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The Role of Artificial Intelligence in Transforming Clinical Practice and Biomedical Research: A Review of Opportunities and Challenges

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ABSTRACT
Artificial Intelligence (AI) is rapidly transforming healthcare sector by improving diagnostic accuracy, enhancing drug discovery and pharmaceutical research, and advancing electronic prescription processing (e-prescribing; eRx), although its adoption in developing contexts remains limited. This study the role of artificial intelligence in transforming clinical practice and biomedical research: a review of opportunities and challenges presents systematic review of 20 peer-reviewed articles examining the role of AI in clinical practice and biomedical research. The key findings show that AI significantly improves diagnostic precision, supports personalized medicine, enhances real-time patient management system, and optimizes medication management through intelligent e-prescribing systems with accuracy of perception of drugs for each patient. Additionally, AI contributes to faster and more efficient biomedical research processes. However, challenges such as inadequate infrastructure, high implementation costs, data privacy concerns, and limited technical expertise persist, particularly in developing country. The review concludes that effective and sustainable AI integration in healthcare requires context-specific strategies, supportive policy frameworks, increased investment in digital infrastructure, and capacity building among healthcare professionals.

Keywords:
Artificial Intelligence,
Healthcare Innovation,
Medical Diagnostics,
Health Systems,
AI Adoption,
Nigeria.

INTRODUCTION

Artificial Intelligence (AI) has become an integral part of the medical profession system, offering transformative potential and accuracy in diagnostics, treatment planning, patient monitoring system, and administrative efficiency of medical professionals and education system. (Shiwlani *et al.*, 2023). This study aims to examine the the role of artificial intelligence in transforming clinical practice and biomedical research: a review of opportunities and challenges across various facets of the healthcare system. By analyzing recent and existing Artificial Intelligence applications into medical profession, assessing their benefits and challenges, use/misused, and proposing future directions, the report need to provide a comprehensive understanding of how AI contributes to the medical profession.

Smart healthcare has increased to meet the needs of the growing human population and medical expenses. People are all hurrying to catch up with work schedules, academic appointments, and social engagements, especially in this jet age, this study develops a cardiovascular disease prediction system with specific objectives (Anikwe C. V et al., 2025).

Artificial intelligence has made a huge transformative technology in the healthcare sector due to its function of ability to enhanced diagnostic accuracy, treatment planning, patient automatic refill system, electronic prescription processing and biomedical research. The rapid advancement deep learning through machine learning and predictive analytics has improved healthcare delivery and operational efficiency in many developed region such as Nigeria remain limited due to inadequate digital infrastructure, high implementation coast, and insufficient technical expertise. Most existing literature focuses primarily on developed healthcare systems, with the limited contextual evidence regarding the adoption, effectiveness and implementation challenges of AI technologies in developed countries (Secinaro et al., 2021). This create a significant research gap, particular in understanding the use and challenges of AI integration with limited resource healthcare environments in Nigeria. Interest and advances in medical profession AI applications in the medical field have surged in recent years due to substantial improvements in computing power and the increasing availability of digital health data.

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Artificial intelligence is gradually changing medical practice system. There are several artificial intelligence applications in medicine learning, deep learning that can be used in a different fields of medical and medic, such as clinical skills, cancer detection system, pharmacy management system, Electronic Prescription Processing (eRx). Another important area of medicine where artificial intelligence is making an impact is drugs information and research.

The aim of this study is to: (1) examine the current applications of AI in medical diagnostics system. (2) To evaluate the impact of artificial intelligence on treatment planning and personalized medicine (3) To assess the role of AI in patient monitoring and management.

This study is significant because it contribute to the growing body of knowledge on the application of Artificial Intelligence in different healthcare sector and biomedical research by providing a full comprehensive synthesis of the related works on Ai applications, benefits, challenges and future prospects in healthcare delivery. This study will make any healthcare professionals, researchers and educational system in understanding how and when to use AI technologies improve diagnostics, treatment planning and patient monitoring. Additionally, this study contributes to knowledge by integrating different dimensions of AI in healthcare, unlike related works that studies only on isolated application such as diagnostics or robotic surgery (Rajkomar et al., 2019).

Clinical and Operational Benefits of AI

A dominant theme in the related work is the transformative potential of AI in enhancing both clinical outcomes and healthcare operational accuracy. AI applications into healthcare sector in nigeria have been widely recognized for their ability to enhance diagnostic accuracy, particularly in fields such as radiology, oncology, and pathology and pharmacy, where image recognition algorithms have demonstrated remarkable precision (Esteva et al., 2017).

In addition, AI contributes significantly to treatment planning by enabling personalized and data-driven medical decisions using the existing data of each patient as patient management systems. (Johnson et al., 2021). The use of predictive analytics further allows healthcare providers to anticipate patient outcomes and implement preventive interventions base on the existing data (Rajkomar et al., 2019). Furthermore, AI plays a vital role in reducing administrative burdens by automating routine tasks automatically, thereby allowing healthcare professionals to focus more on patient care (Andoronie et al., 2021). These findings are consistent with established theoretical frameworks such as the Technology Acceptance Model and the Diffusion of Innovation Theory, which emphasize perceived usefulness and efficiency as key drivers of technology adoption (Soneka & Phiri, 2019).

Impact on Patient Outcomes and Healthcare Delivery

The integration of AI into healthcare systems has been associated with notable improvements in patient outcomes and the overall quality of healthcare delivery. Different researchers indicate that AI-driven systems contribute to reduced diagnostic errors, faster clinical decision-making, and more effective treatment strategies (Secinaro et al., 2021). Despite these benefits, the related works will also points to concerns regarding patient trust and acceptance of AI technologies. Issues related to transparency, particularly the opaque nature of certain AI algorithms, continue to influence patient perceptions and may affect the widespread adoption of these technologies in Nigeria (Shahriar et al., 2023).

Challenges and Ethical Considerations in AI Implementation

Despite the different advantages associated with AI in healthcare system, several challenges continue to impede its widespread implementation. One of the most significant barriers identified in the related work is the high cost of implementation of any AI models, which includes expenses related to infrastructure, software development, and workforce training of the deep learning models (Andronie et al., 2021). Additionally, there exists a considerable gap in technical expertise among healthcare professionals, limiting their ability to effectively utilize AI tools (Lee & Yoon, 2021).

Related work

AI holds significant potential in promoting personal health by reducing the reliance on doctors and improving overall well-being. By leveraging Artificial Intelligence in healthcare recruiting companies are contributing to consumer health swiftly. These technological advancements and mobile apps motivate individuals to adopt healthier habits. This actively manages their lifestyle, empowering a consumers to take charge of their personal health. Furthermore, the artificial intelligence enhances health professionals' understanding of the individual's daily routine. Which ultimately enables them to provide informed advice, guidance, and support to facilitate long-term wellness (Hasselkus & Dickie, 2024). The integration of Artificial Intelligence in healthcare system brings significant time and resource-saving benefits. This acceleration of operations through AI technology allows medical establishments to optimize their productivity hours, leading to potential cost savings. The healthcare industry incurs substantial unnecessary costs, estimated at around $200 billion annually. A significant portion of these costs arise from administrative burdens (Andronie *et al.*, 2021).

Artificial intelligence has transformed the healthcare system industry. The integration of Artificial Intelligence in the field of healthcare staffing solutions has brought

revolutionary changes. It has transformed the methods of diagnosis, treatment, Drug Information and Research and Electronic Prescription Processing (eRx). This technology has a profound impact on healthcare research and outcomes by delivering precise diagnoses and enabling personalized treatment (Kelly *et al.,* 2020).

By streamlining administrative tasks and leveraging Artificial intelligence healthcare professionals can save valuable productivity hours. They will also be able to allocate resources effectively. This, in turn, provides them with increased availability to engage with and support patients effectively. The integration of Artificial intelligence enables healthcare facilitates to streamline tedious and meticulous tasks leading to increased efficiency. Intelligent radiology technology can identify significant visual markers. It reduces the significant time for intense analysis by healthcare professionals (Andronie *et al.,* 2021).

Utilizing a healthcare staffing agency offers numerous advantages. These agencies have access to a vast pool of qualified candidates. This enables them to find the most suitable match for each position. Additionally, these staffing agencies provide a range of services. These include background checks and drug screening to ensure the qualifications and safety of the staff they place. As a result, the healthcare staffing agencies serve as an invaluable resource for healthcare facilities (Vargo *et al.,* 2021).

Although these Artificial intelligence systems are sometimes flawed leading to complaints it is also crucial to acknowledge that Artificial intelligence is beneficial in our lives. Furthermore, its capabilities are expected to significantly improve in the next five years implying that its usefulness will only continue to grow (Imoize *et al.,* 2023).

Extensive research has been conducted on the applications of Artificial Intelligence (AI) in healthcare system, highlighting its transformative potential. Many report have shown that AI improves diagnostic accuracy, particularly in medical imaging, pathology, and radiology. For example, AI algorithms have been developed to detect cancers, cardiovascular diseases, and neurological disorders faster and more accurately than traditional methods. AI-powered robotic surgery has also enhanced precision in complex procedures, reducing complications and recovery times. Most studies on AI in medicine are conducted in developed countries with advanced healthcare systems. There is limited empirical research on the adoption, effectiveness, and challenges of AI in healthcare system settings in countries like Nigeria.

Machine learning

Machine learning is a methodology that involves developing models by analyzing and learning from data. It is a fundamental component of many artificial intelligence approaches and there are different variations of this technique. In the healthcare field, classical machine learning is commonly applied in precision medicine. Machine learning systems are more convenient for certain tasks that involve processing large amounts of data or are challenging to develop as an algorithm by a software engineer. (Isah et al., 2024).

The Future and Use Cases of Artificial intelligence (AI)

Undoubtedly artificial intelligence is advancing at a rapid pace, becoming increasingly sophisticated with each passing day. As AI capabilities expand, it's only natural to ponder the healthcare industry's future in relation to AI. There exists a wide array of potential uses for artificial intelligence in healthcare. This encompasses areas such as diagnostics treatment planning, patient care, and safety. The applications of artificial intelligence in healthcare will undoubtedly progress as the technology itself continues to evolve (Ahmad *et al.,* 2021).

Use Cases

The future of artificial intelligence in healthcare system appears highly promising. As AI capabilities continue to expand rapidly, we can anticipate significant advancements in medical care. This ultimately enhances the well-being of numerous individuals worldwide (Johnson *et al.,* 2021). In the upcoming year and beyond, there will be a focus on enhancing automated scheduling, particularly in the context of primary care. According to Schibell these companies will be at the forefront of adopting automated scheduling as it is not yet widely utilized by traditional healthcare providers (Johnson *et al.,* 2021). Dr. Peter Kotanko head of biomedical evidence generation highlights the role of AI in assisting doctors in diagnosing and managing kidney disease. Plus for predicting trajectories for kidney patients. According to Dr. Kotank, AI and ML are employed by nephrologists and other medical disciplines to evaluate a profusion of medical images. These images include the images obtained from radiology or histopathology (Johnson *et al.,* 2021). The healthcare sector has made significant advancements in the past two decades leading to an increased life expectancy worldwide. However, the aging population has also posed new challenges and placed additional pressure on the healthcare systems. The need for long-term care management has become crucial (Ahmad *et al.,* 2021).

MATERIALS AND METHODS

SYSTEMATIC REVIEW APPROACH

This study adopts a systematic literature review (SLR) design aimed at critically synthesizing existing empirical and theoretical scholarship on the application of Artificial Intelligence (AI) in the medical profession. Unlike traditional narrative reviews, the systematic

review approach ensures methodological transparency, replicability, and reduces bias through a structured process of existing work identification, screening, synthesis and remove of irrelevance data. The study is grounded in the principles of evidence-based research, which emphasize the integration of high-quality academic sources to generate reliable and generalizable insights. This design is particularly suitable given the rapidly evolving nature of AI technologies in healthcare, where consolidating dispersed knowledge is essential for advancing both theory and practice. The following diagram show in figure 1 is the systematic approach of the study.

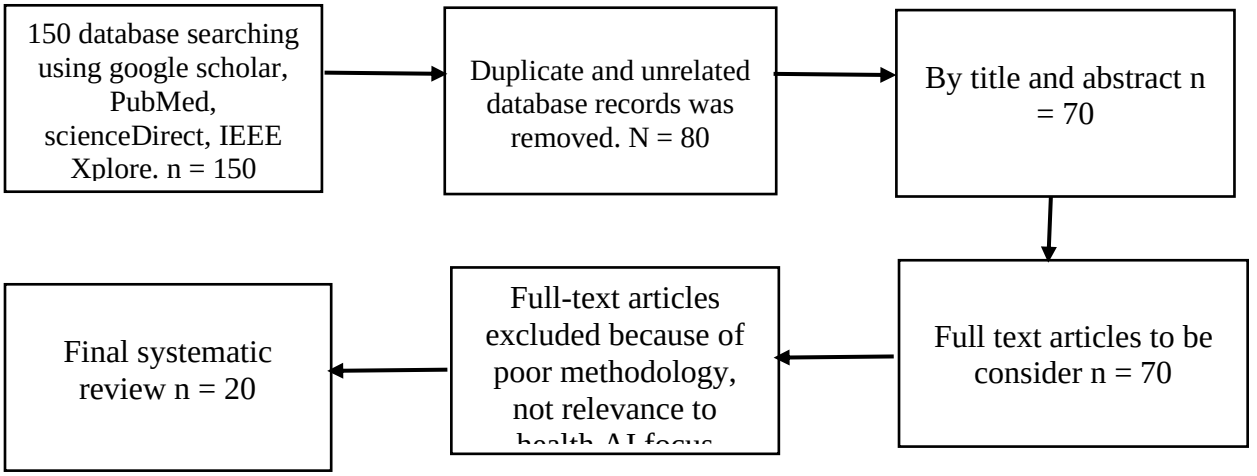

Figure 1: PRISMA Study diagram

DATA SOURCES AND SEARCH STRATEGY

This study focus on secondary sources of data which is obtained through a comprehensive and systematic search of different academic databases, including *Google Scholar, PubMed, ScienceDirect, IEEE Xplore*. A combination of Boolean search operators and carefully selected keywords during the search was employed to improve the precision and relevance of retrieved studies. These keywords was used during search which include Artificial Intelligence in healthcare, AI in medical diagnosis, machine learning in medicine, AI adoption in healthcare systems, and challenges of AI in healthcare. The search was restricted to publications between 2015 and 2025 **to capture recent advancements and contemporary scholarly perspectives.**

To ensure methodological rigor, explicit inclusion and exclusion criteria were applied during the study selection process. Only peer-reviewed journal articles and high-impact conference papers focusing on AI applications in healthcare sector were going to be consider. Both empirical and theoretical research, as well as systematic reviews approach, were included provided they were published in English and in Nigeria within the specified timeframe which is 2015-2025. Papers and journals that lacked clear methodological clarity, were not peer-reviewed, or were unrelated to healthcare applications of AI in Nigeria were excluded. The selection process followed a structured screening protocol involving title screening, abstract screening, and full-text review to ensure that only relevant and high-quality studies were included using PRISMA.

DATA EXTRACTION AND SYNTHESIS

Relevant data were systematically extracted from the different researchers and arrange into thematic categories. The study adopt thematic synthesis as the primary analytical technique, integrating both qualitative and quantitative findings across the existing base-line papers. The synthesis was guided by key thematic areas, including AI awareness and adoption clinical and operational benefits, implementation challenges and ethical concerns, and future prospects of AI in healthcare. This approach enabled a comparative and interpretive analysis, facilitating the identification of patterns, and emerging trends across different area of research.

To enhance the credibility and reliability of the review, all selected base-line paper were subjected to critical appraisal based on their methodological rigor, validity and reliability of findings, relevance to the research objectives and aim, and overall scholarly impact. Particular attention was given to the quality of research design, data analysis techniques, and the consistency of conclusions drawn. This process ensured that the review was informed by robust and credible evidence, thereby strengthening the overall validity of the study.

RESULTS AND DISCUSSION

The base-line papers reveals a significant increase in awareness and adoption of Artificial Intelligence technologies among healthcare professionals across Nigeria. Empirical evidence suggests that clinicians, particularly young practitioners from different sector, demonstrate higher levels of familiarity and engagement with AI-driven tools and AI Software's. A total of 150 papers were identified through database searches; after removing duplicates and irrelevant studies, 70 papers remained. Following full-text screening, 50 studies were excluded due to lack of relevance and methodological limitations, resulting in 20 studies included in the final review.

Findings from the reviewed papers and journals indicate that a wide range of artificial intelligence (AI) software and tools are increasingly utilized in medical practice and research, particularly in areas such as clinical decision support, diagnostics, data management, and electronic prescription processing. All 20 studies included in this review reported AI applications in healthcare delivery, of which 7 specifically focused on electronic prescribing (e-prescribing) systems.

Algorithms and machine learning models used in medical practice

These systems used in Nigeria medical practice often integrate machine learning and deep learning algorithms with electronic health records (EHRs) to provide intelligent and accurate recommendations during the prescribing process of drugs. (Sutton et al., 2020).

Furthermore, natural language processing (NLP) recent tools are used to interpret or translate unstructured clinical notes and convert them into structured prescription data, thereby improving workflow efficiency and reducing manual and human errors. In addition, AI-integrated pharmacy management systems facilitate automated dispensing and prescription validation, which contributes to improved patient outcomes and operational efficiency (Topol, 2019)

AI in Medical Research

AI tools are used for patient monitoring, personalized treatment planning, and follow-up care. Wearable devices and AI-driven mobile health applications enable continuous monitoring of patients with chronic diseases such as diabetes and hypertension, thereby improving long-term health outcomes.

Despite these benefits, the review also identified challenges including data privacy concerns, algorithm bias, high implementation costs, and limited infrastructure in developing regions These findings align with existing literature and reinforce the dual role of AI as both an enabler and a challenge in healthcare systems**.**

ANALYSIS

Critical Synthesis and Research Gaps

Although the existing base-line papers provides substantial evidence on the benefits and applications of AI in healthcare sector, several research gaps remain that give further investigation on the topic. There is a notable lack of empirical studies focusing on low- and middle-income countries, particularly within the African context, where unique challenges and opportunities exist. Of the 20 studies included, 13 were empirical studies and 7 were review papers. Additionally, limited attention has been given to the long-term implications of AI adoption on healthcare systems in Nigeria and workforce dynamics. The absence of standardized ethical and regulatory frameworks further underscores the need for comprehensive policy development. Future research should adopt interdisciplinary approaches that integrate clinical, technological, and socio-economic perspectives to provide a more holistic understanding of AI in healthcare

CONCLUSION

Artificial Intelligence (AI) has proven to be a very transformative force in the medical profession, significantly improving the quality and accuracy of healthcare systems, enhancing Pharmacy Management Systems through Inventory tracking and automatic stock updates, and streamlining healthcare operations. Artificial Intelligence has the ability to analyze large volume of data quickly and accurately which enables early detection of diseases, personalized treatment plans, and efficient management of medical resources. Its integration into various aspects of healthcare ranging from medical imaging and diagnostics to patient monitoring and administrative tasks has the potential to revolutionize the industry, leading to better patient outcomes and more efficient healthcare systems. However, while Artificial Intelligence offers numerous benefits it also presents challenges, including data privacy concerns, the need for extensive training and adaptation among healthcare professionals, and the potential for bias in Artificial Intelligence algorithms. Addressing these issues is critical to ensuring that AI can be safely and effectively integrated into healthcare. Future efforts should focus on developing context-specific policies, strengthening digital infrastructure, and enhancing capacity building, particularly in developing countries such as Nigeria. Furthermore, researchers are encourage to investigate the future healthcare professionals using artificial intelligence

RECOMMENDATIONS

Based on the key findings, the following recommendations were made:

i. Regular medical curricula should incorporate Artificial Intelligence training to equip future healthcare professionals with the necessary skills to work alongside Artificial Intelligence technologies on use and misuse.
ii. The healthcare industry in Nigeria must prioritize the digitization of medical records example (Patient Monitoring System) and establish standardized data protocols to ensure the safe and effective use of Artificial Intelligence.
iii. Developing comprehensive ethical guidelines and regulatory frameworks is essential to address the implications of Artificial Intelligence in healthcare system, ensuring patient safety and maintaining trust in Artificial Intelligence systems.

CONFLICT OF INTEREST

The authors declare there is no competing interest regarding publication of this article

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