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Knowledge Mapping of Medical AI Ethics: A Cross-country Comparative Analysis

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Abstract

The widespread application of artificial intelligence(AI) technology in medicine has brought unprecedented opportunities for healthcare service and health management. However, ethical issues such as data privacy, fairness, transparency, and algorithmic bias have become more prominent, which attract attention of both the academia and the public. This study systematically analyzes the current status, hotspots, and trends of medical AI ethics research through a combination of bibliometrics and knowledge mapping analysis, while comparing Chinese and international research. The findings show that research in medical AI ethics has been increasing annually, with academic research networks gradually forming, although Chinese research lags behind English-language research in both quantity and growth rate. Chinese and international research share similar network structure characteristics, but neither has formed a close-knit academic community yet. In terms of research characteristics, international research is led by interdisciplinary departments, showing significant cross-disciplinary collaboration, while Chinese research is primarily conducted by medical schools and their affiliated hospitals, with more

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emphasis on inter-departmental collaboration within institutions. Although both focus on core issues such as privacy protection and data security, international research emphasizes the integration of technology and ethics, while Chinese research focuses more on developing localized ethical theoretical frameworks. The research results provide important references for promoting the development of medical AI ethics research.

Keywords

medical artificial intelligence, medical ethics, knowledge mapping, ethical governance

Introduction

In recent years, the deep application of artificial intelligence technology in the medical field is reshaping the modern healthcare service system. In areas such as clinical diagnosis, personalized treatment, and disease prediction, medical AI technology significantly enhances healthcare efficiency and diagnostic accuracy by efficiently processing massive medical data and optimizing clinical decision-making processes, strongly promoting the development of precision medicine. Especially during the COVID-19 pandemic, medical AI assisted diagnosis systems played an irreplaceable role in pandemic control and remote healthcare, fully demonstrating the practical value of medical AI.

However, with the rapid advancement of technology, ethical issues in the application of medical AI have become increasingly prominent, attracting widespread attention from academia, the legal profession, and society(Tang et al., 2023). These ethical challenges are mainly reflected in multiple dimensions such as data quality, algorithmic bias, system transparency, security, and accountability(Zhang et al., 2023). Global surveys show that the primary concerns regarding AI ethical issues include: technology misuse (49%), privacy risks (45%), lack of transparency (35%), ethical impact (30%), and bias and discrimination (24%)(Maslej N et al., 2023). In the Chinese context, the key ethical issues scholars focus on center on core problems such as Privacy, Equality, Responsibility, Transparency and Security(Maslej N et al., 2023). These ethical issues not only affect the fundamental rights of patients but also relate to the future development direction of medical AI.

To address these challenges, the international community has reached a broad consensus regarding the need to the strengthen AI ethical governance. UNESCO’s 2021 publicatin, "Recommendation on the Ethics of Artificial Intelligence"established a fundational values and principle framework for AI ethical(United Nations Educational, 2023). The same year, the World Health Organization(WHO) issued the guideline"Ethics and Governance of Artificial Intelligence for Health" which emphasized integrating ethical principles throughout the entire lifecycle of medical AI from design and deployment to use and and proposed six core governance principles(Reis A et al., 2021). In 2024, the WHO further extended this effort by releasing specific ethical guidelines for multimodal large models(WHO, 2024) and for AI applications in drug

research and development(WHO, 2024). These documents systematically elaborate on methods for risk prevention, control, and governance in their respective fields(Yue Wang et al., 2024).

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At the national level, as of 2023, 128 countries globally have introduced legislation pertaining to AI, with 32 countries having enacted at least one specialized AI bill(Maslej N et al., 2023). China has also placed significant emphasis on the ethical governance of AI, including medical AI. In September 2021, the National Governance Committee for the New Generation Artificial Intelligence released the "Ethical Norms for the New Generation Artificial Intelligence," which requires integrating ethics into the entire AI lifecycle and proposes 18 specific ethical requirements. In March 2022, the General Office of the CPC Central Committee and the General Office of the State Council issued the "Opinions on Strengthening the Governance of Science and Technology Ethics," specifying governance requirements for AI, including in the medical field. In February 2024, to promote standardized research in areas such as brain-computer interfaces, the AI Ethics Subcommittee of the National Science and Technology Ethics Committee researched and compiled the "Ethical Guidelines for Brain-Computer Interface Research" for reference by relevant research institutions and researchers.

The ethical governance of artificial intelligence (AI), particularly in medicine, is a matter of profound global importance. While academic interest and the volume of related literature are growing rapidly, a comprehensive and systematic review of the research landscape—specifically regarding the composition of researchers, institutional distribution, research hotspots, and developmental trends—is notably absent. To address this gap, this study employs bibliometric methods to conduct a visual analysis of both Chinese and international research on medical AI ethics. Through a cross-country comparative approach, we aim to delineate research disparities, clarify China's current standing and challenges within the field, and thereby provide a valuable reference for fostering theoretical innovation and guiding practical applications.

Data Collection and Research Methods

1. Data Collection

This study employs bibliometric methods to systematically analyze literature on medical AI ethics retrieved from major Chinese and international academic databases. Using CiteSpace software, we performed visual analyses including keyword co-occurrence, burst detection, and timezone views to reveal the developmental trajectory and evolution of medical AI ethics research in China and internationally, thereby establishing a basis for cross-country comparison.

To ensure comprehensive and representative data coverage, academically influential databases were selected from both domestic and international sources. Chinese literature was sourced from China National Knowledge Infrastructure (CNKI), Wanfang Database, and VIPU

Database, while English literature was primarily obtained from the Web of Science Core Collection and Scopus. The search period covered all records from the earliest available date in each database up to October 31, 2024, to fully capture the field's developmental context.

Regarding the search strategy, this study constructed a system of search terms covering three dimensions: artificial intelligence technology, the medical field, and ethics. The first group comprised AI-related terms, including "Artificial Intelligence", "Deep Learning", "Machine Learning", "Neural Network", "Natural Language Processing", "Pattern Recognition", "Algorithm", and "Computer Vision". The second group consisted of terms related to the medical field, such as "Healthcare", "Medicine", "Clinical", "Public Health", "Hospital", "Treatment", "Nursing", "Health Care", "Disease", "Patient", "Doctor", and "Nurse". The third group focused on the ethical dimension, incorporating keywords like "Ethics", "Morality", "Philosophy", "Privacy Protection", "Informed Consent", "Bias", "Autonomy", "Benefit", "Justice", and "Equality".

The English search strategy adhered to the same three-dimensional framework. The first group comprised AI-related terms (e.g., "artificial intelligence", "natural language processing", "NLP", "deep learning", "machine learning"). The second group included medical field terms (e.g., "medical", "medicine", "clinical", "healthcare"), and the third group contained ethics-related terms (e.g., "ethics", "moral", "philosophy"). The search was confined to the title, keywords, and abstract fields. Boolean operators were employed to combine terms: "OR" was used within each conceptual group, and "AND" was used to connect across groups, ensuring search precision and relevance.

2. Data Screening and Processing

The initial search identified a total of 2,626 publications, comprising 687 from Chinese databases (CNKI: 245; Wanfang: 203; VIPU: 239) and 1,939 from English databases (Web of Science Core Collection: 616; Scopus: 1,323). For the Chinese literature, we manually screened titles, abstracts, and keywords to exclude irrelevant records, resulting in the removal of 91 documents from CNKI (154 retained), 36 from Wanfang (167 retained), and 59 from VIPU (180 retained). After cross-deduplication across the three Chinese databases, which removed 271 duplicates, a final set of 230 Chinese publications was included for analysis.

For the English literature, we first applied two filters to both the Web of Science and Scopus databases: 1) restricting document types to "Article" and "Review"; and 2) limiting the language to English. This process yielded 433 documents from Web of Science and 761 from Scopus. Subsequent deduplication removed 385 records, resulting in 809 English publications for final analysis.

Following this systematic screening process, the study incorporated a total of 1,039 valid publications (230 Chinese and 809 English). The entire procedure adhered to systematic and objective principles, ensuring the representativeness and reliability of the research sample. The literature selection flow is detailed in Figure 1.

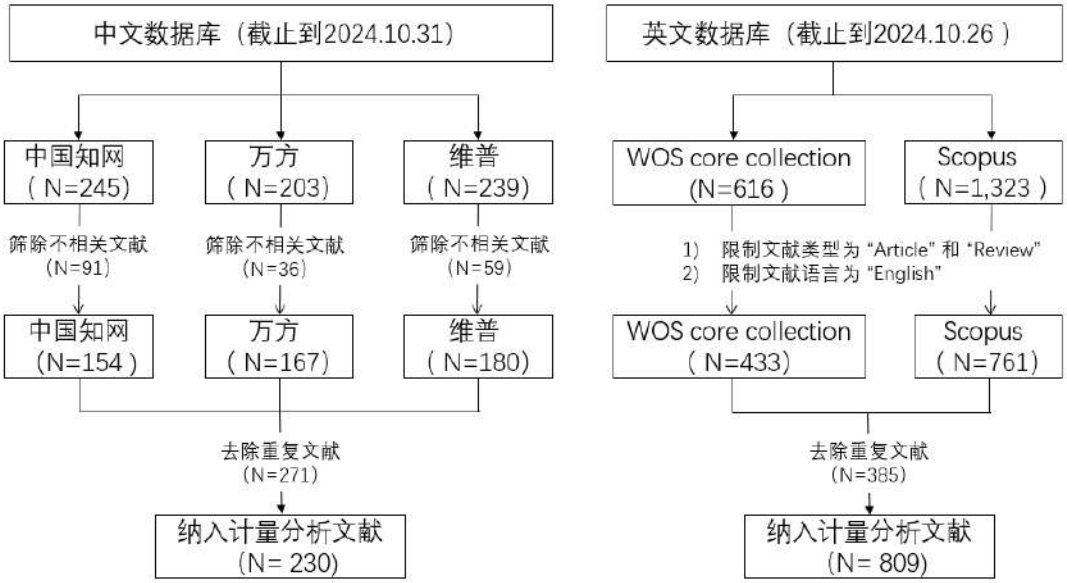

Figure 1. Flowchart of Database Search and Analysis

3. Research Methods

This study employs bibliometric methods, utilizing CiteSpace software for visual analysis of the collected literature. CiteSpace is a scientific knowledge mapping tool developed in Java, first introduced by Professor Chaomei Chen in 2004 and subsequently refined(Jie Li et al., 2016). The software generates visualizations that reflect the structure and evolution of scientific knowledge through techniques such as co-occurrence analysis, cluster analysis, and timezone analysis. As a key tool in bibliometric research, CiteSpace is widely adopted in academic studies, providing robust technical support for tracing disciplinary development and identifying research frontiers and trends(Jianhua Hou et al., 2013).

Our analysis proceeds systematically along three dimensions: temporal, spatial, and knowledge-based. From the temporal perspective, we examine annual publication trends, journal distribution, and the evolution of research topics in Chinese and English literature on medical AI ethics, thereby elucidating the field's development trajectory and current status. Spatially, we analyze co-occurrence patterns among authors and institutions to reveal collaborative networks and academic community structures. In the knowledge dimension, keyword co-occurrence analysis and timezone mapping are applied to identify research hotspots and frontier issues, establishing a foundation for discussing future research directions and emerging trends. Additionally, a comparative analysis of Chinese and English literature explores differences in research focus and developmental characteristics between domestic and international scholarship.

Results and Analysis

1. Publication Volume Trend Analysis

Statistical analysis of the literature in medical AI ethics research shows that this field is developing rapidly, with particularly strong growth in the last five years. English-language publications lead significantly over their Chinese counterparts in both quantity and growth rate, indicating a higher level of international research activity. In 2019, the number of Chinese and English publications was relatively close, at approximately 50 and 56, respectively. Since 2020, however, their developmental paths have diverged significantly. From 2020 to 2021, the number of Chinese publications grew slowly and even decreased slightly in 2021 to only about 10 papers. In contrast, the number of English publications grew rapidly in the same period, rising from 56 to 113 and exceeding one hundred for the first time.

Entering 2022, the number of publications in both English and Chinese continued to climb, but their growth rates differed dramatically. By 2024, the count of English documents was close to 300, starkly contrasting with the roughly 39 Chinese documents, which was less than one-sixth of the English total. This data indicates that the international academic community's focus and investment in medical AI ethics are substantially higher than those within the domestic academic sphere, particularly in terms of research scale and influence.

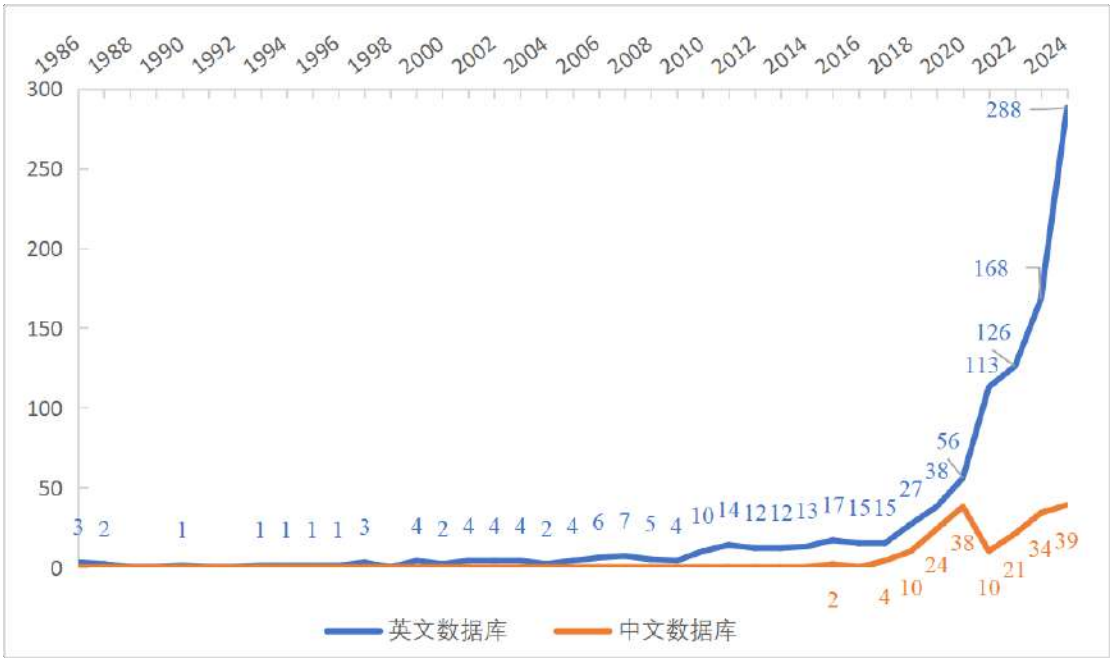

Figure 2.Number of Publications in Medical AI Ethics from Chinese and English Databases

Chinese and international research in medical AI ethics differ markedly in terms of publication volume. The considerable advantage of English literature in both quantity and growth rate signifies that this field has become a hotspot in international academia. In contrast, domestic research in China is still in a relatively early stage. To assume a more important position in the international discourse, it is necessary to further strengthen the investment of academic resources and intensify the depth of research.

2. Author Collaboration Network Analysis

We also examined author collaboration patterns through co-occurrence analysis in both Chinese and international medical AI research (Figures 3 & 4). For English publications, the author co-occurrence network (Modularity Q = 0.8515, Weighted Mean Silhouette = 0.9505) exhibits clear clustering, yet inter-cluster connections are weak, and no dominant core has emerged. This indicates that while productive authors and stable, small-scale teams exist, the broader collaborative network remains decentralized, and a tightly-knit academic community has not yet coalesced. Within the network, three discernible collaborative groups are evident: a cohesive team centered on Souza Raissa; a stable, triangular research group comprising Buyx Alena, Hein Alice, and Kaira Manudeep; and a dual-center network led by Saba Luca and Saxena Sanjay. Notably, Obermeyer Ziad serves as a bridge, connecting these distinct research groups.

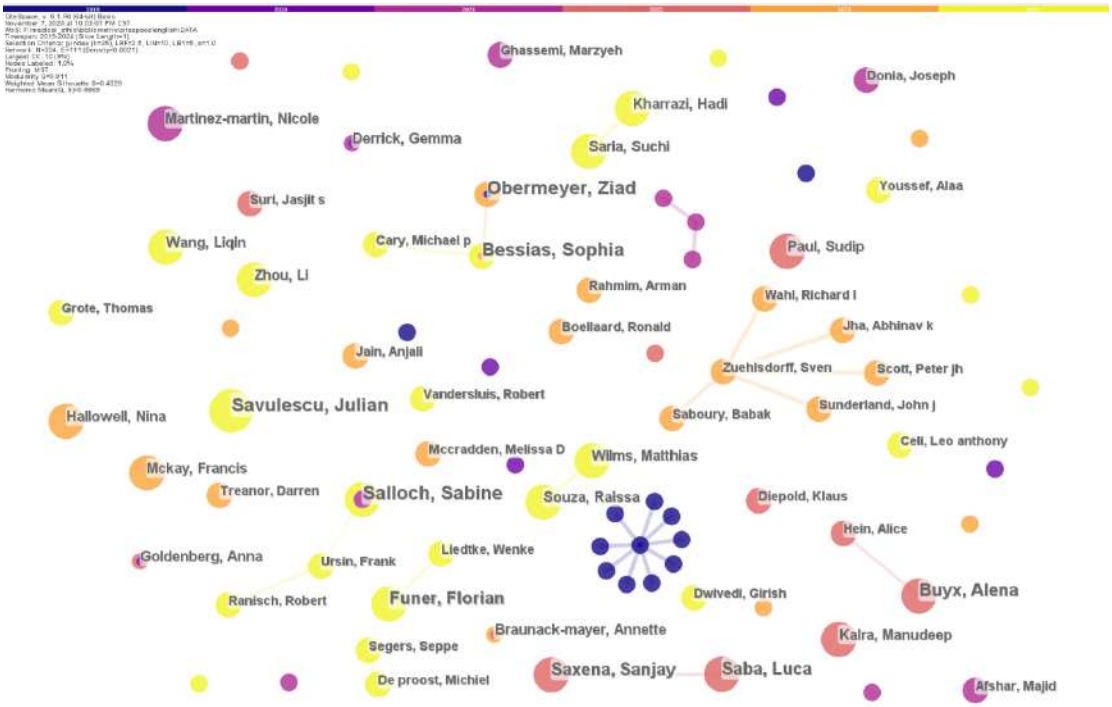

Figure3.Co-authorship Network of Authors in Medical AI Ethics (English Publications)

The Chinese author co-occurrence network (Figure 4) exhibits structural similarities to its international counterpart, with identical metric values (Modularity Q = 0.8515; Weighted Mean Silhouette = 0.9505) confirming distinct clustering yet weak inter-cluster connectivity and the absence of a dominant core. Analysis reveals two primary collaborative structures within the Chinese research landscape. The first is a prominently interconnected team — visually distinguished by purple nodes—anchored by authors including Liu Qi, Gu Xiaoying, and Wang Qiangfen, demonstrating strong internal cohesion and frequent collaboration. A second network, centered around Wang Chen, Sun Qigui, and Wang Yuanxu, likewise exhibits clear collaborative patterns, though potentially differing from the first group in either scale or cohesion.

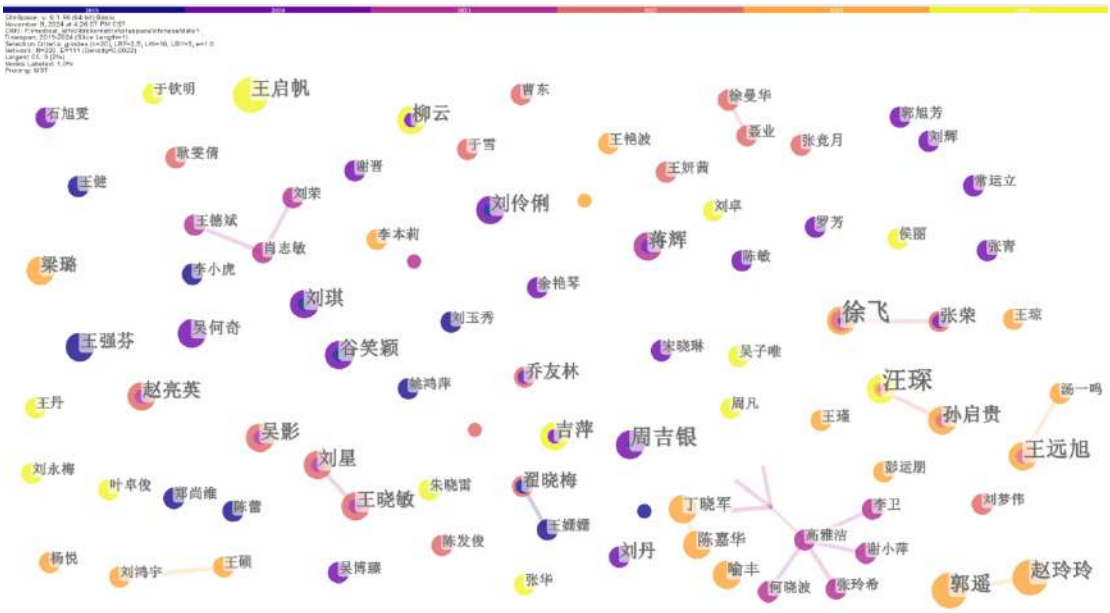

Figure 4.Co-authorship Network of Authors in Medical AI Ethics (Chinese Publications)

A comparative analysis of author networks reveals that while Chinese and international research share similar structural metrics (Modularity Q = 0.8515; Weighted Mean Silhouette = 0.9505), indicating common clustering patterns, their collaborative characteristics differ distinctly. In English-language research, several well-defined collaboration networks have emerged, such as those centered around Souza Raissa; the triangular collaboration among Buyx Alena, Hein Alice, and Kaira Manudeep; and the dual-core network of Saba Luca and Saxena Sanjay. These groups exhibit strong internal cohesion and stable partnerships, with Obermeyer Ziad serving as a key bridge across clusters.

In contrast, Chinese research is characterized by two principal collaborative teams: one led by Liu Qi, Gu Xiaoying, and Wang Qiangfen, and another anchored around Wang Chen, Sun Qigui, and Wang Yuanxu. Both demonstrate clear collaborative tendencies, though neither has achieved the scale or integration seen in the international networks. Overall, collaborative relationships in both contexts remain relatively loose, with no tightly-knit, large-scale academic community yet formed. This suggests that despite the presence of productive authors and stable small-scale groups, broader collaboration across the author community remains limited, underscoring the need for enhanced cooperation to foster a more integrated academic ecosystem.

3. Country and Institution Collaboration Network Analysis

The global distribution of research output in medical AI ethics, illustrated in Figure 5, identifies the United States, United Kingdom, Germany, the Netherlands, and Australia as the most prolific countries. The collaboration network reveals distinct regional clusters: a tightly connected European group centered around the UK, Germany, and the Netherlands, which also links to France, Italy, and Spain; a stable North American partnership between the US and Canada; and an Asia-Pacific network with China and Australia as its primary hubs, connected to Japan and South

Korea. A temporal analysis further shows a clear evolutionary pattern: early leadership by the UK and US (reddish nodes), followed by the activation of Germany and the Netherlands (yellowish nodes), with recent participation from countries like New Zealand (purplish nodes). This chronological expansion indicates the field's continuing globalization.

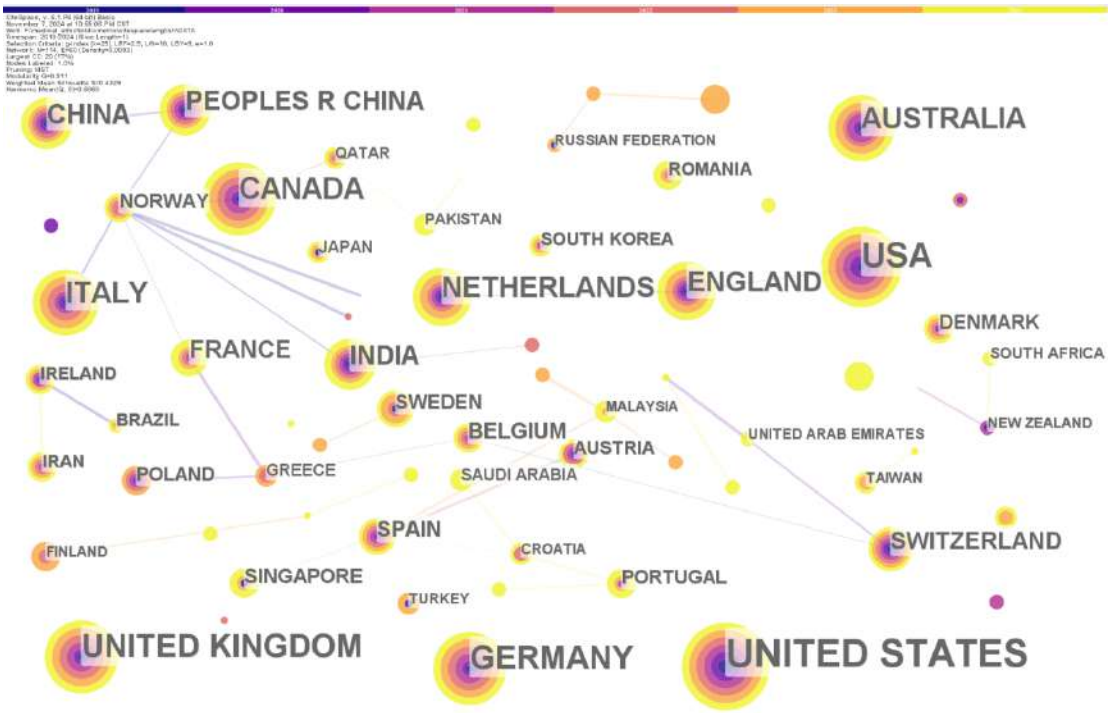

Figure 5.Collaboration Network between Countries in Medical AI Ethics (English Publications)

The institutional collaboration network reveals several core research entities, including departments of Computer Science, Psychiatry and Behavioral Sciences, and Medicine, which have contributed prominently to the literature. The network structure illustrates multiple thematic clusters. A medically oriented group centers around the Department of Medicine, which maintains strong ties with the Department of Psychiatry and Behavioral Sciences and the Department of Biomedical Informatics. Stanford University emerges as an active hub in interdisciplinary collaboration, engaging with units such as the Department of Computer Science and the Department of Psychology. Similarly, Harvard Medical School has established stable partnerships with the Department of Radiology, Department of Surgery, and Department of Pediatrics in clinical and technology-related areas. Collaborations between the Department of Computer Science and entities such as the Department of Biomedical Engineering and MIT further underscore the growing convergence of computational and biomedical engineering research.These cooperative patterns reflect the inherently interdisciplinary character of the field and reveal evolving collaborative dynamics over time. Notably, the Department of Medicine serves as a critical bridge within the network, connecting institutions across medicine, ethics, and information science, thereby facilitating cross-disciplinary knowledge exchange and advancing research innovation.

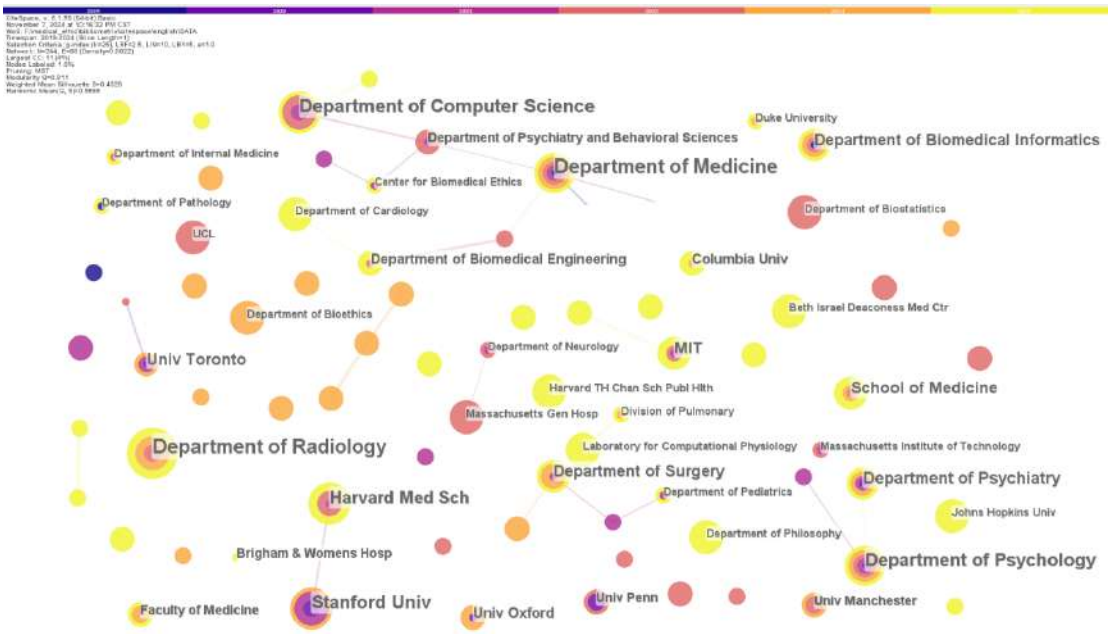

Figure 6.Institutional Collaboration Network in Medical AI Ethics (Based on English Databases)

The Chinese institutional collaboration network (Figure 7) identifies prominent contributors such as the School of Health Humanities at Peking University, Shanghai Jiao Tong University School of Medicine, and the Second Clinical Medical School of Heilongjiang University of Chinese Medicine, indicated by their larger node sizes. Several distinct collaborative clusters have formed within specialized domains. These include a multi-disciplinary research group in medical ethics and public administration centered at the School of Public Administration, Central South University; intra-university cross-disciplinary collaborations among schools at Shanghai Jiao Tong University (e.g., the School of Biomedical Engineering and the School of Medicine); and a stable network within the military medical university system, encompassing its First and Second Affiliated Hospitals. The formation of these groups reflects the diversified nature of research in this field. Temporal analysis reveals a clear evolutionary pattern: early activity from institutions such as the School of Health Humanities at Tianjin Medical University and Shanghai General Hospital (reddish nodes), followed by mid-term engagement from Peking University and China Jiliang University (yellowish nodes), with recent participation from institutions including the Chinese PLA Medical School (purplish nodes). This chronological expansion signifies the continued growth and institutional diversification of the field within China.

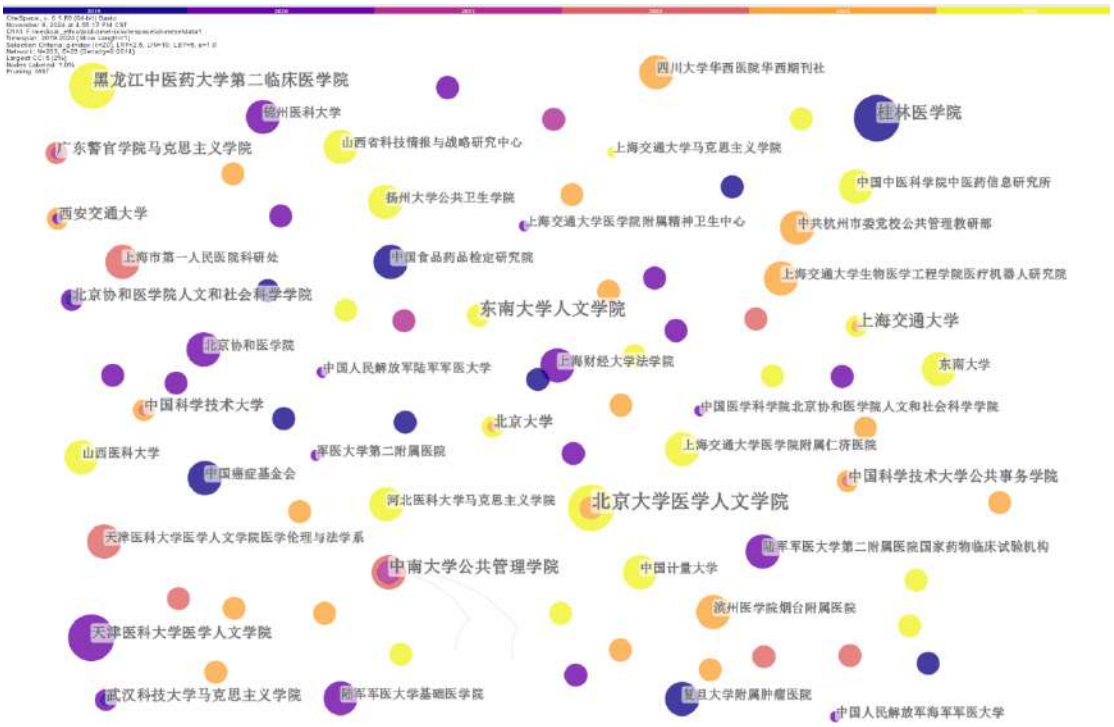

Figure 7.Institutional Collaboration Network in Medical AI Ethics (Chinese Publications)

A comparative analysis reveals distinct institutional collaboration patterns between Chinese and international research. Internationally, research is predominantly driven by interdisciplinary departments such as Computer Science, demonstrating pronounced cross-disciplinary characteristics. In contrast, Chinese research remains primarily anchored in medical schools and their affiliated hospitals, with collaboration largely occurring as intra-university cooperation between departments. Although both models have evolved from single-discipline origins toward multi-disciplinary integration, the interdisciplinary nature of international research appears more developed and extensive.

4. Keyword Co-occurrence Network Analysis

The keyword co-occurrence network for medical AI ethics research in English-language literature (Figure 8) positions "artificial intelligence" at its core, with strong linkages to key terms such as "ethics," "machine learning," and "decision making." The analysis identifies several well-defined research clusters: first, a foundational ethics group represented by "medical ethics," "bioethics," and "morality," addressing core ethical principles of medical AI; second, a patient rights cluster centered on "patient safety," "patient autonomy," and "informed consent"; third, an algorithmic fairness group focusing on "algorithmic bias" and "statistical bias"; and fourth, a technology application cluster comprising terms such as "electronic health records," "health care delivery," and "digital health."

Temporal analysis further reveals a clear evolution in research focus. Early studies primarily engaged with foundational concepts like "medical ethics" and "technology" (represented by

reddish nodes). Subsequent work incorporated technical themes such as "machine learning" and "deep learning" (yellowish nodes), while recent publications show heightened attention to equity-related challenges, including "health disparity" and "algorithmic bias" (purplish nodes).

The emergence of "covid 19" and "coronavirus disease 2019" in the keyword analysis notably demonstrates the field's responsiveness to pressing healthcare challenges. Furthermore, the significance of keywords such as "trust", "responsibility" and "justice" reflects a growing scholarly attention to the broader social implications of medical AI.

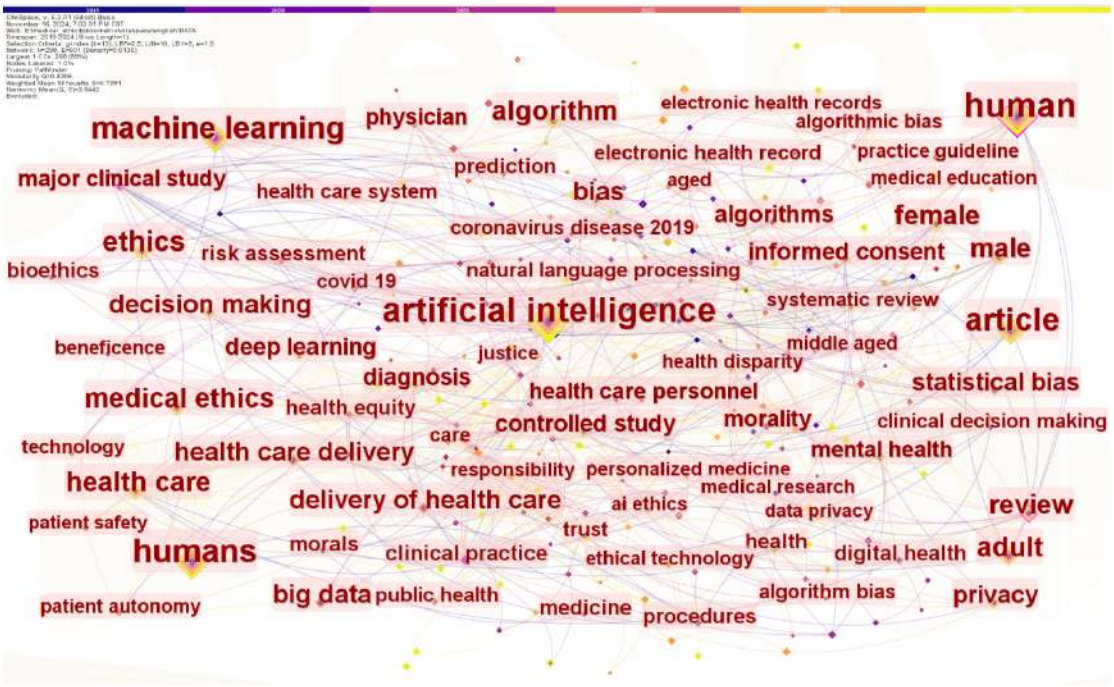

Figure 8.Keyword Co-occurrence Network in Medical AI Ethics (English Publications)

The Chinese keyword co-occurrence network (Figure 9) similarly positions "Artificial Intelligence" as the central node, strongly linked to core concepts including "Medical Ethics," "Ethical Risks," and "Ethical Review." The network reveals four relatively distinct research domains: an ethical foundation cluster focusing on fundamental principles; a data security cluster centered on privacy and information protection; a social equity cluster addressing fairness and public interest; and a technology application cluster encompassing medical devices and intelligent healthcare systems. The prominence of "Doctor-Patient Relationship" and "Medical Safety" underscores domestic research's particular emphasis on AI's impact on traditional care paradigms, while keywords like "Law," "Ethical Codes," and "Ethical Principles" indicate a trend toward institutionalization and standardization.

Temporal analysis of both English and Chinese research shows a parallel evolutionary trajectory. Early work concentrated on foundational theories and basic concepts, followed by increased attention to technical implementation, with recent scholarship shifting toward applied

ethical concerns including human-machine relationships and algorithmic governance, reflecting the field's maturation from theoretical inquiry to practical implementation.

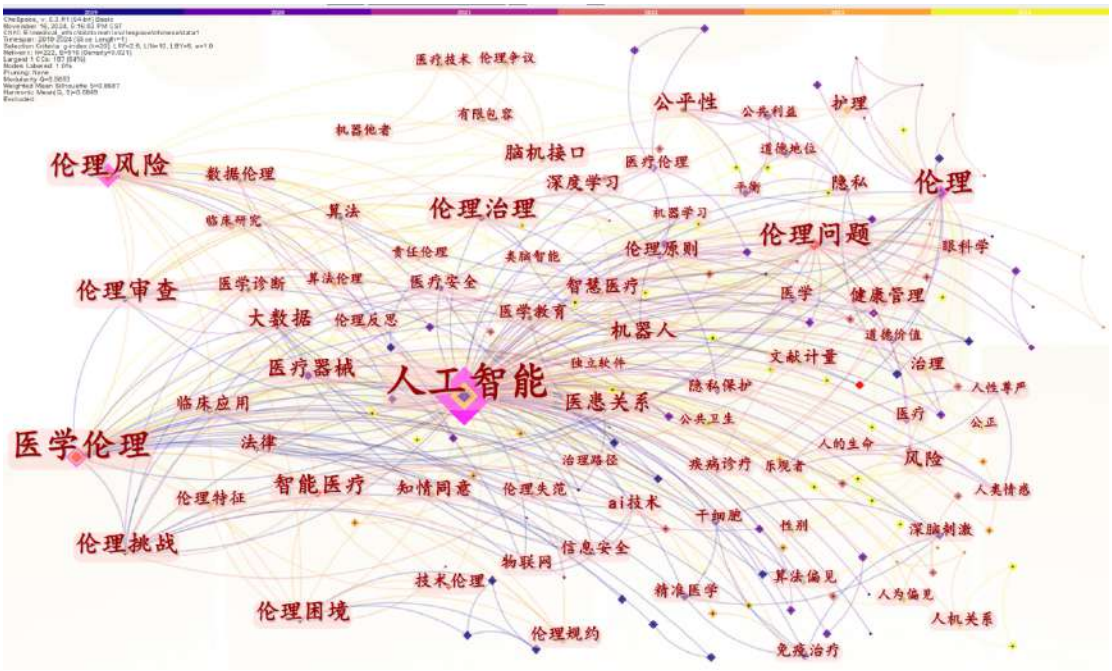

Figure 9.Keyword Co-occurrence Network in Medical AI Ethics (Chinese Publications)

A comparative analysis reveals divergent research priorities between English and Chinese scholarship. English-language research demonstrates a distinct focus on applied challenges such as patient safety and algorithmic bias, with its trajectory showing a clear evolution from technical applications toward broader societal values. Conversely, Chinese research emphasizes systemic development through ethical norms and review mechanisms, reflecting a progression from foundational ethical theories toward engagement with technology-specific ethical practices.

5. Evolution Path Analysis

The timeline visualization of English-language medical AI ethics research (Figure 10) delineates the field's evolutionary trajectory from 2019 to 2024. The analysis identifies eleven primary research clusters—artificial intelligence, policy, precision medicine, medical education, informed consent, electronic health, technology, algorithms, COVID-19, health equity, and medical information — demonstrating multidimensional development spanning technical applications to ethical governance.

Temporally, the research themes exhibit a clear evolutionary pattern. Initial investigations concentrated on fundamental AI applications in healthcare, subsequently expanding toward policy frameworks and precision medicine. As scholarship matured, attention extended to ethical dimensions including medical education and informed consent, alongside sustained advancement in electronic health technologies. A notable surge in algorithmic ethics and COVID-19 related research marked the field's responsive engagement with emergent technological and public health

challenges. Most recently, scholarly focus has shifted toward health equity and medical information management, signaling a broader transition from predominantly technical considerations toward socially-oriented values.

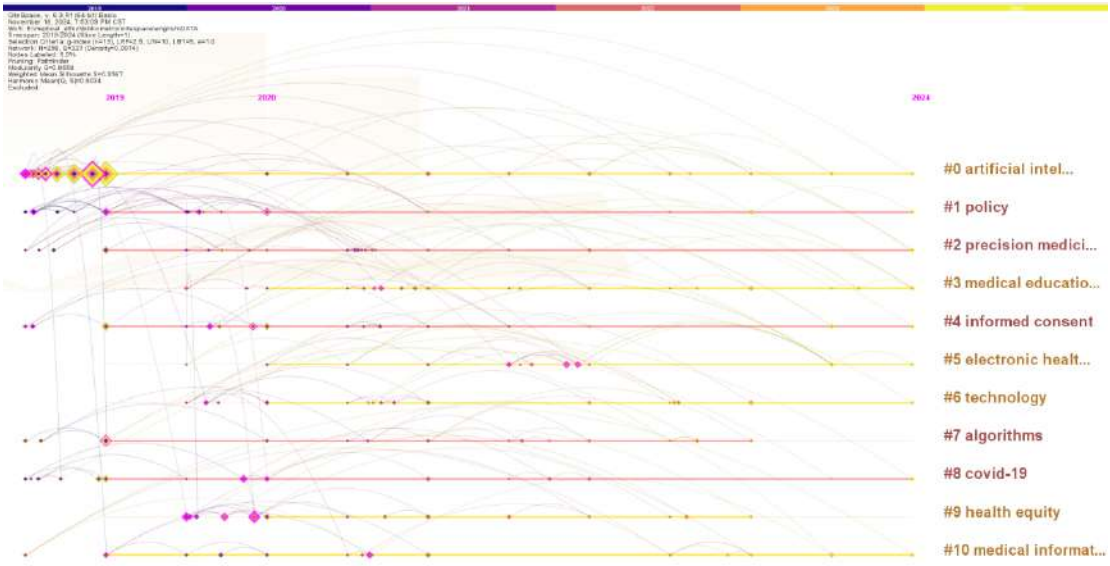

Figure 10.Timeline View of Medical AI Ethics Research (English Publications)

The timeline analysis of Chinese medical AI ethics research (Figure 11) identifies eleven major research clusters, including medical ethics, ethical issues, ethical risks, ethical review, ethical dilemmas, ethical principles, public interest, robotics, and algorithmic black box. The temporal evolution from 2019 to 2024 reveals a clear developmental trajectory. Research initially centered on foundational medical ethics and basic ethical issues, subsequently expanding into ethical risk assessment and related sub-fields. As the field matured, scholarly attention shifted toward practical implementation challenges including ethical review mechanisms and resolution of ethical dilemmas, while theoretical work on ethical principles continued to develop. Notably, research concerning public interest considerations and robotics ethics grew substantially during this period, reflecting increased emphasis on normative frameworks for technology application. Most recently, scholarly focus has turned to cutting-edge challenges such as algorithmic black boxes, demonstrating the field's progression from fundamental ethical inquiry toward concrete technical ethics.

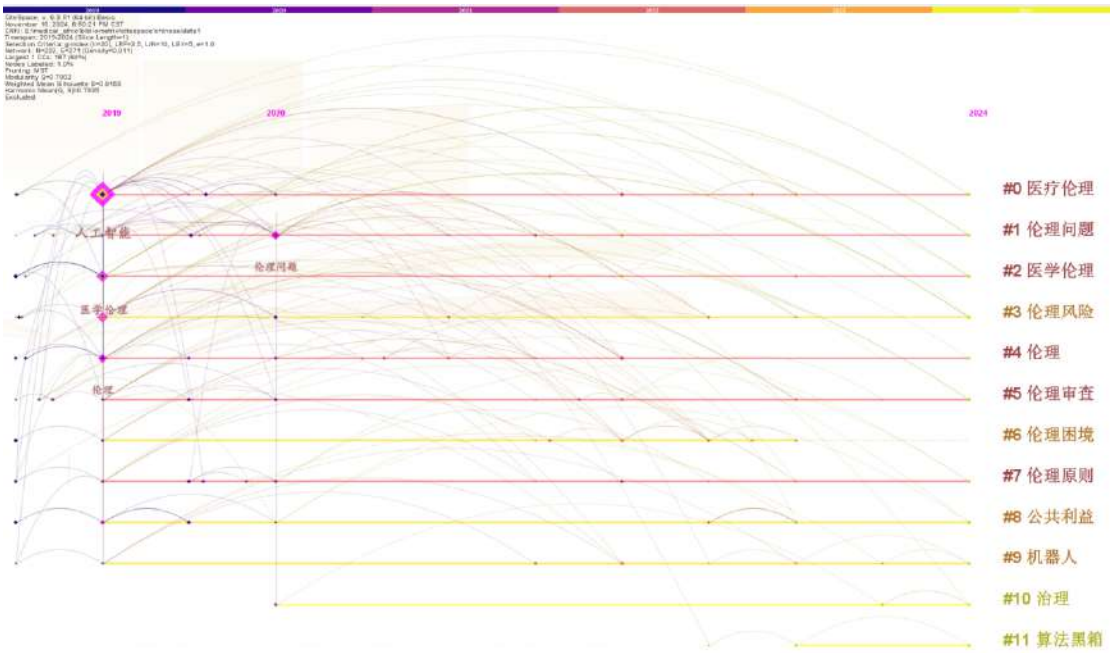

Figure 11. Timeline View of Keyword Clusters in Medical AI Ethics (Chinese Publications)

Based on the comparative analysis of Chinese and international medical AI ethics research, several distinct patterns emerge. The international (English-language) scholarship demonstrates a stronger emphasis on technology-ethics integration, exhibits more robust interdisciplinary and cross-institutional collaboration, and shows greater responsiveness to emerging topics. In contrast, Chinese research prioritizes theoretical system-building and institutional norm development, while maintaining a distinct focus on preserving the continuity of traditional doctor-patient relationships.

Despite these divergent priorities, both research traditions share important commonalities. Each remains in a relatively nascent phase of development, with both communities demonstrating strong focus on core concerns including privacy protection, data security, ethical governance, normative frameworks, fairness considerations, and clinical application ethics. Furthermore, both Chinese and international research exhibit parallel evolutionary trajectories—progressing from theoretical foundations toward practical implementation, and from single-discipline approaches toward multidisciplinary integration.

Discussion

1. Characteristics of Current Medical AI Ethics Research

Our systematic review identifies several key characteristics of current medical AI ethics research. The field is generally in its early stages. Although publication numbers are rising

annually, author groups are dispersed, collaboration networks are loose, and a stable academic community has yet to form, reflecting a field still in exploration. Analysis of institutional collaboration networks also reveals an important trend: interdisciplinary collaboration between medical and technical schools is intensifying(Ming Li et al., 2024). This model facilitates the deep integration of medical ethics and technological innovation but also introduces new challenges. For instance, researchers from different disciplines often possess varying ethical frameworks, requiring the establishment of effective interdisciplinary dialogue mechanisms(ZhouJun Ye et al., 2024). Additionally, participation from clinical institutions needs enhancement to strengthen the link between theoretical research and clinical practice(Hongrui Zhao et al., 2023).

The research displays distinct multidisciplinary characteristics. The institutional collaboration network shows that research institutions from fields such as medicine, computer science, and ethics are increasingly forming cooperative relationships. This interdisciplinary model is necessitated by the inherent complexity of medical AI technology, which requires the combined expertise of multiple fields to fully comprehend its ethical implications(Zhimin Xiao et al., 2021).

Finally, the evolution of research hotspots indicates a shift from technical ethics to social ethics. Early research primarily concentrated on technical aspects like data privacy and algorithmic bias, whereas recent studies more frequently address social value issues such as fairness and transparency(Chen Wang et al., 2023). This shift is linked to the profound societal concerns and changes triggered by the deep application of AI in medicine(Anbing Bao et al., 2018). Moreover, the introduction of AI ethics regulations by various countries since 2019 has further promoted this shift, steering research focus toward governance(Reis A et al., 2021).

2. Differences between Chinese and International Medical AI Ethics Research

Current research in medical AI ethics reveals notable differences between Chinese and international approaches. Regarding institutional characteristics, international research is often led by interdisciplinary departments such as Computer Science, displaying more pronounced cross-disciplinary collaboration. Chinese research, however, is primarily conducted within medical schools and their affiliated hospitals, manifesting more frequently as inter-departmental collaboration inside a single university. In terms of research focus, international studies pay greater attention to specific application problems like patient safety and algorithmic bias, with their research trajectory showing a shift from technical applications towards social value orientation. In contrast, Chinese research focuses more on system construction, such as ethical norms and ethical review, evolving from basic ethical theories toward a deeper engagement with technical ethical practices.

These differences primarily originate from differing policy environments and technological development backgrounds. The "technology-ethics integration" characteristic of international research is closely tied to the earlier development of AI ethical governance and the establishment of relatively comprehensive ethical review systems in Europe and the United States(Morley J et al., 2020). The EU's General Data Protection Regulation, for example, sets strict requirements for personal data processing, influencing the emphasis on data privacy and ethical governance in medical AI research(Bingrui Kui et al., 2020). Conversely, the "theoretical and practical dual-track parallel" model observed in Chinese research aligns with a policy environment that actively

encourages the exploration of localized ethical governance paths during a period of rapid AI technological advancement(Baijun Gu et al., 2023). China's "Ethical Norms for the New Generation Artificial Intelligence," which emphasizes balancing technological development with ethical norms, is clearly reflected in its medical AI ethics research.

3. Future Prospects for Chinese and International Medical AI Ethics Research

Medical AI ethics research is still in its early phases, with ample room for development in both research and practice. Future work should prioritize several areas. First, substantive cooperation between institutions must be strengthened to break through the current limitations of dispersed author networks and loose collaboration. In particular, deep dialogue among experts from diverse fields such as medicine, technology, and ethics should be promoted to form a more closer academic community. Second, it is important to facilitate the sharing of complementary advantages between Chinese and international research. China can learn from the interdisciplinary cooperation experience of international research, while also leveraging its own strengths in system construction and practical exploration. Through international exchanges and cooperation, the global ethical challenges brought by medical AI can be jointly addressed(Aiyi Zhang et al., 2024). Finally, it is necessary to move beyond established frameworks and enhance regulatory mechanisms, including legislative improvements(Chen Chen et al., 2024). This will help realize a governance model characterized by multi-stakeholder participation and multidisciplinary integration, thereby achieving innovation in regulation and governance(Bingshu Chen et al., 2024).

Conclusion

This study employs bibliometric and knowledge mapping analysis to systematically examine Chinese and international literature on medical AI ethics published between 2019 and 2024, revealing key developmental characteristics and trends in this field. The main findings are as follows: (1) The field demonstrates a steady growth trajectory overall, with both the annual growth rate and total volume of English publications significantly surpassing those of Chinese literature; (2) Chinese and international research networks share structural similarities. Although productive author groups have emerged, represented by the Souza Raissa team and the Chen Jiahua team, the overall author network remains relatively decentralized, and a closely-knit academic community has yet to form; (3) In terms of institutional collaboration, international research is predominantly led by interdisciplinary departments such as Computer Science, demonstrating distinct cross-disciplinary characteristics, whereas Chinese research is primarily conducted within medical schools and their affiliated hospitals, more frequently manifesting as intra-university departmental cooperation; (4) Although both Chinese and international research address core issues including privacy protection, algorithmic fairness, and data security, they diverge in their research approaches—international research emphasizes the integration and innovation of technology with ethics, while Chinese research focuses more on developing localized ethical theoretical frameworks. These findings provide valuable insights for promoting the robust development of

medical AI ethics research and fostering academic exchange between China and the international community.

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References

Tang, L., Li, J., & Fantus, S. (2023). Medical artificial intelligence ethics: A systematic review o f empirical studies. Digital health, 9, 20552076231186064. https://doi.org/10.1177/20552076231186064

Zhang, J., & Zhang, Z. M. (2023). Ethics and governance of trustworthy medical artificial intelligence. BMC medical informatics and decision making, 23(1), 7. https://doi.org/10.1186/s12911-023-02103-9

Maslej N , Fattorini L , Perrault R ,et al.(2024). Artificial Intelligence Index Report 2024. https://doi.org/10.48550/arXiv.2405.19522

United Nations Educational, Scientific and Cultural Organization. (2021). Recommendations on the Ethics of Artificial Intelligence. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000381137

Reis A ,Alois, Malpani R ,et al. (2021). ETHICS AND GOVERNANCE OF ARTIFICIAL INTELLIGENCE FOR HEALTH: WHO GUIDANCE. https://researchprofiles.ku.dk/en/publications/ethics-and-governance-of-artificial-intelligence-for-health-who-g/

WHO.（2024）.Ethics and governance of artificial intelligence for health: Guidance on large m ulti-modal models.https://www.who.int/publications/i/item/9789240084759.
WHO.（2024）.Benefits and risks of using artificial intelligence for pharmaceutical developme nt and delivery.https://www.who.int/publications/i/item/9789240088108
Yue Wang, Yaxin Song, Yifei Wang, et al. (2024). Ethics and governance of artificial intelligenc e in health: a guide to multimodal macromodeling. Chinese Medical Ethics,37(09):1001-102 2.
Jie Li, Chaomei Chen. (2016). CiteSpace:Scientific and Technological Text Mining and Visualiz ation[M]. Capital University of Economics and Business Press.
Jianhua Hou, Zhigang Hu. (2013). Review and Prospect of CiteSpace Software Application Rese arch[J]. Modern Intelligence,33(04):99-103.
Ming Li, Yuxi Li, Lian Dai, et al. (2019). Exploration of some issues of medical artificial intellig ence ethics[J]. Medicine and Philosophy, 40(21):4.
ZhuoJun Ye, Yanli Shen, Xiao Jiang, et al. (2024). A focused study on ethical governance in the field of medical artificial intelligence. China Medical Ethics,37(01):39-44.
Hongrui Zhao, Gengqi Yang, Yue Yang. (2023). Research on legal and ethical issues of medical artificial intelligence--a measurement and visualization analysis based on foreign literature. J ournal of Shenyang Normal University (Social Science Edition),47(02):26-32.
Zhimin Xiao, Xingrong Shen, Rong Liu, et al. (2021). Current status of application of medical ar tificial intelligence in China and reflection on ethical issues. Health Soft Science,35(07):87-8 9.
Chen Wang, Qingui Sun, Fei Xu. (2023). Trends in medical artificial intelligence ethics research - topic distribution, knowledge base and future outlook. Natural Dialectics Letters,45(12):18-29.
Anbing Bao, Pei Xu. (2018). Ethical risks and coping strategies of medical artificial intelligence. Medicine and Philosophy(A),39(06):37-40.
Reis A. , Alois, Malpani R. ,et al. (2021). Ethics and Governance of Artificial Intelligence for He alth: WHO Guidance.
Morley J , Machado C C V , Burr C ,et al. (2020).The Ethics of AI in Health Care: a Mapping Re view.Social Science & Medicine, 260:113172.
Bingrui Kui, Peng Xue, Yu jinag, et al. (2022).World Health Organization's guidelines on the eth ical governance of artificial intelligence in healthcare and implications for China. Chinese Me dical Journal, 102(12):5.
Baijun Guo, Longda Zhang. (2023).Application status and related ethical analysis of medical arti ficial intelligence in China. Chinese Science and Technology Journal Database (Full Text Edi tion) Medicine and Health, 2023(4):3.
Aiyi Zhang, Zhongguang Yu. (2024).Research on the ethical risk governance of medical artificia l intelligence based on domestic and international policy analysis.Chinese Medical Ethics,37 (09),1061-1067.
Chen Chen, Lin Chen, Zikai Guo, Ning Ren. (2024). Ethical Challenges and Countermeasures of Medical Artificial Intelligence in the Context of Artificial Intelligence Industry Developmen t. China Medical Ethics,,37(09),1046-1051.

Bingshu Chen, Yue Wang. (2024).Artificial intelligence medical regulation and governance innovation: thinking beyond the current normative framework.China Medical Ethics,37(09),1030-1036.