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A bibliometric analysis of the literature on the use of artificial intelligence in pediatric dentistry

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ABSTRACT

Aims: This study aims to conduct a bibliometric analysis of the scientific literature on the use of artificial intelligence (AI) in pediatric dentistry to evaluate publication trends, citation impact, key contributors, and research themes.

Methods: A comprehensive literature search was conducted in the Web of Science (WoS) database up to February 8, 2025. The search included AI-related terms combined with pediatric dentistry keywords. A total of 78 relevant articles were identified and analyzed. VOSviewer software was used for bibliometric mapping, including co-authorship, co-citation, and keyword analysis.

Results: The number of publications on AI in pediatric dentistry has increased significantly since 2020, peaking in 2024, followed by a decline in 2025. The analysis identified key research topics, including diagnostic imaging, early childhood caries detection, dental age estimation, and orthodontic assessments. Despite the growth in research output, AI applications in pediatric dentistry remain significantly underdeveloped compared to other dental fields. Citation impact was relatively low, with the most referenced article receiving 83 citations.

Conclusion: AI is gaining attention in pediatric dentistry; however, its adoption is still in the early stages. Further research is needed to validate AI models, enhance clinical integration, and expand interdisciplinary collaboration. Addressing data limitations and improving real-world applicability will be crucial for AI's long-term impact on pediatric dental care.

Keywords: Artificial intelligence, deep learning, bibliometrics, pediatric dentistry

INTRODUCTION

The concept of artificial intelligence (AI) was first introduced in 1956, using the term to refer to technology designed to replicate human behavior.[1] Since then, the field has had substantial improvement and growth.[2] The emergence of AI has initiated a transformative period in medicine and dentistry. AI possesses the capacity to fundamentally alter the methodologies employed by dental practitioners in patient care, serving as a revolutionary instrument within the discipline.[3]

A prominent characteristic of AI is its ability to process and interpret extensive volumes of data at an extraordinary speed. numerous recent research have evaluated the effectiveness of AI in pediatric dentistry. These include dental plaque, assessing children's oral health, mesiodens and supernumerary tooth identification, early childhood caries, fissure sealant categorization, chronological age assessment in kids and adolescents using neural modeling, detecting deciduous and young permanent tooth, ectopic eruption of first permanent molar.[4] Scientific research indicate that AI can enhance dental care standards, improve diagnostic accuracy and efficacy, generate superior treatment graphics, model outcomes, and forecast oral diseases and health conditions.[4-7] AI models have garnered attention for their role as supplementary tools, enhancing the precision and accuracy of diagnosis. AI technology has been extensively utilized in medical sciences, exhibiting exceptional efficacy in many patient care activities, including disease diagnosis and risk assessment for disease development, among others.[8-10]

The incorporation of AI in pediatric dentistry is an anticipated trend, considering the swift technological advancements in this field. A bibliometric analysis is necessary to thoroughly examine the publication features of academic work focused on AI in pediatric dentistry. This research will facilitate a thorough grasp of the publication environment and citation trends. A bibliometric analysis is an efficient approach for the systematic evaluation of the quantity, quality, and importance of research output in a certain subject area.[11] To the best of our knowledge, no studies have been conducted on this topic. The primary aim of this study is to develop a detailed profile of the research on the application of AI in the field of pediatric dentistry. This will furnish researchers, physicians, and other stakeholders with essential insights and information. This will

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enable the identification of critical research areas and industry trends, therefore promoting the creation of more targeted and effective AI-based interventions and enhancing the quality of care for kids receiving pediatric dentistry.

METHODS

This study is a bibliometric analysis based on publicly available scientific literature and does not involve human participants, clinical trials, patient data, or any interventions requiring ethical approval. Therefore, approval from an institutional review board (IRB) or ethics committee was not required for this research. In line with ethical research standards and the policies of the Journal of Dental Sciences and Education, this study adheres to the Declaration of Helsinki and international ethical guidelines for research integrity. Since no patient information, medical records, or experimental procedures were used, a clinical trial registration number is not applicable. All data analyzed in this study were obtained from the Web of Science (WoS) database, and no confidential or personally identifiable information was accessed, ensuring full compliance with data protection and research ethics policies.

In February 2025, a comprehensive literature search of the WoS database, established by the Institute for Scientific Information (ISI) and now maintained by Clarivate Analytics, was conducted. Prior to 8 February 2025, a screening process was conducted on published articles, and pilot searches were carried out with the objective of optimising the search strategy. The initial searches were broadened, resulting in the identification of 93 studies. The "all fields" option was employed to conduct the electronic search, which enables the retrieval of all searchable data. To ensure that no relevant publications were overlooked, our search was comprehensive, and manual sifting was employed to enhance the accuracy of the results.

As a result of these pilot searches, a total of 93 studies were found when ''artificial intelligen*'' OR ''deep learn*'' OR ''machine learn*'' OR ''convolutional neural network*'' OR ''CNN*'' OR ''recurrent neural network*'' OR ''RNN*'' OR ''fully Convolutional Network*'' OR ''FCN*'' OR ''artificial neural network*'' (all fields) and "pediatric dentist*" OR "paediatric dentist*" (all fields) was typed in the search bar to determine the publications to be included in the study. The document types "article," "proceeding paper," "review," and "early access" were selected by applying a filter to the chosen articles. The language of publication was stipulated to be English throughout the process of identification and analysis. Only those publications that were published in this language were considered for inclusion in the study. Following the filtering process, the articles were evaluated in terms of their suitability for the subject matter. Initially, this was done according to the titles and abstracts of the articles. In cases where a decision could not be reached based on these criteria, the full text of the study was opened and examined by a single author. The selected articles were saved in a marked list. After the completion of all screening processes, a total of 78 studies were selected. The VOSviewer software (developed by Leiden University's Centre for Science and Technology Studies) were employed in this analysis for the purposes of bibliometric investigation and data visualisation.

The VOSviewer enables the production of maps of authors or journals based on co-citation data, as well as maps of keywords based on co-occurrence data. The software provides an extensive viewer for the detailed examination of bibliometric maps.[12] On 8 February 2025, the version 1.6.20 of the software VOSviewer was downloaded free of charge from the official website. The data in the '.txt' format, which was exported by creating a marked list, was opened with Microsoft Excel (Microsoft, Inc., Redmond, Washington) and the data set was edited to prevent the programme from misreading due to errors in the data set. In the author section, the names 'Çelik, Özer' and 'Celik, Ozer' are written in two different ways, and the programme identifies these as three distinct authors. A number of such errors in nomenclature were corrected in order to prevent erroneous interpretations. In order to identify the discrepancies between the authors, the author information in the WoS was initially examined. When the desired information was not found, the author data in Scopus was then consulted. If this information was also unavailable, a search was conducted on the internet. In the countries section, the spelling errors "Turkey" and "Turkiye" were corrected, despite the fact that they refer to the same country. Following the rectification of these inaccuracies, the data were exported in a '.txt' format using Microsoft Excel and processed in the VOSviewer program, resulting in the generation of visual representations.

The Microsoft Excel program was employed for the purpose of data tabulation.

In accordance with the ethical standards governing research, no approval was required, as the study did not involve clinical studies or the use of patient data. That is why clinical trial number is not applicable.

RESULTS

Growth in Publications

A total of 78 articles were obtained for review concerning the application of AI in pediatric dentistry. The analysis of publication trends and citation impact over time reveals a dynamic growth pattern in the application of AI within pediatric dentistry. The data indicates a notable increase in research output beginning in 2020, with a steady rise in both the number of publications and citations up to 2023, suggesting a growing academic and clinical interest in AI-driven innovations within the field. The peak year for publications and citations is 2024, where both metrics reach their highest values, potentially reflecting a culmination of advancements in AI methodologies, increased funding, and interdisciplinary collaborations within pediatric dentistry research. The substantial number of citations in 2024 further signifies the relevance and impact of recent publications, highlighting the recognition and adoption of AI-based approaches in the field. However, a sharp decline is observed in 2025 for both publications and citations, which may be attributed to several factors, including data incompleteness for 2025, as the year is still ongoing; a potential plateau in research interest, indicating a shift in focus toward more specialized applications of AI; and publication lag effects, where ongoing research has not yet been indexed or cited (**Figure 1**).

Countries/Regions and Institutions

A total of 30 countries or regions published at least one article on the topic of AI in pediatric dentistry between the years 2017 and 2025. The United States of America has published the greatest number of articles on the subject, with 17 articles,

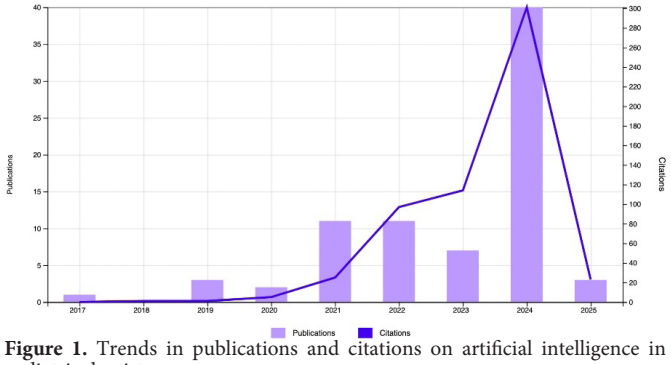


Figure 1. Trends in publications and citations on artificial intelligence in pediatric dentistry

followed by Turkey and China, which have published 13 and 12 articles, respectively. Moreover, these countries were the recipients of the greatest number of citations. A collaboration map of countries on this subject, together with a list of the five most prolific countries, is provided in **Figure 2A, B**. In terms of institutional affiliations, there were notable examples of robust collaborative relationships, including those with Eskişehir Osmangazi University and Ankara University (**Figure 3A**). The University of Alabama Birmingham published the greatest number of papers, with a total of 6, followed by Osaka University and Sichuan University, which published 5 and 5 papers, respectively. With regard to the analysis of citation figures, Ankara University and the Peking University were the most highly cited universities, with respective figures of 137 and 84. The top five most prolific institutions are represented in **Figure 3B**.

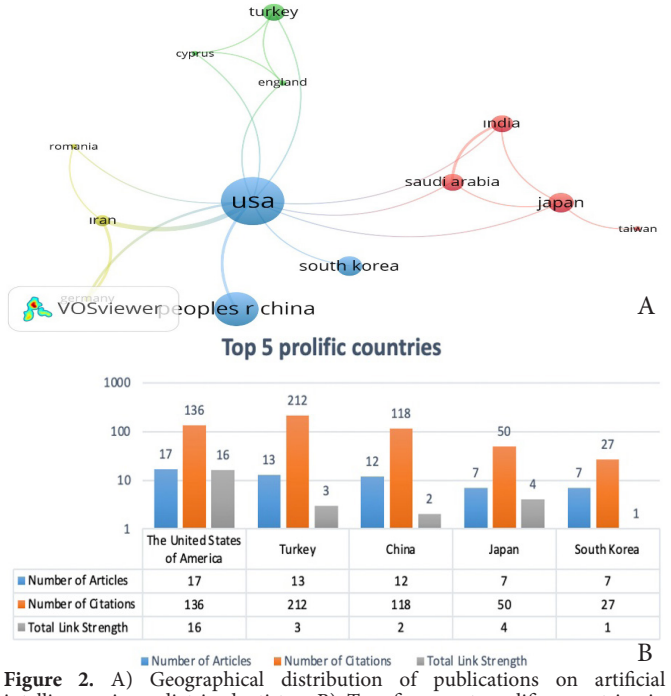


Figure 2. A) Geographical distribution of publications on artificial intelligence in pediatric dentistry, B) Top five most prolific countries in artificial intelligence research in pediatric dentistry

Authors

The author profiles extracted from the publications were subjected to analysis with the aim of identifying the most influential scholars in the field of AI in pediatric dentistry. The seven most prolific authors according to article numbers, and citation numbers are presented in **Figure 4A**, **B**, respectively. With regard to the attention paid to their work by other authors, Orhan, Kaan; Xia, Bin; and Hao, Aimin, have had the most significant impact on this field, having been cited 137,

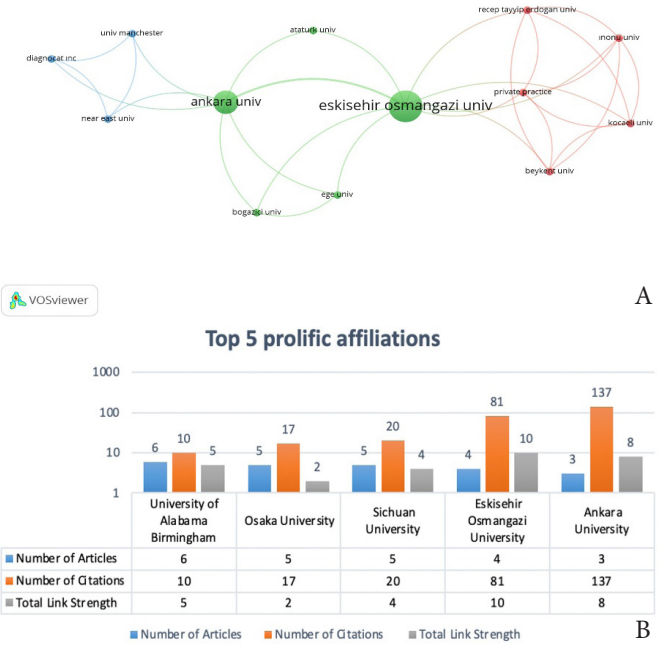


Figure 3. A) Affiliation collaboration network in artificial intelligence research in pediatric dentistry, B) Top five most prolific affiliations in artificial intelligence research in pediatric dentistry

84, and 82 times, respectively. The findings suggest that the majority of collaborating authors were from the same country or region. A notable degree of collaboration in **Figure 4C** was evident between the following research teams: Celik Ozer, Bayrakdar Ibrahim Sevki, Orhan Kaan, Bilgir Elif, and Kilic Munevver Coruh.

Figure 4. A) Most 7 prolific authors based on the number of publications, B) Most cited 5 authors in artificial intelligence research in pediatric dentistry, C) Co-authorship network in artificial intelligence research in pediatric dentistry

Articles

The most highly cited publications provide readers with a comprehensive overview of the development and current status of a field of study, offering guidance to subsequent investigators and influencing the direction of ongoing research. **Table** presents the 10 most frequently cited papers in this context.

Journals

Figure 5 depicts the five most prolific journals, as determined by the number of publications and citations. The three journals with the highest number of publications were Journal of Clinical Pediatric Dentistry, International Journal of Paediatric Dentistry, and BMC Oral Health, with respective publication numbers of 11, 8, and 6. With regard to the number of citations, the most influential journals were BMC Oral Health, Scientific Reports, and Journal of Clinical Pediatric Dentistry, with 90, 75, and 71 citations, respectively.

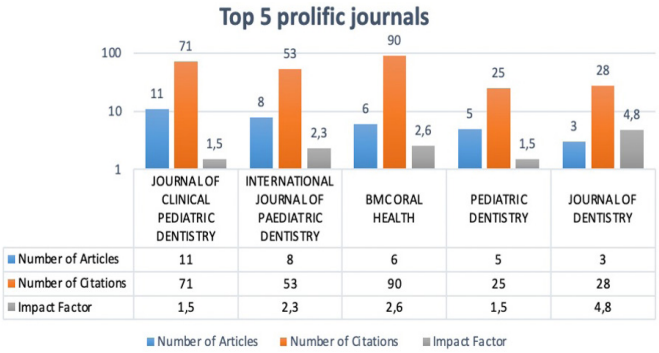


Figure 5. Top five most prolific journals publishing artificial intelligence research in pediatric dentistry

Co-Citation References

A co-citation references network is a network comprising nodes representing documents and edges indicating the co-citation relationships between these documents in the context of bibliometric analysis. The term "co-citation" is used to describe the occurrence of two texts being cited together by one or more later documents. The application of co-citation analysis enables the identification of interdisciplinary connections, the discovery of pivotal publications, and the elucidation of the structural and developmental nuances of scientific domains. **Figure 6** presents an illustrative co-citation references network map of references mentioned at least ten times.

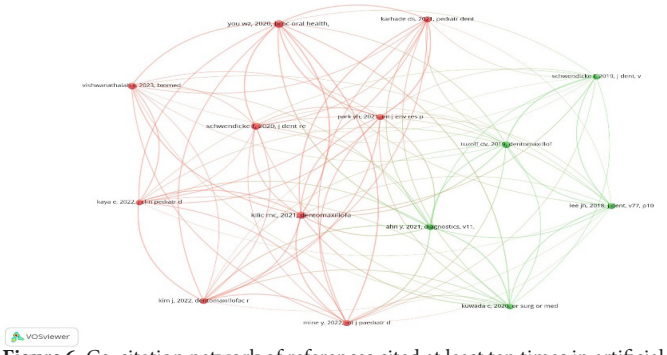


Figure 6. Co-citation network of references cited at least ten times in artificial intelligence research in pediatric dentistry

Keywords

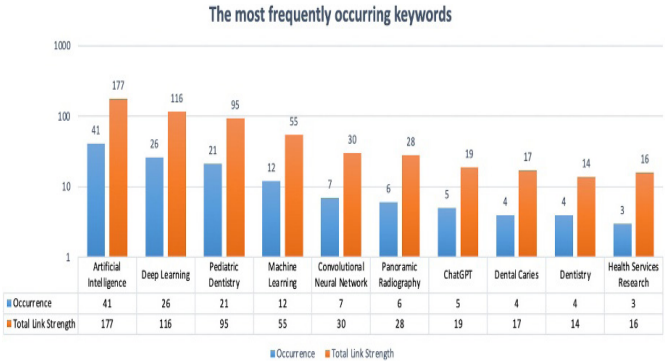
The most frequently occurring keywords were "artificial intelligence," "deep learning," "pediatric dentistry," "machine learning," "convolutional neural network," "panoramic

Table. Most cited 10 articles

Title	Author	Sources	Publication year	Total citations	Type of study
Deep learning-based dental plaque detection on primary teeth: a comparison with clinical assessments	You WZ, Hao AM, LI S, Wang Y, Xia B	BMC Oral Health	2020	82	Article
Clinically applicable artificial intelligence system for dental diagnosis with CBCT	Ezhov M, Gusarev M, Golitsyna M, Yates JM, Kushnerev, E, Tamimi D, Aksoy S, Shumilov E, Sanders A, Orhan K	Scientific Reports	2021	75	Article
Artificial intelligence system for automatic deciduous tooth detection and numbering in panoramic radiographs	Kılıc MC, Bayrakdar IS, Celik O, Bılgır, E, Orhan K, Aydın OB, Kaplan FA, Saglam H, Odabas A, Aslan AF, Yilmaz AB	Dentomaxillofacial Radiology	2021	58	Article
Artificial intelligence its uses and application in pediatric dentistry: a review	Vishwanathaiah S, Fageeh HN, Khanagar SB, Maganur PC	Biomedicines	2023	34	Review
Detecting the presence of supernumerary teeth during the early mixed dentition stage using deep learning algorithms: a pilot study	Mine Y, Iwamoto Y, Okazaki S, Nakamura K, Takeda S, Peng TY, Mitsuhata C, Kakimoto N, Kozai K, Murayama T	International Journal of Paediatric Dentistry	2022	33	Article
Proposing a CNN method for primary and permanent tooth detection and enumeration on pediatric dental radiographs	Kaya E, Gunec HG, Gokyay SS, Kutal S, Gulum S, Ates HF	Journal of Clinical Pediatric Dentistry	2022	31	Article
An automated machine learning classifier for early childhood caries	Karhade DS, Roach J, Shrestha P, Simancas-Pallares MA, Ginnis J, Burk ZJS, Ribeiro AA, Cho HY, Wu D, Divaris K	Pediatric Dentistry	2021	24	Article
Deep learning neural modelling as a precise method in the assessment of the chronological age of children and adolescents using tooth and bone parameters	Zaborowicz M, Zaborowicz K, Biedziak B, Garbowski T	Sensors	2022	19	Article
Artificial intelligence-aided detection of ectopic eruption of maxillary first molars based on panoramic radiographs	Liu JL, Liu Y, Li SH, Ying SC, Zheng LW, Zhao ZH	Journal of Dentistry	2022	18	Article
A pilot study of a deep learning approach to submerged primary tooth classification and detection	Caliskan S, Tuloglu N, Celik O, Ozdemir C, Kizilaslan S, Bayrak S	International Journal of Computerized Dentistry	2021	18	Article

CBCT: Cone beam computed tomography, CNN: Convolutional neural network

radiography," "ChatGPT," "dental caries," "dentistry," and "health services research" (**Figure 7**). The results revealed that artificial intelligence exhibited the highest occurrence and total link strength. In light of the recent proliferation of publications on the subject of artificial intelligence in pediatric dentistry, particularly in the period following 2019, we present in **Figure 8** a map of the co-occurrence network of keywords used on this topic.



	Artificial Intelligence	Deep Learning	Pediatric Dentistry	Machine Learning	Convolutional Neural Network	Panoramic Radiography	ChatGPT	Dental Caries	Dentistry	Health Services Research
Occurrence	41	26	21	12	7	6	5	4	4	3
Total Link Strength	177	116	95	55	30	28	19	17	14	16

Figure 7. Keyword co-occurrence network in artificial intelligence research in pediatric dentistry

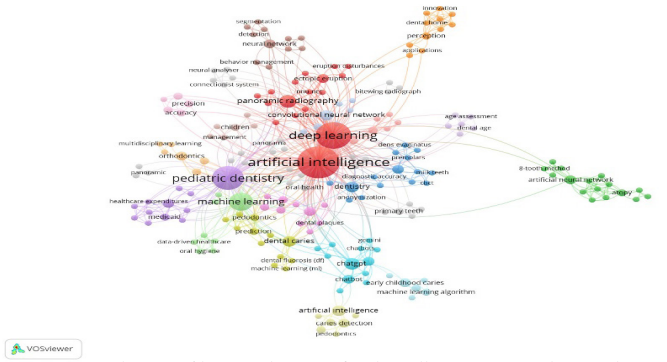


Figure 8. Evolution of keywords in artificial intelligence research in pediatric dentistry over time

DISCUSSION

AI is generally characterized as "a system's capacity to accurately interpret external data, learn from it, and utilize these insights to adapt flexibly and accomplish specific tasks and goals". The substantial enhancement in processing power over the last fifty years, along with the proliferation of large data, has advanced AI applications into novel domains. AI is already prevalent in our daily lives via gadgets such as cellphones and automobiles. It is currently achieving substantial progress in the realm of medicine. The swift progress in computer technology over the last two decades complicates the forecasting of AI's future significance in medicine. Nonetheless, given present uses, it is probable that physicians and AI will collaborate closely in the imminent future[9]. The most significant roles of AI in pediatric dentistry: AI systems, particularly deep learning algorithms, can be applied to areas such as dental plaque detection,[13] dental diagnosis with 3D imaging,[14] tooth detection and numbering,[15] the assessment of chronological age,[16] the detection of ectopic eruption,[17] the classification of submerged primary teeth,[18] the tooth germ detection,[19] clinical guidance, remote care, clinical documentation, and prediction of treatment outcomes.

The findings of this bibliometric analysis highlight the increasing academic and clinical interest in the application of AI in pediatric dentistry. The steady growth in publications and citations from 2020 to 2024 reflects the expanding role of AI technologies in various aspects of pediatric dental care, including diagnosis, treatment planning, and disease prediction.[20] This trend aligns with the broader integration of AI in healthcare, where machine learning algorithms and deep learning models are increasingly leveraged to enhance diagnostic accuracy, optimize treatment efficiency, and improve patient outcomes.

The peak in both publication output and citation count in 2024 suggests a pivotal moment in AI research within pediatric dentistry. This surge may be attributed to advancements in AI methodologies, increased accessibility of computational tools, and interdisciplinary collaborations between dental researchers, computer scientists, and healthcare professionals. Additionally, the growing number of studies exploring AI applications, such as early childhood caries detection, dental age estimation, and orthodontic assessments, underscores the diverse capabilities of AI in pediatric dental care. The high citation count further signifies the influence and impact of recent publications, indicating that AI-driven approaches are gaining widespread recognition in the field.

Despite the upward trajectory, a notable decline in both publications and citations is observed in 2025. This trend may be attributed to multiple factors. First, as the year is still ongoing, data incompleteness could be influencing the observed decline. Second, research interest in AI applications may have reached a plateau, with scholars shifting their focus toward more specialized and refined AI models rather than broad exploratory studies. Third, publication lag effects could also play a role, as studies conducted in 2024 may not yet be published or cited extensively. Future bibliometric analyses should monitor whether this decline represents a temporary fluctuation or a longer-term shift in research trends.

The analysis of publications on AI in pediatric dentistry highlights distinct geographical and institutional trends, with contributions from only 30 countries or regions. This limited engagement suggests that the adoption of AI in pediatric dentistry remains insufficient, especially when compared to its application in other dental specialties such as orthodontics, prosthodontics, and maxillofacial surgery, where AI-driven research has seen significantly higher publication volumes. The United States, Turkiye, and China lead in research output on this topic, with 17, 13, and 12 publications, respectively. Their prominence can be attributed to substantial financial investments, strong government support, and strategic prioritization of AI-driven advancements in healthcare. The United States' leadership is driven by large-scale federal funding initiatives, extensive private sector investments, and strong integration of AI research within academic and clinical institutions. Likewise, Turkiye and China have allocated significant funding toward AI development, with direct government-backed research initiatives aimed at expanding AI applications in healthcare and dentistry.[21]

In terms of institutional contributions, the University of Alabama at Birmingham recorded the highest number of publications, with a total of six, followed by Osaka University and Sichuan University, each contributing five publications. An analysis of citation metrics revealed that Ankara University and Peking University were the most frequently cited institutions, with 137 and 84 citations, respectively.

The prominence of these universities highlights their strong research capabilities and commitment to advancing AI technologies in pediatric dentistry. However, the significantly lower number of publications on AI in pediatric dentistry compared to other dental disciplines underscores a major gap in research and clinical integration. This highlights the need for increased global investment, interdisciplinary collaboration, and broader international engagement to enhance AI's role in pediatric dental care and improve patient outcomes.

This bibliometric research identified the most frequently cited articles on the use of AI in pediatric dentistry. However, the citation impact remains relatively modest, with the most referenced article receiving only 83 citations, a figure significantly lower than those observed in other dental disciplines. This suggests that while AI is gaining attention in pediatric dentistry, its influence and research impact are still limited compared to its applications in fields such as orthodontics, prosthodontics, and maxillofacial surgery.

Limitations

While this bibliometric analysis provides valuable insights into the research landscape of AI in pediatric dentistry, certain limitations must be acknowledged. First, the study is based exclusively on data retrieved from the WoS database, potentially leading to the omission of relevant studies indexed in other databases such as Scopus, PubMed, or IEEE Xplore, which also contain AI-related dental research. Second, variations in keyword selection and search strategies may have influenced the scope of retrieved studies, as AI-related terminology continues to evolve, and some relevant works may not have been captured. Third, as a bibliometric study, this research focuses on quantitative publication trends and citation metrics rather than directly evaluating the clinical effectiveness or real-world applicability of AI-driven tools in pediatric dentistry. Future research should incorporate qualitative assessments, including clinical trials and expert opinions, to better understand the practical implications of AI in pediatric dental practice. Additionally, given the rapid advancements in AI technologies, continuous updates to bibliometric studies are necessary to track emerging innovations, shifting research trends, and evolving clinical applications over time.

CONCLUSION

This bibliometric analysis reveals that while the use of AI in pediatric dentistry has grown in recent years, it remains underdeveloped compared to other dental specialties. The relatively low number of publications and citations indicates that AI applications in this field are still in their early stages. Despite its potential to enhance diagnostics, treatment planning, and disease prediction, further research is needed to validate AI models, improve clinical integration, and expand interdisciplinary collaboration. Future studies should focus on addressing data limitations and real-world applicability to maximize AI's impact on pediatric dental care.

ETHICAL DECLARATIONS

Ethics Committee Approval

This study is a bibliometric analysis based on publicly available sources and does not involve human or animal participants and therefore does not require ethical approval.

Informed Consent

Since this research is a bibliometric study, it did not require informed consent.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

Availability of data and materials

The data used and analyzed during the current study are available from the corresponding author on reasonable request.

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