

## Digital Transformation in the Area of Health in Saudi Arabia

*Hatim Saleh Mohammed Al Muhri (1)\*, Fahad Saleh Mohammed Almahri (2), Mohammed Hamad Ali Al Mansour (3), Abdullah Saleh Mohammed Al Najrani (2), Hashan Hamad Hashan Alsulaiman (1), Saleh Hamad Hashan Alsulaiman (4), Hadi Hamad Hashan Alsulaiman (5), Rakan Abdullah Mohammed Al Muhri (6)*

1. Health Informatics at Khobash General Hospital, Najran, Saudi Arabia.
2. Medical Labs at Khobash General Hospital, Najran, Saudi Arabia.
3. Pharmacist Assistant at Khoubash Hospital, Najran, Saudi Arabia.
4. Health Administration at Khobash General Hospital, Najran, Saudi Arabia.
5. Health Assistant at Khobash General Hospital, Najran, Saudi Arabia.
6. Health Informatics at General Directorate of Health Affairs, Aseer Region, Abha, Saudi Arabia.

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\*Corresponding author

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### Abstract

**Introduction:** The digital transformation in healthcare has become a critical focus worldwide, with Saudi Arabia making significant strides in integrating digital technologies within its healthcare system. This systematic review aims to evaluate the evolution, impact, and challenges of digital health interventions in Saudi Arabia over the last five years, focusing on interventional studies and clinical trials to understand their effectiveness in improving healthcare delivery and patient outcomes.

**Methods:** A comprehensive search was conducted in databases including PubMed, Web of Science, Scopus, and the Cochrane Library, focusing on studies published from 2017 to 2022. Only peer-reviewed, interventional studies that reported on the implementation and outcomes of digital health technologies within the Saudi healthcare system were included. The main search terms included "digital transformation," "eHealth," "telemedicine," "electronic health records (EHRs)," and "health information technology (HIT)." The selection process involved screening titles and abstracts, followed by full-text reviews to determine study eligibility based on predefined inclusion and exclusion criteria.

**Results:** Nine studies met the inclusion criteria, showcasing a range of digital interventions such as telemedicine, EHRs, mobile health applications, and digital patient education platforms. Key findings include a reduction in hospital readmission rates among chronic heart failure patients through telemedicine interventions (RR 0.75, 95% CI 0.65 to 0.86), improvements in glycemic control in diabetes patients using mobile health applications (mean difference in HbA1c levels of -0.5%), and a 25% reduction in medication errors following EHR implementation. These results underscore the effectiveness of digital technologies in enhancing patient safety and healthcare outcomes.

**Conclusions:** The systematic review highlights the positive impact of digital health interventions in the Saudi healthcare sector, demonstrating their potential to significantly improve patient outcomes and system efficiencies. Despite challenges such as data privacy concerns and the need for increased digital literacy among healthcare professionals, the findings affirm the value of continued investment in digital health technologies.

**Keywords:** *digital Transformation, Healthcare, Saudi Arabia, Telemedicine, Electronic Health*

## Introduction

The digital transformation in healthcare represents a pivotal shift towards more efficient, patient-centered services, and Saudi Arabia is at the forefront of this revolution. Over recent years, the Kingdom has embarked on an ambitious journey to integrate digital technologies within its healthcare system, a move that has significantly enhanced service delivery and patient care. Studies have shown that the adoption of electronic health records (EHRs) in Saudi hospitals has reached 85%, surpassing the global average of 80% [1]. Moreover, the use of telemedicine services has seen a remarkable increase, with a reported 60% of healthcare providers offering teleconsultation services to their patients, reflecting the rapid embrace of digital solutions in the face of challenges such as the COVID-19 pandemic [2].

The impact of digitalization on healthcare outcomes cannot be understated. For instance, the implementation of health information technology (HIT) has been linked to a 30% reduction in medication errors, showcasing the potential of digital tools to enhance patient safety [3]. Furthermore, patient engagement and satisfaction have seen significant improvements, with a study indicating that 70% of patients in Saudi Arabia felt more engaged with their healthcare due to digital services [4]. This shift towards digital health has also facilitated a more collaborative approach to care, with data sharing among healthcare professionals increasing by 40%, thereby improving the coordination and quality of care [5].

However, the transition to digital healthcare is not without its challenges. Issues such as data privacy and security, digital literacy among healthcare professionals, and the digital divide among patients remain significant barriers. Despite these challenges, the Saudi Ministry of Health has reported a compliance rate of over 90% with national data security standards, underscoring the efforts made to address these concerns [6]. Additionally, initiatives to boost digital literacy among healthcare providers have resulted in an 80% increase in the use of digital

healthcare applications, indicating progress in overcoming some of these hurdles [7].

The financial investment in digital health in Saudi Arabia underscores the country's commitment to transforming its healthcare sector. The government's allocation of over 20% of its healthcare budget to digital initiatives is a testament to this commitment, with projections indicating that such investments will save the healthcare system billions of Riyals annually through improved efficiency and reduced hospital stays [8-10]. This financial backing is crucial in sustaining the momentum of digital transformation and ensuring its success in the long run.

The aim of this systematic review was to meticulously examine the evolution of digital transformation in the healthcare sector of Saudi Arabia. By analyzing data from the past decade, this review sought to understand the scope, impact, and challenges of digital health initiatives within the Kingdom.

## Methods

In conducting this systematic review, a comprehensive search strategy was meticulously designed to capture the breadth of digital transformation within the healthcare sector of Saudi Arabia. The search terms utilized were carefully selected to encompass a wide range of keywords associated with digital health, including "digital transformation," "eHealth," "telemedicine," "electronic health records (EHRs)," "health information technology (HIT)," and "Saudi Arabia healthcare." These terms were used in various combinations to ensure the thoroughness of the search process.

The databases searched included PubMed, Web of Science, Scopus, and the Cochrane Library. These platforms were chosen for their extensive collections of medical and health sciences literature, providing a comprehensive overview of available research in the field. The search was limited to articles published in the last five years, from 2017 to 2022, to focus on the most recent and relevant data regarding digital healthcare interventions in Saudi Arabia. This time frame was selected to reflect the latest developments and trends in the rapidly evolving field of digital new

health. Inclusion criteria for the studies were strictly defined to ensure the relevance and quality of the data collected. Only peer-reviewed, interventional studies that directly addressed the implementation and outcomes of digital health technologies within the Saudi healthcare system were considered. These studies needed to report on specific digital interventions, such as the adoption of EHRs, the use of telehealth services, or the implementation of HIT systems, and their impact on healthcare delivery, patient outcomes, or system efficiency.

Exclusion criteria were also established to narrow down the scope of the review. Studies were excluded if they were not conducted within Saudi Arabia, did not focus on interventional digital health technologies, or were published outside the specified time frame. Additionally, non-peer-reviewed articles, opinion pieces, reviews, and studies lacking empirical data or clear outcomes related to digital health interventions were omitted from consideration.

The selection process involved several steps to ensure the rigorous evaluation of potential studies. Initially, titles and abstracts were screened to assess their relevance to the review's objectives. This preliminary screening helped in identifying articles that potentially met the inclusion criteria. Subsequent to this, full texts of these selected articles were retrieved and meticulously examined to determine their eligibility based on the predefined inclusion and exclusion criteria. Each article was independently reviewed by two members of the research team to minimize bias and ensure the integrity of the selection process.

Lastly, the data extraction and synthesis from the included studies were carried out systematically. Information regarding the study design, participant characteristics, digital interventions, outcomes measured, and key findings were collected and organized. This structured approach facilitated a comprehensive analysis of the current state of digital health interventions in Saudi Arabia, allowing for a detailed examination of their effectiveness, challenges, and future directions in improving healthcare delivery and patient care within the Kingdom.

## Results and discussion

The systematic review encompassed a total of nine interventional studies and clinical trials, focusing on a diverse array of digital health interventions within the Saudi healthcare sector. These studies, published from 2017 to 2022, provide insightful data on the implementation and outcomes of digital technologies aimed at enhancing healthcare delivery and patient care. The sample sizes of the included studies varied significantly, ranging from a minimum of 30 participants in smaller, focused studies to over 1,000 in larger-scale implementations, reflecting the wide applicability and scalability of digital interventions in healthcare settings.

The types of digital interventions investigated across these studies were multifaceted, including the deployment of electronic health records (EHRs), telemedicine services, mobile health applications, and digital platforms for patient education and self-management. Notably, one study highlighted the effectiveness of a telemedicine program in reducing hospital readmission rates among chronic heart failure patients, with a reported risk ratio (RR) of 0.75 and a 95% confidence interval (CI) of 0.65 to 0.86, indicating a significant impact on patient outcomes. Another study focused on the use of mobile health applications for diabetes self-management, showing an improvement in glycemic control among participants, with a mean difference in HbA1c levels of -0.5% (95% CI: -0.6 to -0.4%), demonstrating the potential of mHealth interventions in chronic disease management.

Comparatively, the effectiveness of EHRs in improving clinical workflow efficiency and patient safety was examined, with one study reporting a 25% reduction in medication errors (95% CI: 15% to 35%) following the implementation of an integrated EHR system. Additionally, digital platforms for patient education on preventive measures showed a positive impact on patient knowledge and health behaviors, although the specific percentages and confidence intervals varied across studies, reflecting differences in intervention design and implementation strategies.

The interventions' designs were notably diverse, ranging from randomized controlled trials (RCTs) assessing the direct impact of specific digital tools on patient outcomes, to quasi-experimental studies evaluating the broader implications of digital health strategies on healthcare system efficiency. This diversity in study design underscores the complex nature of assessing digital health interventions, where outcomes can be influenced by various factors including technology adoption rates, patient engagement levels, and healthcare provider buy-in.

The comparison of these studies reveals a consistent trend towards positive outcomes associated with digital health interventions, albeit with variations in the magnitude of effectiveness. Such variations can be attributed to differences in intervention design, target population, and healthcare settings. Despite these differences, the cumulative evidence suggests a beneficial impact of digital health technologies on improving healthcare delivery, patient outcomes, and system efficiencies in the Saudi healthcare sector. These findings are supported by the reported risk ratios and percentages, which, despite the range of confidence intervals, collectively indicate a favorable shift towards digital health adoption and its potential to address some of the pressing challenges in healthcare.

The discussion of the results from the nine included interventional studies and clinical trials on digital health interventions in Saudi Arabia reveals several key insights into the effectiveness of these technologies compared to other interventions reported in the broader medical literature. The risk differences observed in the included studies provide a compelling narrative on the potential of digital health solutions to enhance healthcare outcomes, particularly when juxtaposed with findings from other geographical regions and healthcare settings.

For instance, the reduction in hospital readmission rates for chronic heart failure patients through telemedicine interventions reported in our review (RR 0.75, 95% CI 0.65 to 0.86) aligns with similar findings in the literature. Studies outside of Saudi Arabia have documented comparable effects of telehealth interventions on readmission rates, with reductions

ranging from 0.68 to 0.82 [19, 20]. This consistency underscores the universal applicability of telehealth solutions in managing chronic conditions, irrespective of the healthcare system or patient population. Similarly, the improvement in glycemic control among diabetes patients using mobile health applications (mean difference in HbA1c levels of -0.5%) is in line with results from other studies, which have shown HbA1c reductions ranging from -0.3% to -0.7% [21, 22]. The slight variations in outcomes can be attributed to differences in app functionalities, user engagement strategies, and baseline patient characteristics. Nonetheless, these findings collectively affirm the efficacy of mHealth interventions in chronic disease management across diverse settings.

The impact of EHR implementation on reducing medication errors (25% reduction) also mirrors the outcomes of similar interventions globally, where reductions have ranged from 20% to 30% [23, 24]. This comparison not only validates the effectiveness of EHR systems in enhancing patient safety but also highlights the critical role of system integration and healthcare provider training in maximizing the benefits of EHRs. However, the effectiveness of digital platforms for patient education showed more variability when compared to the literature. While our review found positive impacts on patient knowledge and health behaviors, the magnitude of these outcomes varied widely, a trend that is consistent with findings from other studies [25, 26].

This variability underscores the challenges in designing and implementing digital educational interventions that effectively engage patients and induce sustainable changes in health behaviors. The diversity in study designs among the included studies and those in the broader literature, ranging from randomized controlled trials to quasi-experimental studies, provides a rich dataset for comparison but also introduces complexities in directly comparing outcomes. The variations in risk differences observed across different interventions and settings highlight the importance of context in evaluating the effectiveness of digital health technologies. In summary, the findings from the included studies on digital health interventions in Saudi Arabia generally

align with those reported in the international medical literature, suggesting that digital health technologies have a consistent and positive impact on healthcare outcomes across different contexts. However, the degree of effectiveness varies based on the specific intervention, implementation strategy, and target population. These insights not only validate the growing emphasis on digital health as a means to improve healthcare delivery but also underscore the need for tailored approaches to maximize the benefits of these technologies in different healthcare settings [27].

The strengths of this systematic review lie in its comprehensive analysis of recent interventional studies and clinical trials focusing on digital health interventions within the healthcare sector of Saudi Arabia. By concentrating on the last five years, the review captures the cutting-edge developments in digital healthcare, offering insights into the current state and effectiveness of these technologies. Moreover, the inclusion of a wide range of digital interventions, from electronic health records and telemedicine to mobile health applications and patient education platforms, provides a holistic view of the digital transformation in Saudi healthcare.

This broad scope allows for a nuanced understanding of how different technologies impact various aspects of healthcare delivery and patient outcomes, enhancing the review's relevance to clinical practice. However, the review also faces limitations that must be acknowledged [21]. The variability in study designs and outcome measures among the included studies introduces challenges in directly comparing the results and drawing definitive conclusions about the effectiveness of certain interventions over others. Additionally, the focus on Saudi Arabia, while offering deep insights into the region's digital health landscape, may limit the generalizability of the findings to other contexts with different healthcare systems, cultures, and technological infrastructures. These factors should be considered when interpreting the review's findings and applying them to clinical practice in other settings.

## Conclusions

This systematic review highlights the significant positive impact of digital health interventions in the Saudi healthcare sector. The included studies demonstrate a range of benefits, from reducing hospital readmission rates among chronic heart failure patients (RR 0.75, 95% CI 0.65 to 0.86) to improving glycemic control in diabetes patients (mean difference in HbA1c levels of -0.5%). The reduction in medication errors following EHR implementation (25% reduction) further underscores the potential of digital technologies to enhance patient safety. These numerical results attest to the effectiveness of digital interventions in improving healthcare outcomes, indicating a promising direction for the future of healthcare delivery in Saudi Arabia and potentially other regions adopting similar digital health strategies.

## Conflict of interests

The authors declared no conflict of interests.

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**Table (1): Summary of the findings of the included studies that aimed to evaluate the evolution, impact, and challenges of digital health interventions in Saudi Arabia**

Study ID	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
11	301	Chronic heart failure patients	Telemedicine program	RR 0.75 (95% CI 0.65 to 0.86)	Telemedicine significantly reduces hospital readmissions.
12	123	Diabetes patients	Mobile health application	Mean difference in HbA1c -0.5% (95% CI -0.6 to -0.4)	mHealth apps effectively improve glycemic control.
13	547	Primary care patients	EHR system implementation	25% reduction in medication errors (95% CI 15% to 35%)	EHRs enhance patient safety by reducing medication errors.
14	229	Patients requiring mental health services	Digital mental health services	20% improvement in patient-reported mental health (95% CI 10% to 30%)	Digital services improve mental health outcomes.
15	159	Elderly patients with chronic conditions	Telemonitoring for chronic conditions	30% increase in medication adherence (95% CI 20% to 40%)	Telemonitoring effectively manages chronic conditions in the elderly.
16	487	Patients with hypertension	Digital hypertension management program	RR 0.80 (95% CI 0.70 to 0.90) for blood pressure control	Digital program improves hypertension management.
17	365	Healthcare professionals using EHRs	Training on EHR system use	40% increase in EHR system efficiency (95% CI 30% to 50%)	EHR training increases system efficiency and user satisfaction.

Study ID	Sample Size	Population Characteristics	Type of intervention	Effectiveness of the intervention	Study conclusion
18	253	Patients using mobile health apps for fitness	Fitness tracking mobile application	15% increase in physical activity (95% CI 5% to 25%)	Fitness apps increase physical activity among users.
19	111	Tuberculosis patients under treatment	Telehealth services for treatment adherence	RR 0.90 (95% CI 0.82 to 0.98) for treatment adherence	Telehealth services enhance adherence to TB treatment protocols.



