Investigation

Artificial intelligence applications in dentistry

A bibliometric review with an emphasis on computational research trends within the field

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Supplemental material is available online.

ABSTRACT

Background. The aim of this study was to understand the trends regarding the use of artificial intelligence in dentistry through a bibliometric review.

Types of Studies Reviewed. The authors performed a literature search on Web of Science. They collected the following data: articles—number and density of citations, year, key words, language, document type, study design, and theme (main objective, diagnostic method, and specialties); journals—impact factor; authors—country, continent, and institution. The authors used Visualization of Similarities Viewer software (Leiden University) to analyze the data and Spearman test for correlation analysis.

Results. After selection, 1,478 articles were included. The number of citations ranged from 0 through 327. The articles were published from 1984 through 2024. Most articles were characterized as proof of concept (979). Definition and classification of structures and diseases was the most common theme (550 articles). There was an emphasis on radiology (333 articles) and radiographic-based diagnostic methods (715 articles). China was the country with the most articles (251), and Asia was the continent with the most articles (871). The Charité–University of Medicine Berlin was the institution with the most articles (42), and the author with the most articles was Schwendicke (53).

Practical Implications. Artificial intelligence is an important clinical tool to facilitate diagnosis and provide automation in various processes.

Key Words. Deep learning; machine learning; dentistry; bibliometrics.

JADA 2024:■(■):■-■
https://doi.org/10.1016/j.adaj.2024.05.013

Artificial intelligence (AI) is an emerging field of computer science in which the developed techniques allow computers to act similarly to humans in performing functions related to recognition, learning, and use.[1] In life sciences and health care, 2 types of AI methodologies can be applied: physical and virtual. Physical AI involves the use of advanced robots or automated robotic arms,[2] whereas virtual AI is based on algorithms that help with clinical decisions and deep understanding of diseases.[3]

Virtual AI methodologies can be divided fundamentally into 2 approaches: knowledge-based AI and data-based AI. Knowledge-based AI aims to model human knowledge and is built on the basis of previous concepts and knowledge to provide a problem-solving method.[1,4] Data-driven AI runs through training mathematical models to predict or identify patterns on the basis of data interpretation. A widely used machine learning model is neural networks, which show a superior performance over traditional machine learning algorithms, especially when dealing with complex data structures such as images or language.[5] In computer science, a neural network is a computational model that teaches computers to process data in a way inspired by the human brain capable of performing machine learning as well as pattern recognition. It is a type of machine learning process that uses interconnected nodes or neurons in a layered structure, similar to the human brain.[6]

Due to the large amount of dental-related data available in electronic format, data-driven AI has received a lot of attention in dentistry,[7] given its ability to provide greater diagnostic accuracy, faster responses, and better results for patients.[8,9] The applicability of AI in dentistry is widespread, ranging from the diagnosis to the treatment of various oral conditions and diseases.[5,10,11] Also, the application of AI goes beyond academic research and encompasses various commercial areas in dentistry. This expansion of use is supported by the digitalization of processes and methods related to dentistry, for which demand for innovative solutions has increased markedly.[12]

In the literature, bibliometric analyses are reported that explore the application of AI in subspecific areas within dentistry, such as orthodontics and maxillofacial radiology.[13,14] However, to our knowledge, a global bibliometric analysis investigating the use of AI in dentistry has not been performed. Such an approach has the potential to show and inform researchers and clinical dentists about the applications of AI within dentistry, the most explored areas and characteristics, and the less explored interfaces that require more focus for the growth of the field. Our study has substantial value in indicating the scientific status of AI in dentistry in a clear and concise manner. Therefore, in this bibliometric study, we aimed to understand trends in AI within dentistry.

METHODS

The study was conducted following the Guideline for Reporting Bibliometric Reviews of the Biomedical Literature.[15]

Search strategy

On March 15, 2024, we conducted an advanced electronic search on the Web of Science Core Collection (WoS-CC) database. We defined a search strategy considering terms from the Medical Subject Headings, synonyms, and relevant terms on AI and dentistry combined with Boolean operators (AND/OR). We used no date, language, or filter restrictions to generate a broader and more comprehensive search. To ensure accurate comprehension and interpretation of articles in languages other than English, we consulted a proficient speaker of each respective language.

We then conducted the search with the following search strategy: TS=(("Artificial intelligence" OR "Computational Intelligence" OR "Machine Intelligence" OR "Computer Reasoning" OR "AI-based" OR "Computer Vision Systems" OR "Knowledge Acquisition" OR "Knowledge Representation" OR "Machine learning" OR "Deep learning" OR "Expert systems" OR "Natural Language Processing" OR "Neural Networks, Computer" OR "neural networks" OR "computer assisted diagnosis" OR "dental-AI" OR "AI application" OR "augmented intelligence" OR "decision support system") AND ("dental" OR "dentistry" OR "tooth" OR "teeth" OR "dentofacial" OR "maxillofacial" OR "orofacial" OR "Diagnosis, oral" OR "Oral Medicine" OR "Dental Science" OR "Oral Research" OR "oral diagnosis" OR "carious lesion*" OR "orthodontic*" OR "endodontic*" OR "caries" OR "oral radiology" OR "periodontics" OR "periodontitis" OR "periodontal" OR "periodontology" OR "oral pathology" OR "oral rehabilitation" OR "stomatology" OR "periapical lesion*" OR "canal treatment")).

Article selection was carried out by 2 independent researchers (F.P.Z., A.O.R.) after reading the title and abstract and, when necessary, the full text. In case of disagreements, a consensus was reached with a third researcher (L.M.A.). All studies that addressed the applicability of AI methods in dentistry were included. Studies that did not address the applicability of AI methods in dentistry, in addition to duplicates, corrections, letters, and notes, were excluded.

Data extraction

We tabulated the studies and extracted the following data: number and density of citations, year of publication, journal, the impact factor (IF) obtained using the 2022 report of the Journal Citation Reports (Clarivate Analytics), name of the authors, key words, language, document type, study design, theme (defined through a combination of the main objective, the diagnostic method, and a related specialty or subspecialty), country, continent, and institution (based on the corresponding author's affiliation). Regarding the study design, we classified each study as follows: systematic review, literature review, proof of concept, case report, laboratory study, observational study, or intervention study.

ABBREVIATION KEY

AI: Artificial intelligence.
CBCT: Cone-beam computed tomography.
IF: Impact factor.
WoS-CC: Web of Science Core Collection.

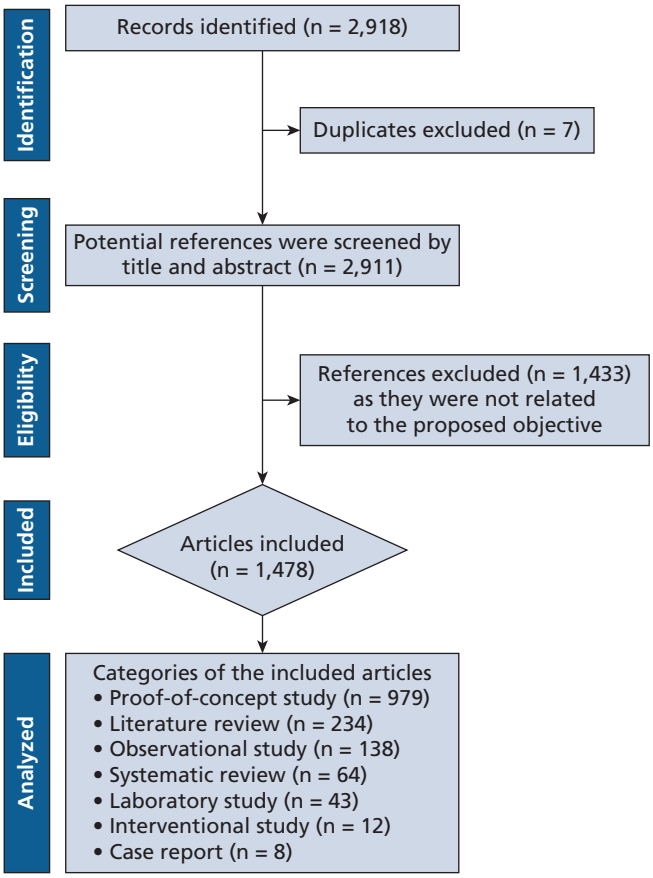


Figure 1. Study selection protocol flowchart. The flowchart represents the stages of study selection as well as the occurrence of different study designs.

Considering the study theme, we grouped the articles into 11 clusters: definition and classification of structures and diseases, patient-centered outcome, knowledge and acceptance of students and professionals regarding AI, scientific status (including reviews), development of auxiliary tools for treatment, forensic application, microbiome or genome mapping and molecular analysis, epidemiologic surveillance, color prediction in cosmetic and restorative dentistry, image processing, and others (all other themes that appeared only once or twice).

We also grouped the articles in relation to the associated dental specialty or subspecialty: caries research, radiology, oral and maxillofacial surgery, general dentistry, oral rehabilitation, pediatric dentistry, geriatric dentistry, sports dentistry, endodontics, oral pathology, temporomandibular dysfunction and orofacial pain, forensic dentistry, orthodontics, periodontics and implant dentistry, and public health. Furthermore, we grouped the studies considering the data input: radiologic imaging methods, clinical imaging, textual methods, histologic images and molecular data, artificial images and 3-dimensional models.

Data analysis

To analyze the data, we used VOSviewer, Version 1.6.17.0 (Leiden University) to generate images of existing bibliometric networks, indicating the connections between the most prevalent authors as well as the most frequent key words. We performed statistical analysis of the data using IBM SPSS Statistics for Windows, Version 24.0. We initially applied the Kolmogorov-Smirnov test to verify the normality of the data distribution, which resulted in a nonnormal distribution. Therefore, we used the Spearman correlation coefficient test to determine the correlation between the number of citations and the year of publication, that is, whether the oldest articles are in fact the most cited as well as the relationship between the number of citations and IF of the journal in 2022.

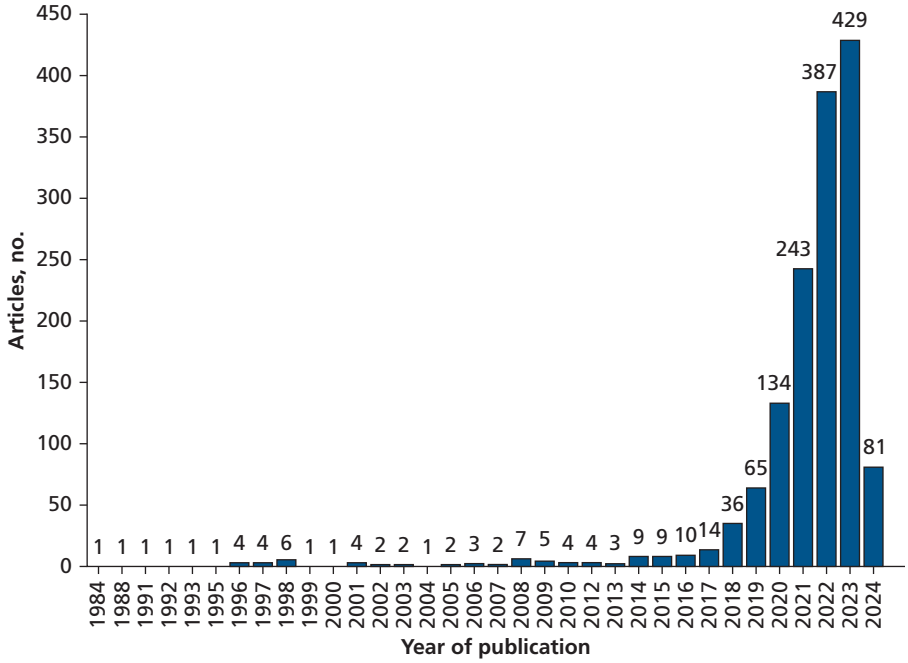


Figure 2. Distribution of the number of articles over the years. This image highlights the increasing number of articles on artificial intelligence in dentistry over the years, particularly in the period from 2020 through 2024.

RESULTS

Search results

We included 1,478 articles in this bibliometric analysis. The detailed process of study selection is shown in Figure 1.

Language and document type

Most studies on AI in dentistry were published in English (1,472), followed by Turkish (2), Chinese, French, German, and Italian (1 each). According to the type of document (WoS-CC), research articles (1,107) were the most frequent, followed by reviews (204), conferences (144), and editorial material (23).

Citation analysis

The selected articles received a total of 17,538 citations in WoS-CC. Self-citations represented 53.69% of WoS-CC citations. Published in 2018, "Detection and Diagnosis of Dental Caries Using a Deep Learning-Based Convolutional Neural Network Algorithm" was the most cited article (327 citations), by Lee and colleagues[16] and published in *Journal of Dentistry*. Published in 2020, the second most cited article was "Artificial Intelligence in Dentistry: Chances and Challenges" (222 citations) by Schwendicke and colleagues[5] and published in *Journal of Dental Research*. The third most cited article, published in 2018, was "Diagnosis and Prediction of Periodontally Compromised Teeth Using a Deep Learning-Based Convolutional Neural Network Algorithm" (195 citations), by Lee and colleagues,[17] published in *Journal of Periodontal and Implant Science*.

Regarding citation density, the article with the highest density was "Artificial Intelligence in Dentistry: Chances and Challenges" (55.50), published in 2020 in *Journal of Dental Research*,[5] followed by "Detection and Diagnosis of Dental Caries Using a Deep Learning-Based Convolutional Neural Network Algorithm" (54.50), published in 2018 in *Journal of Dentistry*,[16] and "Developments, Application, and Performance of Artificial Intelligence in Dentistry: A Systematic Review" (49.67), published in 2021 in *Journal of Dental Sciences*.[18] Using Spearman correlation, we observed a weak positive correlation between the number of citations and the journal's IF (ρ = .280) and a moderate negative correlation between the number of citations and the year of publication (ρ = −.690).

Table 1. Main journals that published studies about artificial intelligence.

JOURNAL	ARTICLES, NO.	IMPACT FACTOR
Scientific Reports	60	4.6
Journal of Dentistry	59	4.4
Diagnostics	57	3.6
BMC Oral Health	48	2.9
Applied Sciences (Basel)	41	2.7
Dentomaxillofacial Radiology	37	3.3
Journal of Dental Research	36	7.6
Clinical Oral Investigations	28	3.4
Journal of Clinical Medicine	27	3.9
IEEE Access	24	3.9
Imaging Science in Dentistry	18	1.8

Year of publication

The oldest article was published in 1984, entitled "A Computerized Decision Support System for Patient Selection in Dental Education" by Tzukert and colleagues[19] and published in *Computers in Biology and Medicine*. A large number of articles (1,274) were published in the past 5 years. The number of articles each year can be seen in Figure 2.

Journals and IF

The main journals in which the articles were published are shown in Table 1. *Scientific Reports* was the most frequent journal, with 60 articles, followed by *Journal of Dentistry* (59 articles), *Diagnostics* (57 articles), *BMC Oral Health* (48 articles), and *Applied Sciences (Basel)* (41 articles). According to Journal Citation Reports, the journals with the highest IFs in 2022 found in this study were *Cell Discovery* (IF, 33.5), *IEEE Transactions on Pattern Analysis and Machine Intelligence* (IF, 23.6), and *Nature Communications* (IF, 16.6).

Study design and themes

Most articles were classified as proof-of-concept studies (979), followed by literature reviews (234), observational studies (138), systematic reviews (64), laboratory studies (43), intervention studies (12), and case reports (5). The most prevalent theme was the definition and classification of structures and diseases (550), followed by auxiliary tool for treatment (272), scientific status (259), image processing (254), microbiome and genome mapping and molecular analysis (39), others (32), knowledge and acceptance of students and professionals (31), forensic identification (27), epidemiologic surveillance (7), color prediction in cosmetic and restorative dentistry (5), and patient-centered outcome (2).

In relation to the dental area or specialty to which the articles were associated, radiology (333) was the most frequent, followed by general dentistry (189), periodontics and implant dentistry (187), orthodontics (168), caries research (137), oral pathology (100), oral rehabilitation (85), oral and maxillofacial surgery (76), pediatric dentistry (48), endodontics (64), temporomandibular disorder and orofacial pain (30), public health (24), forensic dentistry (33), geriatric dentistry (2), and sports dentistry (1).

Considering the data used as input in the studies, a higher occurrence was observed for radiographic-based diagnostic methods (715), followed by clinical imaging (191), textual methods (138), histologic images and molecular data (51), and artificial images and 3-dimensional models (21). We classified studies that did not address diagnostic methods as "others" (334). In addition, we identified studies that used more than 1 input (28). Figure 3 shows the distribution and combination of diagnostic methods.

Countries and continents

A total of 61 countries contributed to the selected articles. Considering the number of articles per country, the first 3 were China (251), United States (164), and Republic of Korea (147). The continents with the most articles are Asia (871), Europe (328), and North America (191) (Figure 4).

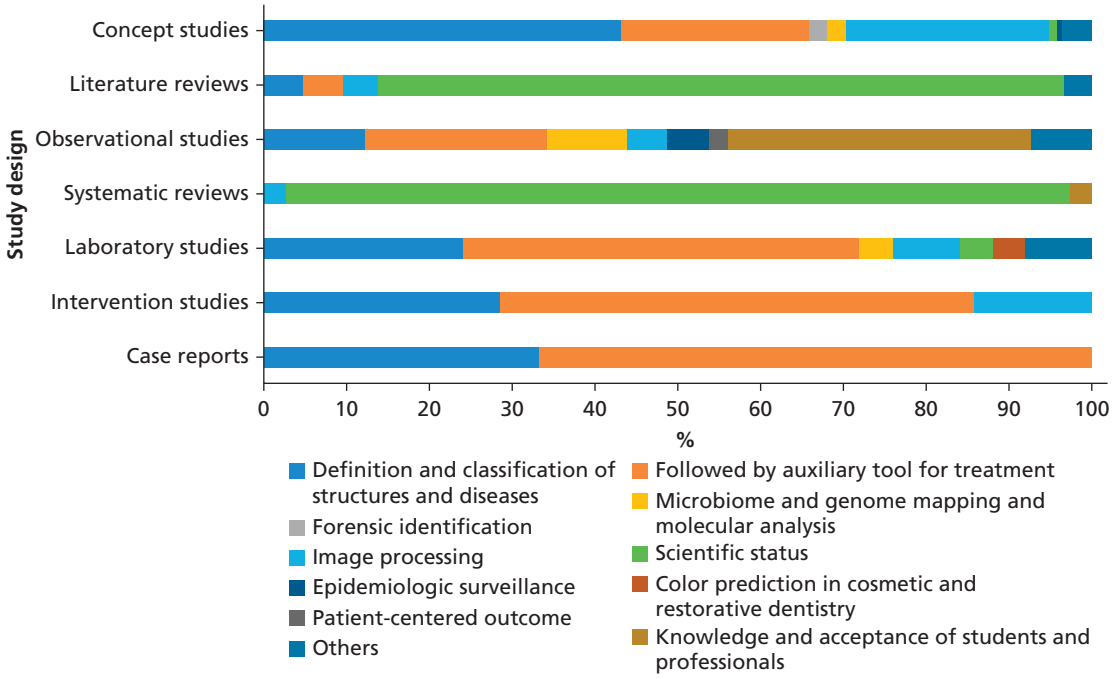


Figure 3. Distribution of themes in study designs. A color was assigned to each theme. The length of the bar (represented by different colors) indicates the distribution of themes within each study design.

Institutions

A total of 625 institutions were related to the selected articles. Table 2 shows the 10 institutions with the highest number of articles. The first 3 positions belong to Charité–University of Medicine Berlin (Germany) with 42 articles, Yonsei University (Republic of Korea) with 31 articles, and Peking University (China) with 28 articles.

Contributing authors

A total of 6,442 authors contributed to publishing AI articles. In Table 3, the authors with the highest number of articles are presented. The author with the highest number of articles was Schwendicke (53), followed by Krois (46), Orhan (30), Bayrakdar (23), and Jacobs (22). The frequency with which they appear and the coauthorship among them is represented in the eFigure, available online at the end of this article.

Key Words

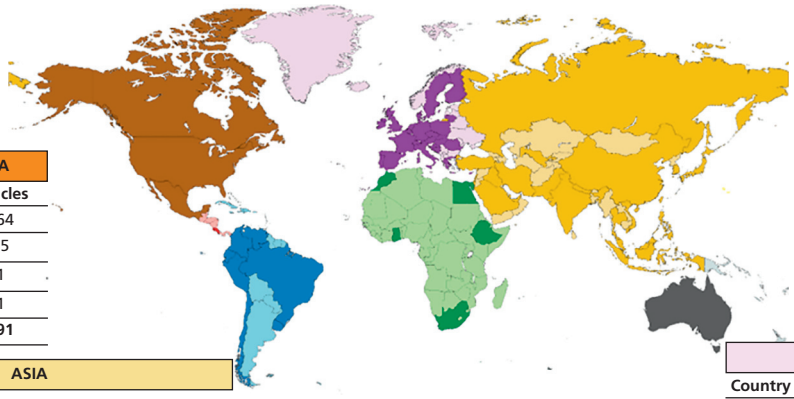
We identified a total of 2,679 key words. The most prevalent key words were "artificial intelligence" (515 occurrences), followed by "deep learning" (442 occurrences), "machine learning" (326 occurrences), "dentistry" (114 occurrences), and "convolutional neural networks" (81 occurrences). Figure 5 shows the most prevalent key words ($\geq$ 17 occurrences) and the collaborative relationships between them.

Trends

The publication trends over the past 4 decades highlight the predominance of proof-of-concept studies, with the most prevalent theme being the diagnosis or classification of conditions, particularly in radiology (eTable 1, available online at the end of this article). The trends of the past 5 years show Schwendicke as the most prolific author and the prevalence of proof-of-concept studies (eTable 2, available online at the end of this article).

DISCUSSION

AI has the potential to revolutionize dentistry, mostly because AI methodologies are applicable in various research on dental-related topics and because of its commercial applications.[12] We found that the trend of AI focuses on diagnostics, especially based on radiographic data. At the same time, it was possible to observe an ongoing crescent curve in the number of articles, starting from 2016 through 2018. Also, China is playing an important role in AI development in dentistry, leading in the number of articles.



NORTH AMERICA

Country	Articles
United States	164
Canada	25
Mexico	1
Costa Rica	1
Total	**191**

OCEANIA

Country	Articles
Australia	16
Total	**16**

ASIA

Country	Articles	Country	Articles
China	251	Indonesia	9
Republic of Korea	147	United Arab Emirates	9
India	97	Russia	6
Turkey	88	Vietnam	3
Japan	78	Iraq	3
Saudi Arabia	53	Qatar	3
Taiwan	34	Singapore	3
Iran	21	Philippines	2
Thailand	19	Nepal	2
Malaysia	16	Lebanon	1
Pakistan	14	Uzbekistan	1
Israel	11	**Total**	**871**

EUROPE

Country	Articles	Country	Articles
Germany	76	Czech Republic	7
Spain	33	Portugal	7
Italy	29	Sweden	5
United Kingdom	24	Greece	5
Belguim	22	Austria	4
Poland	18	Croatia	4
Switzerland	15	Finland	3
Netherlands	15	Lithuania	2
France	13	Bosnia and Herzegovina	2
Denmark	13	Cyprus	2
Romania	13	Hungary	1
Slovakia	7	Ireland	1
Serbia	7	**Total**	**328**

SOUTH AMERICA

Country	Articles
Brazil	45
Chile	3
Peru	2
Ecuador	1
Uruguay	1
Venezuela	1
Colombia	1
Total	**54**

AFRICA

Country	Articles
Egypt	9
South Africa	5
Ghana	1
Ethiopia	1
Morocco	1
Total	**17**

Figure 4. Worldwide distribution of the origin of articles on artificial intelligence. The colors differentiate the different continents. The tables show the number of articles per country as well as the total for each continent. The different shades of each color for a given continent indicate the publication status: darker shades represent countries that have published articles, while lighter shades represent countries that have not published any articles.

Table 2. Main institutions associated with research on artificial intelligence.

INSTITUTION	COUNTRY	ARTICLES, NO.
Charité–University of Medicine Berlin	Germany	42
Yonsei University	Republic of Korea	31
Peking University	China	28
Seoul National University	Republic of Korea	28
Sichuan University	China	25
KU Leuven	Belgium	22
Osaka University	Japan	18
Eskisehir Osmangazi University	Turkey	14
The University of Hong Kong	China	14
Wonkwang University	Republic of Korea	12

Due to the constant development of AI in dentistry, we observed that more than one-half of the included studies were published in the past 5 years. Advancements in software represent 1 of the driving forces behind the surge of deep learning and reinforcement learning, with factors also attributed to the availability and accessibility of large data sets, the advancement of hardware capable of large-scale and parallel processing, and a new wave of development in AI architectures and algorithms.[20]

In terms of territory, Asia is the leading continent in number of articles concerning AI,[13,21] and in relation to the countries, China and the United States are among the main contributors. These countries also occupy prominent positions in other bibliometric analyses regarding the use of AI.[22,23] It could be supposed that government policies and substantial funding for the advancement of AI methodologies have led to a mobilization in research and development among scientists in China and the United States.

Table 3. Authors with the highest number of articles on artificial intelligence.

AUTHOR	ARTICLES, NO.	CITATIONS, NO.
Schwendicke	53	1,272
Krois	46	1,423
Orhan	30	374
Bayrakdar	23	313
Jacobs	22	342
Celik	20	174
Chaurasia	14	358
Bilgir	12	191
Willems	11	309
Van Gerven	11	257

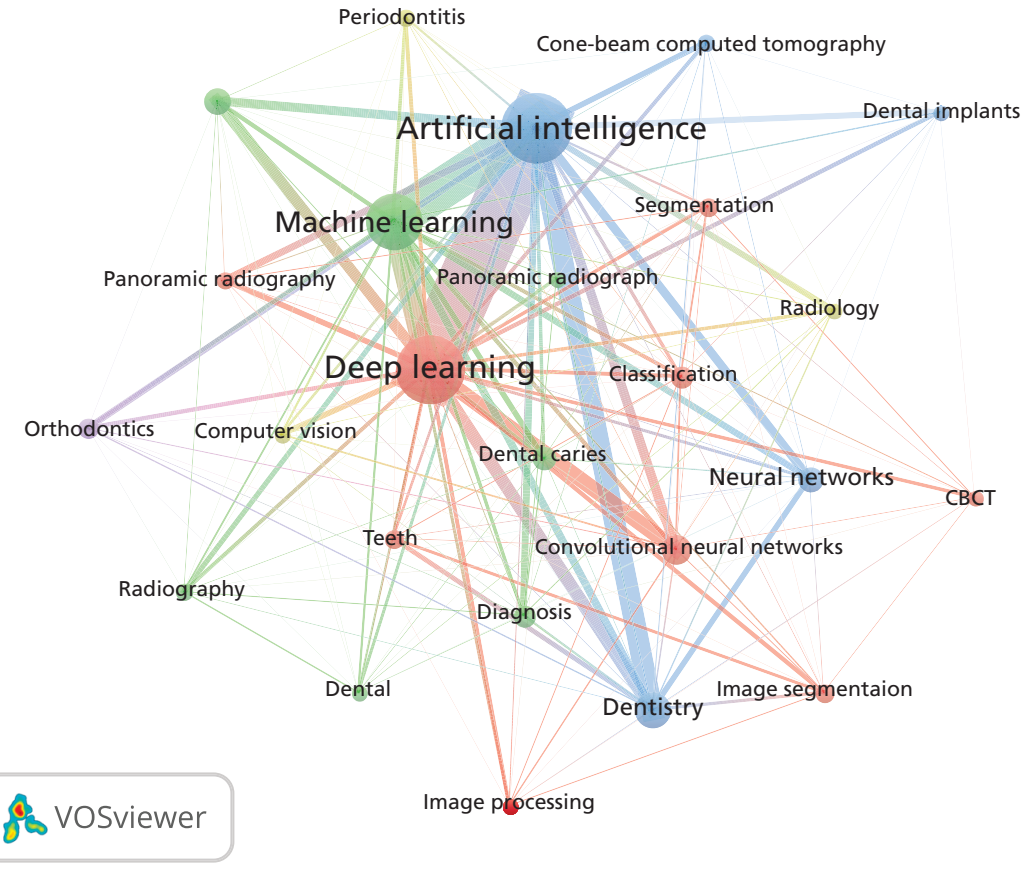


Figure 5. Frequency and interaction of the main key words associated with the included studies. The key words shown in the image were used in at least 20 studies. Terms associated with the larger circles had higher frequency among the studies. The lines connecting the circles indicate the relationship between the terms, that is, terms used together in a study. Circles and lines of the same color indicate clusters with strong connections. In addition, thicker lines also indicate frequent connection between the terms. CBCT: Cone-beam computed tomography.

A single German institution contributed the highest number of articles: the Charité–University of Medicine Berlin, which is recognized as 1 of the most prominent medical research institutions in Germany regarding AI articles in dentistry. Furthermore, other bibliometric studies highlighted this institution,[24,25] thus reinforcing its influence and impact on science. The high frequency of articles from the same institution can be attributed to the substantial contributions of the 2 most prominent authors in the field, as revealed in our study. These authors are Schwendicke, whose h-index (a proposal to quantify the productivity and impact of scientists based on their most cited articles) is 49, and Krois, with an h-index of 23. Both of these researchers have an affiliation with Charité–

University of Medicine Berlin and share a prominent focus in that institution's research activities on AI investigation and its use in the health sciences.

We did not exclude self-citations from the total citation count. Of the selected articles, self-citations represented 50.7% of WoS-CC citations. This figure is high compared with other bibliometric analyses, which have shown less than 8% self-citations in other areas of dentistry,[26-28] and it contradicts the trend of decreasing self-citations in studies.[29] Although self-citations are common in scientific research, an excessive proportion may raise questions regarding the possibility of artificially inflating the importance of articles, especially if these self-citations are not justified by the relevance of the content.[30] However, the practice of self-citation also can be interpreted as a way to show the progression and new data from previous work through new articles.[31] In AI in dentistry, this practice also tends to be supported by the continuous growth and new data generated from the authors' previous works, as the field is in constant development.

In terms of published data coverage, the use of only 1 database (WoS-CC) may have led to a limitation of this study. However, WoS-CC is 1 of the main databases recommended for studies of this nature and covers a variety of fields of knowledge beyond health, expanding its relevance for application in this study due to the abundance of research associated with engineering and computer science, which already were used in previous bibliometric analyses.[24,32,33] In addition, despite conducting a bibliometric analysis, we did not assess the quality of the included studies. Unlike qualitative evaluation, citation counts enable a quantitative assessment of the scientific impact of articles in a specific field. Among the numerous strengths of our study, not using filters in relation to the year, language, or number of citations stands out, allowing us to present a broad global picture of the use of AI in dentistry.

Most of the retrieved studies used radiologic images as data sets for developing machine learning models, indicating a trend among the authors in the use of this type of resource. The preference for using data sets containing radiographs and tomographic scans as inputs for these models is supported by the abundance of available data, a preponderant factor in driving important advances in image processing and pattern recognition.[30] Furthermore, the exploration of AI applications using these types of images has potential, given the complexity of interpreting this data.

There were an extensive number of reviews, including systematic, narrative, and scoping reviews, compared with the number of studies that effectively conducted interventions with patients. Indeed, these reviews reveal the need for a more comprehensive validation of AI in the context of dentistry.[5,34,35] This reinforces the importance of careful validation of existing models and, when they present adequate levels of accuracy, drawing attention to a gap in this emerging field of research. This is particularly relevant to advance the subsequent phases of the development and application of AI in the dental field.

Accordingly, most of the articles were AI proof-of-concept studies focused on creating an AI model capable of detecting and classifying a desired condition. Although many models showed positive results with similar functional characteristics and methodological approaches, AI solutions largely have not entered routine dental practice. To allow their integration into clinical practice, we recommend improving the scalability and robustness of preexisting studies and advancing public access to created models. In addition, 1 question should be raised: in the face of many studies creating numerous AI algorithms and computational methods, in what settings are they applicable? To our knowledge, only a few AI methods are accessible within the clinical practice routine.

CONCLUSIONS

This bibliometric review reveals a progressive increase in studies with the use of AI methodologies within the dentistry field over the past 5 years. A high citation number of studies approaching AI methods indicates the emergence of the use of this technology in dental research. The reviewed articles primarily were associated with radiology, and the most used evaluation method was through radiographic imaging. We observed that most of the studies were performed in China. The authors with the most articles were Schwendicke and Krois. The small numbers of articles from Africa, Oceania, and Central America point to the need for these regions to explore AI technologies further. Considering that the most prevalent study design found was proof of concept, we suggest that new research should focus on clinical applications aiming at development and validation of AI models to diagnosis-related approaches. In addition, beyond image and text analysis, studies focusing on administrative activities such as regulatory, documentation, and record-automated processing models, which can reduce the time spent on bureaucracy, should be encouraged. ■

DISCLOSURES

None of the authors reported any disclosures.

SUPPLEMENTAL DATA

Supplemental data related to this article can be found at: http://doi.org/10.1016/j.adaj.2024.05.013.

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This study was financed in part by grant 001 from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior–Brazil, awarded to Fernanda Pretto Zatt, Aurélio de Oliveira Rocha, and Lucas Menezes dos Anjos. This work was also supported by grant 403656/2021-4 from the Conselho Nacional de Desenvolvimento Científico e Tecnológico, awarded to Ricardo Armini Caldas and Gustavo Davi Rabelo.

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1. Janiesch C, Zschech P, Heinrich K. Machine learning and deep learning. *Electronic Markets*. 2021; 31(3):685-695. doi:10.1007/s12525-021-00475-2

2. Kumar Pr, Ravindranath K, Srilatha V, et al. Analysis of advances in research trends in robotic and digital dentistry: an original research. *J Pharm Bioallied Sci*. 2022; 14(5):185. doi:10.4103/jpbs.jpbs_59_22

3. Wei J, Peng M, Li Q, Wang Y. Evaluation of a novel computer color matching system based on the improved back-propagation neural network model. *J Prosthodont*. 2018;27(8):775-783. doi:10.1111/jopr.12561

4. Steels L, Lopez de Mantaras R. The Barcelona declaration for the proper development and usage of artificial intelligence in Europe. *AI Communications*. 2018; 31(6):485-494. doi:10.3233/AIC-180607

5. Schwendicke F, Samek W, Krois J. Artificial intelligence in dentistry: chances and challenges. *J Dent Res*. 2020;99(7):769-774. doi:10.1177/0022034520915714

6. Sarker IH. Deep cybersecurity: a comprehensive overview from neural network and deep learning perspective. *SN Comput Sci*. 2021;2(3):154. doi:10.1007/s42979-021-00535-6

7. Shan T, Tay FR, Gu L. Application of artificial intelligence in dentistry. *J Dent Res*. 2021;100(3):232-244. doi:10.1177/0022034520969115

8. Calil BC, da Cunha DV, Vieira MF, et al. Identification of arthropathy and myopathy of the temporomandibular syndrome by biomechanical facial features. *Biomed Eng Online*. 2020;19(1):22. doi:10.1186/s12938-020-00764-5

9. Rajkomar A, Dean J, Kohane I. Machine learning in medicine. *N Engl J Med*. 2019;380(14):1347-1358. doi:10.1056/nejmra1814259

10. Farook TH, Jamayet N Bin, Abdullah JY, Alam MK. Machine learning and intelligent diagnostics in dental and orofacial pain management: a systematic review. *Pain Res Manag*. 2021;2021. doi:10.1155/2021/6659133

11. Kose C, Oliveira D, Pereira PNR, Rocha MG. Using artificial intelligence to predict the final color of leucite-reinforced ceramic restorations. *J Esthet Restor Dent*. 2023; 35(1):105-115. doi:10.1111/jerd.13007

12. MacHoy ME, Szyszka-Sommerfeld L, Vegh A, Gedrange T, Woźniak K. The ways of using machine learning in dentistry. *Adv Clin Exp Med*. 2020;29(3):375-384. doi:10.17219/acem/115083

13. Altan Salli G, Alagoz E, Gursoy N, Sarica I. Artificial intelligence in maxillofacial radiology: a bibliometric study. *Mathews J Dent*. 2023;7(1). doi:10.30654/MJD.10033

14. Velasquez R, Barja-Ore J, Salazar-Salvatierra E, et al. Characteristics, impact, and visibility of scientific publications on artificial intelligence in dentistry: a scientometric analysis. *J Contemp Dent Pract*. 2022;23(8):761-767. doi:10.5005/jp-journals-10024-3386

15. Montazeri A, Mohammadi S, Hesari PM, Ghaemi M, Riazi H, Sheikhi-Mobarakeh Z. Preliminary guideline for reporting bibliometric reviews of the biomedical literature (BIBLIO): a minimum requirements. *Syst Rev*. 2023;12(1): 239. doi:10.1186/s13643-023-02410-2

16. Lee JH, Kim DH, Jeong SN, Choi SH. Detection and diagnosis of dental caries using a deep learning-based convolutional neural network algorithm. *J Dent*. 2018;77: 106-111. doi:10.1016/j.jdent.2018.07.015

17. Lee JH, Kim DH, Jeong SN, Choi SH. Diagnosis and prediction of periodontally compromised teeth using a deep learning-based convolutional neural network algorithm. *J Periodontal Implant Sci*. 2018;48(2):114-123. doi:10.5051/jpis.2018.48.2.114

18. Khanagar SB, Al-Ehaideb A, Maganur PC, et al. Developments, application, and performance of artificial intelligence in dentistry: a systematic review. *J Dent Sci*. 2021;16(1):508-522. doi:10.1016/j.jds.2020.06.019

19. Tzukert A, Staif J, Levi R, Sharav Y. A computerized decision support system for patient selection in dental education. *Comput Biol Med*. 1984;14(3):277-284. doi:10.1016/0010-4825(84)90029-5

20. Hashimoto DA, Witkowski E, Gao L, Meireles O, Rosman G. Artificial intelligence in anesthesiology. *Anesthesiology*. 2020;132(2):379-394. doi:10.1097/ALN.0000000000002960

21. Wong KF, Lam XY, Jiang Y, Yeung AWK, Lin Y. Artificial intelligence in orthodontics and orthognathic surgery: a bibliometric analysis of the 100 most-cited articles. *Head Face Med*. 2023;19(1):38. doi:10.1186/s13005-023-00383-0

22. Wu Z, Chen S, Wang Y, et al. Current perspectives and trend of computer-aided drug design: a review and bibliometric analysis. *Int J Surg*. 2024;110(6):3848-3878. doi:10.1097/JS9.0000000000001289

23. Zhang M, Wang Y, Lv M, et al. Trends and hotspots in global radiomics research: a bibliometric analysis. *Technol Cancer Res Treat*. 2024;23:15330338241235769. doi:10.1177/15330338241235769

24. Chen N, Zhang K, Li Y, Liu Y. Knowledge mapping of immunotherapy for allergic rhinoconjunctivitis. *Allergol Immunopathol (Madr)*. 2023;51(1):63-73. doi:10.15586/aei.v51i1.714

25. Tan Z, Zhao Y, Jin Z, et al. The relationship between muscular atrophy/sarcopenia and cardiovascular diseases in the elderly: a bibliometrics study. *Ann Palliat Med*. 2021;10(8):9136-9148. doi:10.21037/apm-21-2144

26. Goebel MC, Rocha A de O, Santos PS, et al. A bibliometric analysis of the top 100 most-cited papers concerning dental fluorosis. *Caries Res*. 2023;57(4):509-515. doi:10.1159/000530831

27. Rocha A de O, Santos PS, Machado BA, et al. The top 100 most-cited papers in erosive tooth wear: a bibliometric analysis. *Caries Res*. 2022;56(1):29-35. doi:10.1159/000521877

28. Tarazona B, Lucas-Dominguez R, Paredes-Gallardo V, Alonso-Arroyo A, Vidal-Infer A. The 100 most-cited articles in orthodontics: a bibliometric study. *Angle Orthod*. 2018;88(6):785-796. doi:10.2319/012418-65.1

29. Livas C, Delli K. Journal self-citation rates and impact factors in dentistry, oral surgery, and medicine: a 3-year bibliometric analysis. *J Evid Based Dent Pract*. 2018; 18(4):269-274. doi:10.1016/j.jebdp.2017.09.001

30. Seeber M, Cattaneo M, Meoli M, Malighetti P. Self-citations as strategic response to the use of metrics for career decisions. *Res Policy*. 2019;48(2):478-491. doi:10.1016/j.respol.2017.12.004

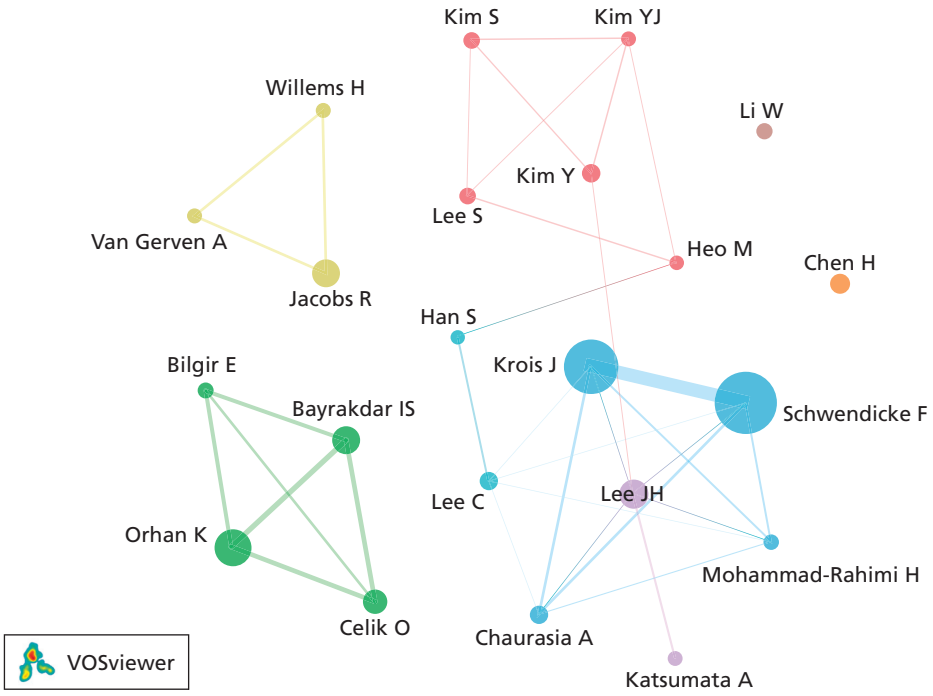
31. Amjad T, Rehmat Y, Daud A, Abbasi RA. Scientific impact of an author and role of self-citations. *Scientometrics*. 2020;122(2):915-932. doi:10.1007/s11192-019-03334-2

32. Yang Q, Yang D, Li P, Liang S, Zhang Z. A bibliometric and visual analysis of global community resilience research. *Int J Environ Res Public Health*. 2021; 18(20):10857. doi:10.3390/ijerph182010857

33. Jiang CM, Duangthip D, Chan AKY, Tamrakar M, Lo ECM, Chu CH. Global research interest regarding silver diamine fluoride in dentistry: a bibliometric analysis. *J Dent*. 2021;113:103778. doi:10.1016/j.jdent.2021.103778

34. Hosny A, Parmar C, Quackenbush J, Schwartz LH, Aerts HJWL. Artificial intelligence in radiology. *Nat Rev Cancer*. 2018;18(8):500-510. doi:10.1038/s41568-018-0016-5

35. Ahmed N, Abbasi MS, Zuberi F, et al. Artificial intelligence techniques: analysis, application, and outcome in dentistry: a systematic review. *Biomed Res Int*. 2021;2021. doi:10.1155/2021/9751564



eFigure. Main groups and authors who researched artificial intelligence in dentistry. The authors shown in the image had at least 7 occurrences. The names associated with the larger points correspond to the most frequent authors. Lines and the same color between the points indicate collaboration between author groups.

eTable 1. Publication trends over the decades.

PERIOD	TOTAL ARTICLES, NO.	AUTHORS (ARTICLES, NO.)	JOURNAL (ARTICLES, NO.)	STUDY DESIGN (ARTICLES, NO.)
1984-1993	5	–*	–	Proof of concept (2)
1994-2003	25	Brickley (4); Shepherd (4)	*Acta Odontologica Scandinavica* (2); *British Dental Journal* (2)	Proof of concept (15)
2004-2013	31	Oliveira (3)	*Oral Surgery, Oral Medicine, Oral Pathology, and Oral Radiology* (2)	Proof of concept (22)
2014-2024	1,417	Schwendicke (53)	*Scientific Reports* (61)	Proof of concept (940)

* –: Large amount of data with similar occurrence.

eTable 1. (Continued)

MAIN OBJECTIVE (ARTICLES, NO.)	DIAGNOSTIC METHOD (ARTICLES, NO.)	SPECIALTY OR SUBSPECIALTY (ARTICLES, NO.)	INSTITUTION (ARTICLES, NO.)	COUNTRY (ARTICLES, NO.)	CONTINENT (ARTICLES, NO.)	CITATIONS, NO.
Definition and classification of structures and diseases (2)	Textual methods (2)	General dentistry (2)	–	–	Asia (2); Europe (2)	31
Definition and classification of structures and diseases (16)	Radiologic images (9); textual methods (9)	General dentistry (4); radiology (4)	University of Wales College of Medicine (4)	United States (8)	Europe (14)	302
Definition and classification of structures and diseases (17)	Radiologic images (14)	General dentistry (10)	Federal University of Pernambuco (3)	Brazil (7)	Asia (14)	685
Definition and classification of structures and diseases (516)	Radiologic images (698)	Radiology (328)	Charité–University of Medicine Berlin (43)	China (246)	Asia (853)	16,519

eTable 2. Publication trends in the past 5 years.

YEAR	TOTAL ARTICLES, NO.	AUTHORS (ARTICLES, NO.)	JOURNAL (ARTICLES, NO.)	STUDY DESIGN (ARTICLES, NO.)
2020	134	–*	*Scientific Reports* (7)	Proof of concept (113)
2021	243	Schwendicke (13)	*Journal of Dental Research* (12)	Proof of concept (170)
2022	387	Schwendicke (18)	Diagnostics (18)	Proof of concept (276)
2023	429	Schwendicke (14)	*Diagnostics* (16); *Journal of Dentistry* (16)	Proof of concept (229)
2024	81	–	*BMC Oral Health* (10)	Proof of concept (38)

* –: Large amount of data with similar occurrence.

eTable 2. (Continued)

MAIN OBJECTIVE (ARTICLES, NO.)	DIAGNOSTIC METHOD (ARTICLES, NO.)	SPECIALTY OR SUBSPECIALTY (ARTICLES, NO.)	INSTITUTION (ARTICLES, NO.)	COUNTRY (ARTICLES, NO.)	CONTINENT (ARTICLES, NO.)	CITATIONS, NO.
Definition and classification of structures and diseases (45)	Radiologic images (75)	Radiology (37)	Seoul National University (6)	Republic of Korea (25)	Asia (87)	3,944
Definition and classification of structures and diseases (74)	Radiologic images (114)	Radiology (53)	Yonsei University (7)	United States (34)	Asia (131)	3,692
Definition and classification of structures and diseases (133)	Radiologic images (211)	Radiology (89)	Charité–University of Medicine Berlin (13)	China (75)	Asia (253)	2,531
Definition and classification of structures and diseases (168)	Radiologic images (201)	Radiology (103)	Charité–University of Medicine Berlin (10); Shanghai Jiao Tong University (10)	China (79)	Asia (258)	880
Definition and classification of structures and diseases (42)	Radiologic images (36)	Periodontics and implant dentistry (16)	Seoul National University (3)	China (16)	Asia (249)	16