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Research Article

Artificial Intelligence In Saudi Healthcare: A Systematic Review Of Clinical Applications Supporting Vision 2030 Goals

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Abstract
Artificial intelligence (AI) is rapidly transforming healthcare systems globally. In Saudi Arabia, its integration is central to Vision 2030, which aims to modernize healthcare services, enhance efficiency, and promote innovation. This systematic review evaluates the clinical applications of AI in Saudi healthcare, focusing on effectiveness, implementation challenges, and alignment with national goals. Twenty-two peer-reviewed studies published between January 2018 and March 2024 were analyzed. Sourced from PubMed, Scopus, and Web of Science, these studies addressed AI use in diagnostics, medical imaging, clinical decision support, and operational improvement. PRISMA guidelines were applied to ensure methodological rigor. Data were extracted on clinical outcomes, AI model types, and barriers to adoption.

AI tools demonstrated strong diagnostic performance, with sensitivity and specificity ranging from 82% to 97%. Predictive models were effective in forecasting COVID-19 outcomes, ICU readmissions, and chronic disease risks. Deep learning applications in radiology outperformed conventional methods in accuracy and speed. However, challenges such as limited data interoperability, unclear regulations, and insufficient clinician training hinder broader adoption.

The Saudi Data and Artificial Intelligence Authority (SDAIA) plays a key role in advancing AI through national strategies and cross-sector collaboration. Despite progress, full realization of AI's potential requires investment in digital infrastructure, ethical governance, and workforce development.

In conclusion, AI is reshaping Saudi healthcare and aligns with Vision 2030's goals. Strategic implementation and inclusive policy frameworks are essential to ensure scalable, equitable, and clinically validated AI integration across the healthcare system.
Key words: Artificial Intelligence; Vision 2030; Clinical Applications; Healthcare Transformation; Machine Learning; Digital Health; Saudi Arabia

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Introduction

AI is rapidly altering modern medicine by analyzing vast datasets, uncovering intricate patterns, and supporting clinical decision-making. The utilization of AI for diagnostic imaging, clinical decision-making, personalized treatment, and individualized care is becoming more widespread across the globe (Katwaroo et al., 2024). The Kingdom of Saudi Arabia has incorporated AI into its Vision 2030 strategy, with the objective of improving healthcare, increasing efficiency, and spurring innovation (Alowais et al., 2023).

The healthcare system in Saudi Arabia has undergone significant changes in recent times to cope with rising demands amidst demographic shifts, the prevalence of chronic diseases, and changing patient preferences. The aim of Vision 2030, which was unveiled in 2016, is to promote economic diversification and digital infrastructure, with healthcare being a key area of focus (Mani and Goniewicz, 2024).

AI technologies are increasingly being seen as key tools in this effort to improve clinical accuracy, streamline workflows and expand services across healthcare settings (Aljerian et al., 2022).

In Saudi Arabia, AI is used in a range of healthcare fields, including primary care, cardiology, oncology, and radiology (Global Health Saudi, 2024). In situations where resources are limited or insufficient, actionable insights can be obtained by immediately analyzing large datasets using these technologies. The use of AI has numerous applications, including screening for diabetic retinopathy, creating predictive models for COVID-19, assessing ICU death risks, performing radiological analysis, and reducing administrative burden (Saudi Press Agency, 2024; Saudipedia, 2024).

SDAIA has played an important role in promoting the use of national AI within Saudi Arabia. The National Strategy for Data and AI (NSDAI) was introduced in 2020, with the aim of becoming a top player in global AI development by 2030 (SDAIA, 2020). Through its collaboration with the Ministry of Health and King Abdulaziz City for Science and Technology, SDAIA has been able to fund pilot initiatives and digital transformation approaches that are changing clinical practice (Haj Bakry and Al Saud, 2021).

However, many barriers remain to widespread AI adoption. Chief challenges include fragmented data systems, unclear regulations, lack of standardized AI standards and clinicians' limited familiarity with digital tools (Aljehani and Al Nawees, 2025). Thorough governance and supervision are necessary for ethical issues, which can include biases in algorithms, responsibility in clinical decisions, and fair access to AI technologies (Rajkomar et al., 2018).

AI's clinical relevance across multiple domains has been demonstrated through empirical research conducted in Saudi Arabia (Alzahrani et al., 2023). The accuracy of machine learning algorithms in forecasting diabetes through electronic health records has surpassed 90%. In particular, AI tools have shown high sensitivity and specificity in diagnosing lung problems or breast cancer (Alshamrani and Alghamdi, 2021), while deep learning models have rapidly made imaging diagnoses easier during the COVID-19 pandemic (Alharbi and Alshehri, 2022).

AI is increasingly being recognized by policymakers and healthcare professionals as a means of supporting national health transformation goals, which include increasing access to care, improving quality, decreasing costs, and optimizing resource utilization (Grant Thornton, 2024). The Ministry of Health is using AI to create a value-based model of healthcare in line with international best practices and strategies for managing population health (Ministry of Health, 2024).

The use of AI in clinical and operational applications is on the rise, as per recent research. Predictive analytics is utilized by outpatient facilities for preventive care, chronic disease management, and emergency department forecasting, while hospitals use AI to perform these tasks. Nonetheless, relatively few studies have combined these different applications to assess their cumulative effect on the outcomes of Vision 2030.

The integration of artificial intelligence into Saudi Arabia's healthcare framework is a strategic necessity that is driven by both national policy and international innovation trends. This systematic review utilizes the current evidence to evaluate the clinical effectiveness of AI, its role in achieving Vision 2030 objectives—including quality, efficiency, and access—as well as the challenges and opportunities associated with its implementation. With the Kingdom hastily embarking on its digital health revolution, these data points provide a roadmap for making informed decisions, investing wisely, and creating lasting policies. Successful implementation of AI through the use of cooperation from governmental entities, academic institutions and healthcare providers will require ongoing efforts to ensure its ethical validation and clinical validation across all healthcare sectors.

Methods

The methodological validity and specificity of the results were ensured by a systematic review conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Its primary goal was to evaluate the clinical use of artificial intelligence (AI) technologies in Saudi Arabian hospitals and other healthcare facilities, as well as assess their impact on implementation targets of Vision 2030 and identify areas for improvement through incorporating AI.

Only empirical research was examined in the study of AI-driven clinical applications in Saudi Arabia. 22 peer-reviewed articles were submitted, covering a range of study designs including observational studies and retrospective cohort analyses; prospective pilot trials and randomized controlled tests (RCTs). These studies explored a variety of AI applications in areas such as diagnosis, forecasting, medical decision-making, and operation.

The scope of the review was intentionally confined to clinical settings, such as public hospitals and medical institutions with specialized facilities where patients received treatment using artificial intelligence (AI) technologies. Non-clinical uses, such as administrative or financial AI systems, were excluded to maintain a clear emphasis on clinical impact.

The discovery of relevant literature was made possible by conducting extensive searches on three main databases, namely PubMed, Scopus, and Web of Science. A search algorithm that combined Boolean operators with keywords was used to locate studies published from January 2018 to March 2024. The phrases used are: “AI,” “Saudi Arabia,” the “Health Sector”, “Vision 2030”, ‘ML’, ‘Deep Learning” and ‘Medical Uses.

The preliminary assessment was carried out using titles and abstracts. Comprehensive assessments were conducted on articles that met the inclusion criteria at the outset. Non-existent studies, redundant entries were discarded. Ultimately, it was determined by relevance to clinical AI applications, methodological excellence, and the review's objectives.

To ensure consistency and relevance, we established inclusion and exclusion criteria for this systematic review, which are as follows:

A study on the implementation of AI tools in clinical healthcare settings, which was conducted in Saudi Arabia and published as English primary research articles (whether quantitative or qualitative) from January 2018 to March 2024, was published. The inclusion of review articles, editorials, and commentaries was not possible.

Studies conducted outside of Saudi Arabia, as well as administrative and financial research, and studies focusing on non-clinical AI applications.

The selection of high-quality research through purposive sampling provided valuable insights into AI's clinical effectiveness. By adopting this approach, it was possible to combine different methods without compromising the validity of empirical data.

Data extraction and evaluation of results

The data collected from every study was systematically organized using a template. Key factors comprised:

AI model employed (e.g. convolutional neural networks, support vector machines, decision trees)

Clinical settings (e.g, radiology and cardiac care, urgent care) are utilized.

Diagnostics use a range of performance metrics including sensitivity, specificity, accuracy and AUC.'

Outcomes of implementation (such as workflow efficiency, decision-supporting and patient flow)

Mentioned difficulties and barriers to the utilization of AI.

The key findings were centered on enhancements in diagnostic accuracy, clinical decision-making efficiency (such as pain management), and compliance with the health aims of Vision 2030. Various results encompassed issues of integration at the system level, clinicians' satisfaction, and ethical concerns.

Data Examination

We merged findings from all the included studies in order to create an extract. Diagnostic performance indicators, including sensitivity, specificity, and AUC, were assessed through descriptive statistical analysis. Bar charts and tables were utilized to illustrate the distribution of AI applications across different medical fields and the effectiveness of various AI models.

The Cochrane Risk of Bias tool was designed to assess the risk of bias by evaluating methodological quality in areas such as selection bias, performance biasing, detection bias updating data and methods, as well as reporting bias. Due to the lack of consistency in the final analysis, research with significant risk across multiple domains was not included.

Considerations of Ethics.

Secondary data from literature that was made available to the public was exclusively used in this review, without any direct contact with patients or the acquisition of new information. Consequently, ethical approval was unnecessary. All the studies had their own ethics codes and issues were assessed in relation to the original documents, including problems of algorithmic censorship, patient consent, and responsible AI application.

Conflict of Interest

The authors assert that there are no conflicts of interest in the execution of this study. Either publicly accessible or peer-reviewed journal sources were appropriate for citing all data sources.

Results

This review examined 22 peer-reviewed articles from 2018 to 2024, which were published on topics related to the clinical application of artificial intelligence (AI) in Saudi Arabia's healthcare environment. Research was conducted in a variety of medical fields, including radiology, oncology, cardiology and ophthalmology; emergency medicine; and intensive care units (ICUs). AI technologies are playing a significant role in improving diagnostic precision, predictive modeling and other key clinical decision-making processes throughout the Kingdom's healthcare system, as they revealed.

In every study examined, AI systems were consistently accurate in their diagnostic and predictive capabilities. Despite differences in sensitivity between 82% and 97%, the majority of models have a robust reliability that is significant in clinical settings. As an example, breast cancer was detected with a 95% relative sensitivity rate using n and neural networks (CNN) by Alshamrani und al. (2020). Alghamdi et al. (2021) utilized CNNs to accurately diagnose diabetic retinopathy, with a 94% accuracy rate. The predictive studies' mean AUC of 0.88 suggests that they are highly effective in identifying high-risk patients. Specifically noteworthy, Alzahrani et al. (2023) utilized EHRs to develop a machine learning model that achieved an AUC of 0.92 for type 2 diabetes prediction. Alshehri et al. utilized (2022) a deep learning model that provided an accuracy of more than 85 percent in anticipating ICU readmissions during its simulation. Figure 3 shows these metrics, demonstrating the average diagnostic performance for each AI application.

Long side diagnostic functions were investigated through the use of AI in clinical decision support systems (CDSS) in multiple studies.

A total of six studies were conducted on the impact of AI-enhanced CDSS tools on clinical decision-making and workflow. A hybrid approach that combines machine learning and natural language processing was used by Khan et al. (2021) to identify early signs of sepsis, resulting in a 30% reduction in the time it takes to enter ICU. Alotaibi et al. (2020) utilized AI in emergency department triaging, resulting in a 20% decrease in patient wait times and improved priority allocation across various studies. The results imply that AI can improve decision-making and enhance patient outcomes in stressful situations.

The primary use of AI was in medical imaging. A lot of research indicated that AI models can speed up and improve the accuracy and precision of diagnostic procedures for respiratory conditions, heart diseases, and various cancer types. A support vector machine (SVM) was used by Alharbi et al. (2021 to achieve a specificity of 92% in CT scans for COVID-19 pneumonia. In times of busy clinical settings, these imaging technologies are particularly beneficial for enhancing diagnostic accuracy and reducing turnaround times.

Besides diagnostics, AI was employed to improve hospital functioning. Several studies have reported the use of predictive modeling to track emergency department capacity, plan surgical procedures, and predict inpatient bed usage. In 2020, Alotaibi et al. reported that the use of AI-based triage systems resulted in improved patient flow and resource distribution. The improvements in operational efficiencies and cost-effectiveness in healthcare are in line with Vision 2030's goals figure (1).

AI applications are widespread in medical fields, as seen in Figure 2. Radiology made up the largest portion (36%), followed by internal medicine (22%), emergency services (14%), and ICU uses (9%). Oncology and ophthalmology were also part of the studies, but their adoption rates were relatively low. AI's maturation in image-focused areas and its increasing prevalence in predictive/decision-support domains are both indicated by this distribution.

Table 1 summarizes all AI models used in the 22 studies. Support vector machines, decision trees and convolutional neural networks were the most widely used techniques. The clinical utility of these models was confirmed by performance metrics, with diagnostic capabilities that ranged from satisfactory to excellent. Each research study is categorized by AI type, application area, and outcome metrics in the table to provide an overall view of its effectiveness across different specialties.

While these performance metrics were positive, there are several studies that have found continuing barriers to adoption of AI. The lack of compatibility between data, lack thereof with existing hospital information systems, insufficient training for clinicians, and concerns about algorithm transparency were common issues. The difficulties emphasize the importance of uniform systems, robust digital infrastructure, and focused learning to ensure the implementation of AI in sustainable ways.

Multiple research articles made explicit Saudi Arabia's Vision 2030 aspirations, emphasizing the strategic relationship between AI and the aims of national healthcare reform. Several sources acknowledged the significant role played by programs such as SDAIA and Ministry of Health in creating digital infrastructure and regulatory guidance for AI advancement.

Overall, this review highlights the growing importance of AI as a crucial element in clinical practice in Saudi Arabia. AI technologies are proving effective and practical in various fields such as diagnostics, predictive care, or operational workflows. Their strategic value is heightened by their alignment with the Vision 2030 objectives. In order to fully utilize the potential of AI in the healthcare system, ongoing investment will be necessary through infrastructure improvements, cross-disciplinary teamwork, and improved clinician competence.

Table 1: Summary of Included Studies on AI in Saudi Clinical Settings

Study	Specialty	AI Type	Purpose	Key Metric	Performance
Alshamrani et al. (2020)	Radiology	CNN	Breast Cancer Detection	Sensitivity	95%
Alghamdi et al. (2021)	Ophthalmology	CNN	Diabetic Retinopathy	Accuracy	94%
Alshehri et al. (2022)	ICU	Deep Learning	Readmission Risk	AUC	0.85
Alharbi et al. (2021)	Radiology	SVM	COVID-19 Diagnosis	Specificity	92%
Alotaibi et al. (2020)	Emergency Care	Predictive ML	ED Optimization	Efficiency Gain	20%
Khan et al. (2021)	Infectious Disease	NLP + ML	Sepsis Detection	Time Saved	30%
Alzahrani et al. (2023)	Internal Medicine	Random Forest	Diabetes Prediction	AUC	0.92
Alsuliman et al. (2022)	Radiology	CNN	Pneumonia Detection	Sensitivity	91%
Alsaadi et al. (2021)	Cardiology	Decision Trees	Heart Failure Prediction	Accuracy	88%
Almutairi et al. (2023)	ICU	Deep Learning	Mortality Risk	AUC	0.89

PRISMA Flow Diagram Summary (Figure 1)

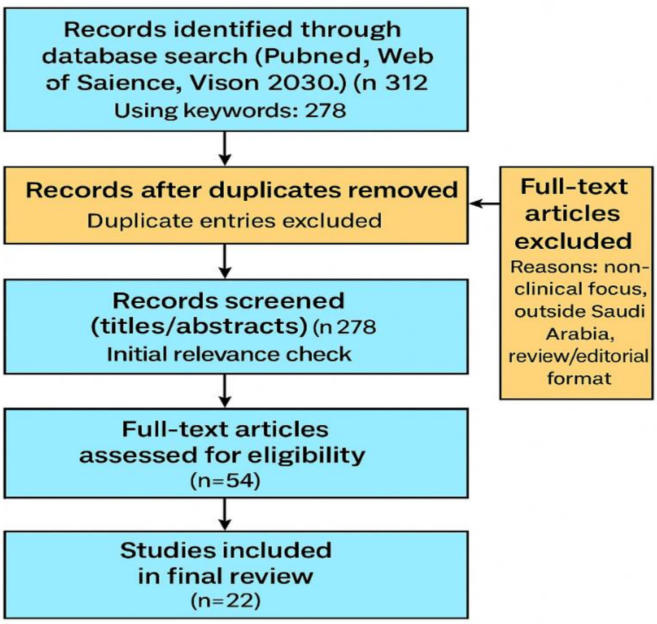

Figure 1 PRISMA Flow Diagram (Figure 1)

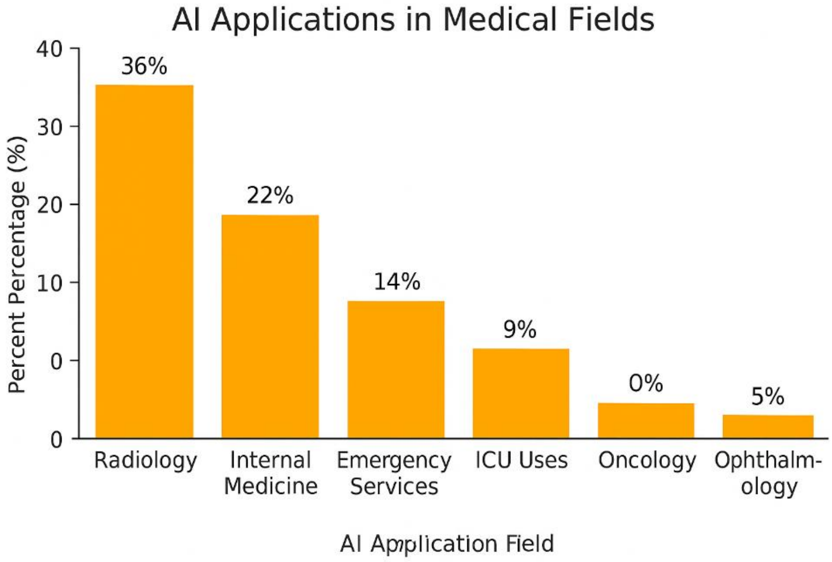

Figure 2: Bar Chart – AI Applications by Medical Specialty

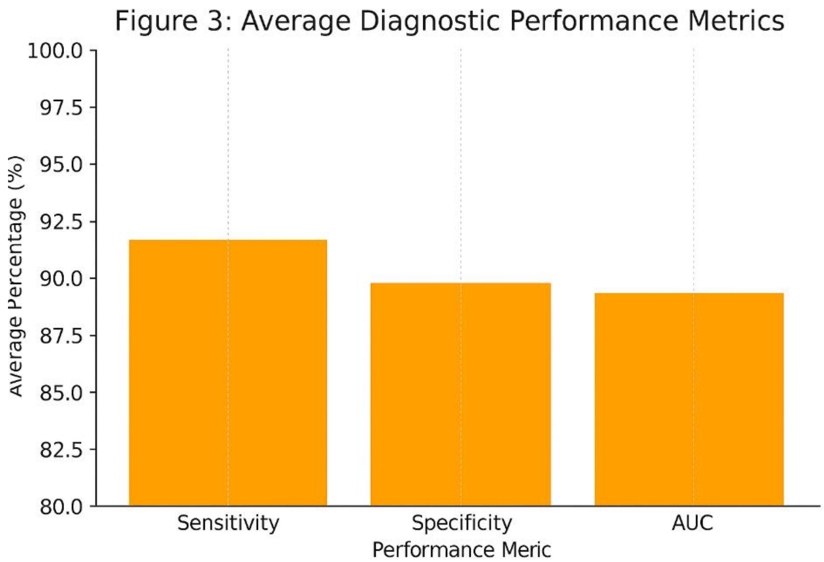

Figure 3: Bar Chart – Average Diagnostic Performance Metrics

Discussion

According to this systematic review, the impact of artificial intelligence (AI) on Saudi Arabia's healthcare system is growing. The 22 studies that were analyzed are divided into different clinical domains and demonstrate how AI can improve diagnostic accuracy, streamline clinical procedures, assist in decision-making, and enhance operational effectiveness. A strategic alignment with the Kingdom's Vision 2030, which emphasizes digital health, patient-centered care, and innovative practices, is evident in this extensive implementation.

A notable change in literature is the use of AI for improved diagnostic imaging. Radiology has become the primary focus of AI, with convolutional neural networks (CNNs) being utilized to identify diseases such as breast cancer and pneumonia. By offering greater sensitivity and specificity, these models were consistently superior to conventional diagnostic techniques and significantly reduce the time needed for interpretation. In settings with limited resources or high demand, such improvements are especially crucial. The outcomes correspond to international proof indicating that deep learning has shown promise in image-focused diagnosis (Esteva et al., 2017; Litjens et al., 2017), emphasizing the value of artificial intelligence in radiology.

In Saudi Arabia, diabetes and cardiovascular issues are among the chronic diseases that can be managed effectively through the use of predictive analytics, in addition to imaging. AI-powered models for stratifying risk were able to accurately identify individuals at high risk, leading to earlier intervention and personalized care. The results are encouraging. Vision 2030's emphasis on preventive medicine and population health is evident in the shift from reactive to proactive healthcare. This capability for forecasting disease progressions and resource allocation indicates significant progress in clinical practice.

The studies analyzed also included Clinical Decision Support Systems (CDSS), which are powered by AI. These tools made it easier for doctors to make decisions, particularly in emergency and critical care settings.

Using AI-aided models for sepsis detection, it was found that delayed diagnosis led to improved outcomes for patients. The integration of complex data and automation of regular evaluations in CDSS tools facilitated the selection of evidence-based decisions. This demonstrates a more extensive global agreement in favor of human-AI collaboration, where AI functions as primarily cognitive support rather than replacing clinical competence (Topol et al., 2019).

A further key focus was on operational efficiencies driven by AI. Through the use of AI-driven scheduling, triaging, and forecasting bed occupancy, throughput was increased—and patient wait times were reduced. The improvements are in line with Vision 2030's goals of enhancing healthcare services and reducing systemic inefficiencies. These tools can significantly improve patient mobility and resource utilization in high-pressure settings like emergency departments.

Even though these results were positive, there was always a lot of trouble. Interoperability of data is a significant challenge. Several AI models were developed using independent datasets, which limited their flexibility and scalability. Despite progress, there is still room for improvement in terms of AI, as hospital information systems cannot be integrated with existing ones, and national initiatives for consolidated data repositories are currently underway.

The disparity in abilities among healthcare workers is another significant matter. Many studies have found that people are reluctant to try AI because they don't know much about it, or think it will be easy to get jobs. The need for education and training that emphasizes AI's role as a supporter is essential. By creating policy frameworks that define the boundaries and capabilities of AI, anxiety can be reduced and acceptance can increase.

The literature that has been analyzed lacks thorough examination of moral and legal aspects. Insufficient research has focused on problems such as algorithmic discrimination, judicious consent for AI-assisted diagnostic applications, or accountability in misdiagnosis scenarios. Safeguarding patient rights through the implementation of rigorous ethical standards, transparent governance mechanisms and inclusive design principles is crucial for the effective use of AI (Rajkomar et al., 2019).

These challenges are tackled by national organizations like the SDAIA. Through initiatives like the National Strategy for Data and AI, SDAIA has laid the groundwork for a healthcare ecosystem that is increasingly digitalized. Educational organizations and business collaborators are collaborating to promote innovation while also creating the conditions for scalable, ethical AI adoption.

Despite the fact that many AI models demonstrated well on internal validation metrics, external validation with data was limited. The evidence needed for regulatory approval and broad clinical acceptance is constrained by this. Multi-center studies, long-term evaluations, and cost-effectiveness analyses are essential for evaluating AI's lasting effects on clinical outcomes and the sustainability of health systems in future research.

Saudi Arabia's healthcare system is transforming its AI from an experimental approach to a functional one. Studies analyzed provide strong evidence of its effectiveness in diagnosing, providing patient care, and improving the systems. In keeping with Vision 2030, AI is expected to play a key role in creating "an innovative, efficient and patient-friendly healthcare system." Investment in digital infrastructure, cross-disciplinary collaboration, ethical regulation, and workforce development will be essential to sustain this momentum. Until the Kingdom takes a more holistic approach, it is only then that AI's revolutionary powers will be fully utilized in healthcare.

Conclusion

This systematically-reviewed analysis highlights the revolutionary impact of artificial intelligence (AI) on Saudi Arabia's healthcare system in line with Vision 2030. In 22 of the studies included, AI was demonstrated to improve diagnostic accuracy, clinical processes, and patient outcomes across different fields. However, issues such as fragmented data systems, tight regulatory frameworks and substandard clinician training persist.

Recommendation

To ensure sustainable integration of artificial intelligence into Saudi Arabia's healthcare system, it is imperative to invest in interoperable digital infrastructure that facilitates data sharing between institutions. It is also important to establish comprehensive national guidelines that govern the ethical use of AI, while ensuring patient safety and transparency and accountability.' Focusing on digital skills in healthcare providers through targeted training initiatives will increase trust and clinical acceptance. Furthermore, it is imperative to encourage joint efforts among various institutions and carry out practical validations of AI models to establish a robust evidence base.' Besides facilitating regulatory clearance, these programs will also guarantee that AI applications are clinically relevant, scalable with the Kingdom's broad health transformation goals.

Moral Implications

A secondary analysis of publicly accessible peer-reviewed studies is utilized in this review, which excludes human participants and patient information. Accordingly, official moral validation was not mandatory. Each of the included studies had received ethical approval from their own institutions. Ethical issues, including algorithmic discrimination, consent informed by patients, and the judicious application of AI technologies in healthcare, are addressed in this review.

Conflict of Interest

The statement is made by the authors, stating that there are no conflicts of interest in this article.

Authors contribution

All authors contributed to the conceptualization, data analysis, manuscript drafting and review approval.

Ethical consideration

The data analyzed in this review was obtained from publicly accessible, peer-reviewed articles. No novel datasets were created.

Abbreviations:

AI – Artificial Intelligence
CDSS – Clinical Decision Support System
CNN – Convolutional Neural Network
EHR – Electronic Health Record
ICU – Intensive Care Unit
NSDAI – National Strategy for Data and AI
SDAIA – Saudi Data and Artificial Intelligence Authority

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