Personalized Medicine Meets Artificial Intelligence A Systematic Literature Review

Xin Zhao
Department of Computer Science
Seattle University
Seattle, USA
email: xzhao1@seattleu.edu

Parth Reshamwala
Centene Corporation
Austin, USA
email: Parth.Reshamwala@centene.com

***Abstract*—Personalized medicine represents a paradigm shift from the traditional one-size-fits-all approach to a more customized healthcare model that seeks to provide the right treatment to the right patient at the right time. With the significant increase in the maturity of related technology over the past several years, Artificial Intelligence (AI) is enhancing personalized medicine, making it more precise, efficient, and accessible. To gain a deeper understanding of the interplay between personalized medicine and AI, we conducted a Systematic Literature Review (SLR), aiming to provide AI's pivotal role in advancing tailored healthcare solutions. Synthesizing insights from 36 articles, our investigation explores key factors of AI-driven personalized medicine, including techniques, tools, and effectiveness. Furthermore, we examine the limitations and lay out the potential future work inherent in this field. Our review organizes the state of the art in AI-based personalized medicine and paves the way for better patient outcomes and more effective healthcare delivery in clinical practice.**

Keywords-Personalized medicine; Artificial Intelligence; Systematic Literature Review.

I. INTRODUCTION

In recent years, the convergence of personalized medicine and AI has heralded a new era in healthcare. Personalized medicine, which tailors medical treatment to individual patients, marks a significant change from traditional one-size-fits-all approaches. This shift improves diagnostic accuracy, optimizes treatment, and enhances patient outcomes through large-scale data and algorithms. The role of AI in this transformation is pivotal, offering unprecedented capabilities to analyze diverse datasets, identify patterns, and generate insights that drive more effective and personalized healthcare solutions [1] [2].

In the realm of personalized medicine, AI holds immense potential. For instance, recent research has demonstrated that AI-driven approaches can significantly improve the identification of genetic variants and their associations with various diseases [3]. By leveraging AI algorithms, researchers can analyze vast genomic datasets to identify genetic variations associated with diseases and drug responses. This enables the development of targeted therapies tailored to an individual's genetic makeup, enhancing treatment efficacy while minimizing adverse effects [2]. Additionally, AI-driven approaches facilitate the interpretation of complex genetic data, providing clinicians with insight to guide treatment decisions and improve patient outcomes [4]. Despite challenges, such as data quality, interpretability of results, and ethical considerations surrounding genetic privacy, AI is still considered a revolution in human healthcare [5]. Addressing these challenges is essential to fully harness the power of AI in genomic medicine.

Furthermore, AI plays a crucial role in optimizing the selection and dosing regimens of medications for individual patients [1]. By analyzing patient data, including genetic profiles, medical history, and treatment responses, AI algorithms can predict the most effective drugs and dosages for specific individuals. This personalized approach not only improves treatment results but also reduces the likelihood of adverse reactions and side effects. This ongoing progress promises even greater advancements in personalized medicine, making AI a powerful tool to optimize patient care.

Despite the growing body of studies and successful applications, the integration of AI in personalized medicine faces numerous challenges. An outstanding challenge is the lack of a comprehensive synthesis of existing studies. This paper aims to fill this gap by thoroughly exploring AI's role in personalized medicine. We conducted a Systematic Literature Review (SLR) to synthesize existing research, analyzing how AI technology is applied in various aspects of personalized medicine. The overarching goal of our investigation is to delve into the intersection of AI and personalized medicine from three aspects: techniques, tools, and clinical specialties, providing a holistic view of the current state and future directions of AI in personalized medicine. To reach this goal, we propose the following Research Questions (RQs):

1) RQ 1: What techniques are adopted in the area of AI-based personalized medicine?
2) RQ 2: What tools are used when applying AI to personalized medicine?
3) RQ 3: What specialty is benefited from the intersection of AI and personalized medicine?

II. RELATED WORK

Recent literature has explored the application of AI across various domains of personalized medicine. Gallo [3] and Suwinski [2] examined AI-driven approaches for genetic data interpretation and drug development. The integration of electronic health records into AI frameworks was studied by Abul-Husn and Kenny [6], highlighting their relevance for individualized care. Petrovic [7] and Nova [8] discussed advancements in deep learning and generative AI models, particularly in clinical decision-making and patient-specific data handling.

Methodological insights were provided by Dinesh [9], Gifari [10], and Ho [11], who explored algorithmic frameworks, AI infrastructure, and enabling technologies for precision medicine. While these studies contribute meaningful perspectives, many are either domain-centric or emphasize selected AI methods. This review complements prior efforts by synthesizing findings across AI techniques, implementation tools, and clinical specialties, to present a consolidated view of the field.

Overall, prior work shows that AI enables personalized medicine by improving diagnostics, treatment selection, and clinical decision-making using large and diverse healthcare data. However, the literature is fragmented across techniques, tools, and clinical specialties, limiting a unified understanding of research gaps. To address this, we conduct a Systematic Literature Review that consolidates and categorizes existing studies and highlights challenges and future directions for AI-based personalized medicine.

III. Methodology

This paper follows Kitchenham's approach [12] to develop our systematic literature review, to ensure a rigorous and comprehensive review process. Kitchenham's approach has been widely used in conducting literature reviews related to AI and medicine [13][14].

A. Query Search

To thoroughly investigate the role of AI in personalized medicine, we construct a detailed search query that includes key terms and relevant phrases. Below are the search terms and combinations that form the backbone of our search strategy:

- “AI in Personalized Medicine"
- “Machine Learning in Personalized Medicine"
- “Artificial Intelligence and Personalized Healthcare"
- “Machine Learning in Precision Medicine"
- “Big Data Analytics for Individualized Treatment"

To enhance the inclusiveness of our search, we also use Boolean operators in the query to create more search terms:

- “AI AND "Personalized Medicine"
- “Artificial Intelligence" AND "Precision Healthcare"
- “Machine Learning AND "Individualized Treatment"
- “Big Data Analytics" AND "Personalized Medicine"

We also include alternate spellings and synonyms to broaden the scope of our search. For example, we use “Artificial Intelligence” and “AI” interchangeably, and “Precision Medicine” is used as a synonym for “Personalized Medicine.”

This systematic approach to formulating our query aims to capture all relevant information, providing a solid foundation for synthesizing insights and drawing meaningful conclusions about the role of AI in advancing personalized medicine.

B. Source Selection

The criteria for selecting sources for this research aim to include high-quality and diverse literature in the field of AI-based personalized medicine. We prioritized the PubMed and SpringerOpen databases due to their extensive collection of research in biomedical and health informatics, with PubMed being a primary source for articles in medicine and life sciences. ScienceDirect, a leading scientific database, was also included to cover a broad spectrum of scholarly articles in various disciplines relevant to health informatics.

We further expanded our selection by including Google Scholar, IEEE Xplore, ResearchGate, PLOS, Hindawi, Cureus, and MDPI to ensure comprehensive coverage of the research landscape. Five additional specialized platforms were included: the British Institute of Radiology, the American Society for Clinical Pharmacology and Therapeutics (ASCPT), the Pacific International Conference on Ecosystem Services (PICES), BioMed Central (BMC), and the Journal of Medical Internet Research (JMIR), to provide a multidisciplinary perspective.

In total, we selected 15 digital databases as sources for identifying relevant papers.

C. Selection Criteria

Inclusion Criteria: The inclusion criteria encompass studies that (1) directly address the integration of AI in personalized medicine. This includes research that focuses on tailoring medical treatment to individual characteristics, such as genomics, diagnostic methods, and treatment optimization. (2) Studies selected for inclusion involve the application of AI techniques, algorithms, and technologies in the healthcare context. Furthermore, preference is given to literature published in peer-reviewed journals and conference proceedings, ensuring the reliability and validity of the findings. (3) Studies involve clinical trials, experiments, or real-world applications, providing practical insights into the implementation of AI in personalized medicine.

Exclusion Criteria: The exclusion criteria were established to ensure the quality and relevance of the selected literature. Studies were excluded if they (1) did not involve the application of AI or machine learning in the context of personalized medicine. (2) lacked clinical relevance, such as those focused solely on theoretical AI models without healthcare applications. (3) were not published in peer-reviewed journals or reputable conference proceedings, including abstracts, editorials, and opinion pieces. (4) were published before the year 2015, as our focus is on recent advancements in the field. (5) demonstrated low methodological quality, including unclear research design, insufficient data transparency, lack of validation, or inadequate explanation of AI model performance. These criteria ensured that only high-quality, clinically applicable, and scientifically rigorous studies were included in the final review.

IV. Review Execution

In this section, we outline the execution of our review process, as discussed in Kitchenham's methodology [12].

A. Initial Search Results

We started with a broad search across 15 academic databases, as discussed in the previous section. This extensive search led to a large initial pool of 31,924 papers. The aim was to cover a wide range of studies discussing technological advancements, applications, challenges, and prospects in personalized medicine related to AI.

B. Preliminary Screening

The preliminary screening involved a preliminary review to eliminate papers that were not directly related to personalized medicine or AI, resulting in the exclusion of 28,450 papers. These exclusions were based on the relevance of the papers to our research scope, despite containing the keywords we defined, did not focus on AI-based approaches. This preliminary screening ensures that the remaining papers address the integration of AI in the context of personalized healthcare. After this preliminary screening, we have 3,474 papers left.

C. Shortlisting

Following the preliminary screening, we examined the titles and abstracts as a more refined set of criteria to further narrow down the selection. We excluded an additional 2,980 papers that, although related to personalized medicine, did not adequately address the application of AI or were not published in peer-reviewed sources.

Another 224 papers were excluded after assessing their introduction sections for alignment with our research focus. After shortlisting, we have 270 papers left.

D. Quality Assessment

At this stage, the remaining 270 papers were subjected to a structured quality assessment to ensure methodological rigor, clinical relevance, and scientific contribution. Each study was evaluated based on specific criteria, including the clarity of research design, transparency of data and methodology, validation of AI models, and reproducibility of results. Studies were excluded if they lacked peer review, presented incomplete or ambiguous findings, or failed to demonstrate a practical application of AI in personalized medicine. This assessment led to the exclusion of 212 papers that did not meet the required standards, resulting in a final set of 58 papers for analysis.

E. Data Extraction

Finally, the data extraction process was carried out on the remaining 58 papers. We focused on studies that provided practical insights into the implementation of AI in personalized medicine, particularly those involving clinical trials, experiments, or real-world applications. This rigorous selection process resulted in a final set of 36 papers. Figure 1 illustrates our paper selection process.

F. Included Studies

Table I lists all the studies included after the review process has been executed.

V. Results and Discussions

A. Techniques

The first research question that we examine is: What techniques are adopted in the area of AI-based personalized medicine? In this section, we present our findings related to this research question.

Our examination reveals that machine learning algorithms and neural networks are commonly utilized in several papers, showcasing the broad applicability of these techniques. Natural Language Processing (NLP) and computational linguistics are applied in text-based data analysis, while others leverage techniques such as the Quadratic Phenotypic Optimization Platform (QPOP), Bayesian Decision Analysis (BDA), K-Nearest Neighbor (KNN), Support Vector Machine (SVM), and Artificial Neural Network (ANN). Some papers specifically emphasize the use of NLP for biostatistical datasets, while others explore Next-Generation Sequencing (NGS).

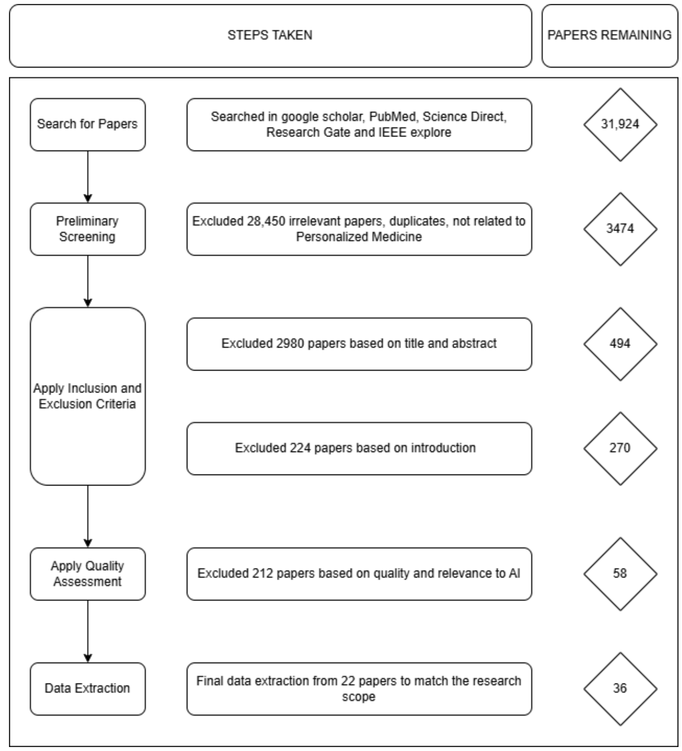

Figure 1. Selection Process of Selected Papers.

In addition, advanced deep learning techniques are widely adopted, including Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Generative Pre-trained Transformers (GPT). Novel approaches such as Evolutionary Enhanced Markov Clustering, AI-assisted Personalized Disease Burden (AI-PDB) assessment tools, and Real-Time Artificial Neural Networks further enrich the methodological landscape. These techniques reflect the interdisciplinary nature of data analysis in AI-driven personalized medicine, showcasing both depth and diversity in technological adoption.

In the discussion below, we divide the techniques in selected papers into two categories: Main Approaches which means the main implementation methods to achieve personalized medicine, and Supporting Techniques which refers to techniques used alongside main approaches in included studies.

1) Main Approaches: In this section, we discuss the main approaches identified from the list of papers in Table I. These approaches represent the key techniques and methodologies employed in the field of AI-based personalized medicine. The reference number in Table II corresponds to the paper numbers

TABLE I. LIST OF INCLUDED STUDIES

Paper #	Paper Title	Publication Year
1	The role of artificial intelligence in shaping future health planning [1]	2025
2	The revolutionary intersection of AI and healthcare: Embracing ChatGPT with caution [15]	2025
3	AI in healthcare: Transforming patient care and outcomes [16]	2025
4	Personalized medicine in urolithiasis: AI chatbot-assisted dietary management of oxalate for kidney stone prevention [17]	2024
5	Revolutionizing healthcare delivery: The role of AI and machine learning in personalized medicine and predictive analytics [18]	2024
6	Synergizing AI and healthcare: Pioneering advances in cancer medicine for personalized treatment [19]	2024
7	AI in healthcare: Revolutionizing diagnosis and treatment through machine learning [20]	2024
8	Artificial Intelligence for Personalized Genetics and New Drug Development: Benefits and Cautions [3]	2023
9	Artificial Intelligence in Brain Tumor Imaging: A Step toward Personalized Medicine [21]	2023
10	Artificial Intelligence based Personalized Predictive Survival Among Colorectal Cancer Patients [22]	2023
11	Artificial Intelligence in Healthcare and Education [23]	2023
12	ChatGPT-4 and the Global Burden of Disease Study: Advancing Personalized Healthcare Through Artificial Intelligence in Clinical and Translational Medicine [24]	2023
13	Deep Learning in Personalized Medicine: Advancements and Applications [7]	2023
14	Generative AI in Healthcare: Advancements in Electronic Health Records, Facilitating Medical Languages, and Personalized Patient Care [8]	2023
15	Personalized Dental Medicine, Artificial Intelligence, and Their Relevance for Dentomaxillofacial Imaging [25]	2023
16	Using ChatGPT to Predict the Future of Personalized Medicine [26]	2023
17	Effectiveness of artificial intelligence for personalized medicine in neoplasms: a systematic review [14]	2022
18	Artificial Intelligence based Algorithms Used for Solving Personalized Medicine Problems in Personalized Medicine Application [9]	2022
19	Artificial Intelligence Toward Personalized Medicine [10]	2021
20	Artificial Intelligence and Hybrid Imaging: The Best Match for Personalized Medicine in Oncology [27]	2020
21	CURATE.AI: Optimizing Personalized Medicine with Artificial Intelligence [28]	2020
22	Enabling Technologies for Personalized and Precision Medicine [11]	2020
23	Use of Machine Learning and Artificial Intelligence to Drive Personalized Medicine Approaches for Spine Care [29]	2020
24	Advancing Personalized Medicine Through the Application of Whole Exome Sequencing and Big Data Analytics [2]	2019
25	Personalized Medicine and the Power of Electronic Health Records [6]	2019
26	Personalized Medicine for Patients with COPD: Where Are We? [5]	2019
27	Personalized Medicine—Concepts, Technologies, and Applications in Inflammatory Skin Diseases [30]	2019
28	Predictive AI Models for Personalized Medicine[31]	2019
29	Using Deep Learning to Model the Hierarchical Structure and Function of a Cell [4]	2019
30	Futuristic Biosensors for Cardiac Health Care: An Artificial Intelligence Approach [32]	2018
31	Pivotal Trial of an Autonomous AI-Based Diagnostic System for Detection of Diabetic Retinopathy in Primary Care Offices [33]	2018
32	Scalable and Accurate Deep Learning with Electronic Health Records [34]	2018
33	The Role of Agent Technologies in Personalized Medicine [35]	2018
34	Integrated Genomic Medicine: A Paradigm for Rare Diseases and Beyond [36]	2017
35	Predicting Effects of Noncoding Variants with Deep Learning–Based Sequence Model [37]	2015
36	E-Health Towards Ecumenical Framework for Personalized Medicine via Decision Support System [38]	2010

TABLE II. MAIN TECHNIQUES AND APPLIED PAPERS

Main Techniques	Applied Papers
Convolutional Neural Network (CNN)	[3] [26] [27] [5] [30] [4] [36] [37]
Support Vector Machines (SVM)	[21] [38]
Deep Learning Neural Networks (DNN)	[25]
Generative Pre-trained Transformer (GPT)	[8]
Bayesian Decision Analysis (BDA)	[23]
Next-Generation Sequencing (NGS)	[25]
Big Data Analytics	[22]

in the table I. The same numbering convention applies to other tables in the paper. Table II summarizes these main techniques.

Several studies [27][11][29][33] referenced the application of Artificial Neural Networks (ANNs) without providing sufficient detail regarding specific subtypes such as Convolutional Neural Networks (CNNs), Deep Neural Networks (DNNs), or Transformer-based models (e.g., GPT). To maintain clarity and avoid redundancy, these studies have been excluded from Table II, but are discussed narratively within the section as part of the broader category of ANN-based approaches.

Although our review includes 36 papers, Table II highlights those that explicitly outline specific AI techniques in the context of personalized medicine. The remaining papers also contribute valuable insights such as conceptual frameworks, application-driven approaches, or interdisciplinary perspectives are discussed narrative within the section to provide a comprehensive understanding of the field.

Artificial Neural Networks (ANNs) and Their Subtypes: Deep Neural Networks (DNNs), including Convolutional Neural Networks (CNNs) and Transformer-based Language Models, fall under the broader category of Artificial Neural Networks (ANNs). CNNs are particularly useful for medical image analysis, extracting features from Magnetic Resonance Imaging (MRI), Computed Tomography (CT), and histopathological scans to assist in diagnostics. Transformer-based models, such as Generative Pre-trained Transformers (GPT), contribute to clinical text mining and genomic sequence interpretation by processing structured and unstructured medical data.

Other Machine Learning Techniques: Beyond neural networks, algorithms such as Support Vector Machines (SVMs) aid in disease classification and treatment response prediction, while Bayesian Decision Analysis (BDA) assists in uncertainty modeling for precision medicine.

Genomic Data Processing: AI plays a significant role in analyzing data generated by sequencing technologies such as Next-Generation Sequencing (NGS) and Whole Exome Sequencing (WES). While NGS and WES are not AI techniques themselves, they produce large-scale genomic datasets that require AI-driven variant classification, pathogenicity prediction, and functional annotation. These AI applications contribute to precision medicine by improving the interpretation of genetic variants.

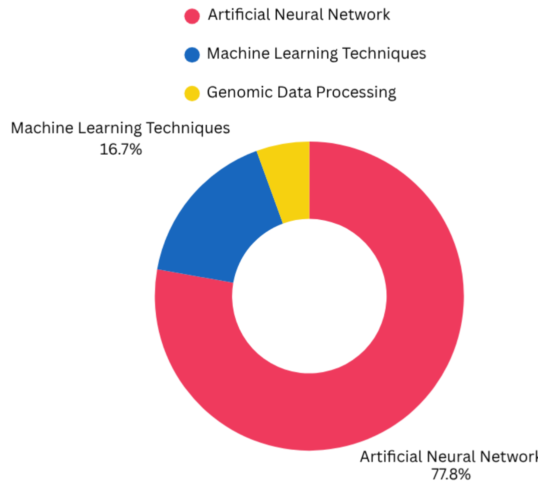

Figure 2. Main Approaches Discussed in Selected Papers.

Big Data Analytics: It was used alongside AI techniques to handle high-volume, heterogeneous datasets. These methods enabled scalable data preprocessing and integration from multiple sources such as electronic health records, genomic repositories, and wearable devices. While not an AI algorithm itself, big data analytics serves as a foundational layer that supports AI-driven personalized healthcare in large scale clinical studies.

Figure 2 summarizes the main techniques adopted in selected papers. The distribution of approaches was determined based on the frequency of each technique's use in the selected papers. As shown in Figure 2, deep learning methods dominate, reflecting a trend toward end-to-end modeling techniques in healthcare.

2) Supporting Techniques: In addition to core AI methodologies, various supporting techniques assist in data pre-processing, feature extraction, and predictive modeling in personalized medicine.

Data-Driven Approaches in Personalized Medicine: Natural Language Processing (NLP) techniques extract meaningful insights from Electronic Health Records (EHRs), clinical notes, and published literature, improving decision-making in personalized treatment plans. Machine learning-based clustering techniques and regression models enhance patient stratification for risk assessment and treatment optimization.

B. Tools

The investigation of AI applications in personalized medicine relies on a diverse array of advanced tools, each designed to enhance different aspects of data processing, analysis, and clinical decision-making. These tools are critical for leveraging large datasets to derive meaningful insights, optimize treatment plans, and improve patient outcomes. By employing various machine learning algorithms, data mining techniques, and specialized tools, researchers can tailor medical care to individual patients needs with higher precision. Table III provides an overview of the key tools used in several studies, illustrating the breadth and depth of technology integration in personalized medicine research.

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TABLE III. TOOLS USED IN THE INVESTIGATION

Tools used in the investigation	Applied Papers
ChatGPT	[29] [5]
GATK	[3] [35]
CURATE.AI	[23]
Da Vinci Surgical System	[2]
AssistDent, Diagnocat, CranioCatch (Dentist)	[6]
Sugar.IQ	[32]
Messaging applications (Facebook, Messenger, WeChat	[35]
Golden Helix VarSeq	[3]

The tools listed in the table reflect a broad scope of AI applications in personalized medicine. These range from advanced data analysis platforms to clinical robotics, each serving specialized roles. For instance, genomic analysis software like GATK and Golden Helix VarSeq enable high throughput interpretation of genetic variants, directly supporting precision medicine.

Similarly, AI-driven decision platforms such as CURATE.AI optimize drug dosing tailored to individual patient responses, while conversational AI tools, such as ChatGPT enhances data synthesis and patient interaction. The tools also include domain specific systems like the Da Vinci Surgical System provides robotic precision in surgery, and applications like Sugar.IQ leverage AI for personalized diabetes management. Even everyday platforms such as messaging applications (e.g. Facebook Messenger, WeChat) and diagnostic aids in dentistry (AssistDent, Diagnocat, CranioCatch) have been used, underscoring how AI technologies in disparate domains converge to improve patient-specific outcomes.

C. Specialty

To comprehend the application of AI in personalized medicine, it is essential to understand the medical specialties included in our surveyed papers. Identifying these specialties provides insights into how those technologies are used to help patients in various fields. We can better understand how data-driven approaches improve diagnostic accuracy and enable tailored treatments, thereby supporting clinicians in making precise, patient-specific decisions.

Therefore, the next research question we delve into is what specialties our surveyed papers focus on. Table IV shows the specialties investigated by our included studies.

The reviewed studies span a wide range of medical specialties, reflecting the wide applicability of AI in personalized medicine. Oncology emerged as the field that is the most frequently addressed, indicating a strong focus on AI for cancer diagnosis, treatment planning, and optimization of patient-specific therapy. Genomics was another dominant area, underscoring the central role of AI methods in interpreting genetic data and guiding precision medicine initiatives.

TABLE IV. SPECIALTIES DISCUSSED IN INCLUDED PAPERS

Medical Specialties	Applied Papers
Oncology	[15] [16] [17] [18] [19] [21] [22] [8] [9] [10] [27] [28] [11] [29] [6] [5] [30] [4] [33] [35]
Genomics	[15] [22] [8] [25] [26] [29] [30] [32] [33] [34] [35] [36]
Cardiology	[22] [25] [10] [28] [29] [37]
Radiology	[17] [18] [8] [10] [29] [2] [4]
Neurology	[10] [28] [2]
Dermatology	[18] [32]
Ophthalmology	[18]
Pathology	[18] [4]
Dentistry	[24]
Endocrinology	[28]
Gastroenterology	[28]
Hematology	[18]
Immunology	[32]
Nephrology	[28] [17]
Orthodontics	[24]
Orthopedics	[10]
Pharmacology	[15]
Surgery	[10]
Health Policy & Public Health	[1]
Health Informatics	[16]
Urology	[17]
Radiology	[20]

Beyond oncology and genomics, other specialties were also represented. Fields such as cardiology and radiology had moderate coverage, highlighting the use of AI in personalized cardiac risk assessment and imaging-based diagnostics. Meanwhile, specialties including neurology, dermatology, and dentistry appeared only in a few studies, suggesting an emerging interest. This distribution suggests that while AI-driven personalization is being explored in healthcare care, it is particularly concentrated in data-rich domains such as oncology and genomics, aligning with the high potential for impact in these areas.

VI. THREATS TO VALIDITY

In any research study, there are threats to the validity. These threats can impact the credibility and generalizability of the results. In this section, we discuss three main categories of threats to validity: internal threats, external threats, and construct threats.

A. Internal Threats

In the context of a systematic literature review, these threats consist of issues associated with the selection of studies, data extraction procedures, and synthesizing techniques. For instance, biases in study selection, inconsistencies in data extraction, or subjective interpretations of findings can pose significant internal threats to the validity of the research. To mitigate these threats, we followed a systematic approach based on established guidelines, ensuring thoroughness and objectivity in our review process.

In our study, another internal threat is related to the included papers. At the time our review was conducted, it was still in the middle of 2025 and, as a result, a complete list of publications for the year was not yet available. Given this limitation, it was not possible to include all relevant studies from 2025, as many papers had not been published or indexed by the time the review was finalized. Therefore, the scope of the review was restricted to studies published up to mid-2025.

B. External Threats

In the context of conducting our systematic review, external threats mainly refer to whether the findings of our review can be applied outside of specific circumstances. Because our review targets existing research, generalizability is not the main concern in our investigation. However, one potential external threat is the potential selection bias. To mitigate this threat, we adopted various resources for paper selection and followed exclusion and inclusion criteria to minimize external threats to validity.

C. Construct Threats

In our study, construct threats mainly refer to the design and execution of the review process. We deal with these issues by using rigorous validation techniques and utilizing standardized protocols.

VII. Challenges

The integration of artificial intelligence into personalized medicine is marked by numerous benefits, but also faces inherent challenges. One such limitation is the lack of a universally accepted definition of personalized medicine. This ambiguity makes it difficult to clearly delineate the scope of our review, which leads to challenges in systematically assessing AI applications across various medical domains.

In addition, when it moves toward customized treatments for individual patients and projects involving whole-genome data, particularly Whole Exome Sequencing (WES), it introduces challenges such as variant complexity and incomplete exome coverage. [2]. Although WES shows significant potential, it creates substantial data challenges that need complete analysis when dealing with complex biological data. Managing and interpreting such data remains a critical challenge.

Another challenge is the adoption of Phenotypic Personalized Medicine (PPM). PPM uses data specific to each individual to determine the best combination and doses of medicines using tools such as CURATE.AI. However, this approach faces challenges because it does not fully account for the differences between individuals and how drugs interact, which cannot be understood by analyzing the results generated from multiple trials [28]. Although PPM aims to optimize results, it faces challenges such as navigating the complex landscape of individual responses and ensuring patient safety.

These challenges underscore the need for advances in data processing, algorithmic refinement, and a deeper understanding of biological systems to exploit the potential of AI in personalized medicine. Despite these challenges, potential benefits, such as precise diagnostics, still highlight the importance of overcoming these challenges and limitations to revolutionize patient care and healthcare outcomes when AI techniques are applied in personalized medicine.

In addition, the cost of personalized medicine, including sequencing, infrastructure, and model maintenance, remains a major barrier to large-scale adoption, particularly in resource-constrained healthcare settings. Another challenge is the readiness of clinical workflows and healthcare systems to adopt AI-driven personalized approaches, which often require integration with electronic health records, clinician training, and organizational change management.

VIII. Future Directions

The future of AI in personalized medicine is closely related to the challenges discussed in our review. Future research efforts must focus on refining AI-based analytics, with a particular focus on improving data handling, storage infrastructure, and algorithmic sophistication to make personalized medicine datasets easier to interpret and more efficient.

Moreover, developing comprehensive ethical frameworks and regulatory paradigms is essential to ensure responsible use of AI in healthcare. These frameworks must address critical issues such as data privacy, fairness, and accountability, aligning with ethical and legal standards. Future research should also explore these barriers while fostering interdisciplinary collaboration among researchers, clinicians, ethicists, and regulators. Such efforts will enhance the equity, effectiveness, and reliability of AI applications in personalized medicine.

IX. Conclusion

Personalized medicine aims to tailor prevention, diagnosis, and treatment to patients' genetic, environmental, and lifestyle characteristics. The integration of AI methods—including machine learning, natural language processing, and deep learning—enables analysis of large, heterogeneous clinical datasets to support risk stratification, treatment-response prediction, and optimization of therapeutic strategies, thereby improving the precision and effectiveness of care.

This systematic literature review synthesizes evidence on the techniques, tools, and clinical specialties that shape current AI-enabled personalized medicine. Key priorities for future research and deployment include strengthening data privacy protections, mitigating algorithmic bias, ensuring regulatory compliance, and promoting equitable access, all of which are essential for responsible and scalable clinical adoption. Collectively, our findings highlight the transformative potential of AI to advance individualized healthcare and inform both methodological development and practice-oriented implementation.

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