Advances In Medical Informatics (ISSN 2819-8298) https://aimi.quantechquest.com
2025; 1: 6 Open Access

Artificial intelligence and medical ethics: A bibliometric analysis of the 100 most cited research articles

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Article Info

Article type:
Research

Article History:
Received: 2025-04-05
Accepted: 2025-05-17
Published: 2025-05-26

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Keywords:
Artificial Intelligence
Medical Ethics
Bibliometric
Citation
Highly Cited Articles

A B S T R A C T

Introduction: As artificial intelligence technologies continue to advance rapidly, understanding their ethical dimensions has become increasingly crucial. This study examines 100 highly cited articles in the fields of artificial intelligence and medical ethics, aiming to identify key trends and insights that can inform future research and practice.

Material and Methods: A comprehensive bibliometric analysis was conducted utilizing data from the Web of Science database. Articles were selected based on citation counts, focusing on both review and original research articles that relate to AI and medical ethics. The analysis encompassed various aspects, including publication trends, geographical distribution, keyword analysis, and sources of the publications, which were performed by Biblioshiny software.

Results: The findings indicate a significant increase in publications since 2018, with a peak observed in 2022. The United States emerged as the leading country in scientific output, contributing 121 articles. Germany with 54 and, Australia with 45 were next in line with the highest production of articles in this field. Key themes identified throughout the analysis include ethics, machine learning, AI applications, and decision-making processes. The keyword analysis revealed distinct clusters surrounding critical ethical issues associated with AI technologies. Notably, prominent journals such as the "Journal of Medical Ethics" and the "American Journal of Bioethics" were highlighted for their substantial contributions to the discourse in this field. "SALLOCH S" had the most activity with 7 articles. Among the categories, ethics, medical ethics and social sciences, biomedical were the most frequent categories.

Conclusion: This bibliometric analysis underscores the growing importance of addressing the ethical challenges associated with AI in healthcare. The intersection of artificial intelligence and medical ethics is emerging as a significant and vital area of research, necessitating further exploration and discussion to ensure responsible and ethical advancements in technology.

Cite this paper as:
Baniasad-Azad S, Fatemi Aghda SA, Bahariniya S, Varadarajan V, Hami A. Artificial intelligence and medical ethics: A bibliometric analysis of the 100 most cited research articles. Adv Med Inform. 2025; 1: 6.

INTRODUCTION

Artificial intelligence (AI) refers to a machine or computer's ability to perform cognitive tasks and exhibit intelligent behaviors that mirror human

actions. It is primarily based on technologies such as deep learning and machine learning [1]. By analyzing extensive sets of clinical data, including medical recommendations, treatment records, and patient outcomes, machine learning algorithms can contribute to designing personalized treatment plans [2].

This technology can play a crucial role in medical decision-making by taking into account the unique characteristics of each patient. Moreover, AI models are capable of identifying patterns in large-scale data, enabling the prediction of disease progression, treatment results, and even future complications. These models can assess the risk of certain diseases by analyzing massive datasets and uncovering trends [3].

One of the central issues in this field is the ethical use of AI. When dealing with sensitive medical data, ensuring patient privacy and data security becomes essential [4]. Medical ethics refers to a set of moral obligations that physicians have toward their patients, colleagues, and society. Ethical principles help determine what is considered right or wrong within a particular culture and historical context, and they support understanding the ethical consequences of medical practices [5]. Possessing adequate knowledge, the right attitude, and comprehensive training in medical ethics plays a pivotal role in preparing medical professionals to anticipate, address, and resolve ethical challenges in daily practice. Therefore, education and application of medical ethics are essential and inevitable for developing the necessary competencies to provide care in an ethically responsible manner [6].

The ethical concerns surrounding AI in healthcare are both broad and complex [7]. Despite its rapid advancement, this technology raises multiple ethical questions—especially in the healthcare domain. The ethical deployment of AI requires adherence to key principles such as privacy, data security, transparency, fairness, accountability, and trust. In this context, medical ethics emphasizes the four fundamental principles of biomedical ethics: autonomy, beneficence, non-maleficence, and justice [7, 8].

Bibliometric analysis, as a quantitative method, uses bibliographic data such as author names, institutional affiliations, journals, and citation counts to map scientific relationships between publications [9]. Despite the growing importance of ethics in the application of medical AI, a comprehensive bibliometric analysis focusing specifically on this topic has not yet been conducted. Therefore, the aim of this research is to identify the top 100 most cited articles in the field of AI and medical ethics in academic journals. This study will highlight the most influential journals, research trends, emerging themes, countries, active authors, and WOS Categories in the field.

MATERIAL AND METHODS

The top 100 most-cited review and original research papers in the field of artificial intelligence and medical ethics, as listed in the WoS database, were examined through bibliometric techniques to evaluate their scientometric significance. This research investigated articles, journals, countries, keywords, authors, and WOS categories. The data collected were limited to the WoS core collection.

To ensure a comprehensive search, this study used the WoS categorization tool to collect all publications related to medical ethics. Subsequently, a search for the term "artificial intelligence" was conducted using an appropriate search strategy along with synonyms derived from medical subject headings (MeSH) as well as other words related to AI. The results were limited to "Review Article", "Article", and English language. Following this, the results were organized by "Citations: highest first," leading to the selection of 100 highly-cited reviews and original articles. The data were obtained on March 22, 2025. For each of the top 100 highly-cited publications, the "Full Record and Cited References" option was chosen during data extraction and saved in a "plain text" format. Finally, the data was transferred to Biblioshiny software for bibliometric analysis.

RESULTS

In this study, the top 100 most cited articles in the field of "Artificial Intelligence and Medical Ethics" were analyzed using bibliometric methods. The results of the data analysis are divided into several main sections:

Annual scientific production trends

As shown in the Fig 1, since 2018 there has been a significant increase in the number of published articles, peaking in 2022 with over 25 articles published that year. Following this peak, a downward trend is observed in subsequent years.

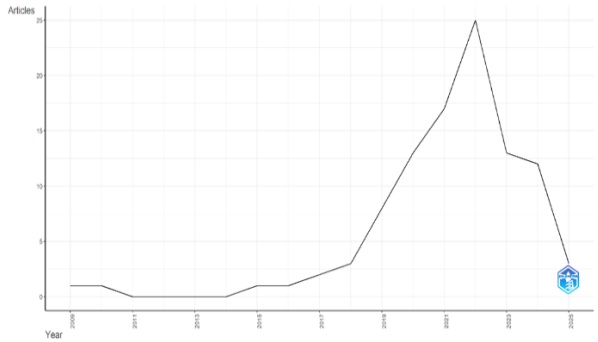

Fig 1: Annual scientific production

Geographical distribution of scientific production

Data analysis reveals that the United States, with 121 articles, holds the largest share of scientific production. It is followed by Germany with 54 articles, Australia with 45 articles, and both Canada and the United Kingdom with 41 articles each (Table 1). All countries that contributed to the production of these articles are shown in Fig 2, from dark blue (most activity) to light blue (least activity).

Table 1: Top 10 countries in article production

Rank	Region	n
1	USA	121
2	GERMANY	54
3	AUSTRALIA	45
4	CANADA	41
5	UK	41
6	SWITZERLAND	35
7	NETHERLANDS	16
8	SINGAPORE	12
9	SPAIN	7
10	FRANCE	5

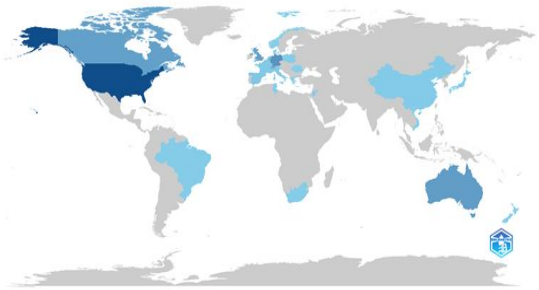

Fig 2: Country scientific production

Keywords of articles

Network analysis of key themes (Fig 3) shows that the reviewed articles are grouped into seven distinct clusters. Major clusters include topics such as “artificial intelligence” and “ethics”. These two words play the most important role in their cluster. There are various connections and links between clusters.

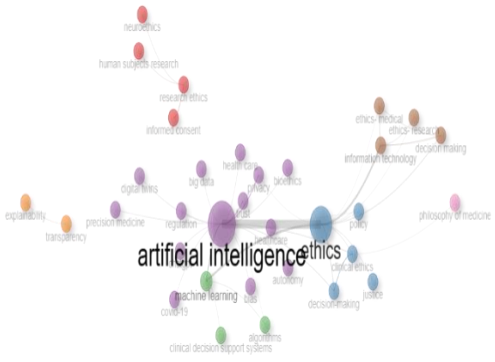

Fig 3: Co-occurrence network of keyword

Frequent keyword analysis

The word cloud map reveals that terms such as "ethics," "machine learning," "information technology," "clinical ethics," "privacy," and "informed consent" appeared most frequently in the article texts. Other frequently used words and topics in this area can be seen in Fig 4.

Fig 4: WordCloud map of keywords

Analysis of journals and sources

Among the reviewed sources (Table 2), the “JOURNAL OF MEDICAL ETHICS” (IF = 3.3/Q = 1), “AMERICAN JOURNAL OF BIOETHICS” (IF = 17/Q = 1), and “BMC MEDICAL ETHICS” (IF = 3/Q = 1) journals produced the most cited articles with 21, 14, and 14, respectively.

Top authors

In Table 3, the top ten authors are presented with the most cited article in the field of artificial intelligence and medical ethics. "Salloch S" has been the most active in the field with 7 polished articles. As can be seen in Table 3, in the next position, the nine authors are in the next rank with three articles. Among these authors, "JONGSMA KR" has received the highest citation (Total Citation = 303) with three articles. In the next position "Grote T" and "Braun M" are with 251 and 152 cite, respectively. "IENCA M", one of the top ten authors, published its first article in 2019, and "Earp BD" begun its articles in 2024.

Web of science categories

Fig 5 shows the co-occurrence network between Web of Science categories. This image shows the 100 most cited articles in the fields of medical ethics and artificial intelligence classified by categories and shows the relationships between them. As can be seen in the figure, there are two main clusters, the main categories of these articles being Ethics, Medical Ethics, and Social Science, Biomedical, with strong relationships between them.

Table 2: Journals that have published 100 highly cited articles

Rank	Sources	Articles	IF	Quartile
1	JOURNAL OF MEDICAL ETHICS	21	3.3	Q1
2	AMERICAN JOURNAL OF BIOETHICS	14	17	Q1
3	BMC MEDICAL ETHICS	14	3	Q1
4	BIOETHICS	13	1.7	Q2
5	NEUROETHICS	8	2.6	Q1
6	HASTINGS CENTER REPORT	7	2.3	Q1
7	JOURNAL OF LAW AND THE BIOSCIENCES	5	2.5	Q1
8	ASIAN BIOETHICS REVIEW	4	1.3	Q3
9	JOURNAL OF BIOETHICAL INQUIRY	3	1.8	Q2
10	JOURNAL OF LAW MEDICINE & ETHICS	2	1.6	Q1
11	RESEARCH ETHICS	2	2.1	Q2
12	SOUTH AFRICAN JOURNAL OF BIOETHICS AND LAW	2	0.5	Q4
13	ACCOUNTABILITY IN RESEARCH-POLICIES AND QUALITY ASSURANCE	1	2.8	Q1
14	ETHICS OF MEDICAL DATA DONATION	1	-	-
15	ETHIK IN DER MEDIZIN	1	0.5	Q4
16	JOURNAL OF EMPIRICAL RESEARCH ON HUMAN RESEARCH ETHICS	1	1.7	Q2
17	LINACRE QUARTERLY	1	0.4	Q4

Table 3: Top 10 authors

Authors	h_index	g_index	m_index	TC	NP	PY_start
SALLOCH S	7	7	1.4	150	7	2021
BILLER-ANDORNO N	3	3	0.75	71	3	2022
BRAUN M	3	3	0.6	152	3	2021
CARTER SM	3	3	0.5	50	3	2020
EARP BD	3	3	1.5	65	3	2024
GROTE T	3	3	0.5	251	3	2020
IENCA M	3	3	0.429	122	3	2019
JONGSMA KR	3	3	0.5	303	3	2020
SAVULESCU J	3	3	0.6	76	3	2021
URSIN F	3	3	0.75	51	3	2022

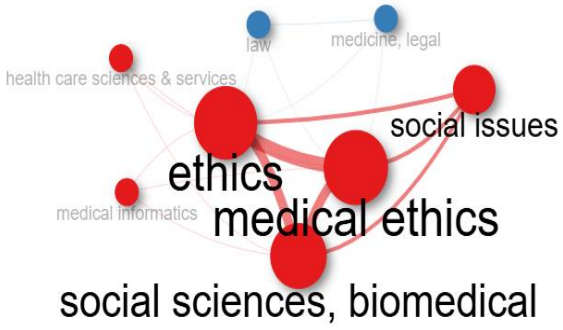

Fig 5: Co-occurrence network between web of science categories

DISCUSSION

The findings of this study indicate the growing attention toward the topic of "Artificial Intelligence and Medical Ethics" in recent years.

An analysis of the temporal distribution of scientific output shows that publications began in 2009 and have continued with fluctuations up to 2025. In the early years (2009 to 2013), the number of articles was very limited, but from 2014 onwards, a growing trend was evident. Since 2018, and especially in 2022, there has been a noticeable increase in scientific publications in this field. This trend is particularly

linked to the increased use of machine learning and AI algorithms in medicine and the resulting need to explore their ethical and social implications. Previous studies have also shown that new technologies in medicine introduce many ethical challenges, particularly in areas such as clinical decision-making and patient privacy [10, 11]. The rapid growth of AI technologies has therefore drawn considerable attention from researchers toward their ethical dimensions [12].

The annual scientific growth rate of 7.11% highlights the dynamic nature and attractiveness of this subject. However, as seen in other research areas, this growth might be challenged by the need for scientific validation and practical feedback in clinical settings. In the field of medicine, ethical research related to emerging technologies must continuously align with clinical needs and the perspectives of physicians and patients in order to support the practical application of these technologies [11].

The findings showed that the United States, the United Kingdom, Germany, Canada, and Australia are the leading contributors to the body of research in this area, indicating a significant geographical concentration in this research domain. This concentration reflects the strong research infrastructure and substantial financial investment of developed countries in the advancement of AI in healthcare. Similar studies in other areas of medical science and bioethics have also shown that countries with robust research and support systems are more likely to lead in knowledge production [13]. This may be due to greater investments in bioethical studies and interdisciplinary research, reinforced by strong research policies, advanced scientific infrastructure, and active international collaborations [14].

Network analysis of themes and frequent keywords revealed that most of the articles are focused on issues related to artificial intelligence, ethics, machine learning, clinical ethics, and information technology. This focus is particularly important and necessary in the context of medical AI, as the use of complex algorithms in clinical decisions may create challenges related to responsibility and ethical issues. Previous studies have also noted that trust in AI systems in medicine is one of the most important challenges to the acceptance of such technologies among both patients and healthcare professionals [15].

Publications like “Journal of Medical Ethics”, “American Journal of Bioethics”, and “BMC Medical Ethics” are recognized for their exceptional quality and original research contributions. Other journals were also identified as high-quality and high-ranking journals that have contributed to the publication of 100 highly cited articles in the fields of artificial intelligence and medical ethics. This high standard leads to their articles being referenced as credible sources in other studies. The topics explored in these journals are often timely and significant, further boosting their citation rates. Journals that rank in higher quartiles typically garner greater interest from researchers, resulting in increased citations for the articles they publish [16].

In total, 350 authors have been involved in the production of the top 100 highly cited articles in artificial intelligence and medical ethics, with 28 % of international cooperation being among the authors. The first highly cited article in this field is published by Tamburrini in Year 2009. 311 authors collaborated in producing one article, 29 people published 2 articles, 9 people published 32 articles, and one has contributed to the publication of 7 artificial intelligence and medical ethics articles. The extent of collaboration emphasizes how global scientific research encourages a variety of perspectives and methodologies [17, 18].

In the analysis of the categories of the 100 most cited articles, it is noteworthy that there are categories in the fields of law, ethics, medical ethics, social media, social issues, and health services that are related to the branches of medical informatics and artificial intelligence. The existence of ethics in the field of medicine and, on the other hand, the relationship of artificial intelligence in it is due to the need to pay attention to different aspects and perspectives, which is indicated by the presence of these articles in related categories [19, 20].

CONCLUSION

Overall, this study demonstrates that “Artificial Intelligence and Medical Ethics” is an emerging and dynamic research area within modern medicine that continues to pose significant ethical challenges. Researchers' attention to the field of medical ethics and artificial intelligence indicates the importance of this field and the need for special attention to it so the number of top articles in this field has increased in recent years, which indicates its value and importance. Moving forward, research must focus particularly on the development of ethical and accountable algorithms, and thoroughly examine human-technology interactions in smart medical environments. These efforts will undoubtedly contribute to the ethical and practical advancement of AI in medicine and lead to improved quality in clinical decision-making.

AUTHOR’S CONTRIBUTION

SBA: Writing original draft, review, and editing; SAFA: investigation, review, and editing; SB: Writing original draft, review, and editing; VV: Writing original draft, review, and editing, AH: Analysis, data curation, conceptualization, supervision, project administration, writing original draft, review, and

editing.

All authors contributed to the read and approved the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this study.

ETHICAL APPROVAL

Not Applicable.

FINANCIAL DISCLOSURE

No financial interests related to the material of this manuscript have been declared.

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