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ORIGINAL ARTICLE

The use of ultrasonography in dentistry: a bibliometric analysis

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Abstract

Objectives In this bibliometric analysis, various parameters such as leading journals, universities, countries, authors and keywords related to the use of ultrasonography (USG) in dentistry were analysed with the help of bibliometric mapping, aiming to help researchers evaluate scientific results on this subject and design future research.

Methods In this bibliometric analysis, using the Web of Science (WoS) database various factors such as publication date, number of citations, publication language, journals published, countries, and keywords of articles covering research on the use of USG in dentistry between 1981 and 2024 were examined.

Results It has been determined that the number of articles and citations regarding the use of USG in dentistry is increasing day by day. While 6 articles were published in this field in 2000, 94 publications were made in 2023. While 25 citations were made in 2000 for articles published on the use of USG in dentistry, this number reached 2334 in 2023. The country with the most publications in this field was the USA, and the journal with the most publications was Dentomaxillofacial Radiology.

Conclusion The findings of this current analysis may help researchers categorize scientific conclusions regarding the use of USG in dentistry and thus select issues to examine when designing future research.

Keywords Ultrasonography · Ultrasound · Sonography · Bibliometric · VOSviewer software

Introduction

Ultrasonography (USG) is a non-invasive, economical, accessible, simple and reliable imaging method that uses high-frequency sound waves that do not contain ionizing radiation and is frequently used for imaging soft tissues [1]. In the examination of head and neck masses and lymphadenopathies used in the evaluation of tongue, hematomas, abscesses, periapical lesions, intrabony pathologies such as cysts and tumors, periodontal bone defects and TMJ diseases, in the diagnosis of salivary gland diseases and in the examination of structural and morphological changes in the salivary glands [2, 3]. USG is a radiological method in which images are obtained in real time, and high frequency sound waves are used in this method [4]. While the human ear can hear sounds between 20 Hz and 20,000 Hz (20 kHz), diagnostic ultrasonography uses sound waves with frequencies much higher than the hearing limit between 2 and 30 MHz. In applications on the head and neck, the frequency of 7.5 MHz is generally preferred [5].

Color Doppler USG can be used to evaluate the vascularization of tissues, such as blood flow rate and resistance index, and to differentiate benign-malignant and inflammatory-non-inflammatory lesions. Additionally, USG-guided fine needle aspiration biopsy can also be performed [1, 2].

USG in dentistry was first performed by Baum et al., who used a 15 MHz ophthalmological USG scanner to view the internal structures of teeth [6]. However; it was not possible to produce images with the desired clarity. Subsequent studies focused on enamel and dentin layer thickness

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measurements, enamel demineralization and dental hard tissue characterization [7, 8]. Kydd et al. began investigating soft tissue applications of USG in dentistry, with studies such as his study of ultrasonic measurement of gingival thickness and the first reported use of ultrasonography to diagnose periodontal disease by Spranger [9, 10]. And satisfactory results were achieved on soft tissue examinations [11]. It also helps diagnosis in hard tissues, albeit in a limited way.

Dentists are often unaware of the potential uses of USG [12]. Evaluation of the historical situation and development trend in scientific research on the areas of use of USG in dentistry can serve as a road map for future research. In addition to providing a basis for improving existing health services, it will also contribute to the development of new areas of use.

Nowadays, analysis of bibliometric has become an accepted method for presenting research models of scientific literature [13, 14]. In addition it highlights the most relevant authors, journals, institutes and country involved in the research field, providing evidence regarding the progress of a particular field [15, 16]. There is a deficiency in the literature regarding the bibliometric analysis of the areas of use of USG in dentistry. Also, the results of this analysis can help students, academics and researchers characterize scientific results regarding the use of USG in dentistry, evaluate diagnostic strategies, and identify important issues that will help design future research. Therefore, this current analysis was carried out to evaluate the scientific literature addressing the use of USG from a dental perspective and to identify the most productive journals, authors, institutions, countries and keywords used in this field of research. In addition, our study aimed to map the areas of use of USG in dentistry and to highlight the current difficulties, knowledge gaps and research status of USG technology in this context.

Material and method

For this analysis, the Web of Science (WoS) (https://www.webofscience.com/wos/woscc/basic-search) database, a large platform that provides necessary information about published articles to researchers worldwide, was used. Since the WoS database is updated every day, data collected on a single day was added to eliminate any bias that may occur. Articles were selected as the document type, and then "dentistry" was selected as the subject area. “Ultrasound OR Ultrasonography OR Sonography (Topic) AND Dental OR Dentistry” (Topic) was selected as the search terms. The researchers carefully scanned the titles and abstracts of potential publications on the subject. Ethical approval was not obtained for this analysis, since did not use any animal or human.

Exclusion criteria included articles published outside the field of dentistry. During the initial screening process by the researchers, articles that were not related to the field of USG use in dentistry were disqualified. Since the research was conducted in July 2024, all articles covering research on the use of USG in Dentistry between 1981 and 2024 (last 43 years) were counted. A thorough search of the WoSCC using the terms “Ultrasound OR Ultrasonography OR Sonography (Topic) AND Dental OR Dentistry” (Topic) yielded a total of 1298 items. The year 2024 was then omitted from the analysis due to a lack of comprehensive data, yielding a total of 1194 findings. The search was then narrowed by excluding review articles, case reports, editorial material, notes, meeting abstracts, proceeding papers, letters, book chapters, and corrections from the document types tab, resulting in 1071 hits. The Science Citation Index Expanded (SCI-EXPANDED) and Emerging Sources Citation Index (ESCI) was used, producing a total of 1044 results. The titles and abstracts were then reviewed, yielding a total of 1044 results, as shown in Table 1.

Article publication date, languages, countries, citation totals, affiliations, research areas, journals, authors and keywords were analysed. WoS broadcasts were saved as TXT files and exported to Excel file.

Descriptive statistical techniques were used to present data obtained from scientific publications. Biblioshiny (version 2.0), accessed via R-Studio (R version 4.2.2), a web interface application, was used for bibliometric analysis (https://www.bibliometrix.org/home/index.php/layout/biblioshiny). The R language environment runs the free-source research software packages Bibliometrix and Biblioshiny. Biblioshiny creates an interactive online data analysis platform that allows users to perform bibliometric and visual analyses. Bibliometric data displays such as publication volume, number of articles, number of citations, and keywords. The article provides diagrams and maps showing research highlights, research status, and publication dynamics over time [17]. Additionally, VOSviewer software version 1.6.18 for Windows was used to create and view bibliometric maps. The main aim of creating VOSviewer was to examine and visualize the bibliometric network and obtain

Table 1 Data extraction and filtration process of publications about use of Ultrasonography in Dentistry

Search criteria	Result count
Initial search	1298
After excluding articles published in 2024	1194
After selecting the document type	1071
After eliminating articles scanned outside the scope of SCI-EXPANDED and ESCI	1044

a comprehensive knowledge of the dynamic structure of scientific study [18].

Results

The results of this current analysis revealed that the number of articles published on the use of USG in dentistry from 1981 to 2000 was relatively small (Fig. 1). While 6 articles were published in 2000, 40 articles were published in 2010, indicating that researchers have developed a strong interest in this field. Similarly, while 62 articles were published in 2019, 83 and 84 articles were published in 2021 and 2022, respectively. The highest number of articles was published in 2023 with 94 publications. Number of citations regarding the use of USG in Dentistry: 25 citations were received in 2000. This number continued to increase until 2017 and reached 852 citations. There was no significant increase in the number of citations between 2017–2018 year and a faster increase was observed between 2018–2023 year, reaching 2334 citations from 1097.

80 Countries/Regions published on ultrasonography between 1981 and 2023. The top 10 Countries/Regions and the number of publications are given in the Table 2. The United States of America (USA) published the most articles (170), followed by Germany and England, which published 96 and 89 articles, respectively. In our study, the country with the highest number of citations was determined as the USA (5609), followed by England (4305) and Germany (1724). In the current analysis, Fig. 2 describes the collaboration network among collaborating countries for research on the use of USG in dentistry.

Table 2 Most published countries about the use of ultrasonography in dentistry

Countries/regions	Number of publications	% 1.044	Number of citations
USA	170	16.284	5.609
Germany	96	9.195	1.724
England	89	8.525	4.305
Japan	80	7.663	1.416
Brazil	78	7.471	1.086
Chına	73	6.992	889
Italy	67	6.418	1.327
India	62	5.939	433
France	49	4.693	980
Turkey	45	4.310	498

Showing first 10 out entries

Table 3 shows the findings of the leading organizations that publish the most on the use of USG in dentistry. The University of Michigan and the Michigan System University published 30 articles, followed by the Center National De La Recherche Scientific Cnrs with 26 articles.

Table 4 and Fig. 3 show the top journals contributing to the field of USG use in dentistry. Dentomaxillofacial Radiology published the highest number of articles (24) and

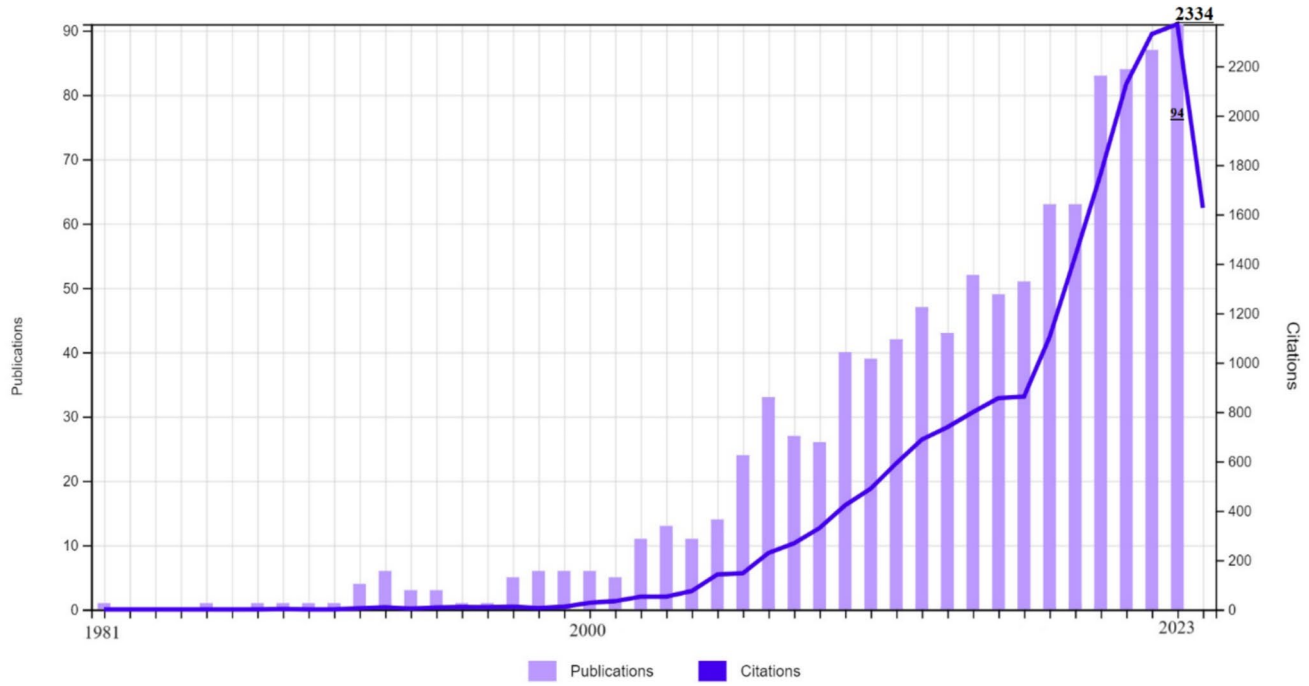

Fig. 1 Number of publications by year about the use of ultrasonography in dentistry

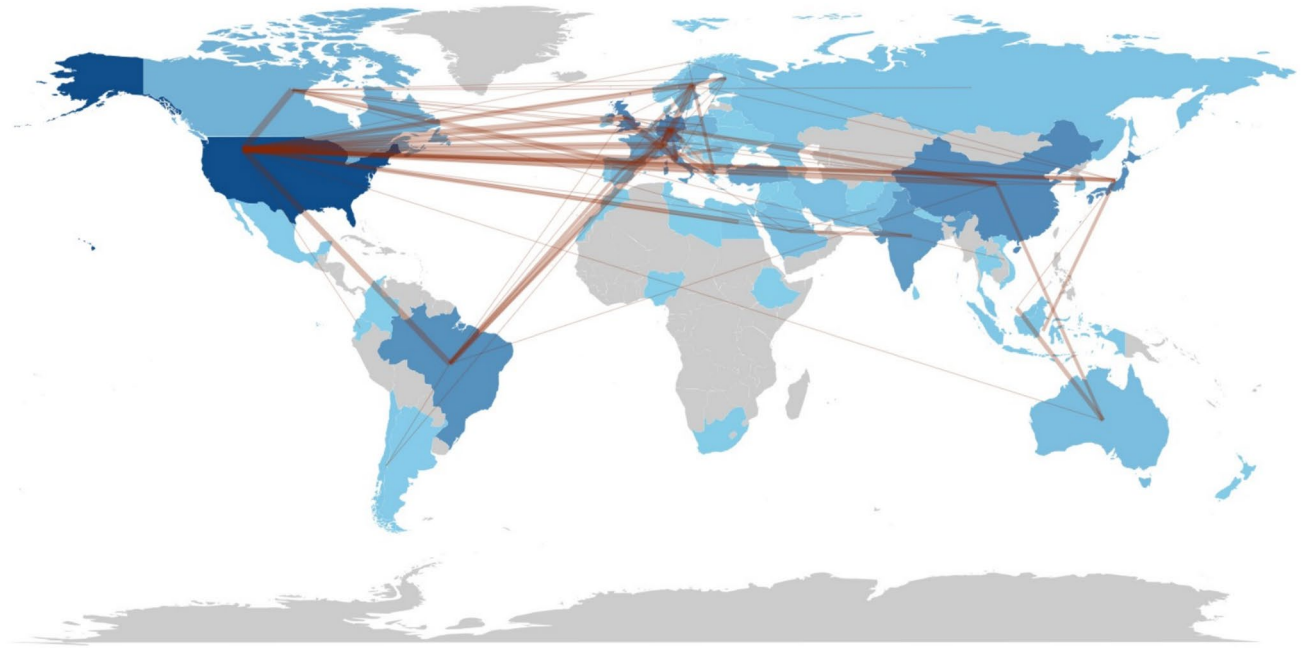

Fig. 2 Cooperation map of broadcasting countries about the use of ultrasonography in dentistry

Table 3 Universities with the most publications about the use of ultrasonography in dentistry

Affiliations	Record count	% of 1.044
University of Michigan	30	2.874%
University of Michigan System	30	2.874%
Centre National De La Recherche Scientifique Cnrs	26	2.490%
Universite Paris Est Creteil Val De Marne Upec	22	2.107%
Universidade De Sao Paulo	21	2.011%
Universite Gustave Eiffel	21	2.011%
University of London	21	2.011%
University of Birmingham	20	1.916%
Harvard University	20	1.916%
University of California System	19	1.820%

Showing first 10 out entries

Table 4 Journals with the most published about the use of ultrasonography in dentistry

Affiliations	Record count	% of 1.044	Number of citations
Dentomaxillofacial radiology	24	2.299%	419
Ultrasound in medicine and biology	22	2.107%	415
Journal of endodontics	16	1.533%	433
Journal of periodontology	16	1.533%	367
Dental materials	15	1.437%	595
Journal of clinical periodontology	15	1.437%	466
Clinical oral implants research	12	1.149%	267
Journal of the acoustical society of America	11	1.054%	442
Clinical oral investigations	10	0.958%	96
Journal of dentistry	10	0.958%	294

Showing first 10 out entries

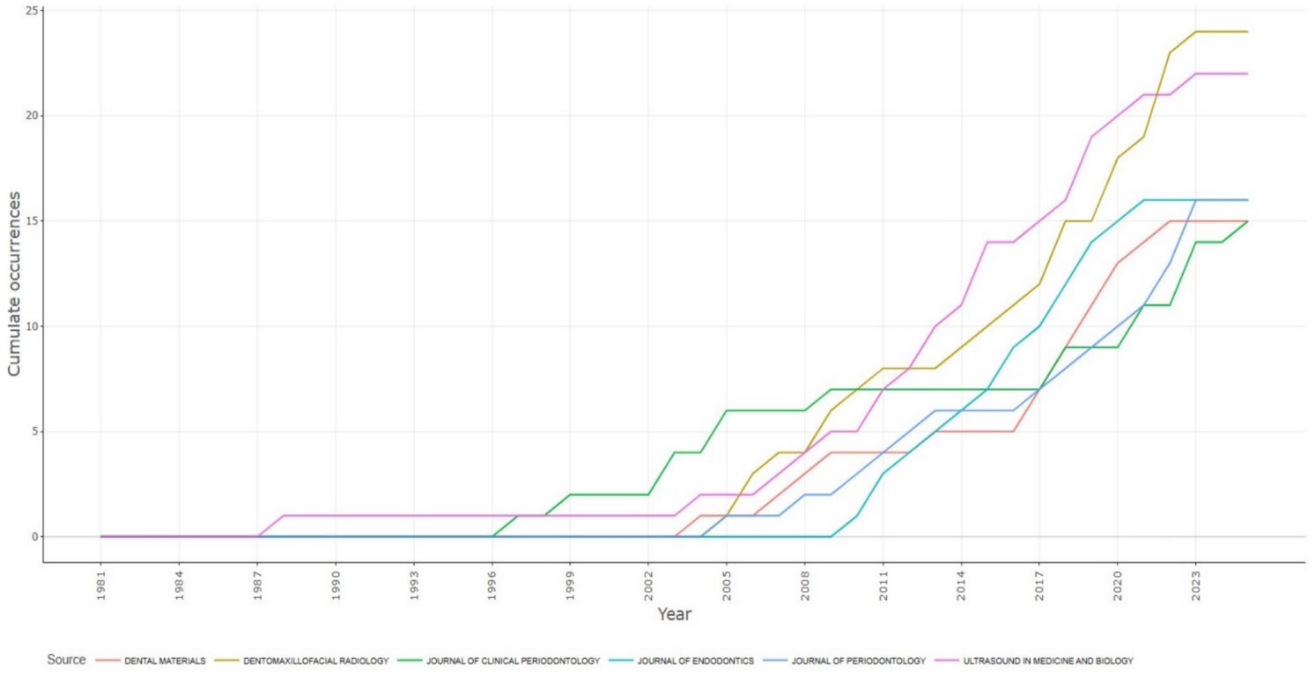

Fig. 3 Journals with the most published about the use of ultrasonography in dentistry

Table 5 Authors with the Most Publications about the Use of Ultrasonography in Dentistry

Authors	Number of publications	% of 1.044	Number of citations
Chan HL	25	2.395	397
Kripfgans OD	23	2.203	396
Walmsley AD	17	1.628	543
Haïat G	14	1.341	174
Wang HL	13	1.245	125
Vayron R	12	1.149	362
Nguyen VH	11	1.054	121
Barootchi S	10	0.958	152
Marotti J	10	0.958	152
Tavelli L	10	0.958	138
Wolfart S	10	0.958	138

Showing those who have at least ten publications

received 419 citations. 'Ultrasound in Medicine and Biology' and 'Journal of Periodontology/Journal of endodontics' have published 22 and 16 articles respectively. Interestingly, 'Dental Materials/Journal of clinical periodontology' published only 15 articles but received 595 citations.

Table 5 identifies leading authors who have published articles on the use of USG in dentistry. Chan HL published 25 articles, followed by Kripfgans OD, who published 23 articles. At the same time, authors Walmsley AD and Haïat G have published 17 and 14 articles respectively. Walmsley AD was the most cited author (543), followed by Chan HL and Kripfgans OD, with 397 and 396 citations, respectively (Table 5). The most cited author relationships are shown in Fig. 4.

Figure 5 shows the relationship between the most published author, country and university. There is a relationship between Chan HL, the most published author, the University of Michigan, which has the most publications, and the USA, the country with the most publications.

In the current analysis, when various keywords used regarding the use of USG in dentistry were analysed, it was seen that the most used keyword was ultrasound (128). This was followed by in-vitro (63), diagnosis (61), risk (43) and ultrasonography (41) (Fig. 6). The relationships between keywords are shown in Fig. 7.

Table 6 shows the languages in which the most publications are made regarding the use of USG in dentistry. While the common language of articles on the use of USG in Dentistry is English and constitutes 94.540% of the total publications with 987 articles, the second language of the publications on this subject is German with 21 articles and a share of 2.011%. German and English were followed by French ($n=8$), Spanish ($n=5$), and Czech ($n=4$).

Discussion

Studies based on bibliometric analysis helps to better understand and visualize a particular scientific field and provide predictions about future trends. In this current study; various

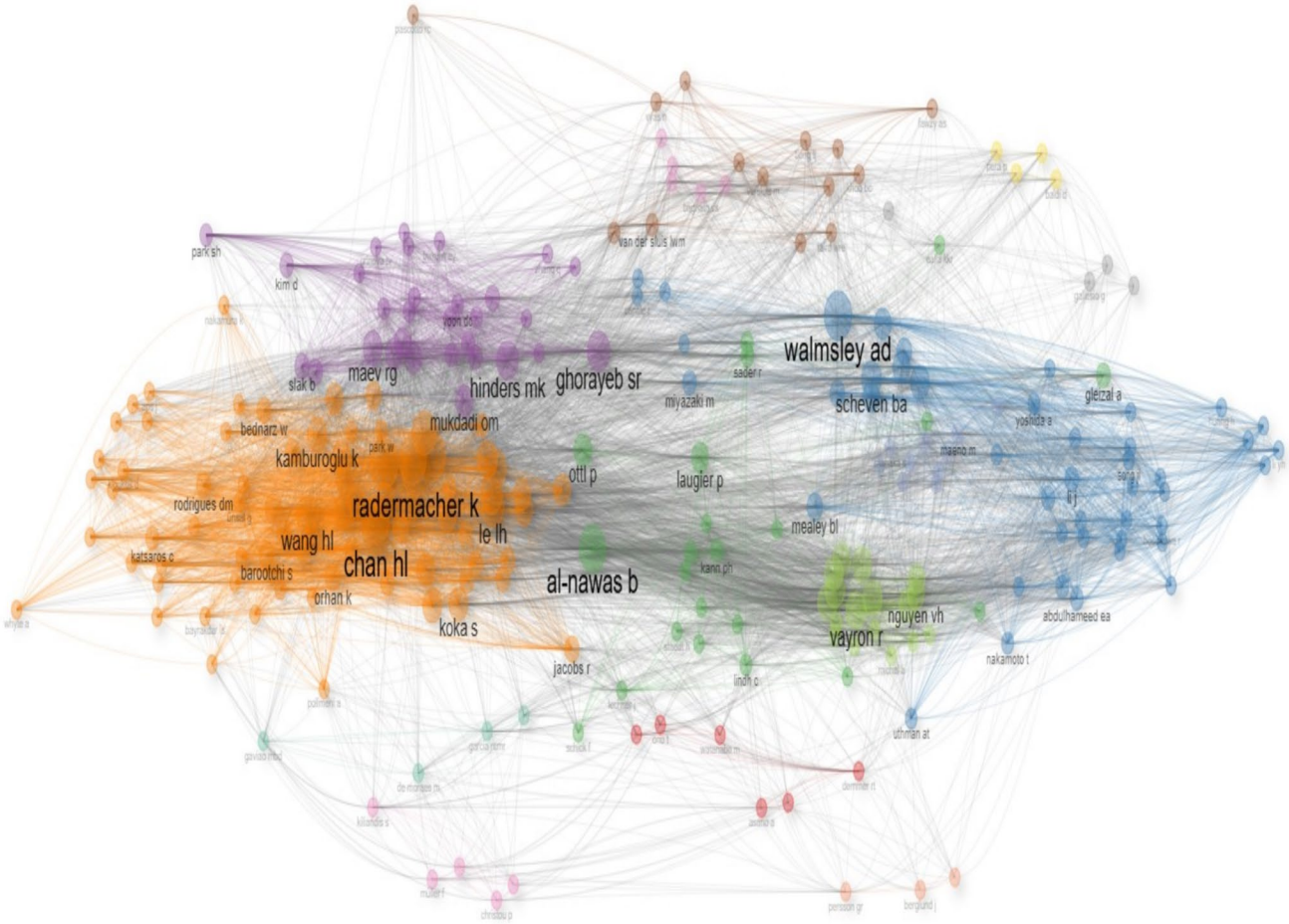

Fig. 4 Authors relationships with the Most Citations about the Use of Ultrasonography in Dentistry. **Citations are shown by lines linking authors. Authors with a greater circle size or font size had a higher number of citations

parameters such as leading journals, universities, countries, authors and keywords have been analyzed with the help of bibliometric mapping [13, 19].

The results of this study show that the USA has the most publications ($n=170$), followed by Germany ($n=96$), England ($n=89$), Japan ($n=80$) and Brazil ($n=78$). This shows that research on USG in dentistry is still dominated by relatively developed countries, reflecting the relationship between economic investments, the national social economy and scientific research. The frequency of citation of publications can represent to some extent the academic impact of the article findings. The citation numbers of the countries are respectively USA ($n=5.609$), England ($n=4.305$), Germany ($n=1.724$) and Japan ($n=1.416$). This situation shows that these countries have higher academic influence about USG in dentistry.

From the USA, the University of Michigan was the most prolific institution, publishing the most papers; Universities from the USA published the most articles. Chan HL, who is affiliated with the University of Michigan and Michigan System in the USA, was the most published and most cited author. This result shows that authors at the University of Michigan produce highly effective publications, thus enabling the university to become a leading institution in this field.

The general trend is consistent in terms of the distribution and national origins of institutions publishing relevant research. In terms of number of publications, the top five institutions are from the USA. The relationship between the most published author, Chan HL, and the most published university is evident. Moreover, a relationship was determined between the most cited author, Walmsley AD, and the University of Michigan with the most publications. Scientists who plan to conduct USG-related research in the field of dentistry should pay close attention to the academic achievements of this institution in the future.

Keywords are important in the discoverability of the published article [20, 21]. In general, when conducting a literature search, researchers tend to use various search terms related to the particular field [22]. In our analysis,

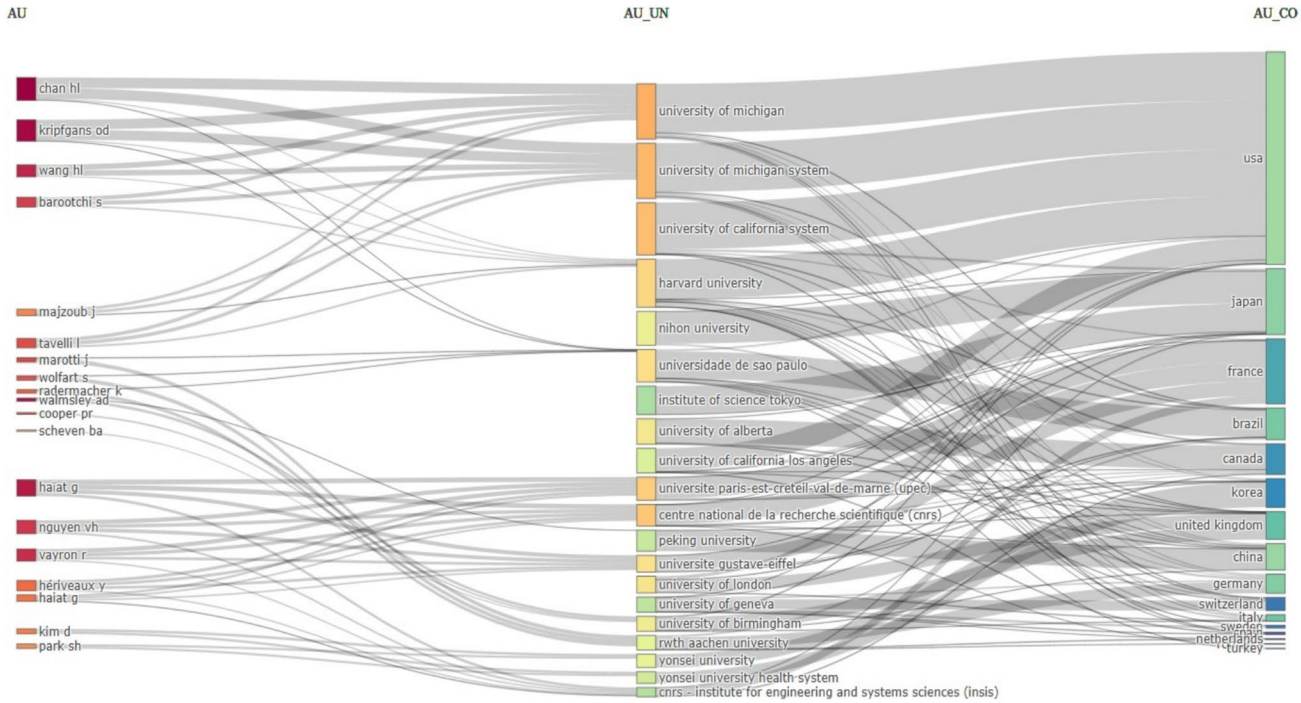

Fig. 5 Authors, country and university with the most publications about the use of ultrasonography in dentistry

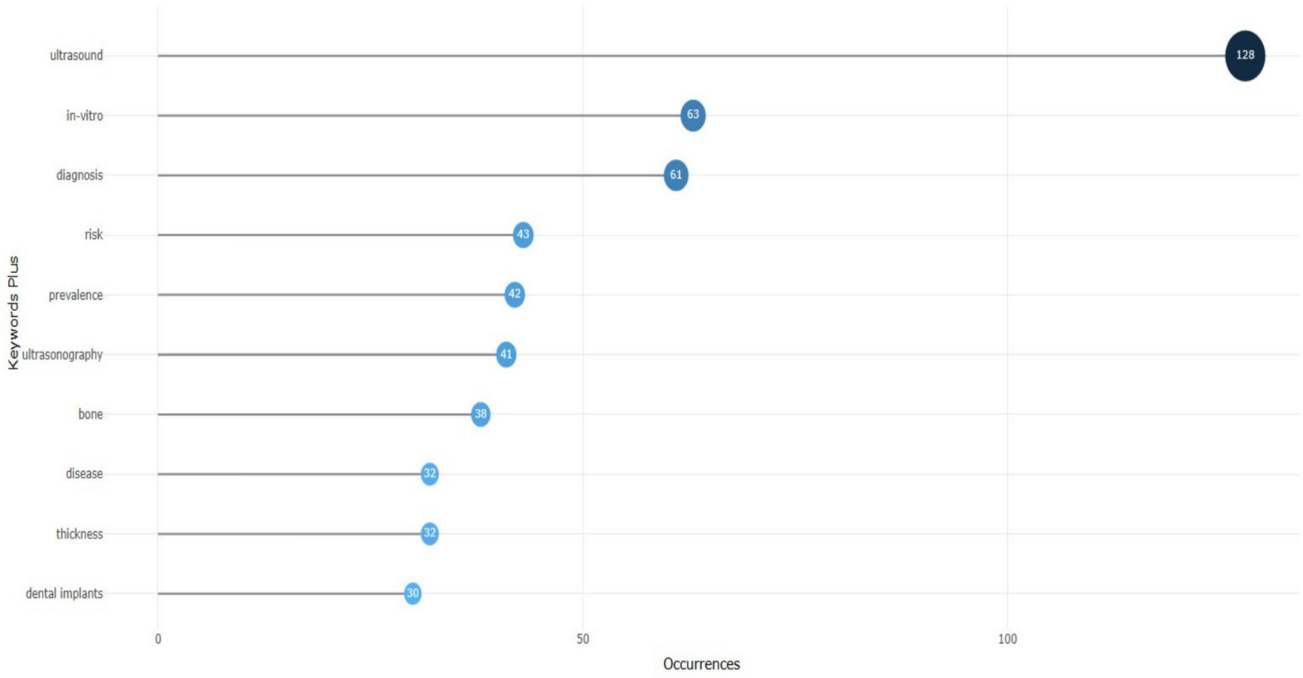

Fig. 6 Keywords most used about the use of ultrasonography in dentistry

ultrasonography, in-vitro and diagnosis were frequently used by researchers as keywords in their publications.

When the best journals are examined according to the number of articles published, Dentomaxillofacial Radiology journal (impact factor: 3.525) ranks first with 24 articles. In general, he published a total of 151 articles in the ten most published journals on the use of USG in dentistry, accounting for 15.89% of the articles on this subject.

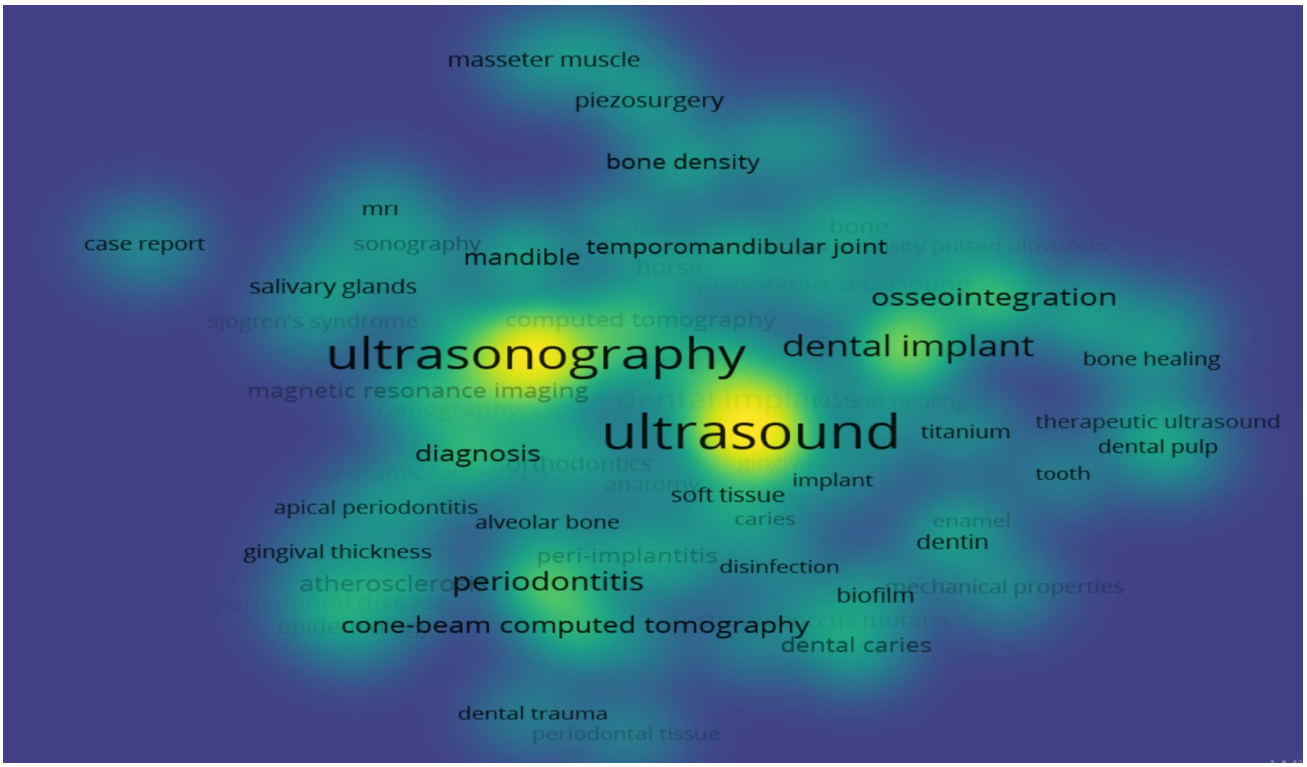

Fig. 7 Relationships between Keywords about the Use of Ultrasonography in Dentistry. *** Colors demonstrate preferred keywords, especially red show popular keywords. Keywords represented with larger circle size or font size had a relatively higher occurrence in the articles

Table 6 Most preferred languages in publications about the use of ultrasonography in dentistry

Languages	Number	% 1.044
English	987	94.540
German	21	2.011
French	8	0.766
Spanish	5	0.479
Czech	4	0.383
Korean	4	0.383
Russian	4	0.383
Portuguese	3	0.287
Chinese	2	0.192

Showing those who have at least two publications

While the common language of articles on the use of USG in Dentistry is English and constitutes 987 (94,540) of the total publications, the second language of the publications on this subject is German, with 21 articles and a share of 2.011%. English and German were followed by French ($n=8$), Spanish ($n=5$), and Czech ($n=4$). This may be due to WoS's broad English language journal coverage and the widespread use of English in scientific language globally [23, 24]. Previously studies reported that English was the most common language in the Scopus index [13, 14].

The main limitation of our research that only examined studies included in the WoS database. The WoS database is the most popular and reliable search engine, but some outlying posts may have been ignored. Second; standardization of author names and terms may not be accurate, since some authors may have more than one name or more than one spelling of their name. For some authors, this can result in inaccurate research output. Despite these drawbacks, this analysis provides an overview of the use of USG in dentistry.

Conclusion

When this bibliometric analysis on the use of USG in dentistry is examined, it can be concluded that the number of citations received by articles in this field has also increased with the increase in the number of publications in recent years. The findings of this current analysis can help students, researchers and academics to categorize scientific results on the use of USG in dentistry, evaluate its role in diagnosis and treatment, and determine the issues they need to pay attention to when designing future research.

Author contributions Protocol/project development: SK,MVK Data collection and management: MEA. Data analysis: SK,MED. Manuscript writing/editing: SK,MEA.

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Data availability Not applicable.

Code availability Not applicable.

Declarations

Conflict of interest MED, SK, MVK and MEA declare that they have no conflict of interest.

Ethical approval Ethical approval not required since for this analysis, since did not use any animal or human.

Informed consent Because the study was not use any animal or human, no written informed consent form was obtained.

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