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Research Article

A Scientometric Review of Medical Artificial Intelligence Research: From A Social Science Perspective

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Abstract

Objective: Along with the increasingly rapid development of digital technology and economy, medical treatment has been enhanced by artificial intelligence (AI). Studies have explored many topics in the field of medical AI. However, there is a lack of a systematic review of the overall research area of medical AI. In a visual way, this study uses quantitative analysis to systematically review the entire field and explore the current status and trends of medical AI research.

Methods: This paper retrieves 692 papers on medical AI from Social Sciences Citation Index core database of the Web of Science from 2013 to 2023. Three bibliometric and network analysis tools, including CiteSpace, HistCite and Pajek, are used to identify the time-and-space knowledge map, research hotspots, emerging trends and primary path of medical AI research.

Results: A co-word network of medical AI research reveals that the field focuses more on the topics of health care and cancer. The analysis of the burst literature indicates the research trends in the sub-sections such as medical ethics, neural network and precision medicine. The analysis of the main path draws the evolution track.

Conclusion: The results of bibliometric analysis illustrate the current situation, past evolution and future trends of medical AI research, and identify hotspots and future research directions.

Keywords: medical treatment, AI, CiteSpace, HistCite, Pajek

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1 INTRODUCTION

With the increasingly rapid development of digital economy, medical treatment has been enhanced by new digital technologies such as artificial intelligence (AI). Medical AI refers to the application of AI technology in the area of medical treatment. The significance of medical AI has been increasingly emphasized, to meet the continuous changes of patient needs. Overall, AI empowers medical

care to alleviate the shortage and imbalance of medical and health resources, by improving the efficiency of clinical diagnosis and the quality of medical treatment[1-3]. Medical AI primarily encompasses various subfields such as medical imaging, clinical decision support, precision medicine, health management, healthcare informatics, drug development, telehealth and medical robotics[4]. The core objectives of medical AI include reducing costs, increasing efficiency, improving diagnostic and treatment standards, enhancing patient experiences, and reducing the risk of illness. AI empowers all stages of healthcare, including pre-hospital, in-hospital and post-hospital care. Medical institutions, scientific research institutes and enterprises jointly tackle the problem, hoping to learn from the successful experience of AI within translation, finance and security to achieve major changes in the medical field[1]. For instance, deep learning is an emerging trend in multidiscipline management research[5]. The intervention of AI induces the applications of deep learning, intelligent machines, big data and other digital technologies in the medical field. The deep integration of precision medicine and AI connects doctors, patients, medical apparatus, other medical stakeholders and media. Technological innovation, combined with institutional transformation, promotes the innovation research and development of medical AI.

Preventing and combating the COVID-19 underscores the original purpose of developing medical AI, that is, to help doctors rescue from repeat births and address the lack of high-quality medical resources. However, medical behavior *per se* is highly complex, uncertain and risky. Accordingly, scientific and technological risks and medical needs will promote innovative changes in the policy ethics of AI regulation in terms of body, value, operation and implementation. Particularly, there is an urgent need for the standardization and intelligence in medical big data.

Given that medical AI is an important issue related to all mankind and society, researchers have shown strong interest in this field. The existing research involves topics such as infectious diseases[6], nursing[7], hospital management[8], patients' trust in medical AI[9], and patients' acceptance of medical AI[10]. Obviously, medical AI is a broad and complex research field, and has led to the fragmentation of various studies to a certain extent. Therefore, it is necessary to conduct a general and systematic review of medical AI research to fully understand the development of medical AI research.

Recently, conducting literature review requires for more systematic procedure and analytical frameworks[11,12]. A common problem in existing articles is that they use qualitative analysis methods to conduct reviews, which tend to make the results subjective. This paper uses quantitative analysis methods to avoid this problem. Bibliometric and scientometric analysis is a quantitative statistical tool of indicating and monitoring research origins, pathways and trends, and recently and widely employed in various research areas of medical treatment[13-15]. Thus, this study uses quantitative analysis as the research method of this paper, so as to make the research results more comprehensive and objective. Nevertheless, there is a dearth of a synthesis and an overview of the research distribution, the historical background, and the research hotspots and the future directions of medical AI research. As a result, it is critical to identify and define the current status of the entire medical AI research in order to offer a research foundation. This study conducted a systematically bibliometric analysis of medical AI research, by using CiteSpace, HistCite and Pajek software and basing on 692 articles of medical AI published from 2013 to 2023.

2 LITERATURE REVIEW

AI is increasingly used in various fields of science and technology. According to current research, more and more AI technologies are being used in medical treatment[16]. However, Gaczek et al.[9] find that consumers remain skeptical of the ability of AI to accurately evaluate their health status, and have reluctance to use health recommendations generated by AI. In addition, the AI applications in the area of radiology has attracted more social media attention and reports, and better informed and shaped public opinion about the role and impacts of AI in radiology[17]. AI technology indeed helps health care professionals, provides more care for a larger number of patients, makes better clinical decisions, and reduces unnecessary hospitalization and health care costs[18]. Gosak et al.[19] investigate the effectiveness of AI within predicting complications associated with multimorbid diabetes mellitus through bibliometric studies. Mihevc et al.[20] find that AI can be integrated into the platform to optimize the cost structure of remote monitoring of AH and T2D older adults in primary care. The ChatGPT tool is demonstrated as a somehow reliable information source for Spanish patients suffering chronic diseases, however, the readability of the information needs to be improved to enhance the usefulness for patients[21]. Lin et al.[22] perform a systematic review of the impacts of technology in the area of speech-language pathology. Digital assistance systems based on AI in medical treatment (e.g., chatbots) play an increasingly essential role in the interaction and communication between doctors and patients in the future[23].

Studies have explored many topics of medical AI. Bitkina et al.[16] identify the current state of medical AI, based on the studies reporting evidence-based guideline. Graili et al.[24] systematically discuss AI in outcomes research, cover the scope of AI techniques used in outcomes research to expend the knowledge of decision-makers. Gosak et al.[19] investigate the effectiveness of AI in predicting complications caused by multimorbid diabetes-related using bibliometrics. Few studies systematically and scientometrically review the overall picture of medical AI.

With the deepening and expansion of medical AI research, many theoretical and empirical results are obtained. In terms of research content, in recent years, there have been many studies on a certain field of medical AI, such as the trend of electronic health development[25], the health information services for the elderly in libraries[26], the important position and distribution of AI technology in medical information[16], the patent metric in medical AI[27], and the reasons for the trust and the reluctance to use medical AI[9]. With regard to research methods, qualitative and quantitative research methods are divided, and most studies adopt qualitative research methods. In the quantitative studies, the web of science (WOS) database is analyzed by using advanced analysis tools[28], e.g., CiteSpace software, HistCite software, Pajek software, etc. Accordingly, this paper attempts to analyze and discuss the relevant problems of medical AI research based on WOS publication data (2013-2023) and using CiteSpace, HistCite, and Pajek bibliometric and scientometric tools.

3 METHODS

3.1 Research Instrument

In this study, three most widely used bibliometric software, i.e., CiteSpace, HistCite, and Pajek, are identified and employed as knowledge map analysis tools for medical AI research. The application of bibliometric review through a variety of methods can provide more valuable insights into the topic[29].

CiteSpace refers to an information visualization tool that is widely used in the field of information graphics[30]. In order to represent and analyze the information context of an area, visualization tools are used to propose the development history and structural links of the specific area. This study uses CiteSpace 5.7.R5 to obtain visualization that convey information about medical AI topic while also highlighting the domain's research boundaries and the knowledge base in important data.

HistCite, i.e., history of cite. is a citation map analyzing software, to visualize the citation links between numerous papers in a specific subject, identify notable documents in the field, and learn about the history of document development.

As the most widely used measurement method and a large-scale complex network analysis instrument, Pajek relies on the Search Path Count (SPC) value to assess the node network link connectivity in the literature[31]. The main path analysis of Pajek is different from established methods such as the general analysis of citation. Pajek concentrates on the relationship of the network nodes rather than the nodes *per se*. HistCite exports and converts documents for the analysis of main path in Pajek. Table 1 presents the functional descriptions of tools used in this study.

Table 1. The Functional Descriptions of Used Tools

Tools	Used Functions in This Study
CiteSpace	Core authors and academic journals analysis, and co-word networks analysis, and burst keywords analysis
HistCite	Literatures citation analysis
Pajek	Main path analysis of medical

3.2 Data Collection

The bibliometric analysis relies on literature databases. WOS is regarded in academia as a highly renowned and prominent journal collection, with a core database containing over 10,000 well-known scientific journals from more than 10,000 area. As a result, the data source of this study is the Social Sciences Citation Index core databases of the WOS main database. As the database updates day by day, this context seeks access to literature retrieval from WOS on one day to avoid bias (i.e., April 12, 2024). The search strategy includes the topic "medical artificial intelligence", and limits to the literature type "Article".

Training notices, news reports, duplicate publications and other documents have been excluded. Incomplete or unpublished literature, such as conference abstracts and conference papers, was then excluded based on WOS's classification labels. And by manually checking the results of the title and abstract retrieval to remove duplicate and irrelevant files.

Articles published from 2013 to 2023 were retrieved. Finally, a total of 692 publications were obtained. All bibliographic information of the publications is recorded for further processing data and the specific analyses.

3.3 Data Analysis

CiteSpace is used for the analysis of academic journals and core authors (Section 4.1), co-word networks (Section 4.2), and burst literature (Section 4.3). Besides, both HistCite and Pajek are used for main path analysis (Section 4.4).

4 RESULTS

4.1 Analysis of the Amount of Publications

To some degree, the time distribution of disciplinary publications can reflect the development trend and theoretical level of academic research in this field. As shown in Figure 1, during the period of 2019-2023, the annual amount of medical AI-related research exceeds 40 articles, indicating that the field of medical AI has attracted much attention since 2018. During the period of 2017-2023, the annual amount of articles is explosive, and the attention continues to rise. In 2021, it reaches a peak, and the annual amount of articles reaches as high as 190, and the researchers push the medical AI-related research to

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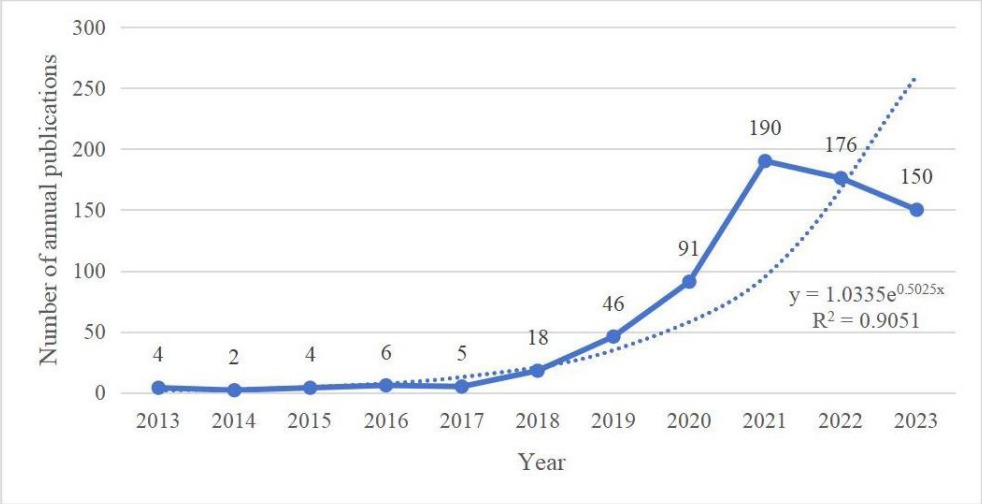

Figure 1. The number of medical AI research publications.

a new height, and the research achievements are more remarkable. In contrast, the number of articles in 2022 and 2023 dropped slightly. On the one hand, the COVID-19 has brought more enthusiasm for research, making the number in the 2020-2022 significantly higher than the trendline. On the other hand, medical AI-related research has gradually become refined and focus on specific areas of medical AI[6,10].

By plotting the trendline of the index, the R-squared value (R^2=0.6741) and the trendline formula ($Y=1.0335e^{0.5025x}$) are used. The R-squared value is close to 1, which indicates that the trendline has a high degree of congruence and the reliability of the trendline is also high. The prediction derives from this is that in the next few years, medical AI research will remain in a constant state of flux, and research in this field will continue to grow at a high rate.

4.2 Analysis of Academic Journals and Core Authors

4.2.1 Analysis of Academic Journal

Relevant literature data are transferred to the CiteSpace software to obtain the academic journal map of the core journals of medical AI research, as shown in Figure 2. The color and thickness of the circle in the graph represent the time and the frequency of citation in the specific year. Each node represents the journal. the size of the citation shows the journal's citation frequency. The thicker the reference before the node, the greater the co-citation between journals.

The journals with high citation frequency of medical AI are "Jama-Journal of the American Medical Association" (223 citations), "Journal of International Medical Research" (204 citations), "Jama-Journal of the American Medical Association" (191 citations), "Plos One" (183 citation), "The New England Journal of Medicine" (176 citations), "Nature Medicine" (171 citations), "Nature" (160 citations), "NPJ Digital Medicine" (154 citations), "BMJ-British Medical Journal" (142 citations), "Science" (135 citations), "International Journal of Medical Informatics" (123 citations), and "Lancet" (117 citations). Respectively, these are journals in the field of medical disciplines, which are significant sources of medical AI research and play a critical supportive role in this research sector.

With regard to the field distribution of academic journals, the core journals of medical AI are mainly distributed in the subject field of medicine, and also involve the field of information technology. Notably, the medical AI research has begun to set foot in the realms of law and ethics[32]. Because the development of intelligent medical robot technology has also caused a series of ethical concerns. If the ethical issues of robots are not faced, this will undermine the society's confidence in medical AI, and even hinder the development and progress of medical science and technology. At the same time, the risks of the application of medical algorithms are also gradually emerging[33]. For instance, the "Wei Zexi Incident" mistrusted the medical institutions promoted by algorithms, the "Gene Edited Baby Incident" abused algorithm technology to partially alter human genes, and other tragic events caused social chaos and reduced the public's trust in medical AI. Therefore, it is urgent to reflect on the ethical and legal issues caused by smart healthcare and find solutions to solve them.

4.2.2 Analysis of Core Authors

Figure 3 presents the core authors map related to medical AI research. The author with the highest citation (i.e., 76 times cited) is Eric Jeffrey Topol, as a key researcher of medical AI. His scientific focus is on the use of genomic and digital data, along with AI, to individualize medicine. He is also a practicing cardiologist. Others, such as Andre Esteva, His studies are mostly focused on medical diagnostics using AI and precision medicine. His publications have appeared on the covers of the journals Nature and Nature Medicine, and have appeared in Cell, The Lancet, Conference and Workshop on Neural Information Processing Systems,

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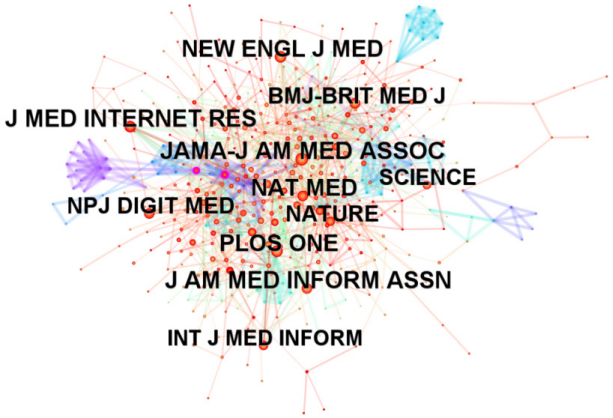

Figure 2. Academic journals map of medical AI research (CiteSpace).

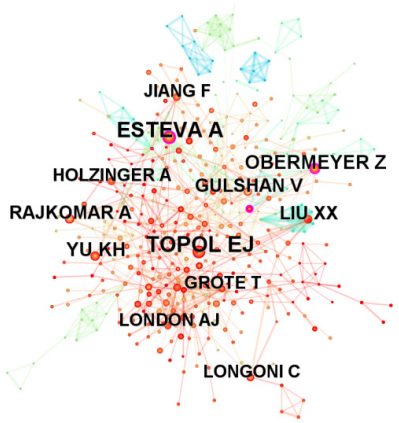

Figure 3. Core authors map related to medical AI research (CiteSpace).

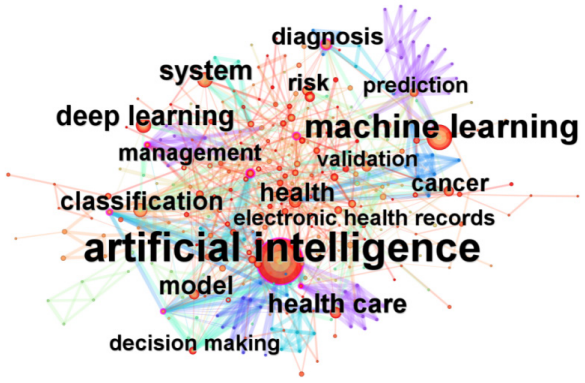

Figure 4. The co-word network of medical AI research (CiteSpace).

among others. His most famous book, "Dermatologist-level Classification of Skin Cancer with Deep Neural Networks", has been cited a total of 6,044 times. Ziad Obermeyer has the highest centrality, with more than 20 publications in machine learning, medicine and other fields. Over the past decade, many authors have delved into topics related to medical AI, and they have been extremely instrumental in advancing medical AI research. They are more interested in the application of medical AI in clinical care, medicine and biological genes.

4.3 Analysis of Co-word Networks

The keywords in the domestic data are analyzed, the Node Type is set to Keyword, the threshold is set to T50, and the rest is defaulted, and the obtained knowledge graph of medical AI research hotspots is shown in Figure 4. Keyword frequency analysis is used to clarify the research trends related to medical AI. After all, keywords stand for hot research topics, and burst word stands for a new frontier of research. A large node indicates a high keyword hit rate. As can be seen from Figure 4, research hotspots include "artificial intelligence", "machine learning", "deep learning", "big data", "system", "health care", "classification", "technology", "model", and "cancer". The respective citations of these keywords are relatively high with frequencies over 30 times as CiteSpace's results shows.

It is not difficult to see from Figure 4 that the research objects of the past decade have mostly concentrated on the AI technology application in health care and cancer. At present, the application of medical AI has broad prospects and is a direction for future medical development. The application of AI in medical treatment follows its development in general. The research topics include the low price of healthcare[34], the resistance of consumers to medical AI[35], and the prediction of the results of machine learning in clinical diagnosis[36]. In-depth and long-term research is need in these areas to drive the development of medical AI research. Therefore, a certain vacancy still exists in the studies on the application of medical AI, that needs to be further explored by researchers.

Through the cluster analysis based on keyword co-occurrence graph, the research trends and hot issues in this field can be effectively revealed, so as to have a deeper understanding of the research trend and frontier direction. CiteSpace is accepted to create a network in normal mode of 2013-2023. Slice length is 1 year. Node Select the node type is Keyword. The nodes are revised based on a given keyword match. The Log-likelihood algorithm is applied to compute the clusters, then obtained the Figure 5. The Modularity Q score is 0.6156. The Mean Silhouette score is 0.8179 (N=401, E=1207, density =0.015). Clustering results mainly locate in "gis-assisted landscape epidemiology approach", "precision medicine informatics", "quiet nicu", "subjective rating", "digital health education", "sharing knowledge", "artificial intelligence perspective", "prospective physician", "public health", "web-based intelligent tutoring system", etc.

4.4 Analysis of Burst Literature

4.4.1 Analysis of Burst Keywords

"Burst words" refer to words that are regularly quoted over an extend period. In this context, the research limit is estimated using the keywords within the strongest

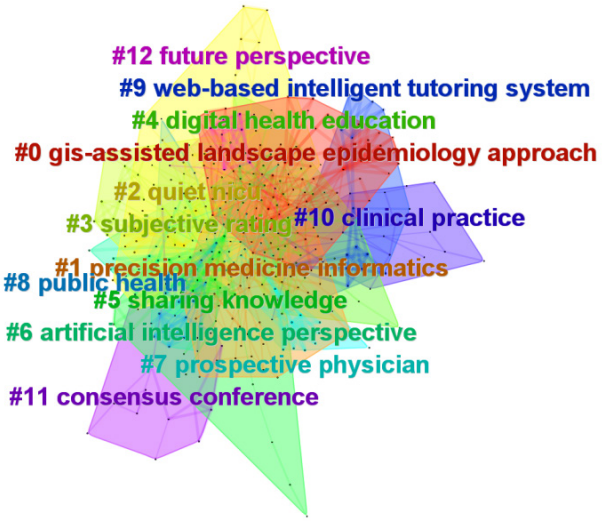

Figure 5. Hot topics of the co-word network of medical AI research (CiteSpace).

citation burst. Table 2 shows the top 15 terms within the most citation burst emerging from 2013 to 2023. Red bars indicate that the specific keyword is quoted frequently. Green bars indicate that the specific keyword is rarely put in quotation marks. Medical ethics and ethics may be mentioned frequently in the coming years, reflecting new trends. In addition, emerging trends may also include COVID-19, machine, neural network and precision medicine.

4.4.2 Analysis of Thematic and Emerging Trends

Citespace is used to count keywords, and the parameter settings are the same as before. Selecting Timeline as the view display type gives Figure 6. It can be seen from Figure 6 that, in 2013 or earlier, the research on medical AI is a lot already and the keywords of that period are concentrated on "artificial intelligence", "management", "health care" and "clinical decision support". Since 2019, research on medical AI has become more diverse, including "system", "digital health", "deep learning", "primary care", "precision medicine", "medical student" and "healthcare organizations", and accounts for large proportions. The evolutions have three main directions. The first one is the support technique for AI, like "system", "information technology" and "machine learning". The second is medical treatment, like "diagnosis", "personal medicine" and "COVID-19". The third one is reasonableness, like "ethics", "regulation" and "trust". This indicates that the medical AI was developing from a disease-centered model towards a patient-centered model.

Analyzing the research frontiers, it is found that recently, medical AI research has begun to involve research in the field of law and ethics[32], and there are also many research and analysis on the advancement of AI technology[37], human resource management of medical AI and its application[8]. In addition, the research also covers patient privacy issues[38], medical AI management issues[39], etc. Medical AI relieves the labor pressure of doctors, facilitates doctors and patients, and reduces the cost of living. The consequent management risks, legal risks, and ethical risks are the general trend and will also be the research concerns.

4.5 Main Path Analysis

Citation analysis is to analyze the process of knowledge flow, and benefits the generation, dissemination, inheritance and diffusion of knowledge. Citation analysis can be divided into citation analysis and document co-citation analysis. "Citation" is the dissemination and inheritance of the research results of predecessors, and it is also the basis for academic research. In this paper, the data processed by CiteSpace is imported into the HistCite software, and the first 60 digits are used to draw a citation chronology chart in local citations (LCS) order (Figure 7). Each node in the illustration represents a document with a high citation rate. The larger node means the greater citation frequency, The arrows between the nodes indicate the citation path of document. The citation chronology chart can visually show the communication of research results and important research results.

Figure 7 shows that the top 10 mostly cited documents are numbered 34, 77, 38, 91, 41, 8, 92, 230, 126 and 219. These studies are the classic literature and knowledge base of the medical AI (Table 3).

In a cyclic network diagram, the main path is a path made up of edges with the highest traversal weight from source to sink. There are scholars proposed a calculation method for the main path[40]. Firstly, all the paths from the source point to the sink point are identified from the network diagram, and the number of paths containing specific edges is indicated. Then, divided the number of paths on an edge by the total amount of paths from the source point to the sink point, the result value is called the traversal weight of the edge. Finally, the path with the largest sum of traversal weights from the source point to the sink point is extracted, that is, the main path. Here, the above citation chronology is imported into the Pajek software, and the path counting method (SPC) is adopted to calculate the key pathway of the citation chronology chart, as illustrated in Figure 8.

The main path of medical AI research consists of 8 articles, numbered 77, 1, 103, 223, 248, 286, 354 and 541 (Table 4). These 8 documents are not among the top 5 mostly cited documents, but form the central structure of the citation chronology chart, and are essential in the flow and dissemination of information.

At the rapid development stage of medical AI, Longoni et al.[35] summarized the previous medical AI research and studied the reasons why consumers are reluctant to adopt medical AI in real and hypothetical choices, and

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Table 2. Burst Literatures (top 15) and Research Hotspots of Medical AI (CiteSpace)

Keywords	Year	Begin	End	2013-2023
decision support	2014	2014	2018	
information	2015	2015	2019	
data mining	2016	2016	2018	
medical informatics	2016	2016	2020	
electronic health records	2017	2017	2019	
classification	2017	2017	2020	
big data	2018	2018	2018	
internet	2020	2020	2021	
precision medicine	2020	2020	2021	
neural network	2021	2021	2021	
medical AI	2022	2022	2023	
machine	2020	2022	2023	
COVID-19	2022	2022	2023	
medical ethics	2021	2022	2023	
ethics	2021	2022	2023	

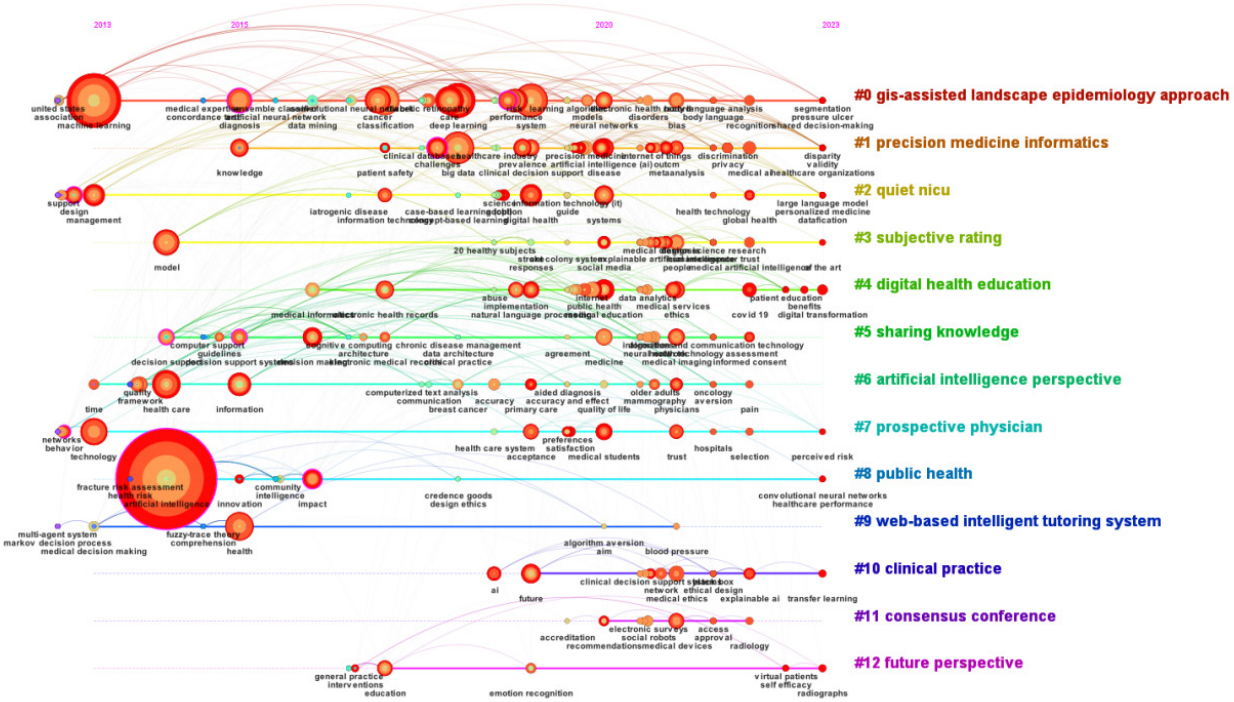

Figure 6. Co-citation map of literatures based on timeline of medical AI research (CiteSpace).

in individual and combined evaluations, and laid a solid foundation for follow-up research on medical AI in the past decade. The study of Longoni et al.[35] contributes to the automation and the psychology of medical decision-making, and plays a crucial supporting role in subsequent medical AI research. Afterwards, Cadario et al.[41] experimentally designed an intervention that promotes consumers' willingness to accept medical AI. Yokoi et al.[42] found that consumers' trust in medical AI is not as good as that of doctors, even if AI performs at the level of doctors. Yun et al.[43] studied the invisible psychological mechanism of consumers' interaction with medical AI and doctors on the basis of evolutionary theory, six classic texts including these articles all cited the conclusions of Longoni et al.[35]. These findings are of great significance to the field of human interaction and of medical decision-making, and show that the replacement of medical AI on doctors is still an impractical issue.

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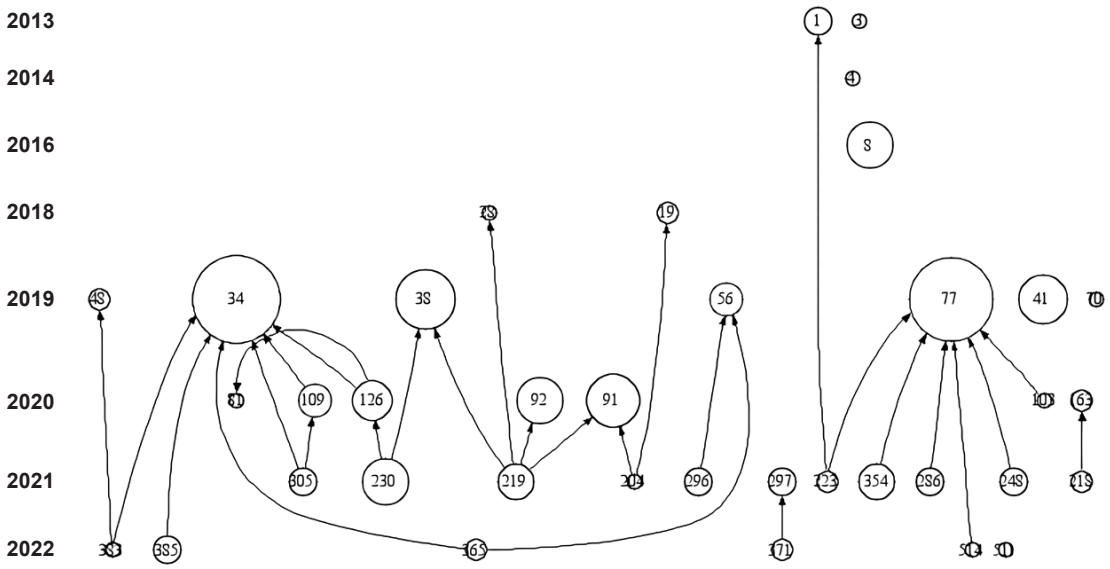

Figure 7. The literatures citation of medical AI (HistCite).

Table 3. Statistics of Citation Frequency of Literature (Top 10) (HistCite)

Number	First Author	Time	Title	LCS
34	London AJ	2019	Artificial Intelligence and Black-Box Medical Decisions: Accuracy Versus Explainability	27
77	Longoni C	2019	Resistance to Medical Artificial Intelligence	25
38	McDougall RJ	2019	Computer Knows Best? The Need for Value-Flexibility in Medical AI	13
91	Reddy S	2020	A Governance Model for the Application of AI in Health Care	10
41	Gong B	2019	Influence of Artificial Intelligence on Canadian Medical Students' Preference for Radiology Specialty: A National Survey Study	9
8	Hengstler M	2016	Applied Artificial Intelligence and Trust-The Case of Autonomous Vehicles and Medical Assistance Devices	8
92	Ploug T	2020	The Right to Refuse Diagnostics and Treatment Planning by Artificial Intelligence	8
230	Durán JM	2021	Who is Afraid of Black Box Algorithms? On the Epistemological and Ethical Basis of Trust in Medical AI	8
126	Hatherley JJ	2020	Limits of Trust in Medical AI	6
219	Quinn TP	2021	Trust and Medical AI: the Challenges We Face and the Expertise Needed to Overcome Them	5

5 DISCUSSION

5.1 Findings

This research retrieves the core database of the WOS based on the search formula and retrieved data of 692 literature of medical AI research from 2013 to 2023. In this study, the amount of publications, core academic journals and authors, co-word networks, burst literature and main path analysis of literature related to medical AI research are studied and discussed through the common review and analysis tools CiteSpace, HistCite and Pajek. The main results are as follows.

(1) Through statistical analysis of the amount of publications, papers on medical AI research increases generally. In recent years, medical AI has been a research hotspot, and is assumed to continue gaining popularity. By plotting the R-squared value of the index, it can be predicted that medical AI research will remain in a constant state of flux in the coming years, and research in this field will continue to grow at a high rate.

(2) Through statistical analysis of academic journals, the core journals of medical AI are mainly distributed in the subject field of medicine, and will also involve the area of information technology. Medical AI research notably has begun to set foot in the fields of law and ethics[32], At the same time, the risks of the application of medical algorithms are also gradually emerging[33].

(3) Through statistical analysis of core authors. many authors have studied medical AI-related issues, and advanced the development of medical AI research. They are more interested in the application of medical AI in clinical care[44], medicine[1] and biological genes[45].

(4) Through the statistical analysis of keywords and research frontiers based on high-frequency keyword analysis,

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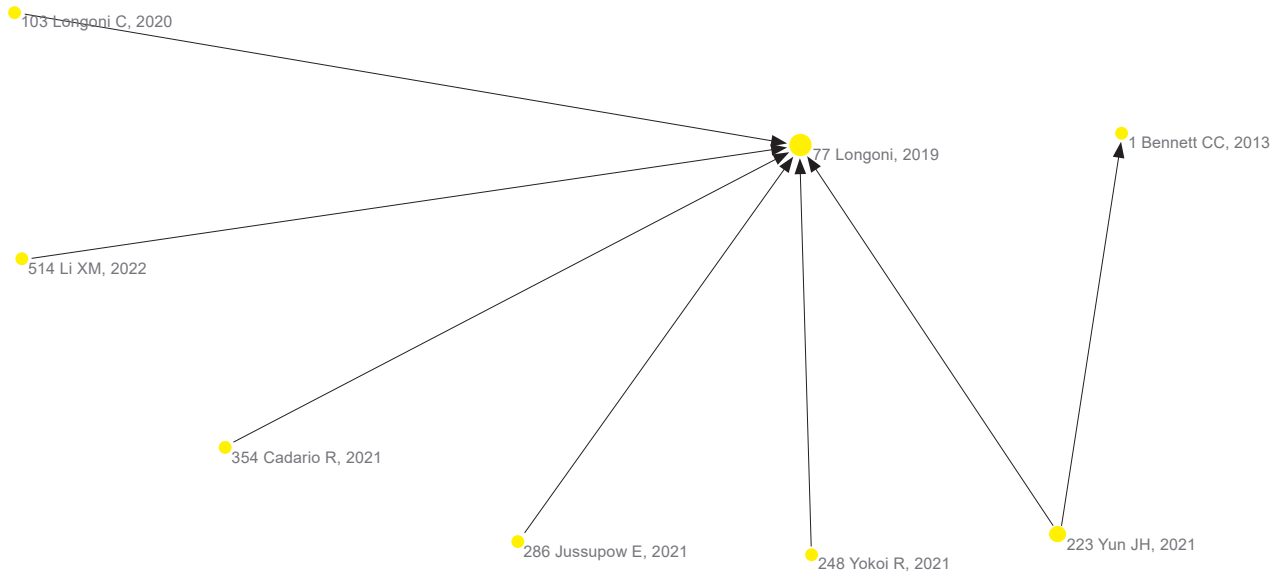

Figure 8. The main path of medical AI (Pajek).

Table 4. Classic Literature on the Main Path (HistCite)

Number	First Author	Time	Title	LCS
77	Longoni C	2019	Resistance to Medical Artificial Intelligence	25
1	Bennett CC	2013	Artificial Intelligence Framework for Simulating Clinical Decision-Making: A Markov Decision Process Approach	3
103	Longoni C	2020	Resistance to Medical Artificial Intelligence Is an Attribute In a Compensatory Decision Process: Response to Pezzo and Beckstead (2020)	1
223	Yun JH	2021	Behavioral and Neural Evidence on Consumer Responses to Human Doctors and Medical Artificial Intelligence	2
248	Yokoi R	2021	Artificial Intelligence is Trusted Less than a Doctor in Medical Treatment Decisions: Influence of Perceived Care and Value Similarity	3
286	Jussupow E	2021	Augmenting Medical Diagnosis Decisions? An Investigation into Physicians' Decision-Making Process with Artificial Intelligence	3
354	Cadario R	2021	Understanding, Explaining, and Utilizing Medical Artificial Intelligence	5
514	Li XM	2022	Leaders' Innovation Expectation and Nurses' Innovation Behaviour in Conjunction with Artificial Intelligence: the Chain Mediation of Job Control and Creative Self-Efficacy	1

the research objects in the past decade have mainly focused on the usage of AI technology in health care[9] and cancer[10]. Through analyzing research frontiers, emerging trends include medical ethics[32], COVID-19[46], machine[36], neural network[47] and precision medicine[48]. Analyzing the thematic and emerging trends, it is found that in recent years, the research of medical AI has begun to involve research in the field of law and ethics[32]. In addition, the research also covers issues of patient privacy[38] and medical AI management[39].

(5) The main path analysis of the medical AI research shows some important studies, including Cadario et al.[41], Yokoi et al.[42], and Yun et al.[43] These studies commonly refer to the study of Longoni et al[35]. Longoni et al.[35] play a crucial supporting role for the subsequent research on medical AI, by discussing the reasons why consumers are reluctant to use medical AI.

5.2 Implications

From a theoretical perspective, the research area of this paper covers the entire medical AI. Previous research of medical AI has focused on specific subfields and themes. Sood et al.[6] discuss information and communication technologies for infectious diseases. Xue et al.[49] explore the research hotspots and research frontiers of rehabilitation robots, and proposed effective strategies for the development of rehabilitation robots. Nevertheless, this study enriches the systematic and scientometric review of the entire field of medical AI[50], through a comprehensive and systematic overview with overall aspects of the entire research field. The results provide a more intuitive overall perspective of medical AI for the whole society and the academia, and help understand and refer to research trends and gaps. In addition, this paper uses quantitative approach, instead of

qualitative methods that are prone to subjective assumptions. Scientometrically, by analyzing WOS data and using CiteSpace software, HistCite software, and Pajek software to discuss the relevant issues of medical AI research. Quantitative research has the advantage of a wide range of investigations, and is easy to summarize in the literature review[51]. The results of quantitative research results are more objective and accurate, compared with those of qualitative research. This method makes this study easier and more clearly to be understood, and grasps the evolution trajectory and research frontiers of medical AI.

From a realistic perspective, this study introduces the research results of medical AI in the past decade and expounds the latest progress in this research, so that more people can have a comprehensive understanding of medical AI and promote the development of medical AI. In addition, our findings may help to develop strategies to promote the development of medical AI technology and optimize the application of medical and AI convergence, and help promote the rapid development of this field.

5.3 Limitations and Directions of Research

Although the reviews of medical AI research in the past decade are more targeted, and can usually provide evidence reference for scholars in the field, it is difficult to confirm whether these conclusions are general due to the limited sample size. Based on 692 literatures, this paper systematically reviews and summarizes the progress and historical context of existing medical AI research, and proposes potential future research directions. The relevant conclusions will help scholars in related fields to grasp the research progress, locate research interests, and bring inspiration for future research work. Medical AI research is still in the ascending stage. Along with the development of medical AI research, future research should include as much literature as possible and carry out a richer and more comprehensive review.

At present, some achievements have been made in the area of medical AI research, but the field is still in the growth stage, and there are still weaknesses that need to be further explored. In view of the above research results, this paper argues that future research can further promote the development of medical AI research from the research gap areas such as law, ethics and social phenomena, and learn from international and overseas research.

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Conflicts of Interest

The authors declared no conflict of interest.

Authors Contribution

Liu Y was responsible for conceptualizing the study, curating data, formal analysis, writing-original draft and editing. Mu Y was responsible for conceptualizing the study, supervising the project, writing-review and editing.

Abbreviation List

AI, Artificial intelligence
LCS, Local citations
SPC, Search Path Count
WOS, Web of science

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