ORIGINAL RESEARCH

Characteristics, Impact, and Visibility of Scientific Publications on Artificial Intelligence in Dentistry: A Scientometric Analysis

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Abstract

Aim: To analyze the bibliometric characteristics, impact, and visibility of scientific publications on artificial intelligence (AI) in dentistry in Scopus.

Materials and methods: Descriptive and cross-sectional bibliometric study, based on the systematic search of information in Scopus between 2017 and July 10, 2022. The search strategy was elaborated with Medical Subject Headings (MeSH) and Boolean operators. The analysis of bibliometric indicators was performed with Elsevier's SciVal program.

Results: From 2017 to 2022, the number of publications in indexed scientific journals increased, especially in the Q1 (56.1%) and Q2 (30.6%) quartile. Among the journals with the highest production, the majority was from the United States and the United Kingdom, and the Journal of Dental Research has the highest impact (14.9 citations per publication) and the most publications (31). In addition, the Charité – Universitätsmedizin Berlin (FWCI: 8.24) and Krois Joachim (FWCI: 10.09) from Germany were the institution and author with the highest expected performance relative to the world average, respectively. The United States is the country with the highest number of published papers.

Clinical significance: There is an increasing tendency to increase the scientific production on artificial intelligence in the field of dentistry, with a preference for publication in prestigious scientific journals of high impact. Most of the productive authors and institutions were from Japan. There is a need to promote and consolidate strategies to develop collaborative research both nationally and internationally.

Keywords: Artificial intelligence, Bibliometric analysis, Deep learning, Dentistry, Machine learning.

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Introduction

Recently with the technological progress of recent years, computational power and data analysis capacity has increased. In addition, new learning models have enabled rapid progress in many fields of knowledge.[1] The strengthening of informatics competence has favored the development of artificial intelligence, which involves complex automated algorithms dependent on statistics that can predict patterns with a certain level of accuracy.[2,3]

Artificial intelligence has been having a real impact on various aspects of society and the area of health is no stranger to this. It has been demonstrated that the implementation of this technology can generate significant improvements during the delivery of healthcare services.[4] In fact, current evidence shows that artificial intelligence can work optimally to identify the diagnosis and treatment of some diseases.[5] Intelligence artificial (IA) has different applications in the dental field. For example, it is used for the diagnosis of caries, periodontal disease, and jaw lesions. They are especially useful for an accurate diagnosis of certain oral pathologies using Big Data. Besides, it is expected that, over time, artificial intelligence technologies will continue to develop innovation for future healthcare.[6]

In the field of dentistry, artificial intelligence is currently used for various purposes, such as periodontics, endodontics, orthodontics, radiology, and detection of oral pathologies. Likewise, its use has been extended to the educational field and especially in the use of dental laboratories.[7] Its rapid development in recent years would allow it to be considered a fundamental tool of routine use for modern dentistry, but it is necessary to continue developing instigations and deepening the ethical challenges so that it can become part of the dentist's professional work.[8,9]

For the implementation of artificial intelligence, a proactive attitude is required to achieve a change in dental practice that will improve care and reduce costs for the benefit of users and society.[10,11] In this sense, dental research should favor the

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development of these technologies based on an understanding of the different techniques, tools, and concepts that exist today.[12]

The exploration of the available scientific evidence is necessary, given the accelerated development of science in the field of dentistry. Evaluating the bibliometric indicators of scientific production makes it possible to recognize its impact and relevance in the different collaborative networks. Due to the scarcity of evidence published in a specific dental specialty, this scientometric study covered manuscripts on the use and application of IA in general dentistry. For this reason, the aim of this study is to analyze the bibliometric characteristics, impact, and visibility of scientific publications on artificial intelligence in dentistry in Scopus.

Materials and Methods

Study Design

A descriptive, cross-sectional, bibliometric study was conducted based on the analysis of documents published in scientific journals indexed in Scopus between 2017 and July 10, 2022.

Search Strategy

The advanced search for information was carried out with a search strategy that was elaborated with the terms Medical Subject Headings (MeSH), which were grouped with the Boolean operator "OR"; in addition, the sub-area of dentistry was included by means of the operative "AND". With these precisions, the search strategy was defined as follows: TITLE-ABS ("Machine Learning" OR "Deep Learning" OR "Artificial Intelligence" OR "Learning Deep" OR "Intelligence Artificial" OR "Computational Intelligence" OR "Intelligence Computational" OR "Machine Intelligence" OR "Intelligence Machine" OR "Computer Reasoning" OR "Reasoning Computer" OR "Computer Vision Systems" OR "Computer Vision System" OR "System Computer Vision" OR "Systems Computer Vision" OR "Vision System Computer" OR "Vision Systems Computer" OR "Knowledge Acquisition" OR "Acquisition Knowledge" OR "Knowledge Representation" OR "Knowledge Representations" OR "Representation Knowledge") AND SUBJAREA (dent). The result of the search was 522 publications of any language made between the year 2017 and 2022; and pertaining to the area of dentistry. As of September 28, 2022, we found Original Article (433), Review (70), Editorial (17), Letter (15), and Conference Paper (12) among other types of published research.

Data Collection

The export of the metadata of the publications was performed on July 10, 2022. Of the total number of publications identified with the search strategy, only 508 were exported with the SciVal software of the Elsevier Corporation and 459 were finally analyzed. This tool allows the analysis of a given topic in a field of knowledge through the exploration of different bibliometric indicators of production, impact, and collaboration. The export was done in a .csv file. In addition, percentages were estimated with the Microsoft Excel program. Finally, all the information was presented in tables.

Selection Criteria

Manuscripts on AI indexed in Scopus.
Manuscripts on AI in all languages.
Manuscripts published during 2017–2022.

Scientometric Analysis

As part of the analysis of this research, the following metrics of the bibliometric methodology were studied: authorship and *h*-index of each author, country, collaboration, number of publications, number of citations, citations per publication, field-weighted citation impact (FWCI), journal quartile, SCImago Journal Rank (SJR), Source-Normalized Impact per Paper (SNIP), and CiteScore 2020.

Results

Top 10 Countries with the Highest Scientific Production

Among the countries with the highest scientific production, the United States (109) has the highest productivity, with approximately twice as many publications as Japan (54). Although Germany has 32 publications, it is the country with the best performance given that it has a higher number of expected citations with respect to the world average (FWCI: 7.31) (Table 1).

Table 1: Top 10 countries with the highest scientific production

Country/ Region	*Scholarly output*	*Views count*	*FWCI*	*Citation count*
United States	109	2341	2.71	772
Japan	54	1082	2.92	564
China	46	716	3.1	184
South Korea	45	916	3.92	811
India	34	832	3.78	225
Turkey	33	786	2.91	236
Germany	32	952	7.31	506
Brazil	31	714	2.9	222
United Kingdom	30	576	2.01	159
Saudi Arabia	21	530	3.21	185

FWCI, field-weighted citation impact

Top 10 Institutions with the Highest Scientific Production

Japan is the country with the most institutions among those with the highest scientific production. In fact, Aichi Gakuin University is the most productive, with 21 publications and 19.5 citations per publication. However, the institution with the highest impact was Yonsei University in South Korea, with 39.5 citations per publication. In addition, the Charité – Universitätsmedizin Berlin of Germany had the highest expected return relative to the world average (FWCI: 8.24) (Table 2).

Top 10 Scientific Journals with the Highest Number of Scientific Production

The 10 journals with the highest production on artificial intelligence in dentistry are of high impact, located in the Q1 and Q2 quartile, moreover, most of them are from the United States (*n* = 3) and United Kingdom (*n* = 3). The Journal of Dental Research has the most publications (*n* = 31) and the highest impact (14.9 citations per publication) (Table 3).

Trend of Scientific Production by Quartile of Indexed Journals

The scientific production increased from 10 publications in 2017 to 169 in 2021. Approximately 90% of the production is in high-impact scientific journals, corresponding to the Q1 (56.1%) and Q2 (30.6%) quartile (Table 4) (Fig. 1).

Top 10 Authors with the Highest Production

Among the 10 authors with the highest production, the majority were Japanese (6 publications), and, in fact, the authors with the highest production were Ariji Yoshiko (19 publications) and Katsumata Akitoshi (16 publications). Likewise, Fujita Hiroshi has the highest impact, presenting 33.4 citations per publication. The German author, Krois Joachim, is the one who had the most expected citations, taking as a reference the world average (FWCI: 10.09) (Table 5). The general dentistry category contains the most publications (253) and citations (2084), followed by oral surgery with 124 publications and 999 citations. Dental hygiene is the field least used for publications on artificial intelligence (Fig. 2).

Collaboration between Countries

It was found that collaboration between countries was clustered in 7 major clusters. The United States was the country with the highest concentration of collaboration, especially with the United Kingdom, China, and South Korea (Fig. 3).

Discussion

Advances in various fields of science have led to the development of different technologies, such as artificial intelligence, which has many implications for society. In the field of health, specifically in dentistry, it has been implemented to improve the process of user care, from diagnosis to treatment of dental diseases. Its study is increasingly relevant to strengthen professional dental practice.

The findings show that there is a tendency to increase scientific production on artificial intelligence in the field of dentistry; furthermore, the United States is the country that contributes the most evidence in this field of knowledge; in fact, up to the date of execution of our study, it has almost twice as many publications as Japan. This highlights the need to strengthen the development

Table 2: Top 10 institutions with the highest scientific production

Institution	*Country*	*Scholarly output*	*Citations*	*Authors*	*Citations per publication*	*FWCI*
Aichi Gakuin University		21	409	35	19.5	4.24
Charité – Universitätsmedizin Berlin		18	338	30	18.8	8.24
Asahi University		16	389	7	24.3	4.62
KU Leuven		14	69	34	4.9	5.11
Ankara University		14	124	3	8.9	3.64
The University of Hong Kong		13	130	21	10	3.88
Seoul National University		13	241	23	18.5	4.16
Karolinska Institutet		13	117	2	9	5.58
Yonsei University		12	471	31	39.3	4.8
Gifu University		11	367	4	33.4	6.26

FWCI, field-weighted citation impact

Table 3: Top 10 scientific journals with the highest number of scientific productions

Scopus source	*Quartile*	*Country*	*Publications*	*Citations*	*Authors*	*Citations per publication*	*SNIP*	*CiteScore 2020*	*SJR*
Journal of Dental Research	Q1		31	461	229	14.9	2.519	12.1	1.78
Dentomaxillofacial Radiology	Q1		27	273	132	10.1	1.539	4.4	0.79
Orthodontics and Craniofacial Research	Q1		21	46	147	2.2	1.373	3.2	0.82
Journal of Dentistry	Q1		20	360	99	18	1.917	6.8	1.11
Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology	Q2		19	226	92	11.9	1.343	3.9	0.57
Oral Oncology	Q1		16	214	116	13.4	1.85	7.9	1.42
Clinical Oral Investigations	Q1		15	51	90	3.4	1.779	5.8	0.92
Oral Radiology	Q2		15	159	78	10.6	1.311	2.7	0.45
Journal of Dental Education	Q2		14	31	59	2.2	1.572	2.1	0.46
BMC Oral Health	Q1		13	59	69	4.5	1.785	3.6	0.79

SJR, SCImago Journal Rank; SNIP, source-normalized impact per paper

Table 4: Trend of scientific production by quartile of indexed journals

							Overall	
CiteScore quartile	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*n*	*%*
Q1	1	4	23	38	99	79	244	56.1
Q2	4	6	13	26	54	30	133	30.6
Q3	4	1	9	15	10	5	44	10.1
Q4	1	0	0	3	6	4	14	3.2
Total	10	11	45	82	169	118	435	100

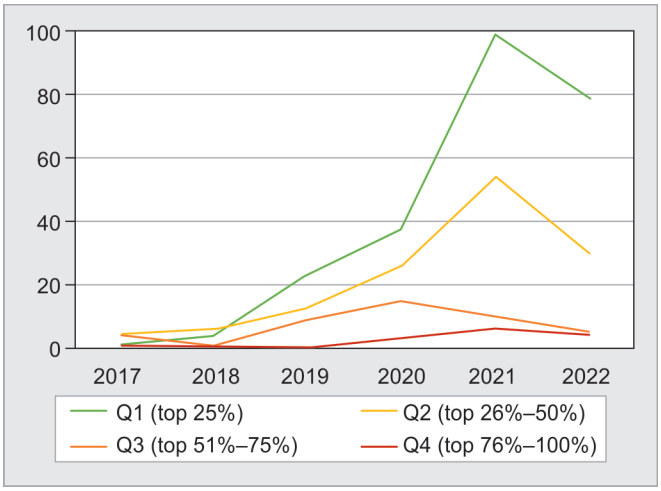

Fig. 1: Scientific publications by quartile of the indexed journals. Scientific production increased from 10 publications in 2017 to 169 in 2021. The number of publications in scientific journals of the third and fourth quartile maintain a homogeneous trend in all years. Approximately 90% of the production is in high-impact scientific journals, corresponding to quartile Q1 (56.1%) and Q2 (30.6%)

of collaborative research between authors and institutions of different nationalities, which requires the standardization of processes, conditions, and tangible products of the different types of collaboration to realize collaborative and interdisciplinary research initiatives.[13,14]

The new research topics that arise with the development of science are of great interest to researchers. The purpose of the development of studies is the dissemination in scientific journals, especially in those with high impact and greater prestige in the scientific community.[15] In this regard, the production on artificial intelligence in the field of dentistry is carried out in Q1 and Q2 quartile journals, the main ones being the Journal of Dental Research, Dentomaxillofacial Radiology, and Orthodontics and Craniofacial Research.

Dental research related to artificial intelligence is gaining more currency in recent years. In fact, our research shows that the authors with the highest output made their last publication in the last 2 years (2021 and 2022) and that most of them are from Japan. To date, the documented publications are focused on models based on artificial neural networks and convolutional neural networks,[16] which demonstrate that artificial intelligence can handle the whole process of attention.[17,18]

Table 5: Top 10 authors with the highest production

Name	*Country*	*Scholarly output*	*Most recent publication*	*Citations*	*Citations per publication*	*FWCI*	*h-index*
Ariji, Yoshiko		19	2022	408	21.5	4.66	28
Katsumata, Akitoshi		16	2022	370	23.1	4.39	24
Schwendicke, Falk		16	2022	338	21.1	9.27	53
Fukuda, Motoki		16	2022	398	24.9	5.38	11
Ariji, Eiichiro		15	2022	404	26.9	5.7	11
Krois, Joachim		14	2022	335	23.9	10.09	16
Orhan, Kaan		13	2022	102	7.8	3.61	27
Kise, Yoshitaka		12	2022	355	29.6	5.95	14

(Contd...)

Table 5: *(Contd...)*

Name	*Country*	*Scholarly output*	*Most recent publication*	*Citations*	*Citations per publication*	*FWCI*	*h-index*
Fujita, Hiroshi		11	2021	367	33.4	6.26	38
Jacobs, Reinhilde		11	2022	65	5.9	6.16	71

FWCI, field-weighted citation impact

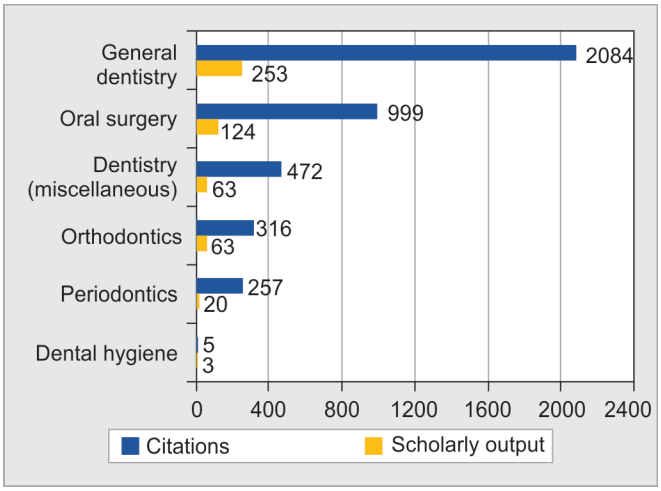

Fig. 2: Scientific publications and citations by specialty. The general dentistry category contains the most publications (253) and citations (2084), and dental hygiene is the field least used for publications on artificial intelligence

The evaluation of the impact or performance of authors is based on the analysis of citations, although this widely used indicator is still a frequent source of debate among the scientific community.[19] In this regard, the author Fujita Hiroshi has the highest impact, with 33.4 citations per publication; however, Krois Joachim was the one who had the most expected citations in relation to the world average (FWCI: 10.09). Although his production has been oriented to the treatment and diagnosis of diseases,[20–22] Krois Joachim has also shown that users of dental services are convinced that artificial intelligence would be useful,[23] which is why its use should be oriented to organizing the patient's own data for individualized treatment.[24]

The main limitation of this bibliometric research was that the search for published documents was only carried out in one database, Scopus,[25] however, since it is one of the most important and with the widest coverage worldwide, it can express in a good way the scientific production in the subject studied. In addition, it should be considered that during the export of information with the SciVal program, metadata of the publications may have been lost, due to a bad registration or because some journals are no longer indexed in the database, these limitations are typical of this methodology, but they do not significantly affect the results presented in this research. This type of study makes it possible to identify the type of studies that are published in dentistry[26,27] to be able to make decisions on strategic alliances for scientific collaboration.

The main dental specialties that can be developed with IA are those involving diagnostic imaging (radiology) and surgery (periodontics, oral implantology, and oral maxillofacial surgery). However, the main limitation is that IA could not be implemented in technologically underdeveloped countries because it is difficult to find resources such as specialized software and state-of-the-art

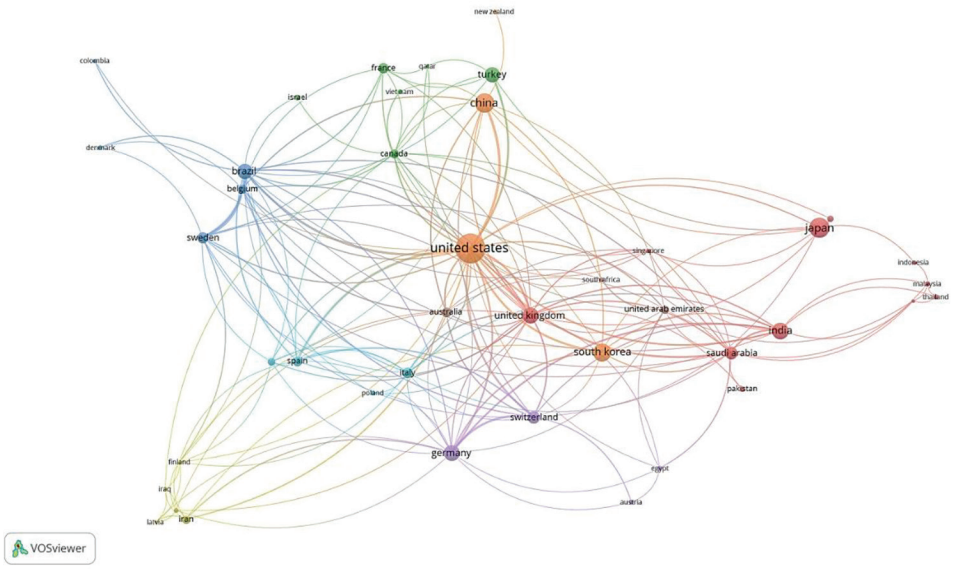

Fig. 3: Collaboration by country. Bibliometric map showing collaborative networks on IA by countries

equipment. Another limitation was that according to the data found, there is little original research on the application of IA in dentistry, therefore, it is important to focus our attention on this field of knowledge for the benefit of dentistry.

Conclusion

In conclusion, scientific production on artificial intelligence in dentistry has increased in recent years, especially in high-impact journals located in the Q1 and Q2 quartile. In addition, the authors with the highest contribution are Japanese, and the journals with the highest preference for publication are from the United Kingdom and the United States, the latter being the country with the most published papers.

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