Scientific production on dental caries 2014–2018: a bibliometric study in Web of Science[1]

Producción científica sobre caries dental entre 2014 y 2018: estudio de indicadores bibliométricos en Web Of Science[1]

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Keywords: bibliometrics, dental caries, statistics and numerical data, dental research

Abstract

Introduction: the aim was to conduct a bibliometric study regarding the scientific production on dental caries in the period 2014–2018. ***Methods:*** a bibliometric study in a five-year period including 2,291 publications from the Web of Science database. The following variables were included: annual production of articles, journals, authors, cooperation, and citation analysis. ***Results:*** a sustained production of information has been conducted throughout the study years. Paiva, from Brazil, is the author with the largest number of publications (n = 33); the journal with the highest number of articles is *Caries Research* (n = 176). The United States and Brazil are the countries with the most publications on this topic. ***Conclusions:*** there is a sustained production of publications on dental caries, validating this topic and showing the importance of scientific groups conducting research in the fields of diagnosis, prevention, and public health mainly.

Palabras clave: bibliometr a, caries dental, estad stica y datos num ricos, investigaci n dental

Resumen

Introducci n: el objetivo consisti en realizar un estudio bibliom trico en relaci n con la producci n cient fica sobre caries dental entre los a os 2014 y 2018. ***M todos:*** se realiz un estudio de indicadores bibliom tricos, con an lisis temporal para cinco a os, de 2.291 publicaciones en la base de datos de Web of Science. Se revisaron las variables de producci n anual de art culos, revistas, autores, cooperaci n y an lisis de citas. ***Resultados:*** se ha producido informaci n de manera sostenida a trav s de los a os de estudio. Paiva, de Brasil, es el autor con el mayor n mero de publicaciones (n = 33); la revista con mayor cantidad de art culos es *Caries Research* (n = 176). Estados Unidos y Brasil son los pa ses con m s divulgaciones asociadas a este tema. ***Conclusiones:*** existe una producci n de publicaciones en caries dental que indican la vigencia de la tem tica y la importancia de los grupos cient ficos asociados que investigan principalmente en el campo del diagn stico, la prevenci n y la salud p blica.

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INTRODUCTION

Dental caries is one of the most prevalent oral diseases worldwide.[1] Therefore, research on the subject is abundant in various fields ranging from aetiology[2,3] to diagnosis,[4] prevention,[5,6] and treatment.[7] However, the direction in which research is currently flowing is unclear, as well as who and how are conducting the scientific production on dental caries.

The literature provides some systematic reviews on dental caries with various perspectives,[8,9,10] but there are few bibliometric studies available. A number of studies have been conducted to observe local production[11] or report local prevalence,[12] and some include dental caries as part of broader bibliometric studies in oral health.[13,14] However, systemic reviews on the scientific production on this specific topic are scarce.

The search for measurable results on the production of scientific knowledge in relation to a specific topic requires specific methodologies to quantify, group, and identify the connections among groups, researchers, and topics, in order to establish the state of the art in a specific subject.[15,16] To this end, bibliometrics is the main quantitative and qualitative analytic tool that has been available for some time now.[17,18]

Bibliometrics is the closest and most useful analytical way to measure and understand production in science.[19] The methodological structure of bibliometric studies helps establish the data that are related to scientific outputs (number of publications per author, years of publication, country of origin), scientific impact (number of citations), scientific collaboration (co-citations and co-authorship).[20,21]

These data show current trends and production patterns in research on the specific topic under analysis, as well as key information for future research and guidelines for publishers with the highest possible strength and quality.[22]

The present study aims to establish the main aspects in the scientific production on dental caries in the period 2014-2018, as a guideline for those interested in the production of new research and as information on the importance of this topic among interested publishers.

METHODS

This dental caries bibliometric study used Clarivate Analytics' Web of Science, which is considered the most robust source of data.[23] The search was conducted in its Core Collection, identifying all the articles on dental caries from January 1, 2014 through September 24, 2018 with the following algorithm: "Dental Caries" OR "Dental decay" OR "Initial caries" OR "Caries susceptibility" or "White spot" OR "Tooth demineralization". The authors agreed on this search algorithm after a pilot test conducted independently with different search alternatives, as recommended by Adnan and Ullah.[24] The search was refined by years of publication from 2014 to September 2018 in "Dentistry Oral Surgery Medicine", including two categories only: articles and revisions. The data obtained from Web of Science were exported to Excel 2013 for content analysis. The information taken from the articles was: name of first author, institution and country of origin of first author, number of authors, name and impact factor of journal, year of publication, number of citations, average citations of each article since publication, and keywords. Descriptive statistics were performed in order to obtain averages and frequencies.

The free VOSviewer software (Center for Science and Technology Studies, Leiden University, The Netherlands) was used to analyze and observe relationships among authors, countries, co-citations and terms.[25,26] This software allows to calculate and locate each unit of analysis in a two-dimensional map. The distance between two elements is a measure of their relations and similarities.[27] Images are represented by color-coded clusters.[28] Interpretation takes into account both the size of nodes and the size of label font and represents the number of occurrences. These charts allow to change the perspective by freely rotating them.[25,29] The analysis of cooperation among authors with VOSViewer was made in authors who had at least five publications on the subject, with a minimum of one citation; all authors lacking connections with others were excluded.

RESULTS AND DISCUSSION

A total of 2,291 publications related to the search algorithm were identified. The number of publications accumulated between 2014 and 2018 has increased significantly. The output of accumulated articles is growing at 23% per year; however, between 2014 and 2015 there was a 28% increase in the number of publications (2014: n = 384; 2015: n = 492) and the production has remained stable after 2015 (Figure 1). In terms of yearly production, the publications on the subject show a linear growth, not counting the production until September 2018, when apparently there was a slowdown in the production of articles on the topic. The average number of publications for the first four years from 2014 to 2017 (up to the September 2017 period) was 458 ± 81 articles. By 2018, the slight decline trend may be associated with an underreporting of the entire production that year. In the same period there were 212 review articles. These results show a trend towards an annual increase of publications in this field; and fluctuations coincide with other publications that clearly show similar changes in pace, keeping the increasing trend in number of publications.[30]

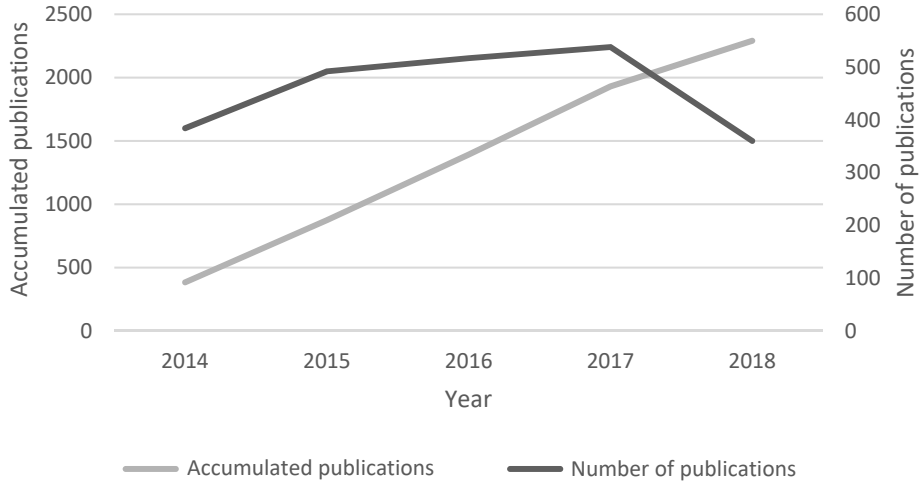

Figure 1. Number of publications on dental caries 2014–2018

Source: by the authors

Number of authors

A total of 7,745 authors participated in the 2,291 articles in this period. A proportion of 46% of authors appear in a single publication (n = 3586/7745), 23.2% (n = 1799/7745) in two publications; between three and five publications or more are credited with 19.8% of authors (n = 1534/7745), and 3.3% of authors with more than 10 publications (n = 258/7745). These values are consistent with claims that a small group of authors make a greater number of contributions on specific topics.[29,31] In a classification based on number of publications per author (Table 1), ten authors have significant productivity on the subject, including Paiva, from Brazil, with 33 publications, followed by Schwendicke from Germany and Twetman from Denmark with 29 articles each. The average citations by number of articles range from 3 to 10, with Schwendicke as the lead author in this respect. Three of the authors do not appear in publications as main authors, while the remainder vary between 2 and 4 articles heading the list of authors. It becomes difficult to analyze the contributions of each author within each publication, as information in this regard is not available. On the other hand, it may be possible to find lead authors not heading the list of contributors, although this may be changing along with the journals' policies for publication.[32]

Table 1. Top ten authors by number of publication on dental caries, 2014–2018

Position	Author	Author's country	Number of Publications	Average citations by publication	Number of publications as main author
1	Paiva, SM	Brazil	33	7	2
2	Schwendicke, F	Germany	29	10	4
3	Twetman, S	Denmark	29	7	0
4	Lo, ECM	Hong Kong	24	6	4
5	Mendes, FM	Brazil	23	4	2
6	Paris, S	Germany	23	9	0
7	Frencken, JE	Netherlands	22	4	2
8	Ramos-Jorge, ML	Brazil	19	4	3
9	Lingstrom, P	Italy	19	3	0
10	Thomson, WM	Germany	19	7	2

Source: by the authors

The average number of authors per publication was 3.38. Publications with a single author accounted for 3.45% (n = 79/2,291); two authors for 7.6% (n = 173/2,291); three authors for 13.0% (n = 298/2,291); four authors for 10.8% (n = 413/2,291); five authors for 19.2% (n = 439/2,291); 6 authors for 16.4% (n = 376/2,291) and articles with 7 authors accounted for 8.6% (n = 198/2,291). More than 7 authors were found in 31.3% of articles (n = 716/2,291) and the maximum number of authors was 25. These results are consistent with the current trend, showing that more and more research is being published in collaboration by multiple authors, while unique authorship is becoming less frequent.[32,33]

Cooperation among authors

The network resulting from this analysis is shown in Figure 2. It shows relationships among authors, represented by the proximity of the nodes and the connection edges; the size of nodes represents number of publications, and lines indicate collaborative publications. Colors represent collaboration groups (clusters)[27] showing the formation of communities by relative frequency in their links in specific fields within the topic of dental caries in this case.[34] The network shows 35 collaboration groups of 851 authors who met the inclusion criteria. The main authors in this collaborative network are Paiva, Mendes, Twetman, Levy, Lingstrom, Lo, and Schwendicke. These maps are a good representation of the situation in terms of cooperation; however, there are some limitations regarding possible biases that are usually controlled using disambiguation thesauruses and by the use of author identification, such as ORCID.[29,35]

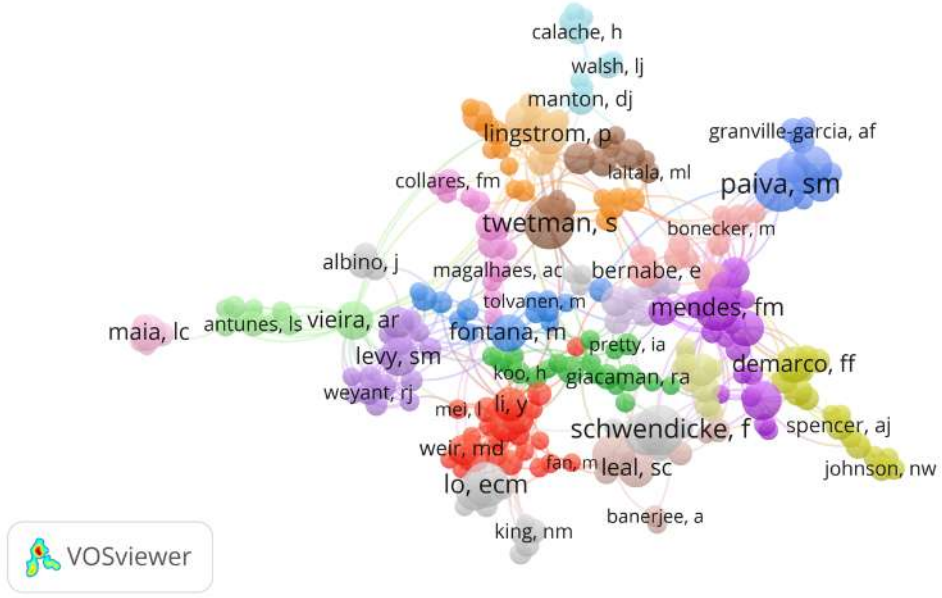

Figure 2. Network of author cooperation on dental caries, 2014–2018

Source: by the authors

Journals with publications on dental caries

The 2,291 articles were published by 177 different scientific journals; this corresponds to a relatively small number of titles, meaning that information on dental caries is probably concentrated. Table 2 groups the 10 scientific journals with the most publications on dental caries. 44.4% (n = 1017/2,291) of total production was published in these 10 journals. The impact factor (*Journal Citation Reports*) ranges from 1,383 to 5,380. *Caries Research* is the journal with the largest number of publications on dental caries (n = 176 articles) and is the only one specialized in the subject, while the others include articles on various disciplines of dentistry (endodontics, periodontics, orthodontics, social and community dentistry), and only two share topics with other disciplines such as medicine.

Table 2. Distribution of the 10 scientific journals with the most publications on dental caries, 2014–2018

Position	Journal title	N	Impact factor	Magazine theme
1	Caries Research	176	2,18	Caries and related diseases
2	BMC Oral Health	172	1,60	Miscellaneous Dentistry
3	Community Dentistry and Oral Epidemiology	120	1,99	Miscellaneous Dentistry and Medicine
4	Journal Of Dentistry	110	3,77	Miscellaneous Dentistry
5	Journal Of Dental Research	98	5,38	Miscellaneous Dentistry
6	Clinical Oral Investigations	86	2,38	Miscellaneous Dentistry
7	International Journal of Paediatric Dentistry	72	1,38	Miscellaneous Dentistry
8	Pediatric Dentistry	63	1,77	Miscellaneous Dentistry
9	Community Dental Health	61	0,93	Miscellaneous Dentistry
10	Archives Of Oral Biology	59	2,05	Miscellaneous Dentistry and Medicine

Source: by the authors

Geographical distribution

With the total number of publications, an analysis was made by country of origin and associated institution according to the information included for main authors. The documents on dental caries originated in 110 countries, 38 of which are in Europe, 32 in Asia, 23 in Africa, 15 in America and 2 in Oceania. 16.4% (n = 18/110) of countries produced more than 50 articles. The countries with the most production on dental caries are the United States (n = 488), Brazil (n = 424) and England (n = 187). The other seven countries and their production are shown in Figure 3. As for production in America, in addition to the U.S. and Brazil, the production concentrates, in order, in: Canada in 13th place with 61 articles, Chile in 23rd place with 29 articles, and Colombia in 37th place with 15 articles.

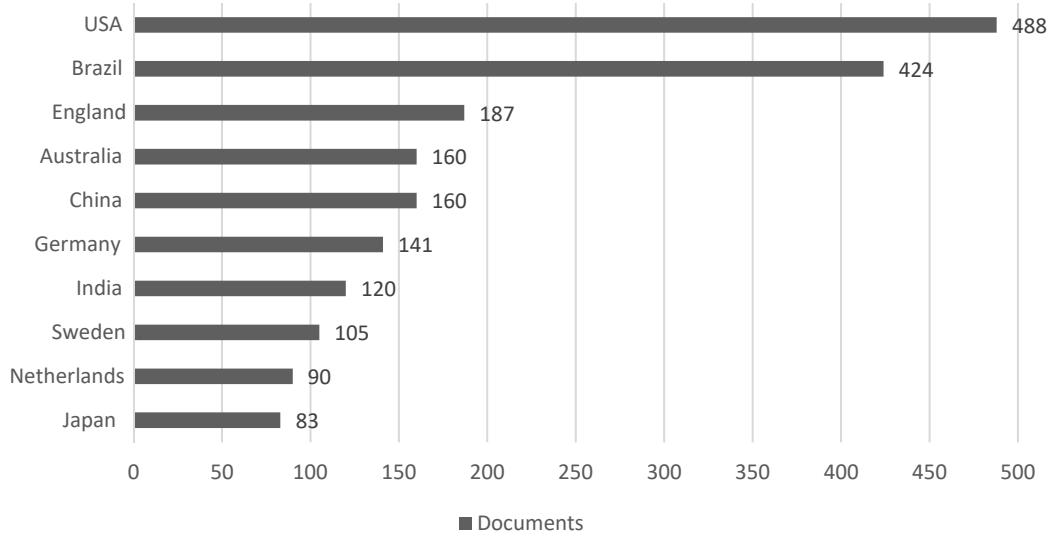

Figure 3. Distribution of publications on dental caries by country, 2014–2018

Source: by the authors

Distribution of institutions and cooperation

A study on the institutions associated with authors was carried out (it should be noted that an author may be associated with several institutions), with 2,070 institutions found for the 2,291 articles. 67.3% of institutions contributed one publication; 13.2% two publications; 5.3% three publications, and 2% contributed more than twenty publications. Table 3 lists the top 10 institutions producing caries-related articles. This classification shows two universities in Brazil, the University of S o Paulo with 91 publications, and Universidade Federal Rio Grande do Sul with 47 publications; these were followed by the University of Copenhagen in Denmark with 56 publications. Three U.S. institutions are listed within the top 10 most productive. In Colombia, the top institution regarding the amount of publications on this topic is Universidad del Bosque, with 6 publications and 21 citations.

Table 3. The 10 most productive institutions with publications on dental caries, 2014–2018

Position	Institution	Country	Number of publications
1	Univ São Paulo	Brazil	91
2	Univ Copenhagen	Denmark	56
3	Univ Calif San Francisco	USA	52
4	Univ Adelaide	Australia	51
5	Univ Gothenburg	Sweden	48
6	Univ Fed Rio Grande do Sul	Brazil	47
7	Kings Coll London	England	46
8	Univ Hong Kong	Hong Kong	46
9	Univ Iowa	USA	44
10	Univ Washington	USA	43

Source: by the authors

The cooperation network among nations was analyzed for countries with at least 10 publications on the subject; all countries that had no connections with others were excluded. The two largest groups are around the United States and Brazil, with the most collaborations with China, England, Sweden, Australia, India, Germany, and Japan among the most important. In this context, several productive Latin American networks appear among the most cooperative. Chile appears with the most connections (with Brazil, USA, Australia, England, Finland, Germany, Israel, Denmark, Egypt, Spain, Switzerland), followed by Colombia (with Brazil, USA, Germany, England and Denmark) and Mexico (with USA, Brazil, France and Canada).

A qualitative review of this list shows that university institutions are dominant, but there are also some hospitals and government institutions, indicating that this topic is both of academic and governmental public interest.

Citation analysis

A citation is described as an article mentioning or referring to another article, which is known as article of origin.[36] The 2,291 articles contain a total of 45,889 references; in addition, they have been cited by other authors 9,410 times at the time of the analysis. The author with the most citations is Kassebaum with 191; 32.56% of the articles do not have citations (n = 746/2,291), representing a significant number of articles with no citations. 67.43% (n = 1545/2,291) have more than one citation and 3% (n = 69/2,291) have more than 20. It should be noted that articles are cited for various reasons, including quality, valuable content or because of their popularity with or without regard to quality, among other factors.[37] The average number of citations per article is 4.1. Table 4 shows the 10 most cited authors and their articles, excluding those who, having a significant number of citations, had no connection with other authors.

Table 4. The 10 most cited publications in relation to dental caries, 2014–2018

Number	Title of article	Author(s)	Country of main author	Journal and impact factor	Year of publication	Citations	Average ciations per year	Topic of article
1	Global Burden of Untreated Caries. A Systematic Review and Metaregression	N.J. Kassebaum, E. Bernabé, M. Dahiya, B. Bhandari, C.J.L. Murray, W. Marcenes	USA	Journal of Dental Research (5.380)	2015	191	64	Data on untreated caries from 1990 to 2010 worldwide.
2	Effect on Caries of Restricting Sugars Intake. Systematic Review to Inform WHO Guidelines	P.J. Moynihan, S.A.M. Kelly,	United Kingdom	Journal of Dental Research (5.380)	2014	176	44	Relationship between sugar intake and dental caries
3	Socioeconomic Inequality and Caries. A Systematic Review and Meta-Analysis	F. Schwendicke, C.E. Dörfer, P. Schlattmann, L. Foster Page, W.M. Thomson, S. Paris	Germany	Journal of Dental Research (5.380)	2015	112	37	Socioeconomic inequity and dental caries
4	Caries risk assessment. A systematic Review	I. Mejàre,S; Axelsson,G; Dahlén,I; Espelid,A; Norlund,S; Tranæus. S. Twetman	Sweden	Acta Odontologica Scandinavica (1.522)	2014	56	14	Evaluation of multivariate models for understanding the development of caries.
5	Diet and Dental Caries. The Pivotal Role of Free Sugars Reemphasized	A. Sheiham, W.P.T. James,	United Kingdom	Journal of Dental Research (5.380)	2015	54	18	Sensitivity of cariogenesis. The response to sugar consumption.
6	Oral Microbiome Metabolism From "Who Are They?" to "What Are They Doing?"	N. Takahashi,	Japan	Journal of Dental Research (5.380)	2015	53	18	Metabolism of the oral microbiome
7	Abundance of MMPs and Cysteine Cathepsins in Caries-affected Dentin	C.M.P. Vidal, L. Tjäderhane, P.M. Scaffa, I.L. Tersariol, D. Pashley, H.B. Nader, F.D. Nascimento, M.R. Carrilho	Brazil	Journal of Dental Research (5.380)	2014	46	12	The presence of Metaloproteinases (MMO) and Catepsin in cavitated lesions.
8	The Ethical Imperative of Addressing Oral Health Disparities. A Unifying Framework	J.Y. Lee, K. Divaris	USA	Journal of Dental Research (5.380)	2014	45	11	Disease burden
9	Sugar-sweetened beverages and dental caries in adults: A 4-year prospective study	Eduardo Bernabé, Miira M.Vehkalahti, Aubrey Sheihame, Arpo Aromaa, Anna L.Suominen	United Kingdom	Journal of Dentistry (3.770)	2014	37	9	Association between the consumption of sugary drinks and dental caries
10	The Microbiome in Populations with a Low and High Prevalence of Caries	Johansson, I.; Witkowska, E.; Kaveh, B.; Holgerson, P. Lif; Tanner, A. C. R.	Sweden	Journal of Dental Research (5.380)	2015	36	12	Microbiome dependent on the prevalence of cavities

Source: by the authors

Citations reflect the visibility of publications. It is generally considered that open access publications[38] are increasingly cited and this may be a limitation for the analysis; on the other hand, the fact that an article is more visible is not related to it being of a better quality, in fact, some publications may have a low citation indicator as they are new in the scientific field.[39] The most cited article in the list is "Global Burden of Untreated Caries. A Systematic Review and Metaregression" by Kassebaum et al, with 191 citations, corresponding to 64 per year. The journal most frequently related to these high scores is *Journal of Dental Research,* which has an impact factor of 5,380 with seven of the ten publications. Some analyses state that the journals with the most impact factor

are often more cited because more libraries want their access and therefore are available to a greater number of researchers.[40] Of the 10 publications in the list, the most cited are associated with authors from the United Kingdom, followed by the United States. Brazil is the only Latin American country among the first. As for the topics in this list of articles related to dental caries, there are four studies related to public health and epidemiology, three related to sugar intake and three to biological and biochemical aspects. The citations, therefore, allow to establish basic and influential documents in the academic community.[36] On the other hand, this analysis may be limited by the parameters established, as well as the fact that the analysis only covers five years, which may limit the influence of important articles that were left out due to the period of analysis. But it can also be an opportunity for other researchers to expand the information on this same topic.

Co-citations analysis

Co-citation is understood as the relation created when an article cites two others, suggesting a relation among them because of content.[41] The VOSviewer 1.6.9 software was used for this analysis, including the 2,291 articles but especially those containing one citation that has been used at least 20 times. Under these conditions, of the 45,889 references in the articles, 180 references reached the analysis threshold. In Figure 4, the size of nodes indicates the number of citations. The larger the node the more times it has been cited. In this representation, smaller distances indicate stronger relations, and colors separate groups by similar topics. Six thematic groups appear in this analysis. Four groups (dark blue, violet, red and yellow) show a nucleus with closer thematic relationships. An analysis by titles associated with each color yields the following groups: red includes articles on dental caries and general health aspects of interest to government institutions such as the World Health Organization; yellow is related to detection and diagnosis; dark blue to biology, microbiology and basic sciences; lilac articles are related to disease impact; the green group is related to techniques and treatment, and the light blue group is related to genetics and molecular biology topics. This indicator also shows the proximity relation that appears when an author belongs to a particular subfield within the topic, as it is understood that articles are cited together when the relations among them are closer.[42]

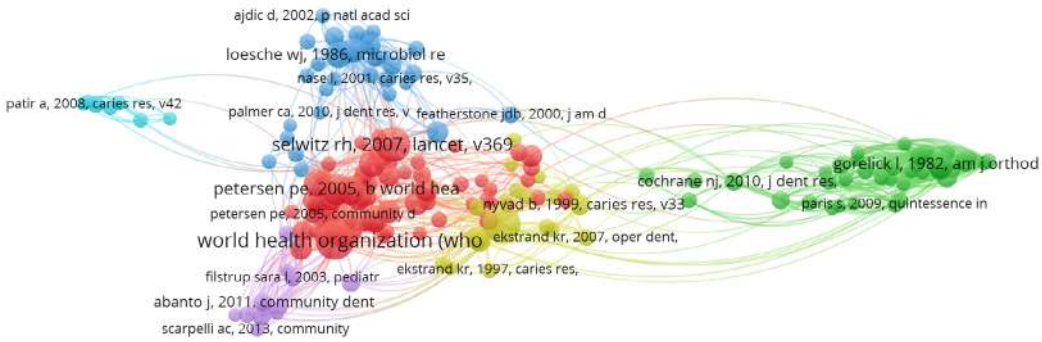

Figure 4. Co-citation analysis among highly referenced articles on dental caries, 2014–2018

Source: by the authors

Co-occurrence analysis

Co-occurrence identifies the most common keywords in abstracts and titles, as well as the keywords that most frequently appear in articles and the corresponding proximity between two or more terms.[43,44] The analysis included all the keywords of the 2,291 articles that had 10 occurrences minimum; of the 6,979 keywords, 405 were included on the threshold. The distance among terms provides information about the relationship among terms and is established by counting the number of times a word appears in titles and abstracts.[26,45] In this way, the more proximity between two terms, the stronger their relation. Colors represent the possible groupings by theme.

The most common keywords and their occurrence values were *dental caries* with 1980, *oral health* with 549, *children* with 526, and *prevalence* with 356. The 20 most common terms and their values can be seen in Figure 5. Analyzed by year in Overlay Visualization by VOSviewer, it shows that since 2016 there have been higher frequencies in the following words: *association, global burden, periodontitis,* and *caries detection*. The association of the keywords *periodontitis* and *caries detection* may be explained because the number of publications related to prevention programs for both diseases have increased.

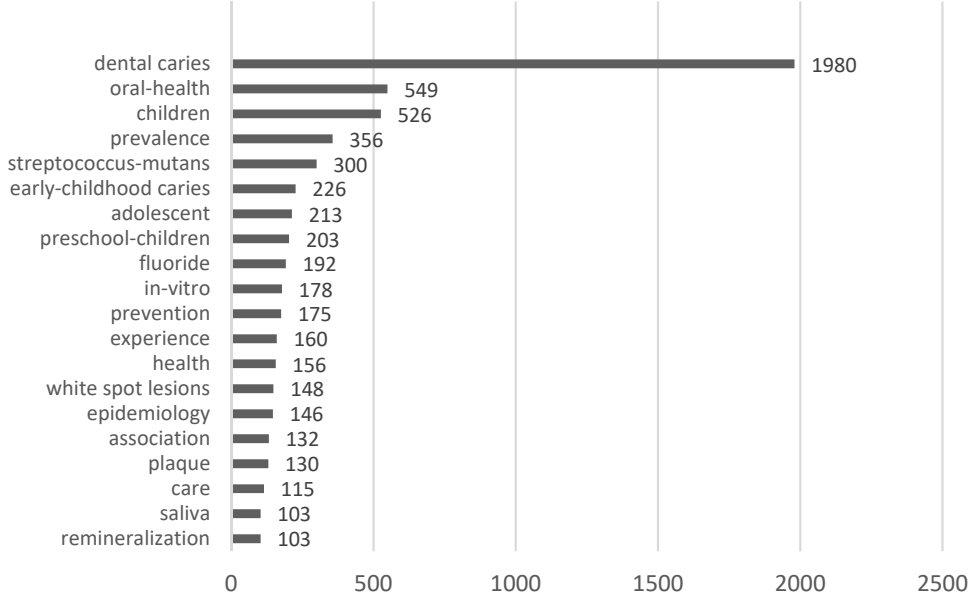

Figure 5. List of the 20 most common keywords and their occurrence values in dental caries 2014–2018

Source: by the authors

Study limitations

It should be noted that there is no scientific literature database containing all the world's production regarding a single topic. This suggests that the results obtained and analyzed in this article contain only the scientific production of a set period of time to analyze this type of data; therefore, some

relevant publications may be outside the analysis and others, which are very recent, could have a high impact on the discipline and subject matter, but at the time of the study may have had a low specific weight in the analysis. On the other hand, some authors suggest that indicators such as the H index may contain biases, and therefore suggest to apply other metric types; however, the databases of scientific production analysis keep using such indicators.

CONCLUSIONS

The present study performed a bibliometric analysis of the academic production worldwide in relation to dental caries for the period 2014-2018 in WOS. It identified that the scientific production remains on the rise for the evaluated years with a linear growth in a low-pitched slope, suggesting that this topic is approaching a saturation point—but this claim requires further study—. The analysis was carried out on 2,291 articles; in these, 3.3% of authors reported presence in more than 10 publications. In terms of countries, the United States has the institutions producing the most articles, followed by Brazil. The institution with the most production in this area is the University of S o Paulo; in terms of authors, Paiva from Brazil is the one with the most publications, followed by Schwendicke from Germany. A total of 177 journals have articles on this topic, with *Caries Research* in the first place; most journals publish a mix of dental topics. As for keywords in titles and abstracts, the most common after *dental caries* and *oral health* are related to *children* and *prevalence*. In the last few years, the words *association* and *periodontitis* are also emerging. On the other hand, research and cooperation groups are connected in six clusters that have to do with detection, diagnosis, basic sciences, disease impact, treatment techniques, and genetic and molecular biology applied to the study of etiology and disease development. This all shows that research on dental caries remains in place and is developed by an important group of productive scientists in aspects that may be of interest to other researchers.

CONFLICT OF INTEREST

The authors state that they have no conflict of interest.

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