

CLINICAL IMPLANT DENTISTRY and Related Research

BIBLIOMETRIC ANALYSIS OF THE SCIENTIFIC PRODUCTION OF LITERATURE ON PERI-IMPLANT DISEASES IN THE WEB OF SCIENCE

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Keywords:	bibliometric study, peri-implantitis, dental implant, implant mucositis, scientific collaboration, funding
Abstract:	Background: The exponential increase in implant placement worldwide and the high prevalence of its associated pathologies has prompted an increasing contribution by the scientific community to the number of publications related to peri-implant pathologies. Purpose: The objective of this work is to carry out a bibliometric analysis of scientific production on peri-implant diseases. Materials and methods: The search strategy included titles, keywords, and abstracts based on the term peri-implantitis and all the possible combinations existing in Science Citation Index Expanded (SCIE) of the main collection of Web of Science. Two limits were established: the document typology was limited to Article and Review, and articles published up to 2019 were selected. All articles were refined and standardized manually to avoid typographical errors and duplications in authors' names or institutions. Results: The total number of papers collected was 2,547. An significant increase was observed in the number of articles published, especially in the past 10 years. The three most productive authors were Europeans, and the 45 most productive institutions were the universities. The most productive funding entities were the governments. Of the published works, 42.28% were funded. Of the 2,547 records, 86.53% presented keywords. Conclusions: Scientific literature on peri-implantitis shows scientific growth in recent years, with a growing trend towards collaboration between authors and institutions. Most of the works have been published in high-impact journals, and in the last two years, more than half of the

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	works have received some type of public or private funding.

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TITLE

BIBLIOMETRIC ANALYSIS OF THE SCIENTIFIC PRODUCTION OF LITERATURE ON PERI-IMPLANT DISEASES IN THE WEB OF SCIENCE

RUNNING TITLE

SCIENTIFIC LITERATURE ON PERI-IMPLANT DISEASES

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CONFLICT OF INTEREST STATATEMENT:

Author Beatriz Tarazona Álvares declares that she has no conflict of interest. Author Andrés López Roldán declares that he has no conflict of interest. Author Antonio Vidal Infer declares that he has no conflict of interest. Author Daniel López Padilla declares

that he has no conflict of interest. Author Adolfo Alonso Arroyo declares that he has no conflict of interest.

AUTHOR CONTRIBUTIONS

Tarazona-Álvarez B and López-Roldan A conceived the ideas, collected the data and led the writing.

Vidal-Infer, A, D⁴, and Alonso-Arroyo conceived the ideas, analyzed the data and led the writing.

López-Padilla analyzed the data and led the writing.

SUMARY BOX:

Background of the topic	There is no history in the literature of any bibliometric study on peri-implant diseases
Study contributions	It is the first bibliometric study on peri-implant diseases. It highlights the great importance and interest of these pathologies on the part of researchers.

MAIN TEXT

ABSTRACT

Background: The exponential increase in implant placement worldwide and the high prevalence of its associated pathologies has prompted an increasing contribution by the scientific community to the number of publications related to peri-implant pathologies.

Purpose: The objective of this work is to carry out a bibliometric analysis of scientific production on peri-implant diseases.

Materials and methods: The search strategy included titles, keywords, and abstracts based on the term peri-implantitis and all the possible combinations existing in Science Citation Index Expanded (SCIE) of the main collection of Web of Science. Two limits were established: the document typology was limited to Article and Review, and articles published up to 2019 were selected. All articles were refined and standardized manually to avoid typographical errors and duplications in authors' names or institutions.

Results: The total number of papers collected was 2,547. An significant increase was observed in the number of articles published, especially in the past 10 years. The three most productive authors were Europeans, and the 45 most productive institutions were the universities. The most productive funding entities were the governments. Of the published works, 42.28% were funded. Of the 2,547 records, 86.53% presented keywords.

Conclusions: Scientific literature on peri-implantitis shows scientific growth in recent years, with a growing trend towards collaboration between authors and institutions. Most of the works have been published in high-impact journals, and in the last two years, more than half of the works have received some type of public or private funding.

KEYWORDS

bibliometric study, peri-implantitis, dental implant, implant mucositis, scientific collaboration, funding.

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INTRODUCTION

Treatment with dental implants has been a revolution in the last 50 years, being widely used owing to the high success rates of over 95% after 10 years of implant placement

(Buser et al., 2012; Degidi, Nardi, & Piattelli, 2012; Fischer & Stenberg, 2012; Gotfredsen, 2012; Jemt, 2016). However, the data on these implant treatment success rates has been primarily based on the loss of implants over a studied period of time, whereas implant treatment is not free from both mechanical and biological problems that are sometimes underestimated in these studies (Berglundh, Persson, & Klinge, 2002).

One of the main biological problems that affects implants is peri-implant pathology (peri-implantitis and peri-implant mucositis). The 2017 World Workshop established the current definition of these pathologies. Peri-implantitis is defined as the pathological condition that occurs in the tissues surrounding the implants and is characterized by inflammation of the peri-implant mucosa and the progressive loss of supporting bone (Schwarz, Derks, Monje, & Wang, 2018). However, peri-implant mucositis is characterized as an inflammatory lesion of the soft tissues surrounding the implants in the absence of supportive bone loss or continued marginal bone loss (Heitz-Mayfield & Salvi, 2018).

Prior to the 2017 World Workshop, data on these diseases with different definitions applied, show a prevalence rate ranging from 1% to 47% and 19% to 65% for peri-implantitis and peri-implant mucositis, respectively. The meta-analysis carried out by Derks et al. shows a prevalence rate of 43% (Confidence interval [CI]: 32-54%) for peri-implantitis, and 22% (CI: 14-30%) in the case of peri-implant mucositis (Derks & Tomasi, 2015).

The exponential increase in implant placement worldwide and the high prevalence of these pathologies has prompted the scientific community to contribute to a higher number of publications related to these pathologies. However, a bibliometric assessment is needed to analyze and measure the scientific production of literature related to peri-implant pathologies. Bibliometric indicators allow the assessment of scientific production by identifying its evolution over time, the most productive authors, research centers, evaluation of impact indices, as well as the most established networks of collaboration between authors (Lopez-Piñero, JM; Terrada, 1992a, 1992b).

There are various bibliometric studies that address various aspects of periodontology and implantology (Ahmad, Asif, Alam, & Slots, 2020; Alonso-Arroyo, Tarazona-Alvarez, Lucas-Dominguez, Peñarrocha-Oltra, & Vidal-Infer, 2019; Geminiani, Ercoli, Feng, & Caton, 2014; Gutierrez-Vela et al., 2012; Shaikh et al., 2019; Tarazona, Vidal-Infer, Tarazona-Alvarez, & Alonso-Arroyo, 2017). The study by Chiang et al. shows that scientific literature on implant complications including peri-implant pathologies has increased notably in recent decades, at a rate of 5.5% in 1987-1996, 11.1% in 1997-2006, and 13.6% in 2007-2016 (Chiang et al., 2018).

There is a lack of bibliometric studies on the research carried out on peri-implant pathologies; therefore, the objective of this study is to assess the evolution and current state of scientific production of literature up to 2019. Accordingly, a bibliometric analysis of articles indexed in the Science Citation Index-Expanded (SCIE) of the Web of Science (Clarivate Analytics, 1500 Spring Garden St, Philadelphia, United States) was performed.

MATERIALS AND METHODS

Search strategy

A search was carried out in the SCIE of the main collection of Web of Science, since it is commonly used in bibliometric studies due to its wide coverage of themes, the count of the citations received by the articles, and its ability to count the institutions participating in each paper.

The search strategy was carried out in the Topic field (title, keywords and abstract) with the following terms: *peri-implantitis OR periimplantitis OR Implant mucositis OR peri-implant disease OR peri-implant diseases OR periimplant disease AND periimplant diseases OR peri-implant mucositis OR periimplant mucositis OR peri-mucositis*. It was limited to the document typologies Article and Review, and since the download was executed in February 2020, the articles published up to 2019 were selected. The number of records retrieved after running the search was 2,547.

Normalization of data

The records were manually normalized. The normalization process consisted of identifying all the variants of the same name/entity and assigning it a single element.

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3 Normalization of authors, institutions, countries, journals, keywords, and funding
4 institutions was carried out to obtain the results.

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7 During normalization of the authors, 13,427 author signatures were found. The main
8 problems detected pertaining to their normalization were related to the existing
9 differences in the degree of development of given names and surnames, that is, for the
10 same author, different signatures could be found depending on the information
11 provided. In these cases, the institutional affiliations that appeared in the database,
12 from which the relevant record had been extracted, were consulted. In case the
13 information could not be extracted, a search was carried out on the web pages of the
14 institutions itself, to resolve possible conflicts. In the event of the presence of several
15 variants for the same author, it was determined that it was the same person if their
16 institutional affiliation matched, considering whichever signature provided more
17 information, in all cases

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28 Regarding the institutions, 8,141 institutional firms were initially found, and the criteria
29 followed was similar to that used in authorship. However, considering the objectives of
30 this study, only the macro-institutions were preserved, that is, Universities, Research
31 Centers or Institutes, Foundations, and Hospitals, etc. Some difficulties were
32 encountered regarding incomplete, inaccurate or erroneous information, and use of
33 abbreviations or organizational subdivisions such as faculties, departments, units along
34 with others. For records with uncertainty, the source databases were consulted. In the
35 event that the information could not be retrieved in this way, internet search engines
36 were used to access the web pages to locate that institution. Following completion of
37 the process of normalization, the duplicates were eliminated so that the counting by
38 macro-institution in the same registry was unique. This was performed because authors
39 from the same macro-institution could have signed in the same registry, but from
40 different departments or services. In the absence of an affiliation to a specific institution
41 or showing a personal or anonymous address, a label (Independent) was assigned, and
42 was considered to be the workplace of autonomous people. Additionally, an analysis of
43 the most productive funding institutions and the most used keywords in the articles was
44 carried out.

Analysis of the data

To carry out the study of production of scientific literature, the evolution of scientific productivity over time, authors, work institutions, countries, journals where the papers were published, keywords, and funding entities were taken into account. Statistical analysis was carried out using Statistical package for social sciences version 21.0 (SPSS Inc., Chicago, IL). The indicators were compared according to the periods 1991-2000, 2001-2010, and 2011-2019. Qualitative variables were presented as absolute numbers and percentages, while quantitative variables as means $\pm$ standard deviations, or medians with interquartile range, as the case may be. The normal distribution of the variables was evaluated with the Kolmogorov-Smirnov test. Depending on whether the distribution was normal or not, the differences between the quantitative characteristics of the study groups were analyzed using the ANOVA test with the Bonferroni correction or the Kruskal-Wallis test, respectively. A p-value of less than 0.05 was considered statistically significant.

The records were imported into a Microsoft Access database for debugging and analysis of results. The construction of the graphical representations of the clusters of authors, institutions, and keywords was carried out using the open-source software Pajek for analysis and visualization of networks.

RESULTS

The scientific literature on peri-implantitis included 2,547 papers published from 1991 to 2019, with a total of 2,225 original articles and 322 reviews. There has been an intense progressive growth, particularly in the last 10 years (2010-2019), wherein 2,094 of the 2,547 papers were published—82.22% of the total number of publications—and from 2015 to 2019, during which, 1,456 articles were published—57.27% of the total number of publications. As displayed in table 1, a statistically significant rise in the number of articles published per year can be observed, with a mean of 8.10 ± 5.78 articles in the period 1991-2000, 37.30 ± 11.46 articles in 2001-2010, and 196.78 ± 73.62 articles in 2010-2019 (Kruskal-Wallis test, $p = 0.00001$). Regarding reviews, the most productive period was 2001-2010, with a mean of 3.30 ± 2.26 documents per year (ANOVA test, $p = 0.009$).

The average number of collaborative papers ranged between 4 and 5 authors per paper throughout the period until 2015, where it increased to more than 5 authors per paper, and reached the highest number in 2018, where 331 papers were signed by up to 6 authors per paper.

Authors

The number of authors who have researched about peri-implant pathologies was 7,329. Table 2 shows the productivity ranking, led by Frank Schwarz (Johann Wolfgang Goethe-University Frankfurt, Germany) with 81 publications and Niklaus P Lang (University of Bern, Switzerland) with 67 articles, followed by Stefan Renvert (Kristianstad University, Sweden), and Hom Lay Wang (University of Michigan, USA) with 62 articles each. The 25 most productive authors (0.34% of the authors), who had 20 or more published articles, contributed to 25% of the total papers selected in this study. The ranking according to the total number of citations received was led by Niklaus P Lang with 7,539 citations, Tord Berglundh (University of Gothenburg, Sweden) with 4,831 citations, and Stefan Renvert with 4,004 citations. However, a total of 885 authors (12.07%) did not receive any citations. If the mean number of citations per paper was considered, Niklaus P Lang still occupied the first place with 112.52 citations per document, followed by Marco Esposito (University of Manchester, UK) with 104.72 and Tord Berglundh with 91.15.

Fig. 1 shows the interrelation in co-authorship of the papers of the most relevant authors. There are 14 collaboration networks represented between authors with more than 10 papers, and the thickness of the spheres determines their productivity and the thickness of the lines together with the value of this scientific collaboration. As the number of collaborative publications decreases, the network becomes more extensive. The figure has been represented in this manner for a correct visualization.

Institutions

Regarding the institutions, a total of 1,381 institutions were involved in the preparation of the 2,547 papers. The 20 most productive institutions were universities; an institution other than a university first appears in the list at position number 46.

Table 3 shows the ranking based on the most productive institutions: University of Bern (Switzerland) with 161 papers, Gothenburg University (Sweden) with 155 papers, and the University of Michigan (United States) with 89 papers.

If we analyze the ranking based on the total number of citations, it can be distinctively noted that the first two institutions (Gothenburg University of Sweden with 10,949 citations and University of Bern of Switzerland with 9,581 citations) have a considerably higher number of citations than the third institution (Kristianstad University of Sweden with 3,941 citations). This could be explained by the fact that both the institutions have highly prestigious authors with a large number of publications, such as Tord Berglundh from Gothenburg University in Sweden who was in the third most representative co-authorship network, and Anton Sculean from the University of Bern (Switzerland) who stood in the first position.

As observed with the authors, there were multi-center papers in which several institutions were involved. As observed in Figure 2, the most characteristic finding is that the University of Bern is the one with the widest network; it has 13 collaboration centers with 10 or more multi-center papers. On the other hand, it can be observed that some institutions are strongly related to each other by the number of papers they share. In this context, the following institutions should be highlighted: Trinity College Dublin, Kristianstad University, and Blekinge Institute of Technology.

Countries

The most productive countries were the United States (535), Germany (424), and Sweden (291) (Table 4). In the United States, the University of Michigan has the maximum publication with 89 papers; in Germany, the University of Dusseldorf and Goethe University tops the chart with 71 and 63 papers, respectively; and in Sweden, Gothenburg University ranks at the top with 150 papers. However, if the number of citations was considered, the ranking changed to Sweden (16,033), Switzerland (13,569), and the United States (13,298). The most intriguing data was found when ranking the countries by the number of citations per article, in which the most

productive country was Iceland with 121.83 citations per article, followed by Singapore with 89.63, and Peru with 81.

Keywords

Of the 2,547 records, 86.53% presented the keywords. Five keywords were found in 30.58% of the papers, while 73.52% had 4 to 6 keywords. However, there were two papers with 85 keywords published in the Journal of Clinical Periodontology and the Journal of Periodontology.

Fig. 3 shows the most used keywords. The thickness of the vertices indicates those words that have been used the most: "peri-implantitis" (1,056), "dental implant" (988), and "peri-implant mucositis" (207), and the thicker lines present between them indicate the keywords that are often used together in many articles. Among the peri-implant pathologies, peri-implantitis was the most studied pathology followed by peri-implant mucositis.

Regrading publication on treatment, the areas of interest with the most publications had the following keywords: treatment, antimicrobial, implantoplasty, surgical therapy, maintenance, air abrasion, decontamination, laser, guide bone regeneration, bone regeneration, and chlorhexidine. Some of these keywords were related to very specific treatments such as implantoplasty, the use of lasers, the use of air abrasion systems, or guided bone regeneration.

A large number of keywords were related to the etiology and risk factors of the pathologies and were excluded, such as microbiology, Biofilm, infection, microbiota, smoking, periodontal disease, periodontitis. These keywords reflect a greater concern that exists regarding the implant surface and its relationship with peri-implant pathology; this concern is apparent from the search results when words such as titanium, surface characteristics, surface roughness, and implant surface are used in the search strategy. Another group of keywords that stand out are those related to histopathogenesis, such as osseointegration, alveolar bone loss, inflammation, histology, bone loss, and cytokine. Finally, we could find the keywords related to the

typology of articles, such as meta-analysis, retrospective study, animal study, review, systematic review.

Journals

The retrieved 2,547 articles were published in 309 journals. Of these, 76.8% (1,956) have been published in journals in the field of Dentistry.

Table 5 shows the most productive journals in the order of number of citations per article with more than 10 citations per article, with most of them cited from the fields of Dentistry, Oral Surgery, and Medicine. Journal of Clinical Periodontology was the topmost journal with 61.34 citations per article, although Clinical Oral Implants Research would be the highest ranked journal with 387 published articles, if the total number of articles were considered. As for the countries of origin of the journals, the United States had the most journals in the ranking; however, the first three journals were from Denmark.

Funding

In terms of funding, it must be considered that the year 2008 marked the beginning of counting the type of financing of the articles in Web of science. Table 6 shows the funding status of publications from 2008 to 2019 with almost half of the publications having received some form of funding (46.81%).

The included studies involved 636 funding entities. Of these, 30% were government entities (state, local or European government), 29% foundations (organizations, associations, scientific societies), 21% private companies, 18% public universities, only 1% were private universities, and another 1% included hospitals and research centers.

Regarding government institutions (30%), most papers received funding from state governments. The government entities with the highest number of papers funded have been the United States (47), Japan (37), and Brazil (31). Following government entities, the most fund providing institutions were the Foundations (29%); the most funded work being provided by China's National Natural Science Foundation of China (NSFC) (89), Switzerland's International Team for Implantology (ITI) (44), and Brazil's State of Sao

Paulo Research Foundation (FAPESP) (36). The third group of institutions were private companies, which funded 21% of the articles. The topmost in the list were three European companies that marketed implants, namely Nobel Biocare from Sweden (40), Straumann from Switzerland (34), and Geistlich Pharma AG (34) for biomaterials. Regarding universities, it should be noted that public universities have a greater dominance in the funding of studies, that is, 366 papers compared to 12. The topmost among universities which provided the most funding was the King Saud University with 30 papers, followed by the University of Michigan with 26 papers.

If we analyze the funding entities by number of citations, it can be observed that the company that obtained the highest number of citations was Colgate-Palmolive with 1,615 citations, followed by the National Institute of Dental and Craniofacial Research (NIDCR) with 1,490 citations, and another association, the International Team for Implantology (ITI) with 1,257 citations.

Regarding the most funding countries, there are countries in all continents which provide funding, except Africa. China (102), the United States (77) and Sweden (52) top the list as the largest funders.

DISCUSSION

As observed in the last decade, there has been an intense progressive increase in publications related to peri-implant pathologies, particularly in recent years, owing to the consolidation of treatment with dental implants, and consequently the higher incidence of peri-implant pathology, as published in other studies (Tarazona et al., 2017). The latest epidemiological studies (Derks & Tomasi, 2015) justify the increase in research and publication in this area of periodontology.

In relation to the authors of the publications, the most prolific ones usually belong to the most productive institutions. However, it must be taken into account that some of them have developed their research activity in different institutions throughout their lives; therefore, the data does not match completely. Another fact to be taken into consideration is that the most prolific authors are the ones with the most collaboration

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3 networks with other expert authors on the subject; this synergy seems to influence
4 productivity. Most of the collaborations are established between professionals
5 belonging to institutions in the same country, increasing collaboration as reflected in
6 other studies (Chiang et al., 2018).
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11 As in other bibliometric studies in dentistry (Tarazona et al., 2017), as well as in medicine
12 (Romero & Portillo-Salido, 2019; Sweileh et al., 2017), the USA is the most productive
13 country, followed by European countries with a long implantology tradition such as
14 Germany, Sweden, and Switzerland. However, the most referenced articles are from
15 Sweden, and specifically Gothenburg University; this is possibly related to the prestige
16 of authors such as Jan Lindhe, Tomas Albrektsson, or Tord Berglundh, and also to the
17 current epidemiological papers on peri-implantitis by Jan Derks. In addition, the
18 institutions with the greatest scientific production of literature also come from these
19 countries, in particular the University of Bern, Gothenburg University, and the University
20 of Michigan in the USA.
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30 The productivity of institutions is related to the number of interrelationships between
31 them. It can be observed that institutions with relationships with other continents, such
32 as the University of Bern, establishes the greatest number of international relations with
33 Asian, European, or American universities, or the University of Michigan with European
34 universities. However, others like Gothenburg University or the University of Dusseldorf
35 collaborate with European institutions, and others like the Dutch form only national
36 collaboration networks.
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44 As shown by other studies, these collaborations allow for research that would not
45 otherwise be possible by technical or human means, but it has also been observed how
46 multidisciplinary papers increase the number of citations. (Gazni & Didegah, 2011;
47 Persson, Glänzel, & Danell, 2004).
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52 Obviously, the most used words are peri-implantitis and dental implant. Additionally,
53 the authors use general words such as periodontitis, titanium, and systematic review.
54 Some studies, such as that of Jeong & Jeong (2020) highlight peri-implantitis among the
55 most used words in articles on dental implants. Yeung & Leung (2018) also found similar
56 keywords, such as peri-implantitis, survival rate, survival (18.74 CPA), implant failure
57 (16.58 CPA), and success rate, indicating the tendency to treat peri-implantitis and look
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for possible causes. In fact, a group of keywords was found which was related to the origin of the pathology and the microbiology that can cause peri-implantitis.

All the articles have been published in 309 journals, most of them in journals in the fields of Dentistry, Oral Surgery and Medicine. Regarding the most productive journals, we found that both implant and periodontics journals, had a high impact factor. However, they are also published in journals from other areas, in this case 77 more areas, which are high-impact journals, as observed by other authors in other disciplines (Prevezanos, Tsolakis, & Christou, 2018). This is due to the fact that in the research of peri-implant pathologies, there are aspects that cover multiple areas such as biomaterials, molecular biology, or microbiology for example, which translates the multidisciplinary characteristics of these pathologies.

Regarding the financing of articles, governments are the greatest funders, unlike other medical disciplines where companies tend to have the greatest share when financing studies (de Granda et al., 2016). Governments and foundations are predominantly from powerful countries such as the United States and China; however the companies that have the highest funding are from countries with a tradition in implantology, such as Switzerland (International Team for Implantology (ITI)) or Sweden (Nobel Biocare), with similar results being found in bibliometric studies of implantology (Alonso-Arroyo et al., 2019).

CONCLUSIONS

The scientific literature on peri-implantitis has grown exponentially in the last decade, and particularly in the last five years. Collaboration between authors and institutions has also increased. There appears to be a positive feedback between the scientific production and the collaboration between authors and institutions. Nevertheless, we can observe how consolidated institutions in the area of periodontology and implantology have a priority role in relation to the studies of peri-implant diseases.

The papers have been published in journals with a high impact factor not only in the area of Dentistry, but also the most relevant journals existing in the thematic area of periodontology and implantology. Almost half of the published papers have received public, governmental, or private funding.

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Table 1. Decade analysis of the scientific production.

	TOTAL	1991-2000	2001-2010	2011-2019	Mean	p-value	Statistical test
Original articles	2,225	8,10 ± 5,78	37,30 ± 11,46	196,78 ± 73,62	76,72 ± 92,04	0,00001	Kruskal-Wallis
Reviews	322	0,80 ± 1,03	3,30 ± 2,26	2,56 ± 1,59	2,21 ± 1,97	0,009	ANOVA
Signatures/work	-	3,84 ± 1,54	4,64 ± 0,27	5,24 ± 0,48	4,55 ± 1,09	0,001	Kruskal-Wallis
No collaboration	870	3,50 ± 2,84	16,00 ± 4,60	75,00 ± 18,99	30,00 ± 32,93	0,0001	Kruskal-Wallis
National* collaboration	1,277	3,40 ± 4,03	17,40 ± 7,14	118,78 ± 56,92	44,03 ± 59,88	0,0001	Kruskal-Wallis
International* collaboration	804	1,10 ± 0,99	13,20 ± 7,54	73,44 ± 41,53	27,72 ± 38,88	0,0001	ANOVA

* The sum of the national and international collaboration does not coincide with the total number of collaborative works since the same work can have both collaborations.

Table 2. Most productive authors (20 or more articles published).

Author	Institucion (*)	País	Total docs	% Docs	Total cites	Average cites / docs
Schwarz, Frank	Johann Wolfgang Goethe-University Frankfurt	Germany	81	3.18	2,635	32.53
Lang, Niklaus P	University of Bern	Switzerland	67	2.63	7,539	112.52
Renvert, Stefan	Kristianstad University	Sweden	62	2.43	4,004	64.58
Wang, Hom Lay	University of Michigan	United States	62	2.43	1,510	24.35
Berglundh, Tord	University of Gothenburg	Sweden	53	2.08	4,831	91.15
Salvi, Giovanni E	University of Bern	Switzerland	49	1.92	2,972	60.65
Becker, Juergen	Universitätsklinikum Düsseldorf	Germany	46	1.81	1,730	37.61
Sculean, Anton	University of Bern	Switzerland	46	1.81	1,421	30.89
Romanos, Georgios E	Stony Brook University	United States	38	1.49	869	22.87
Quirynen, Marc	University Hospitals Leuven	Belgium	34	1.33	2,715	79.85
Mombelli, Andrea	University of Geneva	Switzerland	29	1.14	2,159	74.45
Hammerle, Christoph HF	University of Zurich	Switzerland	28	1.10	1,279	45.68
Monje, Alberto	University of Michigan/Universitat Internacional de Catalunya	United States / Spain	28	1.10	578	20.64
de Bruyn, Hugo	Ghent University /Radboud University Medical Center	Belgium / Netherland	27	1.06	582	21.56
Persson, Gosta Rutger	Kristianstad University /University of Washington	Sweden / United States	27	1.06	1,394	51.63
Sanz, Mariano	University Complutense	Spain	27	1.06	749	27.74
Canullo, Luigi	Independent Researcher	Italy	25	0.98	434	17.36
Espósito, Marco	The University of Manchester	United Kingdom	25	0.98	2,618	104.72
Javed, Fawad	University of Rochester	United States	24	0.94	286	11.92
Lindhe, Jan	University of Gothenburg	Sweden	24	0.94	1,409	58.71

Piattelli, Adriano	University of Chieti	Italy	24	0.94	525	21.88
Shibli, Jamil Awad	University of Guarulhos	Brazil	24	0.94	608	25.33
Heitz Mayfield, Lisa JA	The University of Western Australia / University of Bern	Australia / Switzerland	23	0.90	1,989	86.48
Albrektsson, Tomas	University of Gothenburg	Sweden	20	0.79	1,120	56.00
Jung, Ronald E	University of Zurich	Switzerland	20	0.79	1,156	57.80

(*) The institution shows the affiliation collected in the last article published by each author.

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Table 3. Most productive institutions with more than 40 published works.

Institution	Country	Total docs	% Docs	Total cites	Average cites / docs
University of Bern	Switzerland	161	6.32	9,581	59.51
Göteborg University	Sweden	155	6.09	10,949	70.64
University of Michigan	United States	89	3.49	2,310	25.96
University of Zurich	Switzerland	75	2.94	2,215	29.53
University of Dusseldorf	Germany	71	2.79	2,207	31.08
Goethe University	Germany	63	2.47	780	12.38
Kristianstad University	Sweden	60	2.36	3,941	65.68
Malmö University	Sweden	60	2.36	1,859	30.98
University of Hong Kong	China	59	2.32	3,294	55.83
University of Texas	United States	59	2.32	1,543	26.15
University of Washington	United States	56	2.20	1,886	33.68
Trinity College Dublin	Ireland	52	2.04	2,339	44.98
Universidad Complutense de Madrid	Spain	50	1.96	1,173	23.46
University of Milan	Italy	48	1.88	1,094	22.79
Seoul National University	South Korea	47	1.85	463	9.85
King Saud University	Saudi Arabia	44	1.73	440	10.00
University of Basel	Switzerland	43	1.69	1,988	46.23
Catholic University of Louvain	Belgium	42	1.65	2,793	66.50
D'Annunzio University of Chieti-Pescara	Italy	42	1.65	675	16.07
Stony Brook University (SUNY)	United States	42	1.65	836	19.90

Table 4. Most productive countries with more than 50 articles.

Country	N° Articulos	N° citas	media citas por trabajo
United States	535	13,298	24.86
Germany	424	9,288	21.91
Sweden	291	16,033	55.10
Switzerland	289	13,569	46.95
Italy	283	5,230	18.48
China	200	4,897	24.49
Brazil	197	3,707	18.82
Spain	167	2,944	17.63
United Kingdom	140	4,011	28.65
Japan	117	1,512	12.92
South Korea	106	1,033	9.75
Belgium	81	3,758	46.40
The Netherlands	75	2,366	31.55
Turkey	70	1,047	14.96
Australia	63	2,471	39.22
Saudi Arabia	60	517	8.62
France	56	929	16.59
Ireland	53	2,344	44.23

Table 5. Most productive magazines with more than 10 citations per paper.

Journal	ISSN	Q	Category	Posición	IF	Country Edition	Total docs	Total cites	Average cites docs
Journal of Clinical Periodontology	0303-6979	1	Dentistry	2/91	5.241	Denmark	187	11,471	61.34
Journal of Clinical Oral Implants Research	0905-7161	1	Dentistry	8/91	3.723	Denmark	387	1,340	49.97
			Engineering	22/87	3.723				
Journal of Periodontology	0906-6713	1	Dentistry	1/91	7.718	Denmark	44	1,774	40.32
Journal of Dental Research	0022-0345	1	Dentistry	3/91	4.914	United States	29	1,053	36.31
Journal of Periodontology	0022-3492	1	Dentistry	7/91	3.742	United States	157	5,508	35.08
International Journal of Oral & Maxillofacial Implants	0882-2786	2	Dentistry	24/91	2.320	United States	201	5,726	28.49
Journal of Dentistry	0300-5712	1	Dentistry	10/91	3.242	England	22	581	26.41
Journal of Prosthetic Dentistry	0022-3913	1	Dentistry	21/91	2.441	United States	26	635	24.42
Journal of Biomedical Materials Research Part B: Applied Biomaterials	1552-4973	2	Engineering	35/87	2.831	United States	20	457	22.85
		3	Materials Science	23/38					
Journal of Dental Implant Dentistry and Related Research	1523-0899	1	Dentistry	9/91	3.396	United States	145	3,085	21.28
Advances in Medical Science	0268-8921	3	Engineering	46/87	2.342	England	29	594	20.48
		2	Surgery	74/210					
Australian Dental Journal	0045-0421	3	Dentistry	66/91	1.401	Australia	22	419	19.05
Journal of Clinical Oral Investigations	1432-6981	1	Dentistry	15/91	2.812	Germany	46	767	16.67
European Journal of Oral Implantology	1756-2406	1	Dentistry	18/91	2.619	England	34	545	16.03

Journal of Periodontal Research	0022- 3484	1	Dentistry	13/91	2.926	Denmark	33	485	14.70
Los Angeles One	1932- 6203	2	Multidisciplinary	27/61	2.740	United States	20	247	12.35
Quintessence International	0033- 6572	3	Dentistry	62/91	1.460	United States	25	260	10.40

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Table 6. Temporal evolution of scientific production since 2008 and its financing.

Year	Article	Review	Total docs	% docs	Doc financ	% doc finan resp total doc por año
2008	51	6	57	2.24	7	12.28
2009	54	10	64	2.51	23	35.94
2010	52	8	60	2.36	25	41.67
2011	105	11	116	4.55	46	39.66
2012	120	26	146	5.73	79	54.11
2013	135	14	149	5.85	68	45.64
2014	145	22	167	6.56	78	46.71
2015	216	13	229	8.99	112	48.91
2016	213	32	245	9.62	111	45.31
2017	251	36	287	11.27	138	48.08
2018	278	53	331	13.00	183	55.29
2019	308	56	364	14.29	195	53.57

Figure 1. Co-authorship network of 10 or more papers.

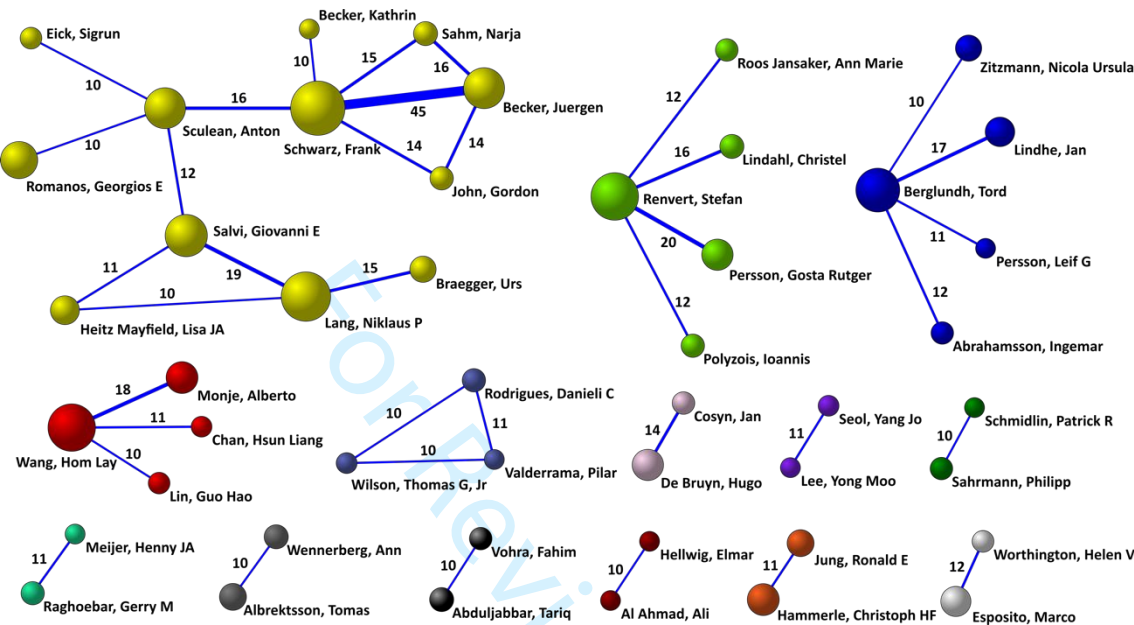


Figure 2. Collaboration networks between institutions with 10 or more paper.



