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Research Article

Artificial Intelligence in Radiology: Global Research Trends and Insights (2000-2025)

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ABSTRACT

Background and Objectives: Artificial Intelligence (AI) applications in radiology are crucial for assisting radiologists in detecting abnormal findings in imaging examinations and reaching a diagnosis. Hence, this study conducted a bibliometric analysis to uncover global research trends on AI applications in radiology, **Methodology :** An electronic search of the Scopus database was conducted on May 02, 2025, using specific keywords to retrieve documents on AI applications in radiology. The search specifically targeted documents published over 26 years, from January 2000 to May 2025. The collected data were downloaded as a plain text file and analyzed using RStudio 2024.12.1, Bibliometrix (biblioshiny), and the Visualization of Similarities (VOS) viewer software (version 1.6.20). The "Article" type documents published in English were included. **Results:** 12,139 research documents on AI applications in radiology were published by global researchers, with a peak publication count in 2024. The University of California, United States, is the leading contributor with 788 documents. Saba L. and Suri JS had 37 publications. China was the most productive country with 3,443 research documents, while the United States published 3,145 documents but showed the highest citation count (*n*=98,928). The strongest collaboration was found between China and the United States, with 415 research documents. **Conclusion:** The publication of AI applications in radiology has improved extensively since 2018 and is expected to peak in 2024. Global researchers can further progress their affinity for AI in radiology by producing additional high-quality research documents in the future. Further, expanding international research collaboration networks across various countries is warranted.

Keywords: Artificial Intelligence, Bibliometrics, Radiology, Research, Scopus.

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INTRODUCTION

Radiology is essential for modern healthcare, but a substantial and rapid increase in the availability and quality of images has placed additional strain on radiologists worldwide (Bruls and Kwee, 2020). AI addresses this challenge by providing tools for faster, more accurate image interpretation and diagnosis. Subsequently, the integration of AI in radiology aids radiologists in identifying suspicious findings in imaging examinations, making diagnoses, selecting tailored patient protocols, following dose parameters, estimating radiation risks, and reducing diagnostic errors (Derevianko *et al*., 2023). In this way, AI is anticipated to reduce workload by speeding up reporting processes, reducing medical errors, and improving competence in repetitive activities (Khafaji *et al*., 2022).

Previous studies have shown that AI has demonstrated strengths in mammography, neuroimaging, lung cancer screening, and abdominal ultrasonography. Its performance can equal or even outperform that of experienced healthcare workers (Ardila *et al*., 2019; Dembrower *et al*., 2020; Watanabe *et al*., 2019). Also, AI is widely used across radiology, and its algorithms focus on improving image quality and patient safety (Akagi *et al*., 2019; Bash *et al*., 2021; Zhang and Yu, 2018). It plays a role in detecting and defining lesions across different regions and disease types (Arefan *et al*., 2020; Yoo *et al*., 2019). Furthermore, a recent study found that Deep Learning (DL) holds great promise for diagnosing imaging problems, regardless of imaging modality (Aggarwal *et al*., 2021). Machine Learning (ML), a subset of AI, is especially enhancing the field of radiology by reinforcing image analysis and reducing diagnostic errors. AI algorithms process and interpret data, executing tasks that match or exceed human cognitive competencies (Najjar, 2023).

Crucial AI applications in radiology embrace refining image analysis via Computer-Aided Diagnosis (CAD) systems, which enhance the detection of abnormalities in imaging, such as tumors.

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Natural Language Processing (NLP) is also applied to assist with report writing and clinical decision-making in radiology (Bhandari, 2024). These applications have demonstrated high precision in analyzing medical images, merging data from imaging modalities such as CT, MRI, and PET to deliver comprehensive diagnostic insights. These progressions enable tailored treatment scheduling and assist radiologists' workflows (Bhandari, 2024). From the viewpoint of the radiology community, there is a pertinent interest in using AI to progress workflow applications and patient care (Derevianko *et al*., 2023). However, integrating AI into radiology workflows poses several challenges, including ensuring transparency, protecting patient data, and avoiding bias, which must be addressed (Bhandari, 2024). Moreover, a previous study found that concurrent use of AI applications increased radiologists' reading time (Müller *et al*., 2022). A recent study measured the radiology professionals' awareness and acceptance of AI (Hamd *et al*., 2024). Another study examined residents' readiness for AI in radiology in Saudi Arabia (Khafaji *et al*., 2022). Another recent study examined the effect of the clinical application of an AI-based Computer-Aided Detection (CAD) system for prostate MRI reading on radiologists' workflow, stress, workload, and workflow throughput time (Wenderott *et al*., 2024).

Various reviews have been conducted on the application of AI in radiology (Mello-Thoms *et al*., 2023; Najjar, 2023; Pierre *et al*., 2023; Wenderott *et al*., 2024). Though studies discuss the application of AI in radiology, bibliometric analysis of AI applications in radiology has gained importance because it enables researchers to measure trends, detect emerging trends, and demonstrate relationships between different scientific topics (Donthu *et al*., 2021). Further, such analysis helps assess the published literature on a specific topic. It focuses on identifying the most influential publications on that topic, detecting trends in a particular area, revealing potential gaps, and emphasizing the need for further research (Hughes *et al*., 2023). Various researchers conducted bibliometric analyses of AI applications in radiology using several electronic databases over different time intervals (Alotaibi *et al*., 2025; Babu *et al*., 2024; Hughes *et al*., 2023; Lv *et al*., 2024; Salli *et al*., 2023). To contribute to the existing literature, this study aims to analyze bibliometric data to identify global research trends in AI applications in radiology, enabling researchers to gain knowledge about the field and conduct further research.

METHODOLOGY

Study Design

This study employed bibliometric analysis to examine the global research trends of AI applications in radiology. An electronic search was conducted through the Scopus database for documents published from January 2000 to May 2025.

Procedure

The search terms used in the Scopus database were TITLE (radiology OR imaging OR "X-ray" OR "CT Scan" OR "Computed Tomography" OR "MRI" OR "Magnetic Resonance Imaging" OR ultrasound OR fluoroscopy OR "Nuclear Medicine" OR "PET Scan" OR "Positron Emission Tomography" OR mammography OR angiography OR echocardiography OR "Electrocardiogram" OR "Electroencephalogram") AND TITLE ("Artificial Intelligence" OR "Machine Learning" OR "Deep Learning" OR "Natural Language Processing" OR "Data Science" OR "Big Data" OR "Artificial Neural Networks" OR "chatbots" OR "Virtual Assistants"). Besides, the inclusion criteria were used to screen documents to be included in the bibliographic analysis: i) documents published on AI, ii) documents published in the Scopus database between 2000 and May 2025, and iii) those published on "Article" type, and in the English language. According to a previous study, this study designated a specific period to gather the necessary data for the bibliometric analysis (Weng *et al*., 2020). Consequently, 12139 documents were retrieved on May 02, 2025, after removing irrelevant and duplicate documents. The collected data (n=12139) were subjected to bibliometric analysis. Also, this study does not require Institutional Review Board approval, as it is a bibliometric analysis.

Data Analysis

The data were downloaded from the Scopus database as a plain-text file. RStudio 2024.12.1, with the bibliometrix

Table 1: Main Information on Collected Data.

Description	Results
Timespan	2000:2025
Sources	2483
Documents	12139
Annual Growth Rate %	29.96
Document Average Age	2.7
Average Citations Per Doc	21.14
References	427330
DOCUMENT CONTENTS	
Keywords Plus (Id)	35335
Author's Keywords (De)	18460
AUTHORS	
Authors	62757
Authors Of Single-Authored Docs	187
AUTHORS COLLABORATION	
Single-Authored Docs	204
Co-Authors Per Doc	7.57
International Co-Authorships %	27.06
DOCUMENT TYPES	
Article	12139

(biblioshiny) software, was used to analyze data on publication frequency, most influential institutions, most cited documents, most influential authors, country-wise collaboration, and author keywords. The Visualization of Similarities (VOS) viewer software (version 1.6.20) was used to analyze and visualize data on country-wise production with citations.

RESULTS

Table 1 offers an outline of the dataset from 2000 to May 2025. It displays that those 2483 sources constituted 12139 documents. The annual growth rate of 29.96% echoes steady research activity in AI in radiology. The documents are relatively recent, with an average age of 2.7 years, and they had a notable average of 21.14 citations per document. The extensive use of references and keywords denotes the depth and diversity of research topics on AI in radiology. The dataset revealed 62757 authors with 27.06% international co-authorship.

Table 2 illustrates year-wise publications and citations. Research on AI applications in radiology peaked in 2024, with 2,821 documents. The fewest documents were observed in 2008. Notably, global researchers showed a growing interest in conducting AI studies in radiology starting in 2018, with more than 100 publications each year. The total citations were highest in 2021 (n=52177) for 1551 documents. In 2009, 1114 documents showed the highest total citations per article of 123.78, indicating the influence of early research. On the other hand, more recent documents from 2022 to 2025 showed lower total citations per article and per year, though the publication count had improved in those years.

Table 3 lists the most influential institutions in AI research in radiology, ranked by publication count. The University of California (United States) is the foremost contributor, with 788 documents, followed by the Mayo Clinic (United States), with

Table 2: Publication Trend with Citations.

Year	Documents	Total Citations	TC per Article	TC per Year	Citable Years
2000	2	10	5	0.19	26
2001	5	146	29.2	1.17	25
2002	5	134	26.8	1.12	24
2003	8	441	55.12	2.4	23
2004	2	67	33.5	1.52	22
2005	4	117	29.25	1.39	21
2007	6	156	26	1.37	19
2008	1	34	34	1.89	18
2009	9	1114	123.78	7.28	17
2010	14	734	52.43	3.28	16
2011	11	1015	92.27	6.15	15
2012	21	1145	54.52	3.89	14
2013	23	942	40.96	3.15	13
2014	37	1869	50.51	4.21	12
2015	42	3715	88.45	8.04	11
2016	67	6758	100.87	10.09	10
2017	98	9792	99.92	11.1	9
2018	198	19842	100.21	12.53	8
2019	498	37102	74.5	10.64	7
2020	895	49780	55.62	9.27	6
2021	1551	52177	33.64	6.73	5
2022	2021	35117	17.38	4.34	4
2023	2400	24423	10.18	3.39	3
2024	2821	9288	3.29	1.65	2
2025	1400	673	0.48	0.48	1
Total	12139	256591			

760 research documents. In addition, three institutions in South Korea have contributed to global research on AI in radiology.

Of the 62757 authors, the top 15 were identified based on publication counts for AI applications in radiology, as listed in Table 4. Among these authors, Saba L and Suri JS published the most documents (*n*=37). Their documents received citations, with an average of around 1800 and 49, respectively. Notably, Erickson BJ published only 25 documents; however, those documents had the highest citation counts and average citations of 2645 and 105.80, respectively.

Table 3: Most Influential Institutions.

Affiliation	Country	Articles
University of California	USA	788
Mayo Clinic	USA	760
Capital Medical University	China	664
Fudan University	China	597
Stanford University	USA	580
Harvard Medical School	USA	559
Zhejiang University	China	474
Sichuan University	China	448
Huazhong University of Science and Technology	China	437
Sun Yat-Sen University	China	428
University of Ulsan College of Medicine	South Korea	410
Shanghai Jiao Tong University	China	365
University of Pennsylvania	USA	314
Yonsei University College of Medicine	South Korea	293
Seoul National University Hospital	South Korea	291

Bernard (2018) published a document in the journal IEEE Transactions on Medical Imaging, which has been cited 1,461 times and has an average of 182.63 citations per year. The author Ardila (2019) published a document in Nature Medicine that received the highest number of citations per year (99.71), totaling 1,398 citations. In addition, a document by Roberts (2021) in Nature Machine Intelligence received the highest normalized citation score of 20.87 (Table 5).

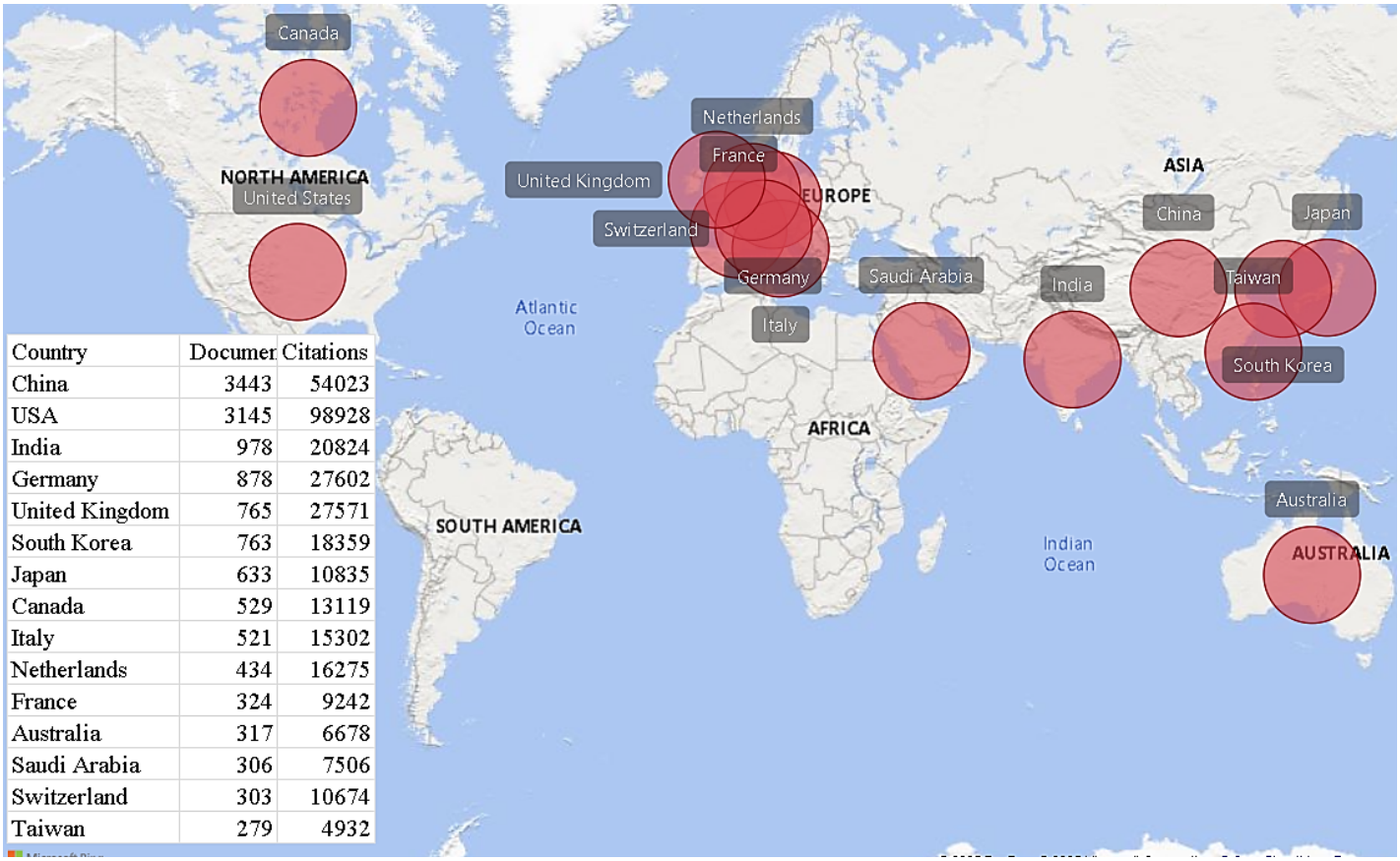
Figure 1 illustrates the top 15 country-wise patterns of citations for documents related to AI applications in radiology. China had the highest publication count (*n*=3443) with 54023 citations, followed by the United States with 3145 documents and 98928 citations. The Netherlands published 434 documents; however, it had the topmost average citations per document (37.50), indicating the influence of quality over quantity.

While reviewing the results, this study detected the strongest collaboration between China and the United States with 415 research documents. Notably, the United States accounts for 9 of the top 15 countries in international collaboration (Table 6).

Table 7 displays the most frequently occurring author keywords. Among the top 15 author keywords, "Deep Learning" had the highest frequency (*n*=11141), followed by "Human" (*n*=7419) and "Female" (*n*=6716).

Table 4: Most Productive Authors.

Authors	Documents	Citations	Norm. citations	Avg. citations	Avg. norm. citations
Saba, Luca	37	1806	62.52	48.81	1.69
Suri, Jasjit S.	37	1847	60.32	49.92	1.63
Nickel, Dominik	36	568	45.86	15.78	1.27
Wang, Wei	35	840	27.72	24.00	0.79
Friedman, Paul A.	33	2120	54.33	64.24	1.65
Abe, Osamu	29	507	28.95	17.48	1.00
Afat, Saif	28	500	54.25	17.86	1.94
Yang, Guang	27	595	35.53	22.04	1.32
Herrmann, Judith	26	509	42.61	19.58	1.64
Turkbey, Baris	26	372	28.29	14.31	1.09
Erickson, Bradley J.	25	2645	52.41	105.80	2.10
Gassenmaier, Sebastian	25	544	44.02	21.76	1.76
Schoepf, U. Joseph	25	1296	28.43	51.84	1.14
Yasaka, Koichiro	24	413	25.35	17.21	1.06
Zaidi, Habib	24	1127	47.54	46.96	1.98



Country	Documer	Citations
China	3443	54023
USA	3145	98928
India	978	20824
Germany	878	27602
United Kingdom	765	27571
South Korea	763	18359
Japan	633	10835
Canada	529	13119
Italy	521	15302
Netherlands	434	16275
France	324	9242
Australia	317	6678
Saudi Arabia	306	7506
Switzerland	303	10674
Taiwan	279	4932

Figure 1: Country-wise publication pattern with citations.

Table 5: Most cited documents.

Documents	DOI	Total Citations	TC per Year	Normalized TC
BERNARD O, 2018, IEEE TRANS MED IMAGING	10.1109/TMI.2018.2837502	1461	182.63	14.58
ARDILA D, 2019, NAT MED	10.1038/s41591-019-0447-x	1398	199.71	18.76
ERICKSON BJ, 2017, RADIOGRAPHICS	10.1148/rg 2017160130	1176	130.67	11.77
LIU X, 2019, LANCET DIGIT HEALTH	10.1016/ S2589-7500(19)30123-2	1139	162.71	15.29
ATTIA ZI, 2019, NAT MED	10.1038/s41591-018-0240-2	841	120.14	11.29
KAISSIS GA, 2020, NAT MACH INTELL	10.1038/s42256-020-0186-1	782	130.33	14.06
SHEN L, 2019, SCI REP	10.1038/s41598-019-48995-4	745	106.43	10.00
ROBERTS M, 2021, NAT MACH INTELL	10.1038/s42256-021-00307-0	702	140.40	20.87
CHILAMKURTHY S, 2018, LANCET	10.1016/ S0140-6736(18)31645-3	700	87.50	6.99
ZACHARAKI EI, 2009, MAGN RESON MED	10.1002/mrm.. 22147	693	40.76	5.60
CHENG J-Z, 2016, SCI REP	10.1038/srep24454	643	64.30	6.37
NAGENDRAN M, 2020, BMJ	10.1136/bmj.m689	625	104.17	11.24
ISMAEL AM, 2021, EXPERT SYS APPL	10.1016/j.eswa.2020.114054	622	124.40	18.49
ZHOU SK, 2021, PROC IEEE	10.1109/JPROC.2021.3054390	605	121.00	17.98
SINHA A, 2017, OPTICA	10.1364/OPTICA.4.001117	596	66.22	5.96

Table 6: Country-wise Collaboration.

From	To	Frequency
China	USA	415
USA	Germany	253
USA	United Kingdom	204
USA	Canada	194
USA	Italy	131
USA	India	121
USA	Netherlands	117
USA	Korea	116
China	United Kingdom	101
USA	Switzerland	95
Germany	United kingdom	93
United Kingdom	Italy	85
Germany	Switzerland	75
Germany	Netherlands	73
USA	France	70

Table 7: Most Frequently Used Authors' Keywords.

Terms	Frequency
Deep Learning	11141
Human	7419
Female	6716
Article	6683
Male	5943
Adult	5195
Humans	5149
Machine Learning	5134
Diagnostic Imaging	4409
Artificial Intelligence	3997
Controlled Study	3930
Middle Aged	3813
Aged	3693
Procedures	3594
Major Clinical Study	3534

DISCUSSION

This study offers bibliometric insights into AI applications in radiology by analyzing data extracted from the Scopus database for documents published between 2000 and May 2025. The analysis covered publication and citation patterns, country-wise production and collaboration, influential affiliations and authors, and the most frequently used keywords.

Publication Trends

The current study identified 12,139 documents on AI applications in radiology from the Scopus database, published from 2000 to May 2025. Consistent with previous research, the number of publications has increased since 2018, with over 100 documents per year. The publication count peaked in 2024 at 2,821 documents, suggesting strong and growing interest among global researchers in AI applications in radiology.

The influence of early research was evident, with the highest total citations per article (123.78) coming from documents published in 2009. Conversely, recent documents from 2022 to 2025 showed lower total citations per article and per year compared to previous years. This outcome highlights the need to improve both the quantity and quality of research on AI applications in radiology, as well as to enhance the wide visibility of these research documents.

Furthermore, no recent documents published between 2022 and 2025 appeared among the top 15 most-cited documents on AI applications in radiology. The most cited documents were published earlier, with Bernard (2018) having 1,461 citations and Ardila (2019) having 1,398 citations. In one comparison, a document by (Wolterink *et al.*, 2017) was found to be the top-most-cited work in AI for cardiovascular imaging in a separate study using the WoS database.

Influential Institutions and Authors

Regarding affiliations, the University of California (United States) led the research with 788 documents, followed by the Mayo Clinic (United States) with 760, which aligns partially with other bibliometric studies that noted US institutions, such as Harvard Medical School, as top contributors in related fields, such as AI in orthopedic imaging. However, some previous studies using databases other than Scopus found different institutions, such as one in China, as leading contributors in specific sub-fields.

The most productive authors were Saba L and Suri JS, each publishing 37 documents on AI applications in radiology. Their documents received an average of 1,800 citations and 49, respectively. Notably, Erickson BJ published only 25 documents but presented the highest citation count (2,645) and the highest average citations (105.80). These observations suggest that researchers should prioritize the quality of their papers over quantity, consistent with similar findings from other bibliometric studies on AI in cardiovascular imaging and radiotherapy.

Country Production and Collaboration

Using the Scopus database, this study detected that China was the topmost country in productivity, with the highest publication count of 3,443 documents and 54,023 citations. However, the United States published 3,145 documents but reported the highest citation count of 98,928, consistent with related research that found China was most productive. Still, the United States had a

higher citation count, suggesting that some of China's documents may be of lower quality. Conversely, the Netherlands published 434 documents with 16,275 citations, yet had an average of 37.50 citations per document, further highlighting the importance of research quality in AI applications in radiology.

The strongest international collaboration was detected between China and the United States, with 415 research documents, underscoring their crucial effort and leadership in the field. The United States was a key partner, accounting for 9 of the top 15 international collaborations. This observation aligns with other studies that noted strong collaboration centers involving the United States, the United Kingdom, and Germany.

Finally, the most frequently used author keywords were identified. "Deep Learning" showed the highest frequency (n=11,141), followed by "Human" (n=7,419) and "Female" (n=6,716). The high frequency of "Deep Learning" is consistent with its significance as a research hotspot in other related bibliometric studies on AI in radiotherapy and orthopedic imaging.

This study's limitations include restricting the search to the Scopus database, "Article" type, and the English language. Future research could expand the analysis to other databases, such as PubMed and Web of Science (WoS), or focus on research hotspots and co-cited entities through 2025.

CONCLUSION

This study found that the publication frequency of AI applications in radiology increased progressively from 2018, peaking in 2024. Nevertheless, the most recent documents showed low citation counts-total citations per article and per year-despite improved publication counts in those years. The University of California (United States) is the leading contributor, with 788 documents on AI applications in radiology. Concerning the authors, Saba L. and Suri JS showed the highest publication count of 37. Among countries, China was the leading publisher, with 3,443 documents and 54,023 citations. However, the United States published 3,145 research documents with the highest citation count of 98,928. Notably, the Netherlands published 434 research documents with 16,275 citations, yielding an average of 37.50 citations per document, highlighting the importance of the quality of research on AI applications in radiology. The strongest collaboration was found between China and the United States, with 415 research documents on AI applications in radiology. Intensifying research collaboration among various countries is warranted in the future. This study offers a vital, current bibliometric roadmap using the Scopus database, adding significant value to the limited literature on research trends in AI applications in radiology from 2000 to 2025.

ABBREVIATIONS

AI: Artificial Intelligence; **DL:** Deep Learning; **ML:** Machine Learning; **CAD:** Computer-Aided Diagnosis/Detection; **NLP:** Natural Language Processing; **CT:** Computed Tomography; **MRI:** Magnetic Resonance Imaging; **PET:** Positron Emission Tomography; **VOS:** Visualization of Similarities.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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