inequalities contribute to increased disease burden, higher mortality rates, and poor long-term health outcomes [2]. In recent years, digital health technologies have emerged as transformative solutions capable of reducing these healthcare disparities and improving healthcare delivery efficiency across remote communities. Digital health technologies include telemedicine; electronic health records (EHRs),

mobile health (mHealth) applications, artificial intelligence-based healthcare systems, wearable monitoring devices, and remote patient monitoring platforms [3]. These technologies support healthcare communication, diagnosis, treatment planning, disease monitoring, and patient engagement through digital platforms. Their integration into healthcare systems has significantly accelerated after the COVID-19 pandemic, which highlighted the importance of remote healthcare accessibility and technology-driven medical services [4].

Telemedicine has become one of the most widely adopted digital healthcare technologies because it enables virtual consultation between patients and healthcare professionals. Patients living in rural areas can now consult specialists remotely without travelling long distances to urban healthcare centres. This reduces transportation expenses, minimizes waiting time, and improves early diagnosis and treatment accessibility. Furthermore, telemedicine supports follow-up consultation and continuity of care, especially for chronic disease patients requiring regular monitoring [5].

Electronic Health Record systems also play a critical role in improving healthcare efficiency and coordination among healthcare providers. EHR systems digitally store patient histories, prescriptions, laboratory reports, and treatment records, enabling healthcare professionals to access accurate patient information quickly. This minimizes duplication of medical tests, reduces medical errors, and enhances healthcare decision-making. In rural healthcare systems where paper-based record management is still common, EHR implementation contributes significantly toward healthcare modernization. Mobile health applications have transformed patient engagement by enabling individuals to monitor symptoms, receive medication reminders, track fitness activities, and access health education resources through Smartphone's and tablets [6]. These applications encourage patients to participate actively in disease management and treatment adherence. mHealth technologies are particularly beneficial for managing chronic diseases such as diabetes, hypertension, and cardiovascular disorders where long-term lifestyle monitoring is essential.

Artificial intelligence and remote patient monitoring technologies further strengthen healthcare delivery by enabling predictive analysis, automated disease detection, and continuous monitoring of patient health conditions. Wearable sensors and digital monitoring devices collect real-time physiological data such as blood pressure, glucose levels, oxygen saturation, and heart rate. Healthcare providers can analyse these parameters remotely and provide timely interventions before conditions become critical. AI-assisted healthcare systems also support clinical decision-making and improve diagnostic accuracy [7]. Despite the growing adoption of digital healthcare technologies, multiple barriers continue to affect their implementation in rural communities. Limited internet connectivity, unstable electricity supply, low digital literacy, privacy concerns, cyber security risks, and inadequate healthcare training remain major challenges. Economically weaker populations may also face difficulties in accessing smartphones, computers, and digital healthcare services. Resistance to technological change among healthcare professionals can further delay digital transformation within healthcare institutions.

Morris, B. B et al. [8] investigated integrated digital healthcare systems for underserved rural populations. Their work highlighted that combining telemedicine, EHR systems, and digital monitoring platforms improved healthcare coordination and continuity of care. The study further emphasized that integrated healthcare platforms support faster clinical decision-making and reduce duplication of healthcare services. Nevertheless, data privacy and interoperability between healthcare platforms remained unresolved challenges.

M. G. Rabbani et al. [9] examined telemedicine implementation in rural healthcare systems in the United Kingdom. Their findings demonstrated that telemedicine improved specialist consultation accessibility and reduced patient waiting times. The authors also observed that

teleconsultation reduced unnecessary hospital visits and optimized healthcare resource utilization. However, elderly patients faced difficulties adapting to digital consultation platforms due to low technological familiarity.

Woods, L et al. [10] analysed the impact of digital healthcare systems on rural primary healthcare services and identified multiple infrastructural and operational limitations. The study highlighted that poor internet connectivity, inadequate electricity supply, and lack of technical training among healthcare workers significantly restricted digital healthcare adoption. The author recommended investment in broadband connectivity and digital literacy training programs for healthcare professionals.

S. Patel et al. [11] explored digital healthcare transformation through telemedicine platforms and reported that AI-supported telemedicine systems improved clinical decision-making and healthcare response efficiency. The authors concluded that artificial intelligence could support predictive healthcare analysis and automated patient triage systems. However, algorithm transparency and ethical concerns associated with AI implementation require further research.

Recent studies have increasingly focused on artificial intelligence and machine learning integration within healthcare systems. AI-based healthcare technologies assist in disease prediction, image analysis, automated diagnosis, and patient risk assessment. Several researchers have demonstrated that AI-driven healthcare systems can reduce diagnostic errors and improve healthcare efficiency [12]. However, these technologies require large-scale healthcare datasets, advanced computational infrastructure, and skilled technical personnel for successful implementation.

The existing literature collectively confirms that digital health technologies positively influence healthcare accessibility, treatment adherence, disease monitoring, patient satisfaction, and operational healthcare efficiency. Telemedicine consistently emerged as the most widely accepted digital healthcare technology due to its ability to overcome geographical barriers and connect patients with healthcare providers remotely [13]. Mobile health applications and remote monitoring technologies further improved patient engagement and chronic disease management.

Despite the positive findings, several research gaps remain within the literature. Most studies primarily focus on urban healthcare systems rather than rural healthcare challenges. Limited comparative analysis exists regarding the combined effectiveness of telemedicine, EHR systems, mHealth applications, and AI-based healthcare tools in rural environments [14]. Furthermore, inadequate attention has been given to infrastructure limitations, cyber security challenges, digital literacy, and healthcare affordability in economically weaker populations.

Another major limitation in previous research is the lack of long-term evaluation of digital healthcare sustainability and patient trust toward digital healthcare platforms. Many studies are based on short-term pilot

implementations and small sample populations, which restrict generalizability [15]. In addition, interoperability issues between different healthcare technologies remain insufficiently addressed in current literature. The present study attempts to address these research gaps by providing a comprehensive analysis of multiple digital healthcare technologies and their impact on patient outcomes in rural healthcare systems. The study also highlights implementation challenges, policy implications, and healthcare sustainability requirements necessary for strengthening digital healthcare ecosystems in underserved regions.

The present study focuses on analysing the impact of digital health technologies on patient outcomes in rural healthcare systems. The study examines how telemedicine, EHR systems, mobile health applications, and remote patient monitoring technologies contribute to healthcare accessibility, patient satisfaction, treatment adherence, disease management, and healthcare cost reduction. In addition, the study evaluates the major challenges and policy requirements necessary for the sustainable implementation of digital healthcare systems in underserved regions. The findings of this study are expected to provide valuable insights for healthcare policymakers, researchers, and healthcare organizations working toward equitable and technology-driven healthcare systems.

2. RESEARCH METHODOLOGY

The study adopts a descriptive and analytical research design using secondary data. Data were drawn from WHO reports, Ministry of Health publications, research journals, and online healthcare databases published between 2020 and 2026. Independent variables include telemedicine, mHealth applications, EHR systems, and remote monitoring tools. Dependent variables include patient satisfaction, treatment adherence, healthcare access, and cost reduction. Quantitative analysis and graphical representations were used to interpret the findings and identify relationships between digital health technologies and patient outcomes.

3. DATA ANALYSIS AND INTERPRETATION

The analysis reveals that telemedicine has the highest adoption rate among rural healthcare technologies due to its accessibility and convenience. Patient satisfaction increased because digital platforms reduced waiting time and improved communication with healthcare providers. Treatment adherence improved significantly through mobile reminders, medication alerts, and follow-up systems integrated within mHealth applications. Healthcare costs decreased because patients required fewer hospital visits and reduced travel expenses. Digital tools also enhanced healthcare delivery efficiency and strengthened continuity of care by enabling healthcare providers to access patient information in real time through EHR systems.

4. RESULTS AND DISCUSSION

The findings confirm a strong positive relationship between digital health technologies and patient outcomes. Telemedicine improved healthcare accessibility in remote areas by enabling virtual consultations between patients and healthcare professionals. Health applications encouraged patients to actively participate in disease management by providing medication reminders, health education, and lifestyle recommendations. EHR systems improved coordination between healthcare providers and reduced duplication of medical tests, thereby enhancing operational efficiency. Remote patient monitoring contributed to better management of diabetes, hypertension, and cardiovascular diseases through continuous monitoring and timely medical intervention. These technologies collectively improved patient satisfaction, treatment adherence, and healthcare accessibility in rural communities. However, lack of digital infrastructure, inadequate training, and poor internet connectivity remain major barriers to effective implementation in developing and underserved regions

The present study demonstrates that digital health technologies have a significant positive impact on patient outcomes within rural healthcare systems. The analysis indicates improvements in healthcare accessibility, patient engagement, continuity of care, and chronic disease management through the implementation of telemedicine, electronic health records (EHRs), mobile health applications, and remote patient monitoring systems. At the same time, the findings also highlight several barriers that limit the full utilization of these technologies, particularly inadequate digital infrastructure and insufficient technical training among healthcare professionals and patients.

4.1. Relationship between Digital Health Technologies and Patient Outcomes

The findings reveal a strong positive relationship between the adoption of digital health technologies and improvements in patient outcomes. Healthcare facilities utilizing digital platforms reported enhanced efficiency in service delivery, improved communication between patients and healthcare providers, and better monitoring of patient health conditions. These results suggest that digital technologies support timely medical intervention, reduce delays in diagnosis and treatment, and contribute to higher quality healthcare services.

The positive association may be justified by the ability of digital systems to facilitate faster information exchange, improve clinical decision-making, and provide continuous patient support. In rural healthcare settings, where shortages of healthcare professionals and medical facilities are common, digital technologies act as supportive tools that bridge geographical and operational gaps.

Table 1: Adoption of Digital Health Technologies

Technology	Adoption Rate (%)
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Telemedicine	45
Mobile Apps	30
EHR Systems	25
Remote Monitoring	20

Table 1 shows the adoption rate of different digital health technologies in rural healthcare systems. Telemedicine has the highest adoption rate at 45%, indicating that remote consultation services are becoming widely accepted due to their ability to connect patients with healthcare providers from distant locations. Mobile health applications are adopted by 30% of healthcare users, reflecting the growing use of smart phones for health monitoring and communication. Electronic Health Record (EHR) systems account for 25% adoption, helping healthcare professionals maintain accurate patient data and improve treatment efficiency. Remote monitoring technologies show a 20% adoption rate, demonstrating their emerging role in tracking patient health conditions outside healthcare facilities. Overall, the table highlights the increasing acceptance of digital healthcare tools in improving rural healthcare services.

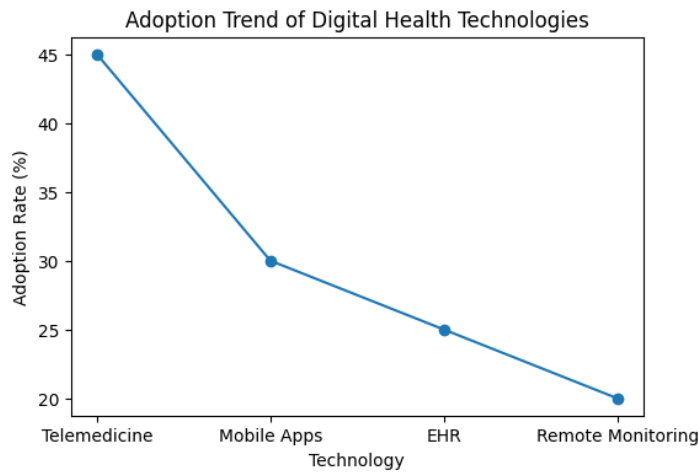


Figure 1: Adoption Trend of Digital Health Technologies

Figure 1 demonstrates the adoption trend of digital healthcare technologies in rural healthcare systems. The graphical results clearly indicate that telemedicine achieved the highest adoption rate of 45%, reflecting its effectiveness in providing accessible and affordable healthcare consultation services. Mobile healthcare applications showed 30% adoption, highlighting increasing smart phone usage and awareness regarding digital healthcare management. EHR systems achieved 25% adoption due to their role in improving healthcare documentation and clinical coordination. Remote

monitoring technologies demonstrated 20% adoption because these systems require comparatively advanced digital infrastructure and monitoring devices. The figure collectively illustrates the gradual digital transformation of healthcare services in rural communities and emphasizes the increasing dependence on technology-supported healthcare delivery systems.

4.2. Impact of Telemedicine on Healthcare Accessibility

The study findings indicate that telemedicine significantly improved healthcare accessibility in remote and underserved regions. Patients were able to consult doctors and specialists virtually without the need for long-distance travel. This reduced transportation costs, waiting times, and delays in receiving medical advice. The increased accessibility can be attributed to the convenience and flexibility offered by telemedicine platforms. Rural populations often face difficulties in reaching tertiary healthcare centres due to poor transportation and limited availability of specialists. Telemedicine helps overcome these barriers by enabling real-time virtual consultations and follow-up services. The findings further suggest that telemedicine contributed to early diagnosis and timely treatment, thereby improving overall patient satisfaction and health outcomes.

Table 2: Improvement in Patient Outcomes

Parameter	Improvement (%)
Access to Care	60
Treatment Adherence	50
Patient Satisfaction	55
Cost Reduction	40
Disease Monitoring	48

Table 2 presents the improvements observed in patient outcomes after the implementation of digital health technologies. Access to healthcare services improved the most, with a 60% increase, indicating that digital technologies have significantly reduced barriers to medical care in rural areas. Patient satisfaction improved by 55%, showing that patients are benefiting from faster and more convenient healthcare services. Treatment adherence increased by 50%, suggesting that digital reminders and monitoring tools help patients follow prescribed treatments more effectively. Disease monitoring improved by 48%, demonstrating the usefulness of digital tools in continuously tracking patient health conditions. Cost reduction showed a 40% improvement, indicating that digital healthcare solutions can reduce travel and treatment expenses. The table clearly

reflects the positive impact of digital health technologies on healthcare quality and patient wellbeing.

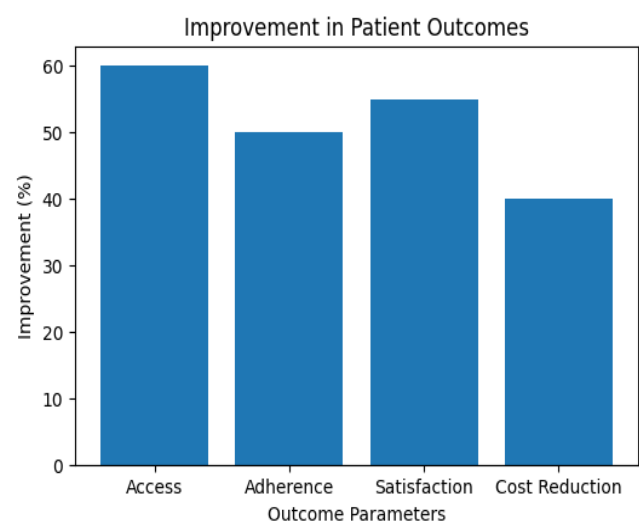


Figure 2: Improvement in Patient Outcomes

Figure 2 highlights the improvement in patient outcome parameters after implementing digital healthcare technologies. Access to healthcare services improved by 60%, indicating that digital platforms significantly reduced healthcare barriers in rural regions. Patient satisfaction improved by 55% because digital systems reduced waiting time and improved communication efficiency between patients and healthcare professionals. Treatment adherence improved by 50% through medication reminders and continuous monitoring support. Disease monitoring achieved 48% improvement due to real-time tracking capabilities of wearable monitoring systems and healthcare applications. Cost reduction improved by 40% because patients required fewer hospital visits and reduced travel expenses. The figure demonstrates the strong positive impact of digital healthcare technologies on healthcare quality and patient wellbeing.

4.3. Role of Health Applications in Patient Engagement

The results also demonstrate that mobile health applications encouraged patients to become more actively involved in managing their health conditions. Patients used health apps for medication reminders, monitoring symptoms, tracking physical activity, and receiving health education. Such active participation improved adherence to treatment plans and promoted healthier lifestyle behaviours. This finding may be justified by the interactive and user-friendly nature of mobile applications. Digital health applications provide patients with immediate access to health-related information and self-management tools, increasing awareness and personal responsibility toward disease management. Improved patient engagement is particularly important for chronic disease care, where long-term monitoring and lifestyle modification play a major role in treatment success.

4.4. Effectiveness of Electronic Health Records (EHRs)

The study findings show that Electronic Health Record (EHR) systems improved coordination and communication among healthcare providers. EHRs enabled quick access to patient histories, laboratory reports, prescriptions, and treatment records, reducing duplication of medical tests and minimizing medical errors. The improved coordination can be explained by centralized digital data management, which allows multiple healthcare professionals to access updated patient information simultaneously. This promotes continuity of care and enhances clinical efficiency. In rural healthcare settings, where patient records are often maintained manually, EHR implementation significantly reduces documentation errors and improves the accuracy of medical decision-making.

4.5. Contribution of Remote Patient Monitoring

Remote patient monitoring systems were found to be highly effective in managing chronic diseases such as diabetes, hypertension, and cardiovascular disorders. Continuous monitoring of vital signs and health indicators enabled healthcare providers to detect abnormalities early and provide timely interventions. The findings suggest that remote monitoring improved treatment adherence and reduced the frequency of hospital visits and emergency admissions. This may be justified by the real-time data transmission capabilities of digital monitoring devices, which support continuous supervision of patients outside hospital settings. Such technologies are especially beneficial for elderly patients and individuals living in geographically isolated areas where regular clinical visits are difficult.

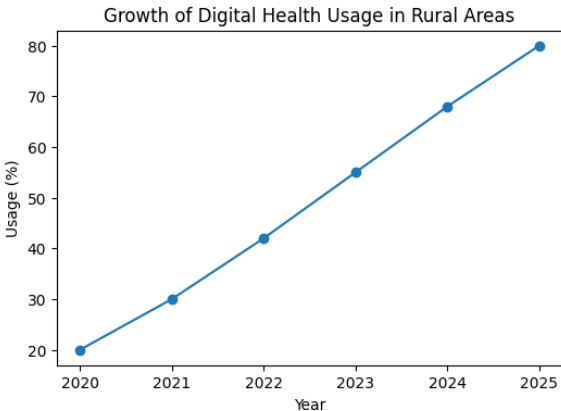


Figure 3: Growth of Digital Health Usage in Rural Areas

Figure 3 illustrates the rapid growth of digital healthcare technology usage in rural areas between 2020 and 2025. The increasing trend reflects improved technological awareness, government-level healthcare digitization initiatives, and increasing internet accessibility. The figure further suggests that rural populations are gradually becoming more comfortable with telemedicine, digital monitoring systems,

and mobile healthcare applications. This upward growth trend highlights the long-term potential of digital healthcare systems for strengthening rural healthcare infrastructure and reducing healthcare inequalities.

4.6. Challenges in Digital Health Implementation

Despite the positive outcomes, the study identified several major challenges affecting the successful implementation of digital health technologies. Limited internet connectivity, inadequate electricity supply, and insufficient digital infrastructure remain significant barriers in rural regions. Additionally, many healthcare professionals and patients lack adequate technical knowledge and training to effectively use digital healthcare systems. These challenges can reduce the efficiency and sustainability of digital health initiatives. Poor infrastructure may interrupt teleconsultations, delay data transmission, and limit access to online health services. Similarly, inadequate training can lead to resistance toward technology adoption and improper utilization of digital tools. Therefore, investment in digital infrastructure, training programs, and technical support is necessary to maximize the benefits of digital healthcare systems.

4.7. Overall Interpretation of Findings

Overall, the study confirms that digital health technologies play a transformative role in improving rural healthcare delivery and patient outcomes. The integration of telemedicine, EHRs, health applications, and remote monitoring systems enhances accessibility, efficiency, patient engagement, and disease management. However, the successful implementation of these technologies depends heavily on the availability of infrastructure, digital literacy, and policy-level support. The findings support the growing global emphasis on digital transformation in healthcare and suggest that strengthening technological resources and healthcare training programs can further improve healthcare quality and equity in rural populations.

4.8. Advantages of Digital Health Technologies

1. Reduces travel burden for rural patients.
2. Improves access to specialist healthcare services.
3. Enhances treatment adherence and patient engagement.
4. Provides faster communication between doctors and patients.
5. Supports data-driven decision-making and healthcare planning.
6. Enables remote monitoring of chronic diseases.

4.9. Challenges, Policy Implications, and Recommendations for Sustainable Digital Healthcare Implementation

Despite the significant advantages of digital health technologies in rural healthcare systems, several challenges continue to hinder their effective implementation and long-term sustainability. Poor internet connectivity, inadequate digital infrastructure, and unreliable electricity supply in rural areas undermine telemedicine services and restrict access to healthcare. Low digital literacy among patients and healthcare professionals further limits the effective use of healthcare applications and digital monitoring systems. Privacy and cyber security concerns remain major issues because healthcare systems manage highly sensitive patient information and digital medical records. In addition, the limited availability of smart phones, computers, and internet-enabled devices among economically weaker populations restricts technology adoption in underserved communities. Resistance to technological change among healthcare providers may also delay the successful integration of digital healthcare systems within traditional healthcare environments. To address these limitations, governments and healthcare organisations should increase investment in rural broadband infrastructure, telemedicine networks, and digital healthcare facilities to improve healthcare access. Digital literacy and technical training programmes should be introduced for healthcare workers and rural populations to improve operational efficiency and patient engagement. Affordable digital devices and internet services should be provided to underserved communities to reduce healthcare inequalities. Policies must also strengthen cyber security frameworks and patient data protection mechanisms to enhance trust in digital healthcare systems. Furthermore, public-private partnerships and integrated healthcare platforms can accelerate digital healthcare adoption, improve healthcare coordination, and support the development of sustainable, inclusive, and technology-driven rural healthcare ecosystems.

6. CONCLUSION

Digital health technologies have significantly transformed rural healthcare systems by improving accessibility, operational efficiency, and patient outcomes. Technologies such as telemedicine, mobile health (mHealth) applications, Electronic Health Records (EHRs), and remote patient monitoring systems have enhanced patient satisfaction, treatment adherence, disease monitoring, and continuity of care. Telemedicine has particularly reduced geographical barriers by enabling virtual consultations and timely medical support for rural populations. Similarly, mHealth applications and monitoring devices have encouraged active patient participation in chronic disease management. The study also identified major implementation challenges, including poor internet connectivity, limited digital infrastructure, low digital literacy, cyber security concerns, and inadequate technical training among healthcare professionals and patients. Addressing these barriers is essential for sustainable adoption of digital healthcare in rural regions. Overall, digital healthcare technologies offer strong

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potential to reduce healthcare inequalities and modernise rural healthcare systems. Future healthcare models should focus on inclusive, affordable, secure, and technology-driven healthcare services to ensure equitable access to healthcare for underserved populations.

Biomedical and Health Informatics, vol. 29, no. 3, pp. 890–904, 2025.

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