

Health-Tech Horizons: AI's Trailblazing Journey Through Telemedicine And Public Health

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ABSTRACT

Background: Healthcare systems should be integrated with massive amounts of data because artificial intelligence (AI) can improve healthcare via improving how it is administered. Artificial Intelligence is driven by computerized information and the handling of complicated data in gadgets that facilitate intervention deployment.

Purpose: To advocate for the utilization and understanding of Artificial Intelligence (AI) within the healthcare sector as a potent tool aligned with contemporary trends in healthcare and patient care.

Method: Using the keywords technology, artificial intelligence, deep learning, technology, health, healthcare, medicine, education, and disease, a systematic review was

carried out focusing on databases like Google Scholar, Scopus, Web of Science, Research Gate, Science Direct, EBSO, ProQuest, Springer, PubMed, ScienceDirect, JSTOR, Embase, EBSCOhost, and ERIC. From 2017 to 2022, only works of English literature were the focus.

Results contemplates: Findings from 16,022 articles reveal AI's diverse applications in technology, including mobile apps, computers, and robotics. AI innovations yield fruitful outcomes in public health, clinical practices, and pharmacology, reducing errors and enhancing productivity. However, challenges persist, necessitating collaboration with social agents to improve healthcare delivery and outcomes.

Conclusions: AI has greatly advanced healthcare innovation. As might bring about more positive adjustments in line with contemporary trends, needs, and human dynamics requirements. Information, communication, and technology-based platforms, along with creative mechanisms, might make human care easier. It is advised to use IA to handle all contemporary issues in pharmacy, public health, and medicine.

Keywords. Artificial Intelligence, Public Health, Technology, Medicine, and Healthcare.

INTRODUCTION

Science and technology advancements make it easier to utilize clever people and machines with artificial intelligence (AI) that mimic human mental processes through reinforcement or machine-cognitive-deep learning. (Agbo et al., 2019). Artificial Intelligence (AI) aims to connect health care systems with massive amounts of data because it can improve health care delivery. Computers are able to make decisions, carry out individualized activities, and learn from and interpret data that models the variables influencing the determinants of health (Persico et al., 2020; Shahbal et al., 2022; Alharbi et al., 2022; Alruwaili et al., 2022; Almutairi et al., 2022; Alotaibi et al., 2022)

Computer science offers methodologies, algorithms, and tools for extracting insights from complex datasets, often in collaboration with interdisciplinary teams. Artificial

intelligence (AI) harnesses machine learning models, such as artificial neural networks, to efficiently process, interpret, and classify data, enabling the addressing of clinical scenarios with ease (Aceto, Persico, & Pescapé, 2018). AI, driven by electronic data management, facilitates interventions aimed at enhancing healthcare outcomes while reducing avoidable medical expenses (Ritschl, 2018).

The theoretical foundation for AI, rooted in probabilistic inference by Thomas Bayes, paved the way for learning algorithms in various applications (Aceto, Persico, & Pescapé, 2018). Additionally, the concept of systems biomedicine, introduced by Takenobu Kamada, integrates bioscience and medicine with computer science through predictive mathematical models and algorithms (Kamada, 1991).

Advancements in AI models, particularly in the 2000s, have been propelled by innovations in hardware and techniques like deep learning, resulting in the development of sophisticated neural networks and voice recognition systems (Aceto, Persico, & Pescapé, 2018). Major tech companies like Google, Facebook, Microsoft, Apple, and Amazon have played pivotal roles in amplifying the capabilities of AI, particularly in machine learning, cognitive computing, and reinforcement learning, across diverse scenarios (Aceto, Persico, & Pescapé, 2018).

In 2017, the FDA emphasized the importance of robust data security and reliability in AI systems to ensure safe use (Price & Nicholson, 2017). AI encompasses general AI, narrow AI, and super AI, with recent achievements primarily in narrow AI (Manne & Kantheti, 2021). AI, closely linked to machine learning and computer science, uncovers hidden patterns in data using algorithms (Price & Nicholson, 2017). Machine learning includes supervised, reinforced, and semi-supervised methods (Konyushkova et al., 2020). Deep machine learning utilizes multi-level representation learning in neural networks, while shallow machine learning relies on simpler models (Saravanan & Sujatha, 2018). The integration of disciplines like biosciences, medicine, and computer science enables systems biomedicine (Kalousis & Hilario, 2003).

Given the relevance of AI in healthcare, particularly amid the COVID-19 pandemic, efforts aim to practically apply

AI as a health tool (Siemens, 2005). The objective is to foster changes in healthcare practices through technological advancements supported by AI (Siemens, 2005). This aligns with George Siemens' theory on learning relationships in highly digitized environments (Mukherjee & Hasan, 2020).

Purpose

The aim of this study was to advocate for the utilization and understanding of Artificial Intelligence (AI) within the healthcare sector as a potent tool aligned with contemporary trends in healthcare and patient care.

Methodology

Research Design: This study employed a systematic literature review approach, utilizing qualitative research techniques to extract, analyze, interpret, and compare findings from selected electronic documentary sources.

Data Collection: Scientific articles, conference papers, reviews, expert opinions, book chapters, and other relevant documents in English were sourced from databases including Scopus, Google Scholar, Research Gate, Web of Science, ProQuest, Springer, PubMed, ScienceDirect, JSTOR, Embase, EBSCOhost, and ERIC. Keywords used for search included technology, artificial intelligence, deep learning, health, healthcare, medicine, and education.

Inclusion and Exclusion Criteria: Inclusion criteria involved relevance to the research question and scientific quality, while exclusion criteria were based on temporal factors, with a focus on content from the past five years or earlier, at the author's discretion.

Study Process: Selected materials underwent thorough review, comparison, and extraction of relevant textual information for citation and referencing purposes. Information was then analyzed and organized into sections reflecting the author's interpretation of the subject matter, including summaries and potential applications in health across various domains such as public health, medical, and pharmaceutical fields.

Ethical Considerations: The study adhered to ethical principles governing scientific research, ensuring rigor in information usage and citation practices.

Search Syntax:

A critical aspect of the research search process is Syntax, which comprises fundamental identifiers within databases, ensuring precise and comprehensive retrieval of relevant literature. These identifiers, typically represented by lowercase letters, elucidate verbs and nouns, facilitating effective documentation and retrieval of literature (Marcos-Pablos & García-Peñalvo, 2018).

Syntax 1: Artificial intelligence

Syntax 2: Artificial intelligence as a potential tool for use in healthcare

Syntax 3: Promote the knowledge of artificial intelligence in the healthcare field.

Syntax 4: Promote the application of artificial intelligence in the healthcare field.

Syntax 5: Knowledge parallel with modern trends in health and care

Step 3: Literature Search

Following the establishment of inclusion and exclusion criteria, the next step involves conducting a literature search across various databases to gather pertinent research content.

Utilized search engines encompass Google Scholar, Scopus, Web of Science, Research Gate, Science Direct, ProQuest, Springer, PubMed, JSTOR, Embase, EBSCOhost, and ERIC, offering vast repositories of research data. Access to these databases is facilitated by search engines like Google Chrome, Maxton, Torrent, and Microsoft Edge.

Database Statistics: Following the collection of necessary data from each database and search engine, methodological explanations regarding their application and significance are provided. Scrutiny of data selection from these databases is essential to ensure the inclusion of pertinent research for interventions. The selection process involves adhering to predefined criteria to choose studies deemed relevant.

Conducting the Review: This step involves executing the research plan and gathering relevant data. It follows the initial stages of planning and preparation, marking the commencement of action.

No	Database	Syntax	Year	No of Research
Journal of Namibian Studies, 3(1) 2018 ISSN: 2197-5523 (online)				
1	Google Scholar	Syntax 1	2018	1,768
		Syntax 2	2019	
		Syntax 3	2020	
		Syntax 4	2021	
		Syntax 5	2022	
2	Scopus	Syntax 1	2018	789
		Syntax 2	2019	
		Syntax 3	2020	
		Syntax 4	2021	
		Syntax 5	2022	
3	Web of Science	Syntax 1	2018	1,091
		Syntax 2	2019	
		Syntax 3	2020	
		Syntax 4	2021	
		Syntax 5	2022	
4	Research Gate	Syntax 1	2018	1,009
		Syntax 2	2019	
		Syntax 3	2020	
		Syntax 4	2021	
		Syntax 5	2022	
5	Science Direct	Syntax 1	2018	1,450
		Syntax 2	2019	
		Syntax 3	2020	
		Syntax 4	2021	
		Syntax 5	2022	
6	EBSCO	Syntax 1	2018	967
		Syntax 2	2019	
		Syntax 3	2020	
		Syntax 4	2021	
		Syntax 5	2022	
7	ProQuest	Syntax 1	2018	659
		Syntax 2	2019	
		Syntax 3	2020	
		Syntax 4	2021	
		Syntax 5	2022	
8	Springer	Syntax 1	2018	678
		Syntax 2	2019	
		Syntax 3	2020	
		Syntax 4	2021	
		Syntax 5	2022	
9	PubMed,	Syntax 1	2018	1,090
		Syntax 2	2019	
		Syntax 3	2020	
		Syntax 4	2021	
		Syntax 5	2022	

10	Science direct	Syntax 3	2020	1359
		Syntax 4	2021	
		Syntax 5	2022	
		Syntax 1	2018	
		Syntax 2	2019	
11	JSTOR	Syntax 3	2020	1578
		Syntax 4	2021	
		Syntax 5	2022	
		Syntax 1	2018	
		Syntax 2	2019	
12	Embase	Syntax 3	2020	1124
		Syntax 4	2021	
		Syntax 5	2022	
		Syntax 1	2018	
		Syntax 2	2019	
13	EBSCOhost	Syntax 3	2020	1178
		Syntax 4	2021	
		Syntax 5	2022	
		Syntax 1	2018	
		Syntax 2	2019	
14	ERIC	Syntax 3	2020	1287
		Syntax 4	2021	
		Syntax 5	2022	

election of Studies Based on Defined Criteria: Effective and pertinent research undergoes scrutiny to ensure alignment with predefined criteria. Approximately 16,022 records were identified through database searches, from which relevant articles were extracted based on inclusion and exclusion criteria. Ultimately, 15 peer-reviewed articles were selected, each providing insights into research design, methodology, variable expression, value representation, population stratification, and sampling techniques. The systematic literature review is based on the identified research, as outlined below.

Results

A total of 16,022 published documents underwent review, resulting in the selection of 15 articles that met the inclusion criteria. Notably, authors from industrialized countries predominated in the selected articles, with representation from the USA, UK, UAE, and KSA. These articles primarily focused on topics related to artificial intelligence (AI), machine

learning (ML), deep learning (DL), and electronic health records (EHR). (as indicated in figure 1).

The bibliographic data revealed that the majority of the selected articles originated from these respective countries, highlighting their effectiveness in contributing to research in this field. This geographic distribution underscores the significance of research collaboration and expertise from diverse regions.

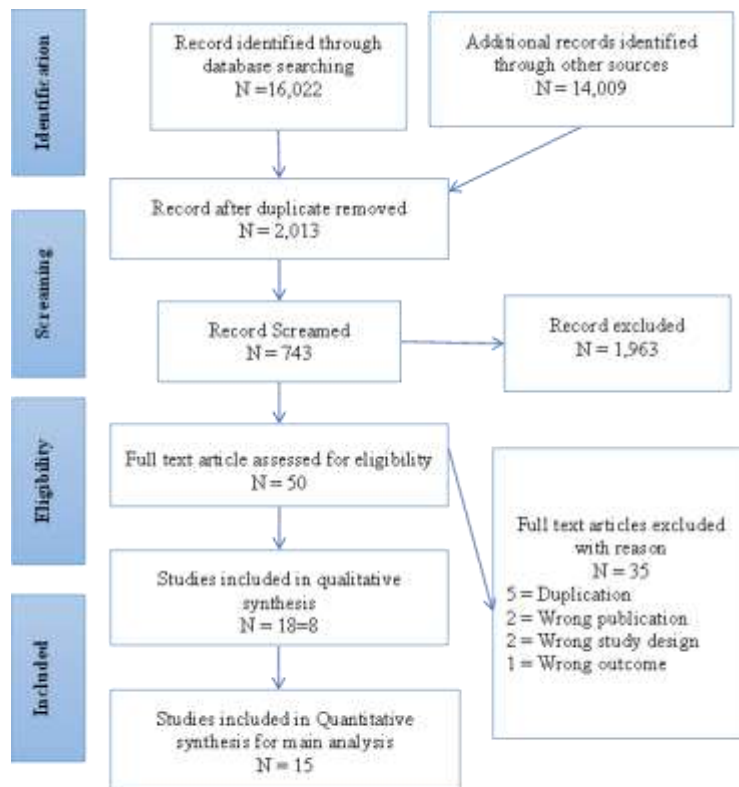


Figure 1.1 Selected Articles for Primary study

Potential applications of artificial intelligence in health

The majority of the selected documents demonstrate a keen interest in the potential applications of artificial intelligence (AI) in the healthcare sector, leveraging data through algorithms supported by various technologies such as information, communication, informatics, and computing (Aithal, 2019). However, it is notable that only a few applications show ease of development, with most being in experimental research phases. These applications aim to achieve clinical applicability after overcoming numerous challenges that currently hinder immediate or widespread use. Among the identified applications, several stand out within specific areas of interest:

In the realm of public and general health, artificial intelligence (AI) offers a wide array of applications:

Computational Modeling: AI aids in the identification and selection of relevant characteristics in various health phenomena. These characteristics are integrated with data in models of modest complexity, often derived from precision medicine. This integration assists in establishing effective disease prevention and treatment strategies (Panch, 2019; Yang et al., 2020).

Behavioral Interviews and Related Applications: AI-supported behavioral interviews utilize various technological tools such as text messages, progress reports via mail, and video-supported visits. Additionally, AI is employed for image processing, voice and text recognition, social networking software, and machine vision software. These applications extend to diverse domains including e-commerce, weather forecasting, speech transcription, video games, and the replication of artistic styles. Moreover, AI facilitates the identification of relationships in news elements, publications, or products of interest to users. The use of AI is also prominent in the development of robot assistants, portable sensors, and platforms for interdisciplinary collaboration (Baclic et al., 2020; Blasimme & Vayena, 2019; Gunasekeran et al., 2021).

The virtual cloud serves as a reservoir of invaluable data, encompassing billions of data points spanning molecular, clinical, cellular, organic, phenotypic, imaging, and social media realms, among others (Malandraki-Miller & Riley, 2021; Choudhur et al., 2022). Research delves into the development of intelligent surveillance systems for monitoring food safety and environmental health, aiming to track outbreaks with the aid of social networks and lifestyle data (Choudhur et al., 2022). Moreover, studies focus on modeling neurodegenerative diseases, with social networks geared towards disease management playing a supportive role. Notable examples of such platforms in the Kingdom of Saudi Arabia (KSA) include Mawid, Seha, PatientLikeMe, Breast Cancer Alliance, and Multiple Research in clinical trials (Aldhahir et al., 2022; Alanzi et al., 2022; Zanad et al., 2022).

In the realm of medical applications, a variety of innovative approaches are being explored:

1. **P4 medicine:** Proposed applications encompass predictive, preventive, personalized, and participatory medicine, integrating systems medicine and biomedicine. Genetic and electrophysiological data are utilized with the support of bioinformatics (Pack, 2016).
2. **Bioinformatics and medical imaging:** Applications span translational molecular bioinformatics, medical imaging, pervasive detection, medical informatics, and biostatistics, catering to various needs in cancer care, neurology, and cardiology (Noell, Faner, & Agustí, 2018).
3. **Telehealth and deep learning:** Telehealth platforms enable real-time, interactive communication between patients and healthcare providers. Deep learning technology facilitates the analysis of electronic health records, images, sensors, and text materials, aiding in the early diagnosis of cardiovascular diseases and predicting survival rates for colon cancer patients. Computational diagnosis and precision medicine leverage high-performance technologies such as genomics, transcriptomics, proteomics, and metabolomics (Love et al., 2019; Kassem et al., 2021).
4. **Digital health monitoring:** The use of digital devices to measure physical parameters such as heart rate, body temperature, weight, respiration, sleep quality, stress levels, nutritional habits, and physical activity is projected. Biomarkers, along with images and genotype biobanks, are also investigated (Alzeidan et al., 2017; Abdulsalam et al., 2021; Zhang et al., 2020; Shahbal et al., 2022).
5. **Telemedicine advancements:** Telemedicine applications encompass videoconferencing, predictive diagnostics projecting hospital stay duration, readmissions, and mortality rates. Additionally, there are models for biological and psychological diseases, along with the utilization of portable skin-environmental sensors, portable or implant-assisted devices, and continuous monitoring of vital signs. Medical care services are also referred through social networks by other users of the services (Melstrom et al., 2021).

Deep learning finds clinical application in image-intensive fields such as radiology, radiation therapy, pathology, ophthalmology, dermatology, and image-guided surgery (Naylor, 2018). Data fusion from biology and medicine includes information from social media, online videos, physiological signals from skin-implanted sensors, wearable devices, drug analysis, and genomic analysis. Studies focus on automatic skin lesion classification, arrhythmia detection, and integrating informatics, images, and data mining with genomics and metabolomics (Naylor, 2018; Beyer et al., 2020).

Automated deep-learning algorithms aid in breast cancer metastasis detection and diagnosing conditions using electromyogram (EMG), electroencephalogram (EEG), electrocardiogram (ECG), and electrooculogram (EOG). Machine learning models assist in intensive care unit management and pulmonary nodule detection on chest X-rays (Rastogi, Chaturvedi, & Gupta, 2020; Klaib et al., 2021).

Supervised machine learning methods are employed for risk estimation models of anticoagulant therapy, classifying cerebrovascular accidents, predicting outcomes in infectious diseases, and identifying arrhythmias from electrocardiograms (ECG) (Rastogi, Chaturvedi, & Gupta, 2020; Klaib et al., 2021).

Predictive bladder volume sensors aid in predicting epileptic seizures and other neurological disorders. Artificial intelligence and robotics are used in regional anesthesia, pregnancy control, and Internet-connected hospitals. Cervical cancer detection, retinal image analysis, bone age estimation, optical coherence tomography for diagnosing retinal diseases, and quantifying vessel stenosis on cardiac imaging are areas of development (Ahmed, Barua & Begum, 2021; Hossain et al., 2021; Hosny et al., 2018).

Artificial intelligence is explored in predicting changes in depression and anxiety with digital interventions. Collaborations between healthcare institutions and organizations yield specific services, such as Deepmind Health's partnership with Moorfields Eye Hospital NHS Foundation, IBM's Watson Oncology, Publink for digital billing, Medical Sieve in radiology imaging, and Artery's artificial intelligence-assisted cardiac imaging system (Zaudere et al., 2014; Strickland, 2019).

Telemedicine and Pharmacy

Telepharmacy services are expanding in hospitals and remote communities, offering services such as medication review, monitoring, dispensing, verification of sterile and non-sterile compounds, medication administration, evaluation, counseling, and patient education. Chemoinformatics is explored for drug development, predicting adverse reactions, identifying biomarkers, and facilitating drug discovery (Hosny et al., 2018).

Safe drug delivery systems, such as robots and medical drones like Zipline, are deployed for chat messaging regarding drug use during breastfeeding and emergency care. Single-cell unit sequencing and flow cytometry technologies support drug discovery and development. Deep learning algorithms aid in predicting drug release, pharmacokinetics, and pharmacodynamics in vitro (Rastogi, Chaturvedi, & Gupta, 2020; Klaib et al., 2021).

Computational models are applied in drug development, including thermodynamic proxy models, simulation of drug solubility in human intestinal fluid, prediction of stability in liver microsomes, autoxidation, identification of CYP2C9 metabolism sites, permeability in human skin, blood-brain barrier penetration, and estimation of skin concentration levels after dermal exposure. Unsupervised learning techniques are utilized to review failed clinical trials involving drugs like spironolactone, enalapril, and sildenafil, compared with placebos, to identify subclasses of patients who may benefit from specific therapies (Paul et al., 2021; Love et al., 2019; Kassem et al., 2021).

Discussion

There is a prevailing perception that AI in telemedicine consultations is limited to specific or narrow AI. However, evidence reveals a wide range of applications including diagnosis, treatment, prevention, rehabilitation, disease investigation, evaluation, and continuing education, among other daily life activities. Specific AI focuses on a single type of disease, whereas general AI is expected to address any type of disease, yet even with various actions, specificity persists (Ahmed, Barua & Begum, 2021; Hossain et al., 2021).

Telepharmacy employs telecommunications tools like videophone systems, software, and automated dispensing machines, enabling pharmacists at distant locations to provide two-way video educational consultations for medication

administration and counseling. Evidence from Australia and the United States demonstrates the positive impact of telepharmacy services, including reductions in adverse drug events, associated costs, hospital stays, and mortality rates, along with increased patient satisfaction and accessibility to health services (Rastogi, Chaturvedi, & Gupta, 2020; Klaib et al., 2021).

The integration of AI in healthcare activities is marked by rapid technological advancements, offering opportunities for enhancing care practices, healthcare services, and professional involvement. However, numerous challenges persist, such as the need for skilled human resources and training in clinical practices to ensure optimal health outcomes (Saravanan, & Sujatha, 2018; Moglia et al., 2021).

While developed countries emphasize the use of AI through digital imaging, record digitization, and integration of deep learning, progress in developing countries is hindered by other pressing needs. Empowering individuals and fostering AI development in these regions is essential, irrespective of advancements in deep learning technology (Guo & Li, 2018).

Certain clinical fields have witnessed faster adoption of deep learning, driven by digitization and high data volumes, notably in radiology, pathology, ophthalmology, dermatology, and image-guided surgery. However, progress varies across different fields, with some experiencing limitations or lagging behind (Panch Szolovits and Atun, 2018).

In the post-millennium era, the potential of AI-mediated computers and robots complements the healthcare workforce, particularly during crises stemming from personnel shortages due to population aging and high demand for chronic care. This underscores the importance of intelligent healthcare and healthy aging, empowering individuals to maintain self-sufficiency and control despite chronic illnesses with AI assistance (Mukherjee & Hasan, 2020).

Efficient health systems must manage workforce availability, accessibility, acceptability, and quality, particularly in the face of aging populations. AI presents an opportunity to address these gaps, although some are hesitant due to concerns about job displacement. Yet, the integration of data from conventional sources with new technology applications can transform healthcare, leveraging technology

advancements to enhance clinical applications (Saravanan, & Sujatha, 2018; Moglia et al., 2021).

Technological advancements, coupled with automation and miniaturization, enable a significant increase in healthcare production by harnessing vast datasets from applications, medical devices, and mobile digital health record systems. It is imperative for managerial personnel to recognize the importance of investing in, acquiring, and maximizing available resources to leverage AI in healthcare effectively. This entails reducing inefficient traditional activities and diversifying intervention strategies in healthcare centers or communities with support from various social actors (Kalousis & Hilario, 2003; Maddox, Rumsfeld, & Payne, 2019).

Collaborative educational or research networks can enhance intensive work by facilitating the sharing and linking of biorepositories or unified data formats such as Fast Healthcare Interoperability Resources. Patients must receive adequate training to control data access and consent to model construction or execution. Text tools in HTML or hypertext markup language on the web can be indexed and accessed using computer search engines, further streamlining information retrieval processes (Maddox, Rumsfeld, & Payne, 2019).

Challenges in the Healthcare field

Several challenges accompany the use of AI in healthcare, necessitating careful attention to align rapid technological advancements with practical application processes. Legal and regulatory frameworks governing AI usage, along with high initial investment costs, present hurdles requiring concerted effort, time, consensus, and visionary decision-making (Gerke, Minssen, & Cohen, 2020). Therefore, healthcare personnel must navigate and manage challenges effectively to maximize the benefits of AI, including:

a. Managing heterogeneous data effectively, which often exhibits high uncertainty and dispersion due to the absence of universal reference points. This involves addressing issues related to data integration, harmonization of formats, processing, analysis, and knowledge transfer (Aung, Wong, & Ting, 2021).

b. Employing models through diverse methodologies to enhance credibility and interpretability, thereby ensuring robust and reliable outcomes (Aung, Wong, & Ting, 2021).

c. Addressing ethical, legal, social, security, privacy, political, economic, and technological considerations, alongside historical, cultural, and technical barriers. This includes the need for extensive sustainable computing resources, continuous monitoring systems, and fail-safe design to prevent harm. Emphasizing transparency, efficiency, and scientific evidence regarding reproducibility, usability, and reliability is crucial in this regard (Gerke, Minssen, & Cohen, 2020).

Recommendations and Suggestions

The application of AI, complemented by advanced technologies and a multidisciplinary approach, holds immense potential in enhancing the delivery of healthcare services. It facilitates effective medical care, informed decision-making, large-scale data analysis, and comprehensive training of healthcare professionals at both undergraduate and postgraduate levels. Moreover, it fosters seamless exchange of information for diagnosis, treatment, and disease prevention, driving forward research initiatives and enabling evaluation of healthcare outcomes. Active involvement of the population, intersectoral collaboration, and continuous education of all stakeholders involved in digital health management are also facilitated. (Gerke, Minssen, & Cohen, 2020; Aung, Wong, & Ting, 2021).

Implications in Saudi Healthcare Context

AI applications offer significant potential in the design, implementation, monitoring, and evaluation of health policies, along with transforming educational processes to align with scientific advancements. They enable access to powerful computing tools and massive open online courses, revolutionizing higher education and promoting individual and community health.

Furthermore, AI facilitates innovative approaches to healthcare delivery, streamlining processes and improving outcomes, including mental health care with early symptom identification and effective interventions. Embracing AI presents a challenge for knowledge sciences, necessitating interdisciplinary collaboration and continuous skill

development to harness its full potential. In the context of Saudi healthcare, integrating AI technologies holds promise for enhancing patient care, reducing errors, and optimizing resource utilization, ultimately improving healthcare delivery, and fostering a conducive work environment.

Conclusion

AI represents a pivotal and transformative tool within the healthcare sector, ushering in revolutionary advancements across medicine, public health, and pharmacology. Its implementation has led to profound positive changes, marking a new era in healthcare delivery. Globally, AI holds immense promise for the future, underscoring the imperative to invest further and allocate increased attention to its continued development and integration within healthcare systems.

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