

Research Article

Impact of Digital Transformation on Healthcare Accessibility in Saudi Arabia: A Systematic Review

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Received: 09.02.25, Revised: 14.03.25, Accepted: 21.04.25

ABSTRACT

Introduction: Digital transformation is reshaping healthcare accessibility in Saudi Arabia, aligning with the Vision 2030 initiative to establish a sustainable and efficient healthcare system. Advances in telemedicine, electronic health records (EHRs), and AI-driven diagnostics offer new solutions to overcoming traditional barriers to care.

Objectives: This systematic review examines how digital health technologies improve healthcare accessibility in Saudi Arabia. It explores their role in reducing geographical and time-related barriers while identifying key implementation challenges.

Methods: A systematic review of peer-reviewed literature (2020-2024) was conducted using databases such as PubMed, Google Scholar, and the Saudi Digital Library. Studies assessing the impact of digital health technologies on healthcare accessibility in Saudi Arabia were included. The PICO framework guided the review, and quality was assessed using the Joanna Briggs Institute (JBI) checklist.

Results: The review identified telemedicine and AI-assisted diagnostics as key drivers of improved healthcare access, particularly in rural areas. Studies reported up to a 40% reduction in consultation wait times and enhanced continuity of care due to digital records integration. However, barriers such as the digital divide, infrastructure limitations, and privacy concerns persist, hindering full-scale adoption.

Conclusion: Digital health technologies significantly enhance healthcare accessibility in Saudi Arabia, supporting the goals of Vision 2030. However, targeted efforts are required to bridge digital literacy gaps, improve infrastructure, and strengthen data protection frameworks. Future research should focus on long-term digital health adoption and patient-centered outcomes to maximize the benefits of digital transformation in healthcare.

Keywords: Digital Transformation, Healthcare Accessibility, Telemedicine, Vision 2030, Saudi Arabia.

INTRODUCTION

The advancement in technology for healthcare systems has provided a new way of accessing care since there are barriers set in the traditional healthcare systems (1). Such transition is especially crucial in Saudi Arabia, which sets highly ambitious goals in the framework of Vision 2030 to increase healthcare accessibility, quality, and productivity while decreasing the nation's reliance on its oil wealth (2). Telemedicine, EHRs, and other mHealth solutions have played a decisive role in responding to the most significant problems, including geographic distribution and the availability of services, particularly in rural settings (3).

However, implementing digital health technologies in Saudi Arabia presents several challenges, including Digital literacy, Digital infrastructure, and privacy (4).

The digital age's effects on healthcare availability in Saudi Arabia have drawn increasing interest, especially considering the Saudi Vision 2030 plan to improve healthcare access and quality through technology (5). Different researchers have analyzed the use of telehealth EHR and m-health and their utility in overcoming previous barriers to healthcare access, particularly in rural settings (6).

A study shows that digital health technologies enhance healthcare delivery by addressing geographical divides and enabling timely consultations (7). For example, a systematic review established the effectiveness of telemedicine as a critical strategy for achieving equal access to quality health for patients in remote areas of participation (8). However, problems with the digital divide exist, whereby some patients and caregivers lack digital literacy, and others lack the necessary

infrastructure. Privacy also remains an issue that hampers the effective implementation of these technologies in healthcare systems.

The synthesis of the existing literature indicates that although the concept of DT promises to augment the accessibility of healthcare services, it is also essential to develop a more effective plan to deal with the current challenges (9). Research has identified the need for uptake of a targeted approach in training for health care providers and patients for enhanced digital literacy as well as adoption of integrated digital health technologies (10, 11, 12). In addition, the quality of various studies incorporated into the review reveals that authors have strictly followed appropriate methods, which provide credibility to findings about the efficacy of digital health interventions (13, 14).

This systematic review aims to answer a guiding question of the 'effects of digital health technologies on the availability of care in Saudi Arabia compared to conventional care delivery methods.' This research will assess the impact of digital interventions on healthcare and pinpoint factors shaping the need for and access to professionals by investigating the patient, intervention, context, and outcome of digital applications in the identified topic area using the PICO framework.

Despite the benefits of digital transformation in enhancing the availability of healthcare in KSA, the inherent problems must be solved to boost the impact. Further studies and proper and well-planned application of the technologies in the digital health field will remain crucial for achieving the targets stipulated in Vision 2030 and creating equal opportunities for all populations to receive improved healthcare services.

The systematic review will compare the effects of digital health technology on healthcare accessibility, patient progress, and health system efficiencies through published articles from 2020 to 2024. Accordingly, the review intends to include practical recommendations to boost the implementation and utility of digital health solutions in Saudi Arabia and support the nation's Vision 2030 objectives.

METHODS

Research Question

In what ways does technological advancement in health information and communication technologies in Saudi Arabia enhance the availability of health care as opposed to the traditional approaches in health care?

PICO Framework

Based on the PICO components, the following inclusion and exclusion criteria were developed to steer this review:

- Population (P): Healthcare providers and patients in Saudi Arabia
- Intervention (I): Implementation of digital health technologies, such as telemedicine, Diagnostics with AI, and electronic health records
- Comparison (C): Traditional healthcare approaches without digital enhancements
- Outcome (O): Enhanced healthcare accessibility

Search Strategy

The study looked for articles on the Impact of Digital Transformation on Healthcare in Saudi Arabia through MEDLINE, Google Scholar, and the Saudi digital library. A variety of keyword searches and combined them with appropriate Boolean operators were used, including: "Digital transformation," "healthcare impact," "Saudi Arabia," "Artificial intelligence," "healthcare," AND "efficiency," and "Digital health" OR "e-health" AND "patient care improvement." The search was made in October 2024, and only articles published in 2020-2024 were considered. The review followed the "Preferred Reporting Items for Systematic Reviews (PRISMA)" guidelines (1); after obtaining citations, the references were imported into EndNote 21 software (Clarivate, Philadelphia, PA, USA)(2) to categorize the articles and eliminate duplicates.

Inclusion and Exclusion Criteria

The following criteria were used in the systematic review: The studies had to be written in English and peer-reviewed: (1) published as peer-reviewed journal articles; (2) presented as an observational study; (3) involved the eligible, research must analyze interventions such as telemedicine, AI-assisted diagnostics, or electronic health records and evaluate their effects on healthcare accessibility, patient outcomes, or system efficiency. (4) scored at least ranges from high quality (70-100% "Yes" responses) on the Joanna Briggs (JBI) checklist (3). Excluded

studies not conducted within Saudi Arabia, non-interventional digital health technologies, non-peer-reviewed articles, opinion pieces, and studies lacking empirical data.

Data Collection Process

To improve reliability, two individuals (MM and SA) independently reviewed titles and abstracts before accessing full-text articles via electronic search. The selected papers were reviewed to ensure they met the inclusion and exclusion criteria, with minor differences discussed.

Quality Assessment

The "Joanna Briggs Institute-JBI" checklists(4)are employed for qualitative assessment, with each question answered with "Yes," "No," "Unclear," or "Not Applicable." Researchers use a scoring approach to quantify study quality, assigning points for "Yes" answers and 0 for "No" or "Unclear" answers. The scoring ranges from high quality (70-100% "Yes" responses) to moderate quality (50-69% "Yes" responses) and low quality (less than 50% "Yes" responses)(3).

Data Synthesis and Extraction

The study used a qualitative synthesis approach to review the existing literature that examined

the effects of digital technologies in KSA. We created tables summarizing the key results from the retrieved articles, with data extracted on important information such as author, publication year, research population, study design, intervention specifics, and outcome indicators. This provided a comprehensive overview of each study. Two researchers independently reviewed all extracted data to ensure accuracy and minimize bias. The Health-ITUES scale (5)was used to evaluate user satisfaction, ease of use, and perceived usefulness of digital health technologies among healthcare providers and patients.

RESULTS

In all, 1,118 studies were located in the first search. By the end of the initial screening, 894 records were identified after removing 224 duplicate articles. Next, 44 papers were identified for full-text review, of which 34 were ruled out because of wrong setting or intervention. Lastly, this review comprises 10 articles (15-25). As shown in Figure 1, the reviewed studies passed through the screening and selection process indicated in the "PRISMA" flow chart.

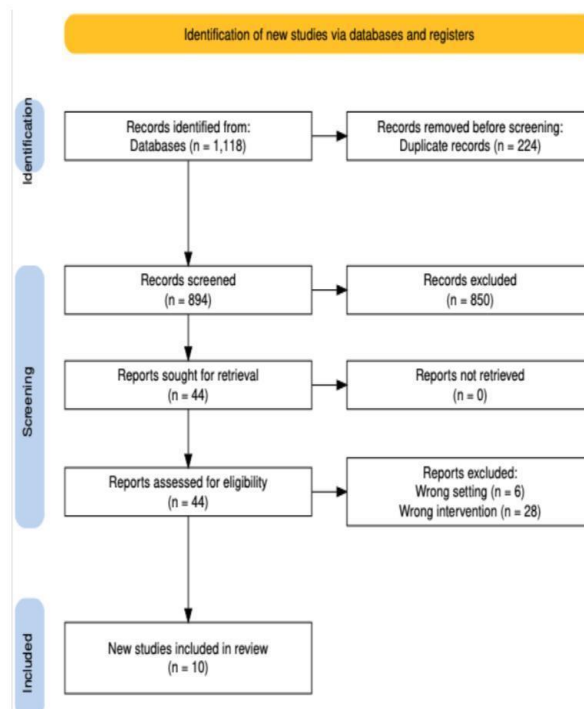


Figure 1 summarizes the PRISMA flow chart of the study selection process.

Bias Assessment Observations

The quality assessment reveals consistently high standards, with scores ranging from 5/6 to

9/11, reflecting robust methodologies and reliable findings. Higher scores (8/8 and 9/11) indicate exceptional rigor. As shown in Tab1, all studies strongly adhere to research criteria, ensuring their reliability and relevance.

Characteristics of Included Studies

The review encompassed ten studies published between 2021 and 2024, utilizing diverse research methodologies, including literature reviews, cross-sectional surveys, focused reviews, analytical approaches, and case-control studies. These research studies were conducted in Saudi Arabia and covered factors related to healthcare and technology, including the application of EMR (electronic medical records) systems and health services delivery systems. The participant demographics varied significantly, with sample sizes ranging from 200 to 1,000 participants in cross-sectional surveys, including healthcare professionals, administrators, and patients Tab1.

Impact of Digital Transformation on Healthcare Accessibility:

The studies utilized diverse tools to ensure validity and relevance. Thematic Analysis and SWOTAnalysis Offered qualitative insights, while Structured and standardized questionnaires ensured reliable data collection in cross-sectional studies. Specialized tools like ATM Evaluation Guides and CPOE assessed specific impacts, while Surveys and Questionnaires provided versatile applicability. Collectively, these tools supported robust and tailored approaches to achieving significance in findings.

Table 1: General Characteristics of Studies and Quality Assessment Using the Joanna Briggs Institute (JBI) Checklists

Author, Year	Methodology	Participants	Findings	Tools are used to determine the significance	Quality assessment
Amnah et al., 2024 (16)	Quantitative cross-sectional survey	300 (180 females and 120 males) healthcare administrators and professionals in Riyadh.	AI adoption improves healthcare efficiency but faces challenges like lack of training and security concerns	SPSS (Cronbach's Alpha, ANOVA, Correlation Coefficients)	8.5/10 (Ethical approval obtained, high reliability, strong validity assessment, but limited generalizability)
Ahmad M. Rayan,. 2024 (17)	Randomized Clinical Trial	154 adults (ages 40-64) with Type 2 Diabetes from Jazan Diabetic Center, Saudi Arabia	Intervention group (weekly text messages) showed improved quality of life, better medication adherence, and lower healthcare costs compared to control	WHOQOL-BREF for quality of life, Morisky Green Levine Medication Adherence Scale (MGLS), t-tests, Chi-square	9 out of 10 High
B. Tasnime et al,. 2024 (18)	Descriptive and Analytical Approach and analytical method	Population of Saudi Arabia	Digital health applications improve healthcare accessibility, efficiency, and personalization	Survey, Statistical Analysis	8 out of 10 High
Zakari A. Mani et al,. 2024 (19)	Comprehensive Rapid Review	Healthcare sector in Saudi Arabia	Evaluated the impact of Vision 2030 on	Thematic analysis, Critical	9 out of 10 High

		under Vision 2030	healthcare transformation, including digital health adoption, infrastructure enhancement, workforce empowerment, and public health improvements	Appraisal Skills Programme (CASP) checklist	
F. Gazzawe et al., 2023 (20)	Qualitative research, thematic analysis, and mixed-methods approach	Security personnel, religious authorities, event management officials, pilgrims, ICT experts, medical personnel	The study found improvements in crowd management due to AI and smart cameras. It highlighted enhanced safety, reduced congestion, and efficient crowd flow strategies. The findings emphasized the importance of AI, RFID tags, and smart city infrastructure in managing large-scale events like Hajj.	NVivo 12, Cohen's kappa	Ensured reliability through intercoder agreement, rigorous thematic analysis, and qualitative data validation. The use of AI and smart technology was tested for potential effectiveness in real-time crowd monitoring.
K. Aboalshamat et al., 2022 (21)	Cross-sectional study using an online questionnaire	334 medical and dental students and practitioners from 22 institutions in Saudi Arabia	AI readiness was low (mean scores: 2.26–2.76/5); dental professionals had significantly higher readiness than medical professionals; no significant gender differences	SPSS v27 (t-tests, descriptive statistics, MAIRS scale, $p \leq 0.05$)	8/10 (Validated MAIRS tool, large sample, strong statistical analysis; limited to student population)
M Khalifa et al., 2021 (22)	Retrospective analysis, health analytics (descriptive, diagnostic, prescriptive)	26,948 ER encounters from King Faisal Specialist Hospital &	Implemented a Fast-Track system and an internal waiting area to improve ER efficiency. ER	Statistical analysis of ER data, performance indicators (ER LOS, patient	Not explicitly stated, but rigorous data validation was conducted using analytics techniques

		Research Center	Length of Stay (LOS) reduced by 40% (from 20 hours in 2014 to under 12 hours in 2016). Patients leaving before treatment decreased by 50%.	admission rates)	
M. Alrehaili et al,. 2021 (23)	Quantitative cross-sectional study, survey-based analysis	150 participants (physicians, nurses, pharmacists, lab technicians, admin staff)	- Clinical effectiveness: EMR implementation improved care quality ($\beta = 0.943$, $p < 0.05$). - Patient-centeredness: Increased patient focus ($\beta = 0.908$, $p < 0.05$). - Patient safety: Reduction in medication errors and hospital complications ($\beta = 1.038$, $p < 0.05$). - Production efficiency: Faster patient care, reduced workload ($\beta = 1.018$, $p < 0.05$).	Pearson correlation, regression analysis, SPSS	Cronbach's alpha: 0.920 (high reliability), ethical approval obtained from IRB.
A Alharb et al,. 2021. (24)	Cross-sectional study, online survey	528 participants (Seha app users and non-users)	- Technical issues: 26% of Seha users reported problems during the first use, and 17% experienced continuous technical difficulties. These users had lower scores for access ($t = 4.47$),	Independent t-tests, chi-square (χ^2) tests, SPSS 23.0	Cronbach's alpha: 0.70 for users, 0.88 for non-users (high reliability). IRB approval was obtained from King Saud University.

			satisfaction (t = 8.11), and efficiency (t = 3.24) (p < 0.05).		
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DISCUSSION

This systematic review presents the results of ten high-quality studies on digital transformation and healthcare accessibility in Saudi Arabia. The integrated evidence shows the transformative potential for telemedicine, EMRs, and advanced technologies such as AI to overcome obstacles to accessing health equitably. These results align with the goals of Vision 2030, which is to enhance the quality, efficiency, and accessibility of health through technological innovation.

Most of the literature reviewed identifies the possible impacts of the EMRs on streamlining healthcare delivery. Alhur (2021) and Gazzawe (2023) relate how the integration of EMRs would guarantee safety in information exchange across hospitals for better quality and efficiency in healthcare delivery. Similarly, Aboalshamat (2022) cites a reduction in administrative burden and paperwork, which aligns with the findings of researchers who also note that efficiency will be achieved based on digitized records (25). The enhanced continuity of care, timeliness of interventions, and proper management of resources are just some of the improvements it brings about, and they are all crucial in achieving equity in health.

Globally, the implementation of EMRs has been opposed because of training gaps and infrastructural challenges, and Khalifa 2021 has pointed this out (22). This again resonates with the findings by Alrehaili 2021, which identify trained training programs as a counter to these barriers. Such findings are supported by global literature, which calls for systematic training programs to enhance their adoption and usability (26).

Telemedicine has become an important tool in bridging distance disparities, particularly in underserved and remote areas of Saudi Arabia. Based on the findings of Benchikh Tasnime (2024) and Mani (2024), the trend of telemedicine thus raised the preparedness of health institutions to serve populations across far distances, with global evidence that telemedicine notably cuts travel time and augments access to specialized care (27).

The review further indicates that telemedicine applications, such as Sea (Alharbi, 2021), have gained wide acceptance in view of the fact that it has been effective in reducing delays in consultations. These findings are in agreement with studies (28). Maita et al. (2024) indicated the potential of telemedicine to help address inequities in care delivery internationally. The scaling up of telemedicine has yet to be fully realized, especially in infrastructurally rural areas, as was pointed out (29).

AI-driven innovations were underlined to bring a sea of change in diagnostics and operational efficiency. For instance, Muafa (2024) and Rayan (2024) highlight evidence of the measurable benefits of AI applications in reducing medication errors and improving hospital management. These findings are in line with international research, which has identified the potential of AI to improve diagnostic accuracy and patient outcomes (30). However, data privacy and ethical considerations remain a major concern and act as significant barriers to adoption.

It further identifies non-technical barriers, including resistance to change and a lack of proper implementation strategies, as main challenges. According to Khalifa (2021), such barriers would call for robust leadership and vision to break, which is again asserted in the findings of Mani, 2024, which underlines well-designed health information systems that guide transformation. This has also brought out worldwide how such barriers need to be overcome for continued digital health adoption (31).

These findings are also in close congruence with the calls of Vision 2030, whose emphasis is to transform all sectors, including health, to become more digitally driven to facilitate accessibility and efficiency. Benchikh Tasnime (2024) and Alhur (2021) have further emphasized the developments in readiness and institutional integration. However, there is a need for the realization of these aims through the addressing of gaps in digital literacy, improvement in infrastructures, and equitability

in resource distribution, as noted by various studies within this review.

The studies in this review reflect the global trend of digital health adoption. For example, the findings on the contribution of telemedicine to reducing disparities based on geographical location align with previous research (27). Similarly, the call for training and capacity building to enhance users' digital literacy is consistent with prior studies (26). Furthermore, this study identifies privacy concerns, as also noted by Muaafa in 2024 (30), who emphasized the need for a robust data protection framework.

Limitations

Geographic Focus

Most of the included studies focused on urban healthcare settings, which limits the generalization of findings to rural and remote areas where the challenges of digital health are very different.

Heterogeneous Methodologies

These studies have adopted various research methodologies, among which are cross-sectional surveys, literature reviews, and even case-control studies. All these create heterogeneity, which does not allow easy synthesis of the results and may introduce variations in the interpretation of results.

Short-Term Perspective

As only studies from 2021 to 2024 were included in the review, it reflects only the short-term impacts of digital transformation and does not touch on long-term effects on the accessibility of healthcare.

Limited Focus on Perspectives Contributed by Patients

While several studies emphasize the technological and administrative aspects, the patients' experiences and satisfaction were very much underexamined; these also form a significant part of the investigation into the accessibility of healthcare.

Infrastructure and Resource Constraints

While infrastructural limitations have been identified, most of these studies did not delve in-depth into the scalability aspect of digital solutions, especially in resource-poor areas, which is an important determinant of their practical feasibility.

Digital Divide

Most of the studies did not go deep into the socioeconomic disparities in accessing digital tools and services, including various levels of digital literacy and internet connectivity.

CONCLUSION

This systematic review has shown that digital transformation has immense promise in improving healthcare accessibility within Saudi Arabia, especially with regard to the imperatives of Vision 2030. Technologies like telemedicine, electronic medical records, and AI-driven diagnostics have had measurable benefits in improving geographic and systemic disparities in health care, enhancing efficiency, and improving patient outcomes.

However, there are still some challenges that one has to go through, such as gaps in digital literacy, infrastructural limitations, and concerns about data security and privacy. These challenges constitute a basis for building tailored training programs, infrastructure investments, and robust data protection frameworks that will eventually lead to trust in digital health systems. Besides, surmounting non-technological barriers to resistance to change and lack of clear implementation strategies becomes very important for wide-scale adoption.

The focus of future research should be on:

- Longitudinal studies regarding the long-term effects of digital health technologies.
- Exploring patients' views to assess their satisfaction and identify barriers to engagement.
- Discuss ways of bridging the digital gap by striving for equitable access to healthcare services across diverse demographic spectra.

Addressing the challenges and capitalizing on the opportunities afforded by digital health technologies, the Kingdom of Saudi Arabia is in a position to become one of the most advanced countries in the world in digital healthcare innovation, a model for other nations that have the aim to further modernize their healthcare systems.

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