ARTIFICIAL INTELLIGENCE IN BIOMEDICAL SCIENCES: OPPORTUNITY AND SCOPES

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Abstract :

In biomedical research and healthcare, artificial intelligence (AI) has emerged as a major disruptive force that improves clinical decision-making processes and allows for more sophisticated analysis of large-scale, complicated biomedical data. AI methods like machine learning (ML) and deep learning (DL) are developing quickly and being used in a variety of biological fields, such as drug development, diagnostics, treatment planning, and disease prediction. The growing amount and complexity of data produced by genomics, imaging, and clinical sources presents difficulties for biomedical research; artificial intelligence (AI) provides effective techniques for identifying significant patterns and insights that conventional methods frequently overlook. AI models have been extensively used in medical imaging for analysis tasks including diagnosis, segmentation, and classification, greatly assisting radiologists and clinicians with automated and accurate picture interpretation.

Key Words : Biomedical Research, Healthcare, Artificial intelligence (AI))

Introduction :

Artificial intelligence (AI) is becoming increasingly important in healthcare for sickness prevention, monitoring, diagnosis, and treatment (Abu El Ruz et al., 2025). AI has applications in genetics, clinical trial optimization, drug development, and allied health. Risk prediction, surgical navigation, diagnostics, and customized medicine have all made substantial use of it (Mohajer Bastami et al., 2025). AI significantly influences biomedical research by offering innovative solutions to difficult issues in drug development, medical diagnostics, and customized therapy, according to recent studies (Sharanabasappa & Soumya, 2024).

Artificial intelligence allows computers to learn from experience and perform human-like activities including as diagnosis, prognosis, treatment planning, surgical assistance, and medication research through the use of machine learning, deep learning, and neural networks (Tim Hulsen, 2022). Generative AI models, such ChatGPT and diffusion models, are transforming medicine by increasing the accuracy of diagnoses and automating clinical procedures. This emphasizes how important it is to evaluate applications and prospects in-depth (Buess et al., 2025).

In a number of domains, including drug discovery, surgery, pathology, clinical decision support systems, and diagnostic imaging, the growing application of AI in clinical medicine opens up new possibilities for enhancing biomedical innovation, therapeutic decision-making, and diagnostic accuracy (Ogut, 2025). All things considered, advancements in digital data collecting, machine learning, and computer infrastructure have enabled the rapid growth of AI in medicine, expanding its applications into domains that were previously thought to be exclusive to human professionals (Yu et al., 2018).

Despite its enormous potential, artificial intelligence in the biological sciences is currently poorly understood due to disparities in models, disciplines, and concepts of application. Future research must focus on robust validation, ethical deployment, protocol standardization, transparency, and interdisciplinary collaboration to ensure safe and successful integration into healthcare systems (Abu El Ruz et al., 2025; Mohajer Bastami et al., 2025; Algethami et al., 2025).

Additionally, by leveraging large datasets and computational expertise, machine learning is crucial for addressing significant healthcare concerns including early detection, personalized treatment regimens, and predictive modeling. Interdisciplinary research and standards frameworks are required to solve practical and ethical challenges such as data quality, interpretability of AI models, and integration into existing clinical processes in order to fully exploit AI's promise in the biomedical sciences.

Literature Review :

In the biomedical sciences, artificial intelligence (AI) is being used more and more to tackle difficult healthcare issues. Convolutional neural networks (CNNs) and other AI models have demonstrated exceptional accuracy in medical imaging when it comes to organ segmentation, illness detection, and helping radiologists diagnose patients (Litjens et al., 2017). In genomics and proteomics, machine learning algorithms have also been widely applied, facilitating the identification of biomarkers, comprehending illness causes, and bolstering customized treatment strategies (Shen et al., 2023).

AI methods, such as deep learning and reinforcement learning, have sped up the process of finding candidate compounds, optimizing drug characteristics, and forecasting drug-target interactions in the drug discovery process (Zhavoronkov et al., 2019). Diffusion models and ChatGPT are examples of generative AI models that have been investigated to improve decision-making in clinical and research contexts, automate workflows, and synthesize biological data (Algethami et al., 2025).

Numerous research emphasizes how AI is used in clinical decision support systems (CDSS), where risk stratification and predictive modeling enhance patient care and results (Rajkomar et al., 2019). Furthermore, AI applications in critical care, pathology, and surgery have demonstrated the ability to improve workflow, lower mistakes, and boost healthcare delivery efficiency (Ogut, 2025).

Model interpretability, data bias, integration with current clinical infrastructure, and ethical considerations are among the issues that still exist despite these developments (BMC

Med Ethics, 2021). According to published research, achieving the full potential of AI in the biological sciences requires multidisciplinary cooperation, standardization of AI protocols, and strong validation techniques (Sharanabasappa & Soumya, 2024).

Research Methodology :

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines, which offer a methodical way to map evidence, identify important concepts, and highlight research gaps in the biomedical sciences, were followed in conducting this scoping review. Initially, 84 articles were identified from databases including PubMed, Google Scholar, Scopus, ResearchGate, and ScienceDirect. resulting in 23 studies being included in the final review. Ethical approval was not required since the review relied on previously published research, with potential limitations including variability among studies and language constraints.

Identification of studies via databases and registers :

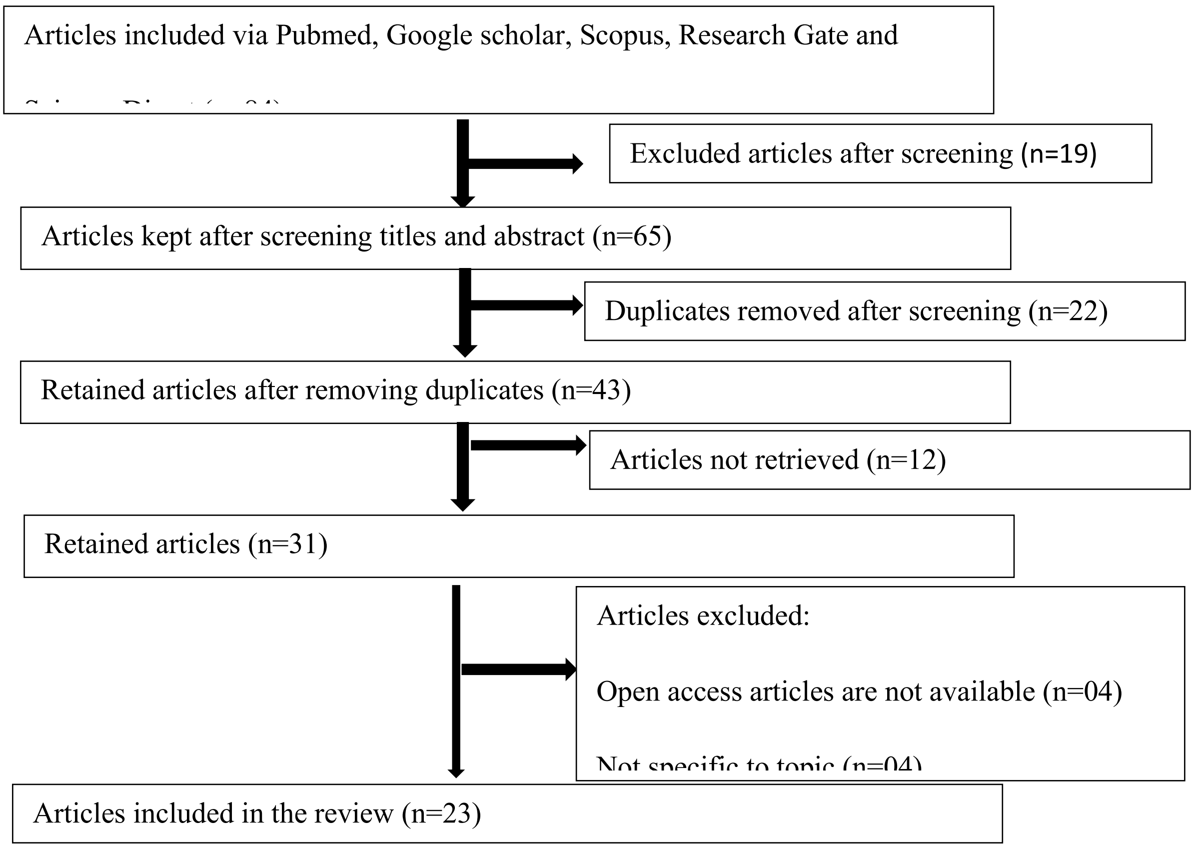

FIGURE 1: PRISMA flow chart

n: Number of studies; PRISMA: Preferred Reporting Items for Systematic Reviews

Several electronic databases, including PubMed/Medline, Scopus, Web of Science, IEEE Xplore, and ScienceDirect, were searched thoroughly using Boolean operators and keywords like "Artificial Intelligence," "Machine Learning," "Deep Learning," "Biomedical Sciences," "Medical Imaging," "Genomics," and "Drug Discovery" (Mohajer Bastami et al., 2025; Sharanabasappa & Soumya, 2024). Peer-reviewed research on AI applications in biomedical sciences published in English between 2015 and 2025 was included in the inclusion criteria, which were established using the PCC framework (Participants, Concept, Context) (Cooper et al., 2023). Editorials, opinion pieces, non-peer-reviewed articles, and studies unrelated to biological AI were among the exclusion criteria (Mohajer Bastami et al., 2025).

Discussion :

Despite their enormous potential, many AI models are rarely tested in real-world situations; instead, they are only verified in controlled settings or using appropriately labeled publically accessible resources. Explainability is still lacking in the majority of ideas. Few approaches are designed with interpretability as their main objective, even if some provide the visualization of internal weights or regions of interest.

One of the main obstacles in biomedical data science issue solving should be the explainability of AI. Without repeatability—the guarantee that findings remain consistent and reliable across time, across various datasets, and upon repeated runs—the validity of even the most transparent AI system's output may be called into doubt. Through the use of technologies such as natural language processing, neural networks, and machine learning, "AI applications have significantly improved diagnostic accuracy, treatment personalization, and patient outcome predictions." After a preliminary screening of titles and abstracts to weed out redundant and unnecessary research, a full-text review for criteria was carried out. Data were recovered into a structured manner to record study characteristics, AI models, biomedical applications, results, and constraints (Mohsen et al., 2022). A narrative synthesis technique was used to describe thematic observations, trends, and knowledge gaps (Mondal et al., 2021).

Using exact methodological processes from previous research projects, which ensure transparency and repeatability, increases the credibility of the scoping review (Tricco et al., 2018; Cooper et al., 2023).

Conclusion :

AI in biological sciences has received little attention because of differences in AI models, disciplines, study approaches, and ideas on application. Even though many AI approaches show promise for increasing efficacy, accuracy, and practical application, significant gaps remain in the areas of methodological standards, comprehensive characterisation across disciplines, and pedagogical deployment. The successful integration of AI in cardiology care requires the implementation of mitigation techniques and more openness on the use of AI in patient care. The intricacy of trust, patient privacy and permission, ethics, and data integration presents prospects for further study.

Biases in training data might cause AI systems to perform badly on underrepresented groups, which would reinforce rather than lessen gaps.In AI systems that have the potential to drastically impact human lives, explainability remains a fundamental challenge, particularly in sensitive domains like healthcare.

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