Original Research / Orijinal Araştırma

Trends in ChatGPT Publications in Health Sciences: A Bibliometric Analysis
Sağlık Alanındaki ChatGPT Yayınlarının Eğilimleri: Bibliyometrik Analiz

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Abstract

Objective: Natural Language Processing is one of the fields of artificial intelligence. To examine articles related to ChatGPT in the field of health and explore its presence in the literature, areas of application, and development.

Material and Methods: Bibliometric analysis was conducted on 699 publications from the Web of Science, Scopus, and PubMed databases. For data preprocessing, visualization, and statistical analysis, EndNote, Python, VOSviewer, Tableau, and SPSS 25 software tools were used in this study. The most frequently used keywords in this study included "Artificial intelligence", "chatgpt", "General and Internal Medicine", "chatbot", "Gpt-4", "machine learning", "natural language processing", and "Medical Writing".

Results: Our review categorizes the publications into main areas: 38.9% "Medical Practice" ChatGPT, 35.6% "Scientific Research and Writing", and 25.5% "Ethics and Concerns". There was a statistically significant difference in the distribution of document types among the three groups based on the topics (chi-square value = 34.4, $p<0.001$).

Conclusion: This study, the comprehensive analysis of ChatGPT's role in health literature, highlighted its potential in medical advice, consultation, education, and scientific writing. Despite ethical and privacy concerns, ChatGPT has proven potential in health, both at present and in the future.

Keywords: Health Publications, Bibliometric Analysis, Artificial Intelligence, ChatGPT

Özet

Amaç: Doğal Dil İşleme yapay zeka alanlarından biridir. Bu araştırmanın amacı, sağlık alanında ChatGPT ile ilgili makaleleri incelemek ve literatürdeki varlığını, uygulama alanlarını ve gelişimini araştırmaktır.

Gereç ve Yöntemler: Web of Science, Scopus ve PubMed veri tabanlarından 699 yayın üzerinde bibliyometrik analiz yapılmıştır. Veri ön işleme, görselleştirme ve istatistiksel analiz için EndNote, Python, VOSviewer, Tableau ve SPSS 25 yazılım araçları kullanılmıştır. Bu çalışmada en sık kullanılan anahtar kelimeler arasında "Yapay zeka", "chatgpt", "Genel ve Dahili Tıp", "chatbot", "Gpt-4", "makine öğrenmesi", "doğal dil işleme" ve "Tıbbi Yazım" yer almaktadır.

Bulgular: Bibliyometrik analiz, yayınları üç ana alanda sınıflandırmaktadır: %38,9'u "Tıbbi Uygulama", %35,6'sı "Bilimsel Araştırma ve Yazım", %25,5'i ise "Etik ve Kaygılar" konularına odaklanmaktadır. Ki-kare testi, bu tematik kategoriler arasında belge türlerinin dağılımında istatistiksel olarak anlamlı bir fark olduğunu göstermiştir ($\chi^2 = 34,4$, $p < .001$).

Sonuç: ChatGPT'nin sağlık literatüründeki rolünün kapsamlı bir analizi olan bu çalışma, ChatGPT'nin tıbbi tavsiye, danışma, eğitim ve bilimsel yazım alanlarındaki potansiyelini ortaya koymuştur. Etik ve mahremiyet kaygılarına rağmen, ChatGPT'nin hem günümüzde hem de gelecekte sağlık alanında kanıtlanmış bir potansiyeli vardır.

Anahtar Kelimeler: Sağlık Yayınları, Bibliyometrik Analiz, ChatGPT, Yapay Zeka.

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Introduction

Natural Language Processing (NLP) and Large Language Models (LLMs) are applied in a wide range of fields, including healthcare, education, finance, technology, and security.[1] Natural Language Processing is a field that focuses on enabling computers to understand, interpret, and generate human language. It covers various tasks like translation, sentiment analysis, information extraction, text classification, and question-answering. These sophisticated LLMs, including chatbots, have emerged with the ability to mimic human-like text production by adopting multiple ways to better grasp and simulate the complexities and nuances of human language.[2] OpenAI, a research organization established in 2015, has been dedicated to the continuous development of Generative Pre-trained Transformer (GPT) models from 2015 to the present day.[3]

ChatGPT, which has broken user base records, has evolved into an exceptionally performing LLM in various fields, such as medical report generation and healthcare research.[2,4,5] These AI technologies have the potential to bring significant and rapid advancements in areas such as analyzing and interpreting patient data, understanding complex medical literature and guidelines, facilitating easier access to health information, enhancing understanding and learning capabilities in medical education, and improving text writing abilities.[6-8] This continuous progress has been fueling the anticipation of future versions of GPT, raising the bar for their performance and potential advancements.

Different types of research related to ChatGPT in the field of health have experienced a surge since the beginning of 2023. Although the use of ChatGPT in healthcare has rapidly expanded, there is still a lack of evidence summarizing its overall research landscape and scientific impact. Especially comprehensive bibliometric analysis evaluating publications related to ChatGPT and its versions in the field of health has not yet been reported. Bibliometric analysis is a quantitative research method used to examine trends and relationships in scientific publications. [9] Such studies are important to understand how natural language processing technology, exemplified by ChatGPT, will shape future research areas. The aim is to provide an in-depth review of the existing scientific literature on ChatGPT in healthcare. This bibliometric analysis focuses on publications indexed in PubMed, Scopus, and Web of Science (WoS) databases to identify ChatGPT's impact on the health sciences, current research trends, and potential directions for future development. Also, this study aims to provide a comprehensive approach to healthcare professionals interested in ChatGPT and its versions in the healthcare domain by visualizing, analyzing, and evaluating data. Through this methodology, factors such as the number of publications, dissemination rate, geographical distribution, and impact of studies related to ChatGPT in the healthcare field can be measured.

Research Questions?

1. What are the main trends and thematic focal points of ChatGPT research in health?
2. How has ChatGPT impacted research and innovation in the health sciences based on current evidence in the literature?

Material And Method

In this study, a bibliometric analysis was conducted to reveal research trends in the field and to identify the most influential publications. The data were extracted independently by three authors. The oldest publication dates to October 2021, and the most recent one was published in May 2023. Articles, reviews, and other relevant publications in the field of health were included from three electronic databases: Web of Science (WoS), Scopus, and PubMed. We aimed to identify all relevant studies, regardless of their language or publication status (published or preprint). Publications were excluded if their primary focus did not relate to health, and if the full text or abstract was not accessible. The following keywords were used in our search strategies: ("chatgpt" OR "Chat GPT" OR "GPT-3" OR "GPT-4"). A total of 1477 publications (including articles, reviews, and other relevant publications) were retrieved in the initial search by selecting the "all fields" option. To ensure a comprehensive and inclusive review of the relevant academic and scientific literature, we did not limit our search to specific sources or publication types. When the search was narrowed down to title and keywords, it was observed that the number of publications decreased. Therefore, the search continued with the "all fields" option, and four independent researchers evaluated the relevance of the studies to the field of health and excluded those not related to the health domain. In cases where there was disagreement, a consensus was reached through mutual decision-making. After filtering based on health-related topics, 1014 publications were obtained. All publications were imported into the EndNote software to facilitate the identification and elimination of duplicate entries. Using this program, it was observed that 245 publications had been duplicated either 2 or 3 times. After removing 315 duplicates, a total of 699 publications were included for network analysis (Figure 1, Table 1).

Table 1. *Search strategy and data collection*

Search: “Chatgpt” OR “chat gpt” OR "GPT-3" OR "GPT-4"				
	All Area			Health-Related Area
Database	**All Fields**	**Title**	**Keywords**	**All Fields**
Web of Science	261	191	107	140
PubMed	563	471	211	563
Scopus	653	320	160	311
Total	1477	982	478	1014
Dublication				245
After the removal of duplicates*				**699**

**245 documents (after 315 deleted)*

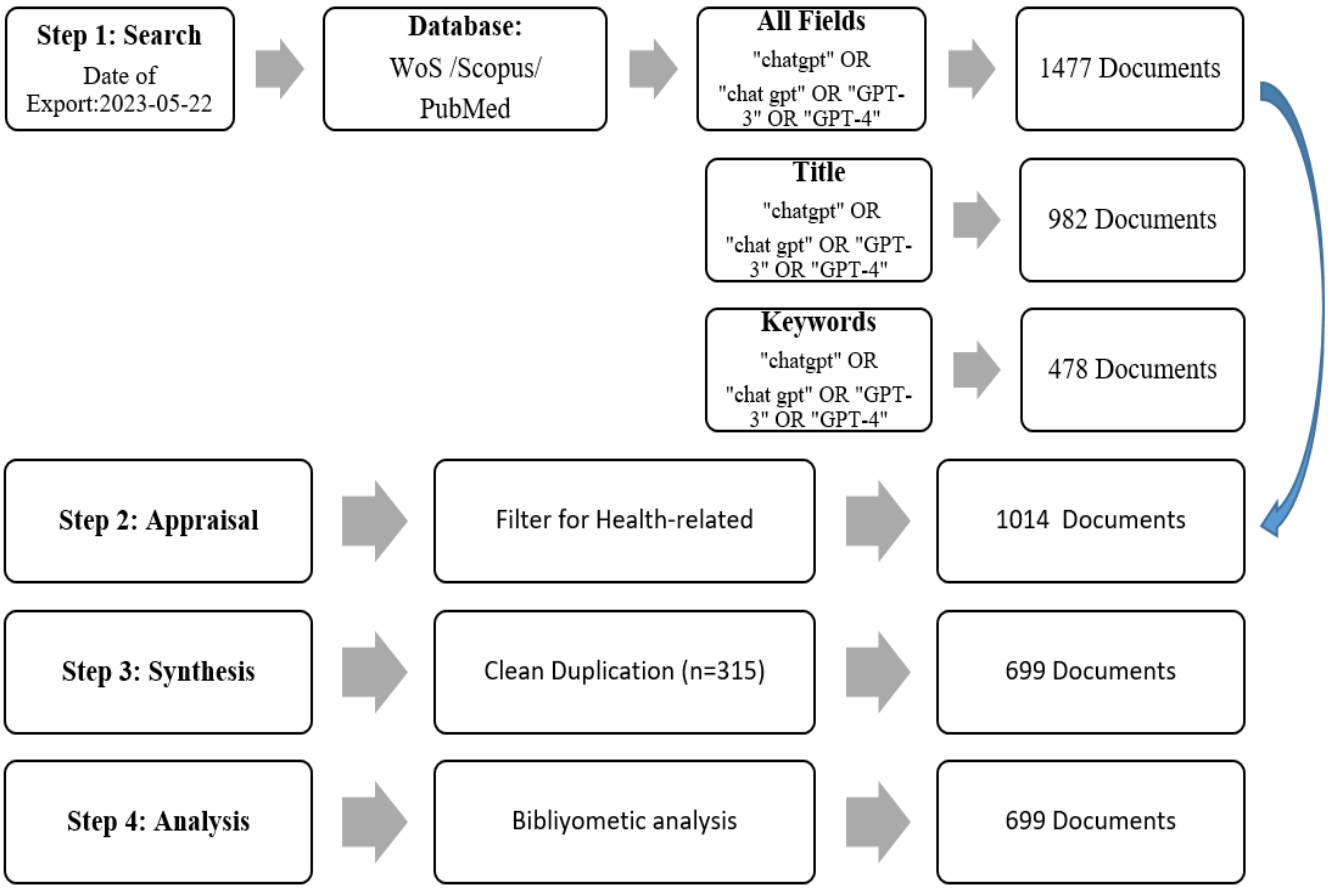


Figure 1. *SALSA (Search, Appraisal, Synthesis and Analysis) framework for a literature search*

The 699 publications were categorized into three main themes based on the topics covered. In cases where there was disagreement, a consensus was reached through mutual decision-making. The identification of the three topics was achieved through a systematic and scientifically grounded process. During the examination of the existing literature, the most prominent and frequently encountered keywords were systematically grouped together.

1- Medical Applications: This category includes studies that investigate the potential and use of ChatGPT in providing medical advice, consultation, and education. The topics encompassed in this category include how ChatGPT can be used in medical applications, its role in the education of students and medical professionals, and how it can support the transfer and understanding of health-related information.

2- Ethics and Concerns: This category consists of studies that address the ethical, security, and privacy issues associated with ChatGPT. These studies examine the role of ChatGPT in decision-making processes, biases and concerns, the privacy of patients and healthcare providers' data, and ethical and legal issues related to the use of these systems.

3- Scientific Research and Writing: This category includes articles that explore the use and benefits of ChatGPT in scientific publications and the research process, highlighting its impact on scientific writing or publication. These studies examine how ChatGPT can contribute to tasks such as literature review, data analysis, hypothesis generation, and overall efficiency improvement in the research process. Specifically, articles that explicitly state the use of ChatGPT in their title, methods, or acknowledgment sections, indicating that they were "written with the assistance of ChatGPT," are particularly included in this category.

Firstly, the data were merged, and duplicates were removed using EndNote X21. Language and country information were obtained through Python (Version 3.11.4) programming language using Jupyter Notebook. Data visualization and clustering were performed using VOSviewer (Version 1.6.19) and Tableau Desktop (Version 1.0) software. However, since VOSviewer could not generate the figure for the network of countries for the PubMed database, Tableau Desktop was used for these analyses. The data were examined based on authors, journal, country, and keywords. Therefore, citation evaluation has not been conducted in this study. The following variables were queried for each article: title, publication year, publication language, author, journal title, keywords, and country of publication. Using the VOSviewer software, we examined the total link strength (TLS). The Total Link Strength reflects the overall connection weight and importance of a node, representing the total connection with other nodes. TLS refers to a probabilistic similarity measure that indicates the co-authorship relationship between a specific researcher and other researchers. This measure quantifies the degree of collaboration ties by assessing the joint occurrence of collaborations.[10,11]

Descriptive statistics were generated using SPSS 25, and categorical data were presented in numbers and percentages. Chi-square test was used for group comparisons of categorical variables. The statistical significance level was set at $p<0.05$.

Bibliometric analysis studies typically do not require ethical committee approval as they are usually conducted on publicly available publications and documents.[12]

Results

A total of 310 (44.3%) original articles, 165 (23.6%) editorials, 136 (19.5%) letters, 38 (5.4%) reviews, 27 (3.9%) notes, and 20 (2.9%) news articles from various disciplines were identified. (Table 2). Most publications (96.9%) were in English, followed by German, Spanish, and other languages. When grouped according to the publication's main subject areas, 38.9% of the studies focused on ChatGPT's performance in medical applications. Additionally, 35.6% of the publications addressed "scientific research and writing topics" while the remaining 25.5% addressed "ethics and concerns topics". This distribution demonstrated a balanced representation across these topics (Table 2). There was a statistically significant difference in the distribution of document types among the three groups based on the topics (chi-square value = 34.4, $p<0.001$).

This analysis performs a Keyword co-occurrence analysis, examining how frequently keywords in a specific field appear together. These keywords were grouped into 62 different clusters based on their co-occurrence and relationships with each other. These clusters represent keywords that are frequently used around a specific topic, method, or research area. "Artificial intelligence," "chatgpt," "General&internal Medicine," "chatbot," "Gpt-4," "machine learning," "natural language processing," and "Medical Writing" were the most occurring keywords (Figure 2, Table 3).

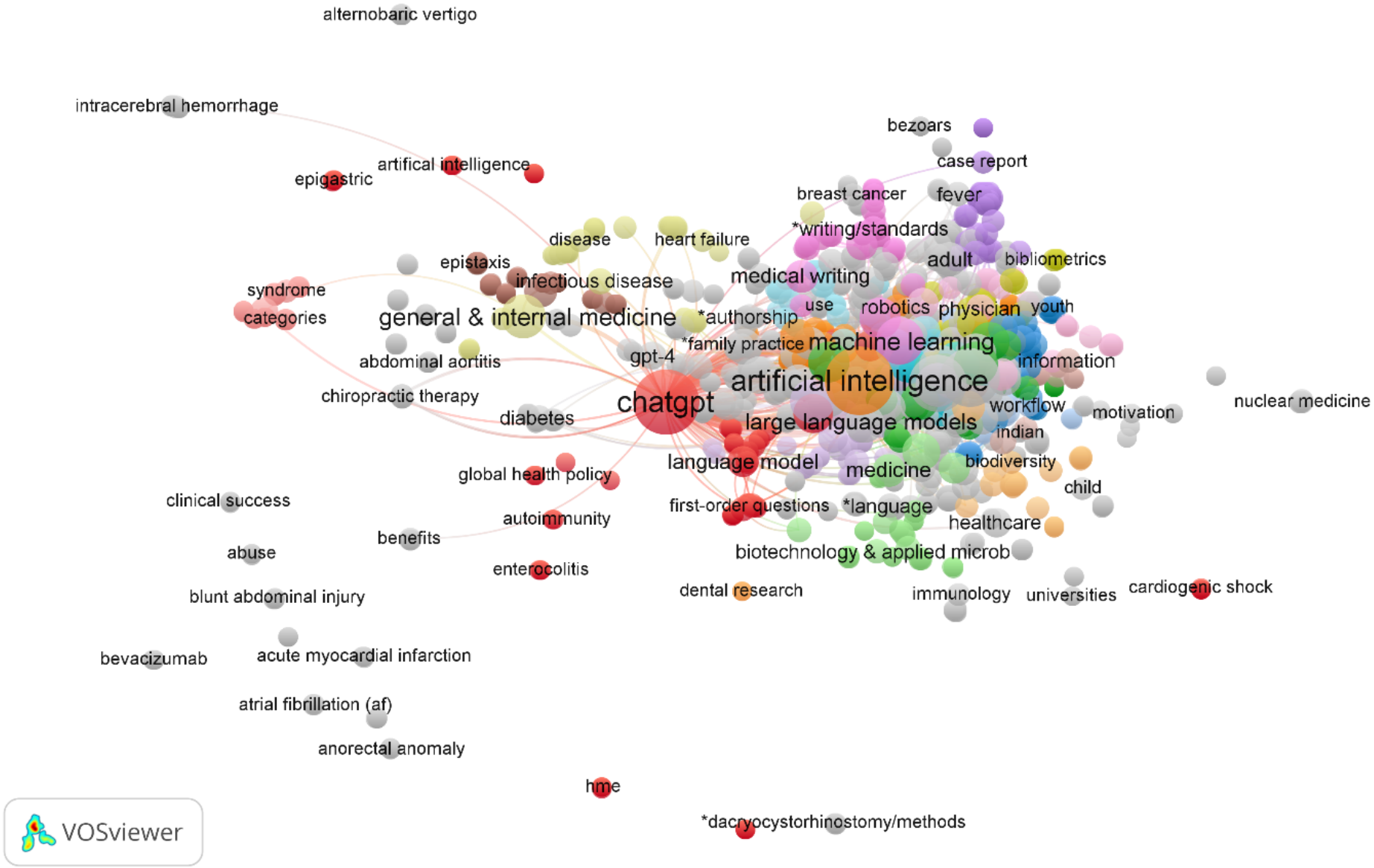
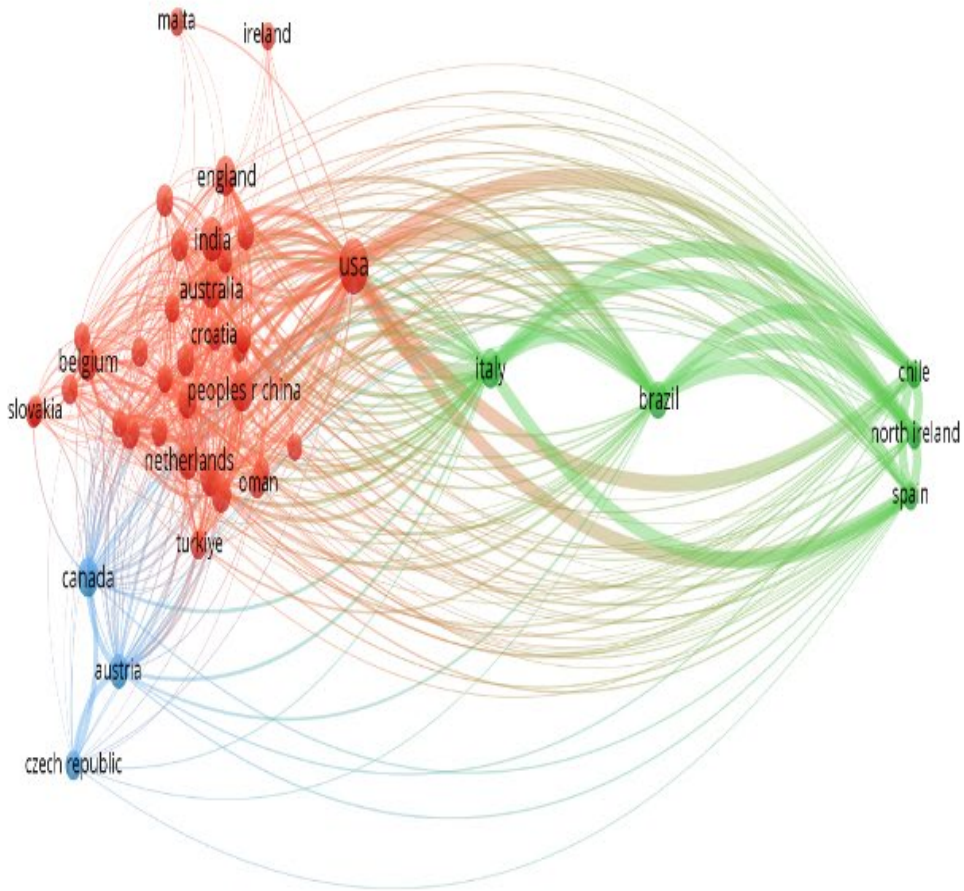


Figure 2. *Co-occurrences Network of Keywords*.

Table 2. *Characteristics of ChatGPT-related publications*

Characteristics (N=699)	n	%
Top 10 Countries by Document Count		
United States	278	39.8
United Kingdom	94	13.5
India	32	4.6
Germany	27	3.9
Netherlands	24	3.4
Switzerland	21	3
France	20	2.9
Canada	20	2.9
Italy	16	2.3
Australia	16	2.3
Languages of Publication		
English	677	96.9
German	6	0.9
Spanish	5	0.7
English; French	4	0.6
English; Spanish	2	0.3
French	1	0.1
Italian	1	0.1
Norwegian	1	0.1
Portuguese	1	0.1
Chinese	1	0.1
Publication type		
Article	310	44.3
Editorial	165	23.6
Letter	136	19.5
Review	38	5.4
Note	27	3.9
News	20	2.9
Erratum	3	0.4
Publication topics		
Medical Applications	272	38.9
Ethics and Concerns	178	25.5
Scientific Research and Writing	249	35.6
Publication year		
2021	2	0.3
2022	15	2.1
2023	682	97.6
Listing of ChatGPT as co-author on papers		
Yes	4	0.6
No	695	99.4

The most collaborative countries were the United States of America (USA), the United Kingdom (UK), Sweden, India, Austria, the Netherlands, Germany, Switzerland, France, Turkey, Belgium, Canada, and Italy (Figure 3). This reflects the countries' activities in literature, national research efforts focusing on specific topics, and global scientific collaborations. These findings demonstrate the significant role of these countries in global scientific research.



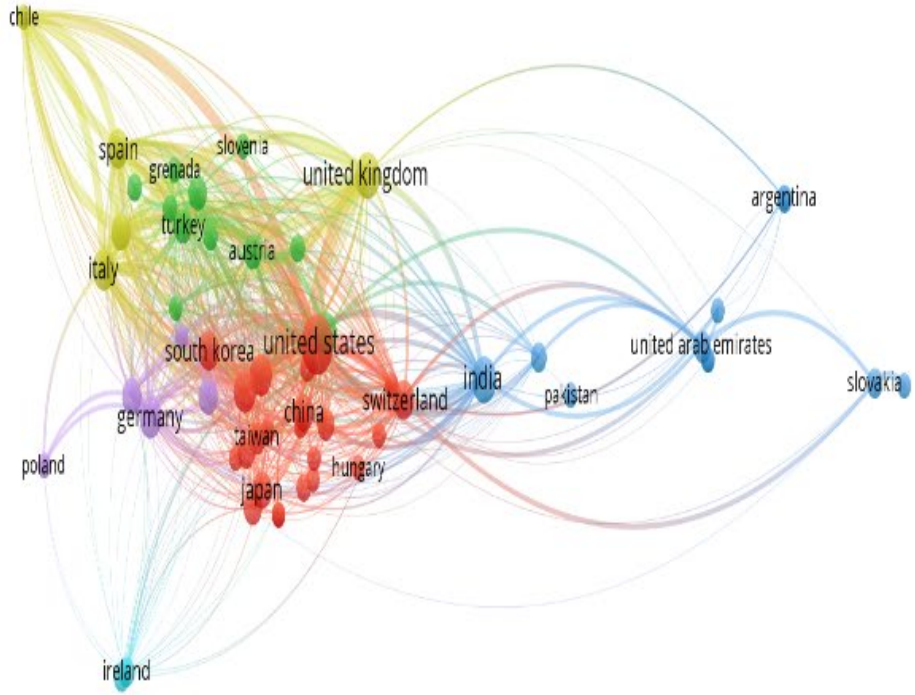


Figure 3. *Networks Coupling of Countries (A) WoS and (B) Scopus*

The keyword "Artificial intelligence" was identified as the most common term in the documents with a frequency of 221 occurrences (29.8%). The keyword "ChatGPT" was the second most common keyword, appearing 182 times (24.5%). The TLS indicates how frequently a keyword appears together with other keywords. Furthermore, when evaluated separately in the WoS, Scopus, and PubMed databases, "Artificial Intelligence" was observed as a prominently used term (Figure 4). The "Artificial intelligence" keyword had the highest total number of links with a value of 432 (Table 3).

Table 3. *Top 10 Keyword Co-occurrence*

Keyword	Occurrences	% of Total Occurrences	Total Link Strength	% of Total Link Strength
Artificial Intelligence	221	29.78	432	27.36
ChatGPT	182	24.53	197	12.48
General&internal Medicine	122	16.44	323	20.46
Chatbot	33	4.45	78	4.94
Gpt-4	35	4.72	110	6.97
Natural Language Processing	35	4.72	101	6.40
Machine Learning	43	5.80	91	5.76
Language	28	3.77	103	6.52
Medical Writing	25	3.37	87	5.51
Software	18	2.43	57	3.61
Total	**742**	**100**	**1579**	**100**

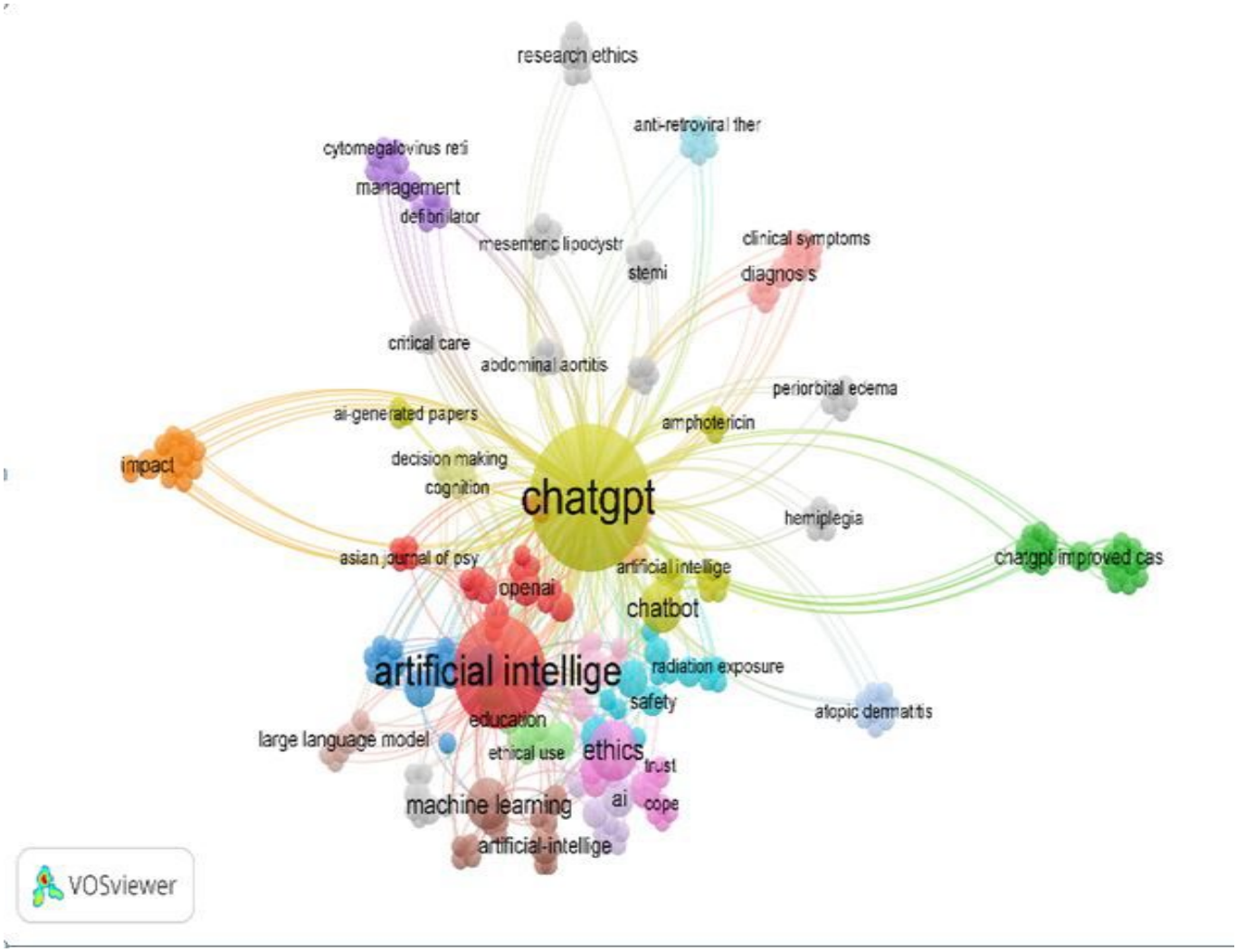


Figure 4. *Co-occurrences-All Keywords: (a) WoS*

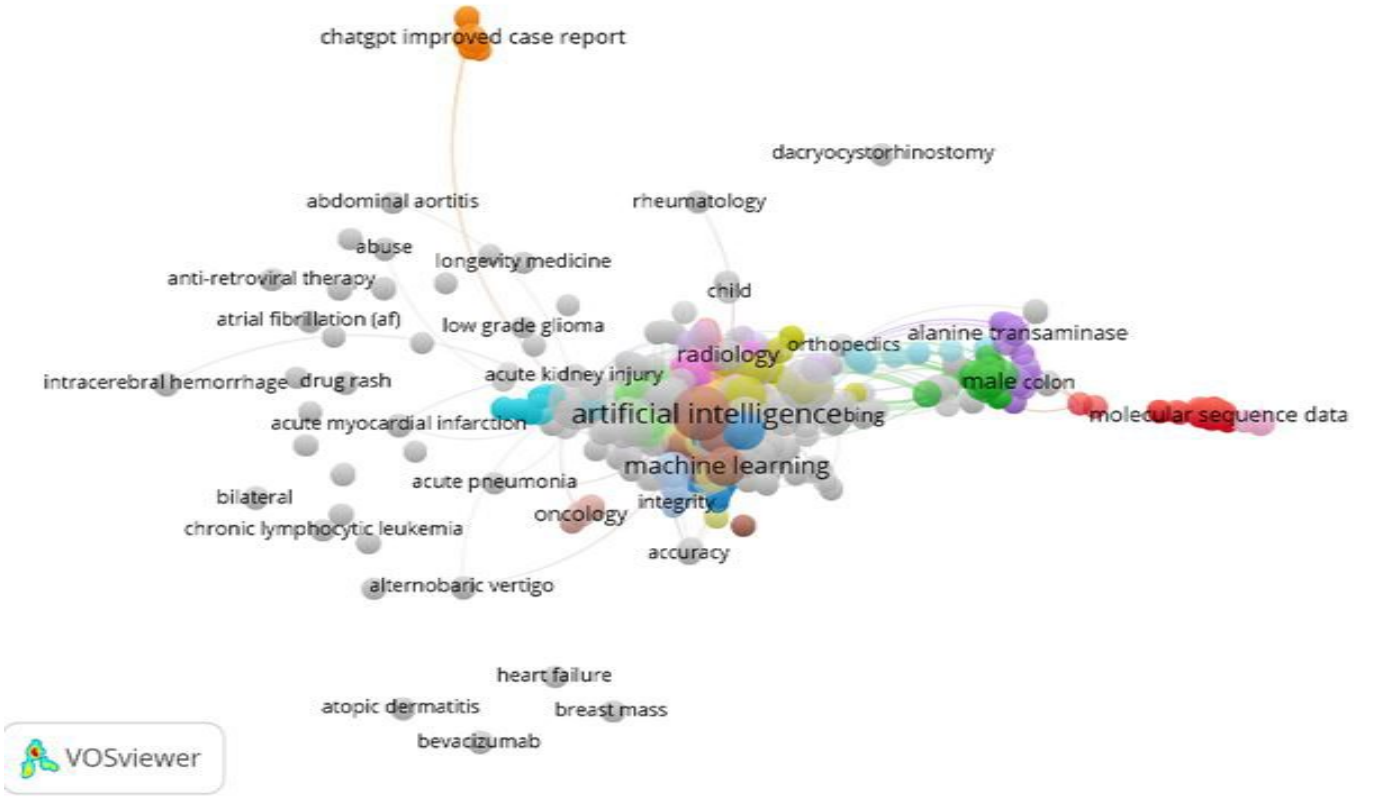


Figure 4. *Co-occurrences-All Keywords: (b) PubMed*

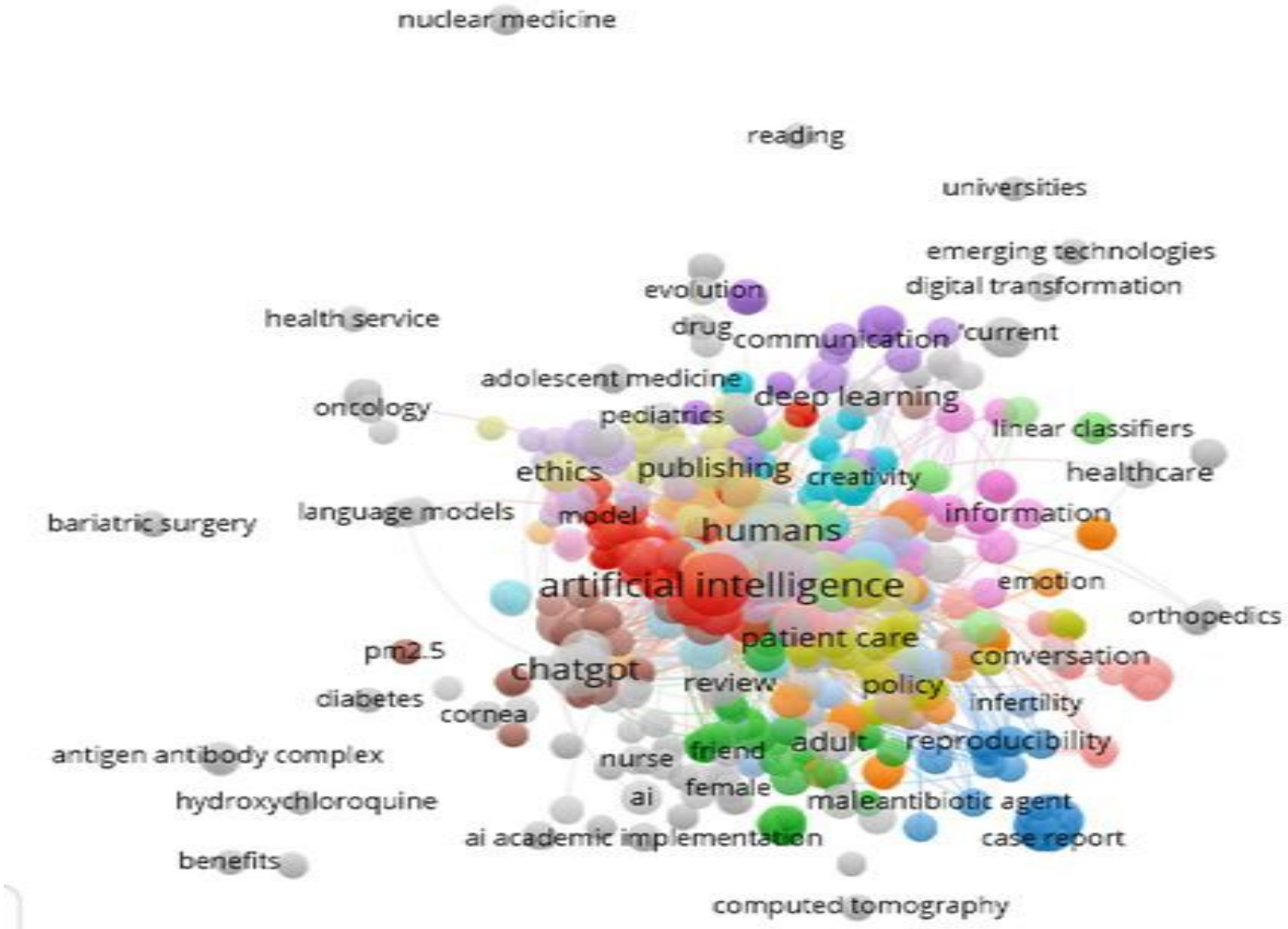


Figure 4. *Co-occurrences-All Keywords: (c) Scopus*

Since VOSviewer was unable to generate the figure of the co-authorship countries for the PubMed database, a geographical distribution graph was presented for the visuals that include this database (Figure 5), and Tableau Desktop 2023 1.0 program was used. The United States has the highest "Document Count" with 278, followed by the United Kingdom (n=94) and India (n=32) (Table 2). The documents published in the United States constitute 39.8% of the documents from a total of 57 countries. The top 10 most productive countries had a total of 548 publications, with the number of publications per country ranging from 278 to 16. Figure 6 shows that while the number of publications was at a very low level in late 2022, a rapid upward trend started in 2023. This increase reached its peak in March 2023.

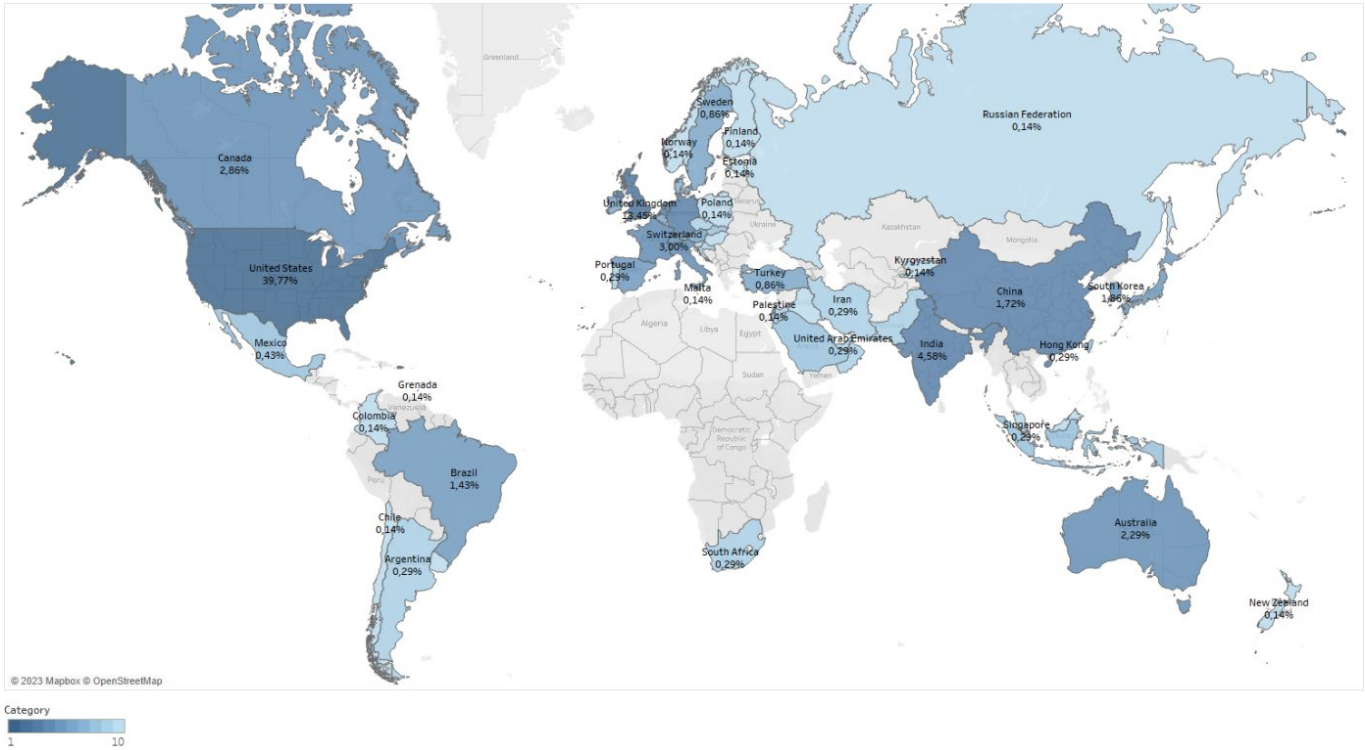


Figure 5. *Geographical Distribution of Publications*

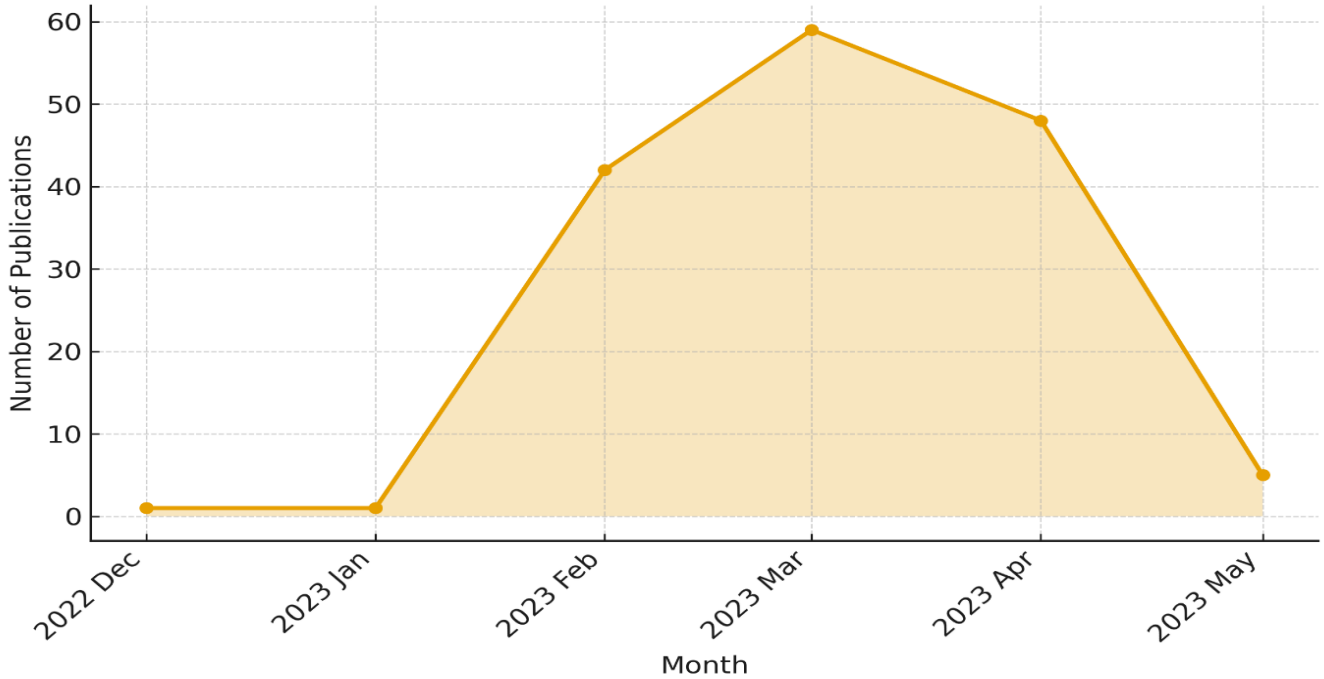


Figure 6. *Yearly distribution of ChatGPT-related publications in health science*

Figure 6 shows that while the number of publications was at a very low level in late 2022, a rapid upward trend started in 2023. This increase reached its peak in March 2023. This sharp rise corresponds to the public release and widespread adoption of ChatGPT, which rapidly stimulated scientific interest in its potential applications, limitations, and ethical implications within the health sciences.

Discussion

This study provides an objective bibliometric analysis of the comprehensive literature on ChatGPT in the healthcare field. It provides researchers and healthcare professionals with valuable insights that can guide them in predicting the future development of this field. The results demonstrate that these AI models have diverse and exciting applications in the healthcare domain. The study focuses on three broad themes related to the use of ChatGPT in the healthcare field. This process constitutes the most original and robust aspect of our study. The findings reveal that a significant portion of the studies examined the effectiveness of ChatGPT in providing medical advice, consultation, medical education, and health-related applications.[13,14] In some publications, it has been mentioned that ChatGPT and other chatbots can provide medical advice to patients by interpreting their medical data.[15-18] It has even been suggested that this technology has the potential to assume a complementary role rather than replacing doctors.[4,15] Another significant focus of the studies was the contribution of ChatGPT to the scientific research process and scientific writing.[19-21] Moreover, discussions were addressing various concerns related to ChatGPT, such as medical liability, ethics, trust, privacy, authorship, and other related issues.[22-24] This distribution indicates a comprehensive examination of ChatGPT's applications and implications within the healthcare context.[13,14]

Cureus journal initiated a call for authors to write case reports with the support of AI.[22] As a result of this call, case reports published in the Cureus journals were explicitly stated to be written with the assistance of ChatGPT, both in the title and acknowledgment sections.[25-27] These types of articles serve as significant examples showcasing the potential contribution of artificial intelligence to the research and publication process. This finding indicates that ChatGPT is widely used in AI-driven healthcare research, with a strong emphasis on artificial intelligence itself. These findings highlight both the importance and the ongoing progress of AI research in the healthcare sector. This result is not surprising, as the USA, with the world's largest R&D budget and many top research institutions, takes the lead.

The use of ChatGPT in the healthcare sector also raises ethical and security issues. These models pose risks related to the privacy and security of medical data, transparency of algorithms, and the potential for bias and providing inaccurate or misleading information. It is important to address these risks and establish policies and guidelines to ensure the safe and ethical use of these technologies.

A key limitation of this study is that bibliometric analysis includes only articles indexed in WoS, Scopus, and PubMed, excluding those outside these databases. Notably, most similar network studies in the literature rely on just one of these sources [14,28-30] In our case, importing data from all three into visualization programs posed challenges, which we addressed by using multiple data analysis tools.

Conclusion

Despite the ethical, privacy, and security concerns, our findings demonstrate that NLP models such as ChatGPT, GPT-3, and GPT-4 have significant potential in the healthcare sector, thanks to their unique language understanding and generation capabilities. We believe that these models will continue to be further developed to assist healthcare providers and patients in understanding and communicating complex medical information. Additionally, as long as there are well-intentioned uses, these models will provide substantial support to authors in interpreting academic writing and research data in the context of healthcare. ChatGPT's research on emerging trending topics and applications in healthcare. ChatGPT's role in exploring new trends, health applications and public trust in AI will continue to grow in the future.

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Use of artificial intelligence: Artificial intelligence support was not utilized in this study.

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