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Original Article

Bibliometric Analysis of ChatGPT's Applications in Medicine: A Comprehensive Assessment of its Impact and Potential

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ABSTRACT

Purpose: The purpose of the paper "Bibliometric Analysis of ChatGPT's Applications in Medicine: A Comprehensive Assessment of its Impact and Potential" is to conduct a systematic evaluation of how ChatGPT, an AI language model, has been applied in the field of medicine. The study aims to assess the impact of ChatGPT's applications in medicine and explore its potential contributions to the healthcare domain. **Materials and Methods:** The Scopus database was selected and the search query (All (ChatGPT AND Medicine) was developed on 11, July 2023 to retrieve all the bibliographic records on the domine of interest. From each record, we retrieved data on the title, author, organizations, journals, publications type, source, country, collaboration, etc. They were exported to MS-Excel for bibliometric analysis and VOSviewer software was used for analyzing Co-Occurrence networks and the data and descriptive analysis were classified, collected one by one, and loaded into the Bibliometric R-package program to create science maps and statistical graphs. **Results:** ChatGPT - related Medicine papers in the Scopus database constitute 532 papers. these publications received 1046 citations, these authored by 1771 authors published 203 article type and etc. Average citations per document 1966 received and 111 (20.86%) received extremal funding support from 62+ research agencies supporting research in this area. selected 65 significant keywords appearing in ChatGPT and Medicine. USA and UK were contributed the highest papers. Medicine is the broad subject of the study were published highest number of papers (312). **Conclusion:** The findings from this study can help researchers, practitioners, and policymakers better understand the impact and potential of ChatGPT in advancing medical knowledge, patient care, and healthcare practices. Additionally, the paper may contribute to identifying knowledge gaps and guide further research in this rapidly evolving field at the intersection of AI and medicine.

Keywords: Bibliometric, ChatGPT, Medicine, Impact, Scopus database.

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INTRODUCTION

The healthcare sector has witnessed significant innovation, propelled by advancements in Artificial Intelligence (AI) technology.[1] OpenAI's ChatGPT, a large language model built on the GPT-4 architecture, has been recognized as a pivotal contributor to medical applications, patient engagement, medical research, and education.[1] Its capacity to generate human-like text emanates from a deep learning algorithm trained on an extensive array of internet text.[2] However, the employment of ChatGPT in medical applications necessitates vigilant supervision and evaluation due to its machine learning nature, devoid of consciousness or comprehension.[3]

Several studies exploring the prospective applications of ChatGPT in the medical sector have been undertaken, yet a comprehensive bibliometric analysis, a quantitative method to assess publications statistically and mathematically, is lacking.[4] Such an analysis could provide a holistic and systematic perspective on ChatGPT's potential, impact, and scope in medicine, thereby aiding in the identification of patterns, gaps, and strategies for future studies. This research aims to perform a bibliometric analysis on the medical applications of ChatGPT, thereby assessing the volume, trends, and patterns in the relevant literature, gauging its impact and potential areas for future investigation.[5]

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LITERATURE REVIEW

The advent of AI technologies has revolutionized healthcare delivery, decision-making processes, and research.[1,2] Notably, language models such as ChatGPT, due to their ability to generate human-like text responses, have garnered considerable interest.[6,7] The expanding range of ChatGPT's applications in medicine mandates a thorough evaluation of its potential and influence through bibliometric analysis.[8]

This literature review provides an in-depth overview of the current research related to the bibliometric analysis of ChatGPT's applications in healthcare. It highlights key findings, trends, and the prospective course of this rapidly evolving field. Several investigations have deployed bibliometric analysis to scrutinize ChatGPT's applications and impact in healthcare.[2-5] Areas explored include conversational response generation[1], clinical decision support,[2] automatic medical coding,[3] patient counseling and education,[4] and mining biological literature.[5]

The bibliometric analysis of ChatGPT's applications in healthcare has elucidated key themes and research hotspots, namely clinical decision support, medical coding, patient counselling and education, and biomedical literature mining.[2-5,14] In these themes, research hotspots have emerged, such as the integration of ChatGPT with Electronic Health Records (EHRs) for clinical decision-making enhancement,[2] the development of domain-specific models for medical coding,[3] the deployment of ChatGPT in virtual patient counselling and education platforms,[4] and ChatGPT's usage for knowledge discovery from biomedical literature.[5]

Bibliometric analysis has also illuminated the collaboration networks and influential authors within the field of ChatGPT's medical applications.[8] Interdisciplinary collaborations, uniting the expertise of researchers, clinicians, and data scientists, have been fostered among academia, industry, and healthcare institutions. Influential authors like Zhang Y., Wang H., and Zhou X. have significantly contributed to the field through high-impact publications and research initiatives.[2-4,14]

Despite considerable progress in the bibliometric analysis of ChatGPT's applications in medicine, there are limitations and future directions that merit attention. The swift advancement of AI technologies necessitates continuous monitoring and analysis to track emerging trends and novel applications.[9,12] Furthermore, careful consideration of the ethical implications of AI adoption, including privacy concerns and potential decision-making biases, is required.[10,13] Future research should explore the integration of ChatGPT with other AI technologies, such as image analysis and sensor data, to bolster its capabilities in medical diagnosis and monitoring.[9,11,12]

MATERIALS AND METHODS

The study obtained publications and citations data related to "ChatGPT" and "Medicine" from Elsevier international bibliographical and citation Scopus database.[15-17] on July 11, 2023. For this purpose, the authors developed a comprehensive search straggly (shown below) that used different keywords related to "ChatGPT" and "Medicine" which are tagged to "keywords" and "Title" confining the search to period 2023. The search yielded 532 records, which were further analyzed using additional features in the Scopus database. The dataset of the bibliometric analysis program "Bibliometric R-package" were analyzed. The "bib" files were converted into "bibtex" files by using the Bibliometric R-packages (or R Studio) software. The data and descriptive analysis were classified, collected one by one, and loaded into the Bibliometric R-package program to create science maps and statistical graphs. The study presents a further graphical presentation of Bibliographic data by using the VOS viewer software can analysed and visualize bibliometric network data such as citation relationships between publications, authorships between authors, Co authorships with organizational, Co authorships with country colorations and Co-occurrence between all keyword, author keywords and Index keywords by the authors were analyzed and visualized by using the VOS viewer software.

RESULTS

In the present study, which was conducted with the bibliometric data analysis system, analyses were made under the headings such as the number of articles, cooperation between countries and the most frequently used keywords by the authors and the data obtained were visualized with graphics and tables. According to the Scopus database results of the publications on the keywords "ChatGPT" and "Medicine" from the year of 2023, 363 sources (Journals, Books, etc.), the distribution of these data sets are; 532 documents, these publications received 1046 citations, 111 (20.86%) received extremal funding support from 62+ research agencies supporting research in this area. selected 65 significant keywords appearing in ChatGPT and Medicine, with a frequency of appearance varying from 4 to 247. The National Institutes of Health supported research contributed the largest number of papers (10 papers), followed by the National Natural Science Foundation of China (7 papers), The majority of publications appeared as articles and letters (38.15% and 18.99%) among total publications and the remaining output appeared as editorials (18.23%) and etc. The majority of publications published from USA (64.47%) papers followed by China (9.96%) papers and remaining 41 countries published 1-44 papers. In all 1771 authors participated in global research in "ChatGPT and Medicine".

Main Information about Data

The data covers the year 2023. There are 363 sources, which could include journals, books, and other publications. There are 532 documents in the dataset. The growth rate is 0%, indicating that the number of documents remains constant. The average age of the documents is not specified. On average, each document has 1.966 citations. There is information about a single reference, but the details are not provided. There are 1639 keywords plus IDs associated with the documents. There are 970 author's keywords associated with the documents. There are 1771 authors who have contributed to the dataset. Out of the total number of documents, 116 are authored by a single author. There are 126 single-authored documents in the dataset. Co-Authors per Doc: On average, each document has 3.8 co-authors. Approximately 26.13% of the co-authorships involve international collaborations. The dataset includes various document types: Article: 203 Book: 2 Book Chapter: 3 Conference Paper: 14 Editorial: 97 Erratum: 1 Letter: 101 Note: 56 Review: 52 Short Survey: 3 and etc (Table 1).

Board subject-wise distribution

The largest number of papers (312 papers and 58% share) was contributed by Medicine, following by Biochemistry, Genetics and Molecular Biology (46 papers and 8.63% share). Nursing (36 papers and 6.75% share), Health Professions (32 papers and 6.00% share), Neuroscience (21 papers and 3.93% share), Psychology (19 papers and 3.56% share), Immunology and Microbiology 16 papers and 3.00% share), Pharmacology, Toxicology and Pharmaceutics (15 papers and 2.81% share) and others. However, in terms of impact, Health Professions and Psychology registered the highest citations impact per paper (4.21 and 3.26) and Nursing and Biochemistry, Genetics and Molecular Biology (2.19 and 1.21) and others (Table 2).

Top most predictive authors

In all 514 authors participated in global ChatGPT's and Medicine research, of which 514 authors published 1-8 papers each. of which 60 authors published 1-5 papers each. 4 authors 6-8 papers each. On further analysis, it was observed that 20 authors contributed more than the average group productivity of all 33 authors: Wu.H (8 and share 1.50% share), He.Y (7 and 1.31% share) papers. etc. The *h*-index is defined as the maximum value h such that the author has h papers that have been cited at least h times. In other words, an author with an h-index of 3 has at least 3 papers, each of which has been cited at least 3 times. The study was observed that the top most 20 *h*-index authors contributed 6 authors reached 3 *h*-index, remining 17 authors reached 2 h index etc. NP: Number of Publications - The total number of publications authored by each individual Figure 1. Table 3 shows that the TC: means total Citations - The total number of times their publications have been cited by others.

h-index: *h*-index - An index that attempts to measure both the productivity and impact of the published work of a scientist or scholar. An author with an *h*-index of h has published h papers, each of which has been cited in other papers at least h times.

g_index: *G*-index - Similar to the *h*-index, but takes into account the total number of citations, not just the h highest-cited papers.

m_index: *M*-index - Similar to the *h*-index and *g*-index, but considers the number of authors who have collaborated on a paper. It represents the largest number of authors on any single paper that has been cited at least m times and PY stars: Publications year started.

Most productive and impactful journals

The ChatGPT and Medicine papers were published 359 journals, of which 352 journals 1–4 papers each, Individually, the top 25

Table 1: Main Statistical information of ChatGPT and Medicine.

Description	Results
Timespan	2023:2023
Sources (Journals, Books, etc)	363
Documents	532
Annual Growth Rate %	0
Document Average Age	0
Average citations per doc	1.966
References	1
DOCUMENT CONTENTS	
Keywords Plus (ID)	1639
Author's Keywords (DE)	970
AUTHORS	
Authors	1771
Authors of single-authored docs	116
AUTHORS COLLABORATION	
Single-authored docs	126
Co-Authors per Doc	3.8
International co-authorships %	26.13
DOCUMENT TYPES	
article	203
book	2
book chapter	3
conference paper	14
editorial	97
erratum	1
letter	101
note	56
review	52
short survey	3

Table 2: Board subject.

Sl. No.	Board Subject*	TP	TC	CPP	%TP
1	Medicine	312	667	2.13	58
2	Biochemistry, Genetics and Molecular Biology	46	56	1.21	8.63
3	Nursing	36	79	2.19	6.75
4	Health Professions	32	135	4.21	6.00
5	Neuroscience	21	10	0.47	3.93
6	Psychology	19	62	3.26	3.56
7	Immunology and Microbiology	16	14	0.87	3.00
8	Pharmacology, Toxicology and Pharmaceutics	15	2	0.13	2.81
9	Physics and Astronomy	13	1	0.07	2.43
10	Decision Sciences	13	24	1.84	2.43
11	Dentistry	5	3	0.6	0.93
12	Chemistry	5	1	0.2	0.93
	Total	533	1054		100.00

*There is overlapping of research output under various subjects. As a result, their total is more than 100% TP total papers, TC total citations, CPP citations per paper.

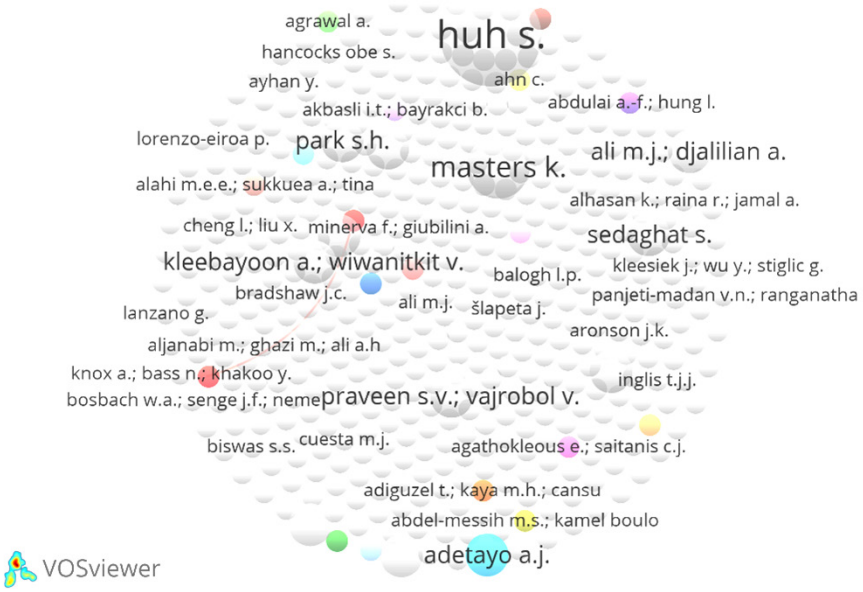

Figure 1: Most Productive authors.

journals published 3 to 26 papers. Together, they contributed 121 papers, constituting 22.74% share in all journal papers of ChatGPT and Medicine. Among the top 25 journals, the five most productive journals were: *Annals of Biomedical Engineering* (n = 26), *Medical Teacher* (n = 7), *Healthcare* (Switzerland) and *Aesthetic Plastic Surgery* (n = 6), *Radiology, Asian Journal of Psychiatry and Obesity Surgery*, (n = 5) etc. Among 25 journals, the top six journals by highest citations were: *Radiology* (c=127) citation, followed by JMIR Medical Education (c = 54) citations, *Annals of Biomedical Engineering* and *Healthcare* (Switzerland) (c = 34) citations, *Library Hi Tech News* and *Accountability in Research* (n = 26) citations and *Journal of Educational Evaluation for Health Professions* 25 citations, etc. Among top 25 journals by CPP were: *Asian Journal of Psychiatry* (55 CPP), *Radiology* (25.40 CPP), *Accountability in Research* and *Library Hi Tech News* (8.67 CPP), *Journal of Educational Evaluation for Health Professions* (8.34 CPP) Table 4.

Most Significant Keywords

The frequency of appearance of essentialness keywords can be used to gauge research. Keywords represent different concept

Table 3: Most productive authors.

Sl. No.	Author	Affiliation	NP	TC	CPP	*h*_ index	*g*_ index	*M* index
1	Cheng, Kunming	Zhengzhou University, Zhengzhou, China.	7	19	2.71	3	3	3
2	Gu, Shuqin	Duke University School of Medicine, Durham, United States.	5	17	3.40	3	4	3
3	Guo, Qiang	Tianjin Medical University, Tianjin, China.	4	11	2.75	3	3	3
4	He, Yongbin	University of North Carolina at Chapel Hill, Chapel Hill, USA.	7	22	3.14	3	4	3
5	Lu, Yanqiu	Zhengzhou University, Zhengzhou, China.	5	16	3.20	3	3	3
6	Wu, Haiyang	Duke University School of Medicine, Durham, United States.	8	23	2.87	3	4	3
7	Ali, Mohammed Javed	L.V. Prasad Eye Institute India, Hyderabad, India.	3	8	2.67	2	2	2
8	Banihashem, Seyyed Kazem	Open Universiteit, Heerlen, Netherlands.	2	11	5.50	2	2	2
9	Chaiyasate, Kongkrit	Oakland University William Beaumont School of Medicine, Rochester, United States.	2	5	2.50	2	2	2
10	Chao J		2	5	2.50	2	2	2
11	Dahmen, Jari	International Olympic Committee, Lausanne, Switzerland.	2	12	6.00	2	2	2
12	Djalilian, Ali Reza	University of Illinois at Chicago, Chicago, United States.	2	5	2.50	2	2	2
13	Gosak, Lucija	Univerza v Mariboru, Maribor, Slovenia.	2	16	8.00	2	2	2
14	Gupta, Rohun	St. Louis University School of Medicine, St. Louis, United States.	2	5	2.50	2	2	2
15	Haluza, Daniela	Medizinische Universität Wien Zentrum für Public Health, Vienna, Austria.	2	5	2.50	2	2	2
16	Herzog, Isabel	Rutgers New Jersey Medical School, Newark, United States.	2	5	2.50	2	2	2
17	Hirschmann, Michael Tobias	Universitat Basel, Basel, Switzerland.	2	12	6.00	2	2	2
18	Huh, Sun	Hallym University, College of Medicine, Chuncheon, South Korea.	5	29	5.80	2	5	2
19	Jungwirth, David	Medizinische Universität Wien Zentrum für Public Health, Vienna, Austria.	2	5	2.50	2	2	2
20	Karlsson, Jón	Sahlgrenska Universitetssjukhuset, Gothenburg, Sweden.	3	13	4.33	2	3	2

and ideas we are selected 65 significant keywords appearing in ChatGPT and Medicine, with a frequency of appearance varying from 4 to 247. The most significant frequency of occurrence (n = 247) was observed for artificial intelligence, followed by human (n =183), language (n = 75), machine learning and natural language processing (n = 37 and n = 37), deep learning (n = 35), human experiment (n = 27), software (n = 24), medicine and radiology (n = 20 and n = 20), chatbots and ChatGPT (n = 19 and n = 19).

These 65 significant keywords (along with their frequency of occurrence) could be broadly divided in following categories Chatbot (n = 28), adult (n = 14), delivery of health care (n = 13), artificial intelligence (n = 253), algorithms (n = 11), and ai (n = 23).

Table 5 and Figure 2 shows the co – occurrence network for the most frequently used keywords. Each keyword is demonstrated by a circle, where its diameter and size illustrate the frequency of the keywords, and its colour reflects the most frequently topics in the field. The larger the circle, the higher the frequency of occurrence of the specific keyword, and smaller the distance between two keywords/circles, the higher co-occurrence of the terms. Colors indicate clusters of closely related terms. Cluster analysis based on 65 keywords co-occurrence identified six significant clusters, (red, green, blue, mustered). The main

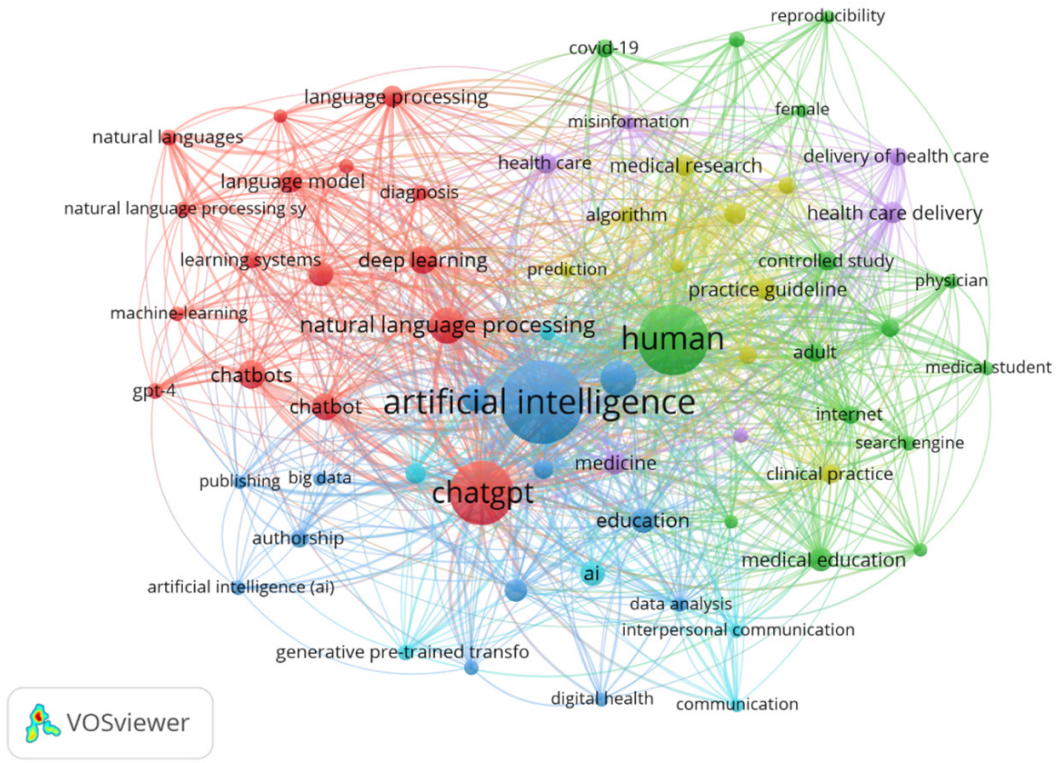

Figure 2: Selected Significant keywords networks.

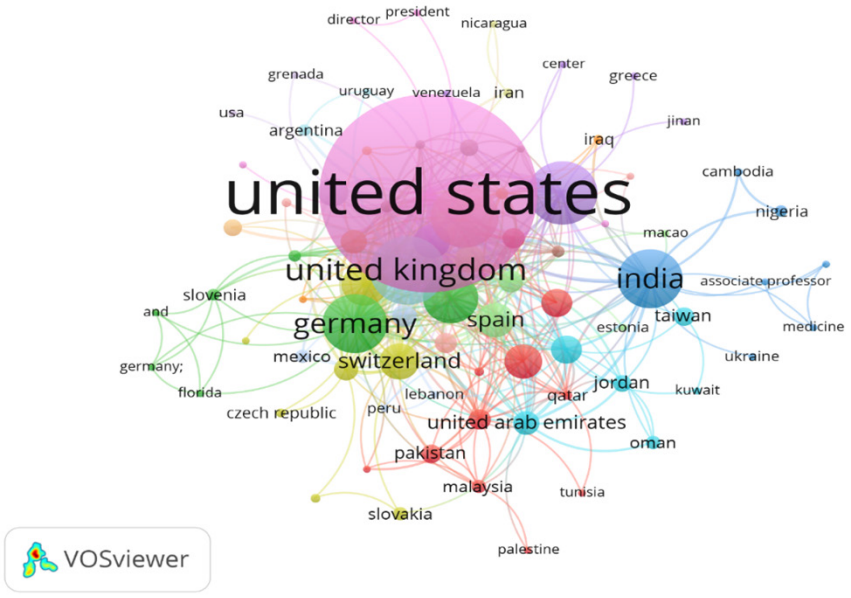

Figure 3: Most productive countries.

keyword, artificial indulgency was situated in the red cluster and was highly connected with keywords from another cluster.

The list of 65 keywords, as observed in the six clusters are as follows:

First Cluster (Red Color) (16 keywords): chatbot, chatbots, ChatGPT, computational linguistics, deep learning, diagnosis, generative ai, gpt-4, language model, language processing, large language model, learning systems, machine – learning, natural

Table 4: Most productive and Impactful Journals.

Sl. No.	Journal Name	TP	TC	CPP
1	Annals of Biomedical Engineering	26	34	1.30
2	Medical Teacher	7	5	3.50
3	Healthcare (Switzerland)	6	34	5.66
4	Aesthetic Plastic Surgery	6	8	1.33
5	Radiology	5	127	25.40
6	Asian Journal of Psychiatry	5	11	55.00
7	Obesity Surgery	5	6	1.20
8	American Journal of Obstetrics and Gynecology	4	18	4.50
9	JMIR Medical Education	4	54	13.50
10	Resuscitation	4	18	4.50
11	Clinical Chemistry and Laboratory Medicine	4	5	1.25
12	Electronics (Switzerland)	4	2	0.50
13	Frontiers In Artificial Intelligence	4	2	0.50
14	Scientific Reports	4	3	0.75
15	Accountability In Research	3	26	8.67
16	International Journal of Environmental Research and Public Health	3	7	2.34
17	Journal of Educational Evaluation for Health Professions	3	25	8.34
18	Knee Surgery, Sports Traumatology, Arthroscopy	3	13	4.34
19	Library Hi Tech News	3	26	8.67
20	Cancer Research, Statistics, And Treatment	3	3	1.00
21	Eye (Basingstoke)	3	2	0.67
22	Jama Internal Medicine	3	12	4.00
23	Journal of Cancer Research and Clinical Oncology	3	4	1.33
24	Journal of Medical Systems	3	20	6.67
25	Journal of University Teaching and Learning Practice	3	1	0.33
	Total output of top 25 journals	121	466	3.85
	ChatGPT and Medicine total output in Journals	532		0.00
	Share of top 25 journals in ChatGPT and Medicine	22.74%		0.00

language process, natural language processing system, natural languages.

Second Cluster (Green Color) (15 keywords): adult, controlled study, coronavirus disease 2019, covid-19, female, health care personnel, human, internet, learning, medical education, medical student, medical health, physician, reproducibility, search engine.

Third Cluster (Blue Color) (13 Keywords): artificial intelligence, ai, authorship, big data, data analysis, digital health, education, human experiment, language, large language models, OpenAI, publishing, software.

Fourth Cluster (Mustered Color) (9 keywords): algorithm, clinical decision support, clinical practice, medical information, medical literature, medical research, patient care, practice guideline, prediction.

Fifth Cluster (in Blue Color) (6 keywords): delivery of health care, health care, health care delivery, healthcare, medicine, misinformation.

Sixth Cluster (sky blue Color) (6 keywords): ai, communication, decision support system, generative pre trained treat, interpersonal communication, radiology.

Most productive organizations

In all 1524 organizations participated in in global ChatGPT and Medicine research. The top 231 organizations contributed 3 to 8 papers and these together contributed 532 papers. On further analysis, it was observed that 15 organizations contributed more than the average publications productivity Duke University 8 papers.

Table 5: Most significant keywords.

Sl. No.	Keywords	Occurrences	TLS	SN	Keywords	Occurrences	TLS
1	Artificial Intelligence	253	1204	16	Internet	13	124
2	Human	183	1097	17	Medicine	19	116
3	ChatGPT	153	618	18	Clinical Practice	14	110
4	Language	49	371	19	Medical Information	13	100
5	Machine Learning	54	305	20	Delivery health care	13	99
6	Natural language Processing	50	301	21	Radiology	15	98
7	Human Experiment	28	228	22	Patient Care	11	95
8	Deep learning	31	186	23	Health care personal	12	81
9	Medical Research	18	157	24	Ai	23	86
10	Medical Literature	18	140	25	Algorithms	11	84
11	Health Care Delivery	18	138	26	Scientific Literature	10	82
12	Practice Guideline	17	133	27	Search Engine	10	75
13	Large language model	24	132	28	Knowledge	8	73
14	Chatbot	28	121	29	Physician	9	65
15	Language Processing	17	128	30	Big data	7	30

TLS: Total Link Strength.

In all 1524 organizations participated and together contributed 532 papers each in global ChatGPT and Medicine research. The 40 organizations contributed 2 papers each, 6 organizations are contributed 3 papers each. 10 organizations are contributed 4 papers each, 3 organizations are contributed 6 papers each and two organizations contributed 5 and 8 papers.

On further analysis, it was observed that 15 organizations contributed more than the highly cited papers (25%) of all 60 organizations. Centre for Data Science, New York University, New York placed first place with 60 citations followed by JAMA, United States placed second with 55 citations, Section for Biomedical Informatics and Data Science, Yale University School of Medicine, United States received 49 citations, Department of Radiology, Le Bonheur Children's Hospital, University of Tennessee, Health Science Centre College of Medicine, United States received 41 citations, etc.

The total link strength of top 60 organizations varying from 1 – 34, with highest collaboration strength, duke molecular physiology institute (34 links), "center for space medicine Baylor college of medicine, USA (33 links), university of Michigan, USA (33 links), department for orthopedics and traumatology, USA (33 links), "human-machine perception laboratory, USA (10 links), etc.

Most Proactive and Impactful Countries

In all 80 countries participated to global ChatGPT and Medicine research, of which 33 countries contributed 1-19 papers each, 12 countries contributed 13 – 30 papers each, 6 countries contributed 37–46 and 1 country contributed 196 papers.

The top 33 countries contributed 5 – 195 papers and those together contributed 532 papers with 886 citations, according to more than 100.00% share each in global publications and citations. Further the total link strength of top 33 countries varied from 2 to 125, with highest collaboration strength and intensity depicted by United states (127 linkages) followed by United Kingdom (80 linkages), Germany (60 linkages), China (46 linkages), Spain (44 linkages), Switzerland (42 linkages), Australia (41 linkages), The Netherlands (38 linkages), Italy (35 linkages), Italy (35 linkages), UAE (31 linkages), Canada and France (30 linkages), India (29 linkages) and etc. The country-to-country collaborative linkages among top 33 countries varied from 2 – 18, with highest collaborative linkages and intensity (18), depicted by country pairs "USA-UK", followed by "USA-China" (17 linkages), "USA-Australia" (8 linkages), "UK-Italy (7 linkages), "Italy-Spain (6 linkages) "USA-India, "Germany-Australia, (5 linkages), "USA-UAE (3 linkages), etc. Among top 33 countries USA become the centre of collaboration attraction, followed by UK and Germany.

Table 6: List of top 10 highly cited papers for studies related to ChatGPT and Medicine.

Rank	Authors	Title	Sources	Citations
1	Shen, Y., Heacock, L., Elias, J., ...Shih, G., Moy, L.	ChatGPT and Other Large Language Models Are Double-edged Swords.	Radiology, 307(2), e230163	60
2	Flanagin, A., Bibbins-Domingo, K., Berkwits, M., Christiansen, S.L.	Nonhuman authors and Implications for the Integrity of Scientific Publication and Medical Knowledge.	JAMA, 329(8), pp. 637–639	55
3	Gilson, A., Safranek, C.W., Huang, T., ... Taylor, R.A., Chartash, D.	How Does ChatGPT Perform on the United States Medical Licensing Examination? The Implications of Large Language Models for Medical Education and Knowledge Assessment.	JMIR Medical Education, 9, e45312	49
4	Biswas, S.	ChatGPT and the Future of Medical Writing.	Radiology, 307(2), e223312	41
5	Rudolph, J., Tan, S., Tan, S.	ChatGPT: Bullshit spewer or the end of traditional assessments in higher education?	Journal of Applied Learning and Teaching, 6(1), pp. 342–363	35
6	Kasneci, E., Sessler,K., Küchemann, S., ... Kuhn, J., Kasneci, G.	ChatGPT for good? On opportunities and challenges of large language models for education.	Learning and Individual Differences, 103, 102274	34
7	Sallam, M.	ChatGPT Utility in Healthcare Education, Research, and Practice: Systematic Review on the Promising Perspectives and Valid Concerns.	Healthcare (Switzerland), 11(6), 887	32
8	Lee, P., Bubeck, S., Petro, J.	Benefits, Limits, and Risks of GPT-4 as an AI Chatbot for Medicine.	New England Journal of Medicine, 388(13), pp. 1233–1239	30
9	Salvagno, M.,Taccone, F.S.,Gerli, A.G.	Can artificial intelligence help for scientific writing?	Critical Care,27(1), 75	28
10	Gordijn, B.,Have, H.	ChatGPT: evolution or revolution?	Medicine, Health Care and Philosophy,26(1), pp. 1–2	24

The Country co-authorship network in ChatGPT and Medicine, built by the VOSviewer, is presented in Figure 3 by network analysis, the country co-authorship data has been presented in 5 clusters: Cluster 1 includes 8 countries namely China, India, Jordan, Oman, Saudi Arabia, Slovakia, Taiwan, United Arab Emirates, Cluster 2: Includes 7 countries, Canada, Hong Kong, Ireland, Mexico, UK, United States, Cluster 3: includes 7 countries, Austria, Denmark, France, Netherlands, Sweden, Switzerland, Turkey. Cluster 4: Includes 4 countries, Italy, Malaysia, Pakistan, Poland, South Korea, Spain. Cluster 5: Includes 5 countries, Australia, Brazil, Germany, Japan, Singapore.

Table 6 shows the top 10 highly cited papers in the field of ChatGPT and Medicine, these are highly cited papers in terms of authors, year, title, Sources and citations. After reading these papers, the study found that many papers are co-authored. The problem is likely difficult to solve, which requires the ingenuity of many specialists and researchers in the field of ChatGPT and Medicine. Among these 10 highly cited papers, the first paper "ChatGPT and Other Large Language Models Are Double-edged Swords" published and placed 1st rank with 60 citations, followed the paper "Non-human authors and Implications for the Integrity of Scientific Publication and Medical Knowledge" placed 2nd rank with 55 citations etc.

CONCLUSION

The bibliometric analysis of ChatGPT's applications in medicine has provided valuable insights into its impact and potential. The research conducted thus far has showcased the diverse applications of ChatGPT in clinical decision support, medical coding, patient counselling and education, and biomedical literature mining. Collaborative networks and influential authors have contributed significantly to this field, driving advancements and promoting interdisciplinary research. However, challenges related to AI ethics and the integration of ChatGPT with other technologies remain areas for future exploration. By leveraging the findings of bibliometric analyses, researchers, practitioners, and policymakers can make informed decisions regarding the integration and utilization of ChatGPT in medical practice,

ultimately contributing to improved patient care and biomedical research.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

AI: Artificial Intelligence; **CPP:** Citations per Paper; **DE:** Author's Keywords; **doc:** Document; **ID:** Keywords Plus; **MS:** Microsoft; **R:** R programming language; **TLS:** Total Link Strength; **TP:** Total Papers; **TC:** Total Citations; **USA:** United States of America; **UK:** United Kingdom.

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