



## Bibliometric Analysis of Composite Resin Restorations From 2000-2020

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### Research Article

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### ABSTRACT

**Aim:** To identify the most effective actors (authors, countries, and journals) about composite resin restorations in the period 2000-2020.

**Materials and Methods:** An electronic research was conducted in the Scopus database by selecting the words 'composite resin' and 'restoration and English language, article and review types, dentistry field. Their bibliometric data including publication title, authorship, citation count, citation dentistry, year of publication, country and institution of origin, journal of publication, study design, and keywords were extracted and analysed.

**Results and Discussions:** To our knowledge, this is the first bibliometric article on composite resin restorations. This study provides information about authors, institutions and countries that contribute to significant improvements in composite resin restorations. From 2000 to 2020, there were 7118 articles published from 99 countries. Articles originate primarily from the USA and Brazil. Results indicate that the USA, Brazil, Germany, Turkey, the United Kingdom, Japan, Switzerland, Italy, Netherlands and India are the leading countries in composite resin restoration research and account for 51.8% of the total number of publications. The total number of citations are 158.404, corresponding to 22 citations per paper publication. During the time period examined, 776 hot articles and 228 classic articles on composite resin restorations were found. The journal with the most publications is 'Operative Dentistry'. The publishing houses of the top 10 journals are from 4 countries: USA(6), Netherlands(2), Germany(1), Japan(1). The most cited article within the boundaries of this study is Ferracane's article titled 'Resin composite-State of the art', which was published in Dental Materials in 2011 and received 913 citations.

**Conclusions:** This article is the first known bibliometric analysis of composite resin restorations. Studies on composite resin restorations are increasing in parallel with the increasing demand for aesthetics. The analysis of the most influential factors of these publications will give an idea for the studies to be done.

**Keywords:** Bibliometric Analysis, Composite Resin, Composite Restoration

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## Introduction

Significant improvements have been made in the field of restorative dentistry with the development of composite resin technology. While amalgam was the most commonly used restorative material in the 20th century, the use of amalgam was decreased due to the development of adhesive materials and the banning of amalgam-based materials in some countries due to concerns about mercury leakage.<sup>1</sup> Despite advances in composite resins, problems such as marginal incompatibility, marginal discoloration, fracture, microleakage, secondary caries, postoperative sensitivity and polymerization shrinkage are still disadvantages of composite restorations. The studies done in this area is important in order to overcome the negativity encountered in restorations and to obtain long-term restorations. Both the advances in composite resins and the importance of work in this area will provide further research and development opportunities in future studies on composite resin restorations.

The choice of appropriate restorative material when a tooth is restored is evidence-based and depends on the study of studies in which materials are used.<sup>2</sup> Studies evaluating the treatment preferences and management strategies of dentists in various countries were carried out and different results were revealed. These differences exist between countries as well as among dentists in each country.<sup>3,4,5</sup>

Nowadays, there is a wide literature on composite resin restorations with advances in composite technology. These studies need to be analysed in order to assess their impact on research and development in the field of composite resins. This effect can be evaluated by bibliometric analysis. In this respect, it is important to determine the basic research themes, which authors are interested in this subject and the contributions of institutions and countries working in this field, and to qualitatively evaluate the publications on composite restorations. Citation analysis, which examines the effect of research publication by examining citation data obtained by a scientific study, is the preferred method in bibliometry.<sup>6,7</sup>

Articles published recently may not have enough time to receive citations, and older articles may have higher citation counts, as the number of citations will accumulate over time. In this way, time bias is the disadvantage of citation analysis, but today it maintains its popularity in measuring the attribution effect of a paper.

The purpose of this study is to examine the articles on “composite resin restoration” published in the period from 2000 to 2020, thus creating an archive of articles on this subject. In this study, the list of journals, institutions and authors on composite resin restorations, citations, geographic distribution of institutions and authors, and publication statistics were examined. Effective performance parameters were selected in order to evaluate the contributions of countries, institutions and authors in a comparative way.

## Materials and Methods

The words “composite resin” and “restoration” were searched in the Scopus database in the titles of “article title, abstract and keywords” between the years 2000-2020. The search results were filtered by selecting “English” language and “article” and “review” document type.

The most cited articles in the resulting list were evaluated in terms of title, author, region of the institute where the author is located, published journals and number of citations.

## Results and Discussion

Articles published on any subject are cited due to their idea of change in practice and their relevance to future studies. The aim of our study was to perform a bibliometric analysis of articles published on composite resin restorations in the last 20 years. Our study determines and highlights the impact of recent developments on publications by providing the opportunity to historically review articles published on the relevant topic. Secondly, it presents scientific and clinical developments in this field and quantitative information

about authors, journals, countries. Finally, he created a group of articles on composite resin restorations.

There are some limits to the citation analysis we performed as a result of the search conducted through Scopus. Self-cited articles by the authors could not be excluded from this search. In addition, in our study, publications other than English language reviews and articles were not included in the analysis.

About composite resin restorations in the field of dentistry from 2000 to 2020; Except for 244 unidentified studies, 7118 articles were published in Scopus indexed journals from 160 research institutes from 99 countries.

### General Statistics

In the period from 2000 to 2020, there are 7118 articles on composite resin restorations in Scopus indexed journals. The timeline of publications on composite resin restorations is shown in Figure 1. Although some fluctuations were observed in the period from 2000 to 2020, similar to the increase in demand for composite resin restorations, studies in this area have also increased. The number of articles published on the subject did not fall below 300 after 2006. Between 2000 and 2020, the least (274) articles on composite resin restorations were published in 2001, and the most (396) in 2018. While the majority of these publications (94.7%) are research article types, the remaining 373 publications are of the type of review (Figure 2).

### Country Statistics

Except for the publications whose country is not defined, there are publications from 99 different countries. However, it can be said that most of the publications are from only a few countries. The main countries that publish on composite resin restorations are America with 1722 publications and Brazil with 1509 publications. These countries are Germany (692) and Turkey (566) is followed. The geographical distribution of the number of publications is shown in Figure 3. Excluding 244 unidentified publications, the publications made by the countries in the top 10 in terms of number of publications constitute 51.8% of the total publications.

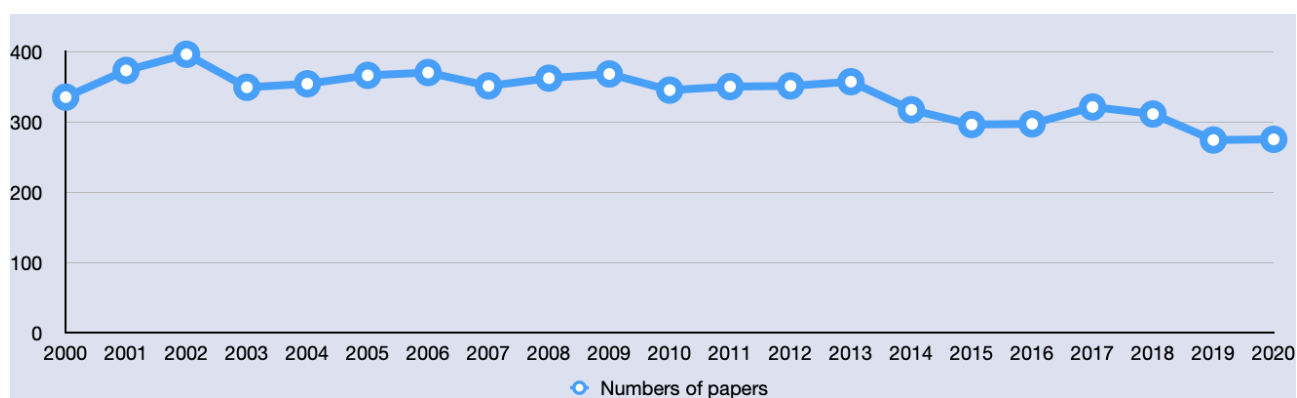


Figure 1. Timeline of publications and patents from 2000 to 2020.

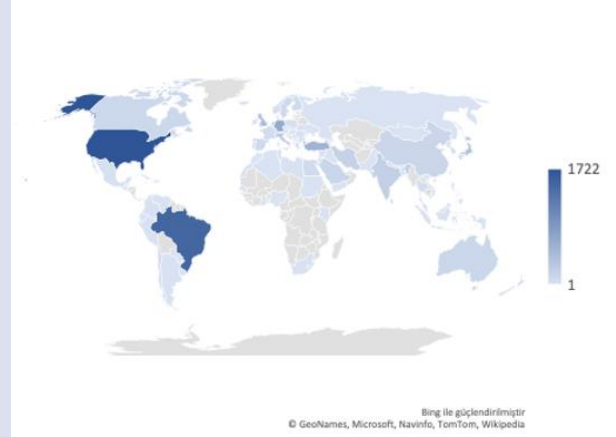
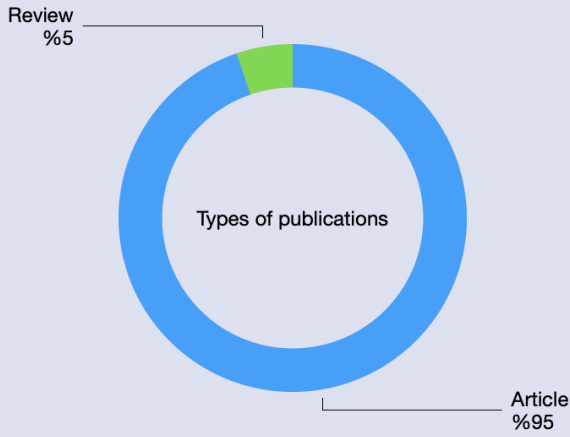


Table 1. Data of the journals that ranked in the top 20 in terms of the number of publications on the restoration of composite resin between 2000 and 2020.

Journal	Papers	IF	h- index	Country	CS(Cite Score)
Operative Dentistry	734	2.387	73	USA	3.9
Dental Materials	645	4.827	132	Netherlands	8
Journal of Dentistry	443	3.470	101	Netherlands	5.8
Journal of Prosthetic Dentistry	336	2.726	109	USA	4.4
American Journal of Dentistry	317	0.900	71	USA	1.5
Journal of Adhesive Dentistry	315	2.464	64	USA	3.6
Clinical Oral Investigations	234	2.903	69	Germany	4.4
Quintessence International	233	1.694	66	USA	2.3
Dental Materials Journal	215	1.545	50	Japan	2.6
Journal of Esthetic and Restorative Dentistry	215	1.986	52	USA	2.6
Dentistry Today	213	0.080	23	USA	0.1
Journal of Contemporary Dental Practice	192	0.670	38	USA	1.0
General Dentistry	184	0.45	30	USA	0.8
Journal of Oral Rehabilitation	115	2.580	84	England	3.8
Journal of The American Dental Association	110	2.803	112	USA	4.3
Journal of Prosthodontics	99	2.122	52	England	3.1
International Journal of Prosthodontics	98	1.550	88	USA	2.4
Journal of Endodontics	92	3.635	131	USA	6.2
Journal of Dental Research	90	4.914	158	USA	9.0
Pediatric Dentistry	86	0.742	62	USA	1.9

IF: (Impact Factor)

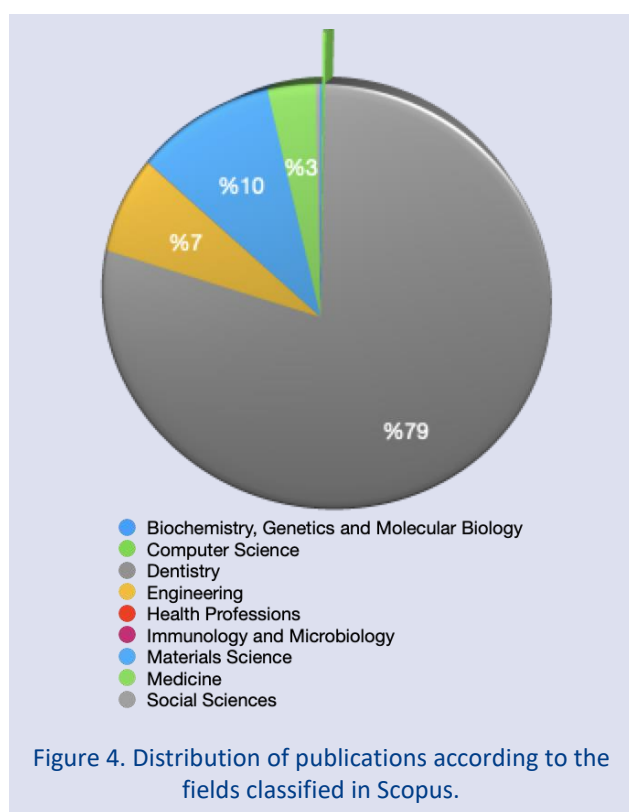
### Journal Distribution

In our study, journals with the largest share in publications related to composite resin restorations were examined. The total number of journals in which the publications take place is 159. The average impact factor (IF) of the top 10 journals in terms of number of publications is 1.78 (0.09 - 4.827). The highest value of these journals in terms of citation score; In 2nd place is Dental Materials, which has a citation score of 8. The

citation score range of the top 10 journals is 1.5–8. Operative Dentistry” is the journal with the most articles with 734 articles. The publishers of the top 10 journals are from 4 countries: America (n=6), The Netherlands (n=2), Germany (n=1) and Japan (n=1). Detailed information about the top 20 journals in terms of the number of publications on the restoration of composite resin between 2000 and 2020 is given in Table 1.

### Subject Distribution

Issues related to composite resin restorations are direct/indirect composite restorations, repair/replacement of direct/indirect composite resin restorations, adhesive systems, composites used in cad/cam system. When the article titles are examined; The word 'repair' is found in 192, 'renovation' 53, 'indirect restorations' 47, 'CAD/CAM' 154, 'adhesive system' 1.155. While the number of publications indicated as in vitro in the title is 531; There are 80 publications that are in vivo. Scopus was given in figure 4 of the distribution of subject categories in the research with the words 'composite resin' and 'restoration'. There are 7118 articles in the field of dentistry, which constitutes 79.2% of the total articles. In our study, 7118 articles in the field of dentistry were examined.



### Evaluation of Authors

The authors with the most publications are Tagami, Junji (Tokyo, Japan) with 90 publications and Reis, Alessandra (Ponta Grossa, Brazil) with 88 publications. The number of authors with a publication number of 20 or more is 108. They are followed by Loguercio, Alessandro Dourado (Ponta Grossa, Brazil), also from Brazil, with 84 publications.

When the author numbers of the publications are examined; the largest number of publications created by 4 authors. The relationship between the number of authors and publications is shown in Figure 5. The average number of authors per article is 4.15(1-24).

### Institutional Statistics

Detailed information about the publishing institutions of composite resin restorations is shown in Table 2. It is seen that the studies carried out in this field are

concentrated in several countries and institutes. So much so that the first four most cited articles belong to institutions in Brazil. 'Universidade de Sao Paulo - USP', which has the most publications on composite resin restorations, also has the most publications in the field of dentistry (8663). 'Universidade do Oeste de Santa Catarina', the institution with the fewest publications on dentistry (101), has 29 publications on composite restorations. While the number of citations of the publications in 45 institutes is over 50; the institutes ranked in the top 10 in terms of number of citations include 21.9% of the publications. Two of the research institutes in the top 10 contain the same number (126) publications (Tokyo Medical and Dental University and Ludwig-Maximilians-Universität München).

### Article Citation

I-10 index is the number of publications containing more than 10 citations. In the period from 2000 to 2020, the i-10 index of the publications on composite resin restoration is 3591. Articles with more than 50 citations are called hot articles. There are 776 hot articles in the analysed time period. Articles exceeding 100 in terms of the number of citations can be named as "classic articles" on demand. These articles have historical reference importance in the development of the subject studied.<sup>8,9</sup> In our study, the number of citations of 228 articles is over 100. In other words, we can say that 3.2% of the total number of articles about composite resin restorations published between 2000 and 2020 is "classical articles". The most recent of these articles is the article titled "Wear, strength, modulus and hardness of CAD/CAM restorative materials" published in Dental Materials by Lawson *et al.* in 2016.

The number of citations per publication (CPP) can be used to evaluate the productivity of the research. 7118 articles were cited 158,404 times in total. The number of citations of the published articles is between 0 and 913. The average of citations is 22,254. The most cited work on this subject in the literature is Ferracane's article titled "Resin composite - State of the art", which was published in Dental Materials in 2011 and received 913 citations. It constitutes 0.57% of the total number of citations. When the articles with the same number of citations from the 100 most cited articles were accepted in the same order, three articles published in different years and 120 cited each took the last place. These; "Effect of different finishing techniques for restorative materials on surface roughness and bacterial adhesion" published in Journal of Prosthetic Dentistry (2010), "Evaluation of dental restorative composites" published in Dental Materials by Fong *et al.* (2005) containing polyhedral oligomeric silsesquioxane methacrylate "and" Crown fractures in the permanent dentition: Pulpal and restorative considerations" by Olsburgh *et al.* (2002) published in Dental Traumatology. Among the first hundred articles, among the articles published in 2000, which is the oldest publication date of the period we examined, the most cited area is "In vivo degradation of resin-dentin bonds in humans" published by Hashimoto *et al.* in the 'Journal of Dental Research' with 502 citations. Over 1 to 3 years.

Table 2a. Institutions publishing composite resin restoration

Institute name	Number of citations	Country	Number of publications
Universidade de Sao Paulo - USP	372	Brazil	8663
Universidade Estadual de Campinas	298	Brazil	4320
UNESP-Universidade Estadual Paulista	209	Brazil	4687
Universidade Federal de Pelotas	133	Brazil	1003
Tokyo Medical and Dental University	126	Japan	3458
Ludwig-Maximilians-Universität München	126	Germany	1145
University of Zurich	124	Switzerland	2331
Hacettepe University	109	Turkey	1261
Université de Genève	100	Switzerland	1144
Radboud University Nijmegen Medical Centre	95	Netherlands	1185
Universidade Federal de Santa Catarina	95	Brazil	900
Medical College of Georgia	91	USA	2061
Faculty of Life Sciences & Medicine	90	England	2861
University of Florida	89	USA	2067
Academic Centre for Dentistry Amsterdam	84	Netherlands	3097
The University of North Carolina at Chapel Hill	83	USA	3373
Charité – Universitätsmedizin Berlin	82	Germany	1175
Universidade Estadual de Ponta Grossa	80	Brazil	514
Turun yliopisto	78	Finland	1565
University of Tennessee Health Science Center	76	USA	917
University of Melbourne	76	Australia	1974
King's College London	75	England	2237
Universidade Federal de Uberlandia	75	Brazil	614
University of Birmingham	75	England	1396
KU Leuven	73	Belgium	1583
Umeå Universitet	73	Sweden	1307
Turku University Institute of Dentistry	72	Finland	1260
Oregon Health & Science University	71	USA	1535
University of Minnesota Twin Cities	71	USA	1788
Università degli Studi di Siena	69	Italy	674
Ege University	68	Turkey	910
The University of Hong Kong	66	China	2634
Christian-Albrechts-Universität zu Kiel	65	Germany	657
University of Washington, Seattle	64	USA	3797
Universidade Federal do Rio Grande do Sul	61	Brazil	1329
King Saud University	60	Saudi Arabia	1562
Københavns Universitet	59	Denmark	1390
Friedrich-Alexander-Universität Erlangen-Nürnberg	58	Germany	720
University of Southern California	55	USA	1933
National University of Singapore	54	Singapore	448
University of Toronto	52	Canada	3177
Universidade Federal de Santa Maria	52	Brazil	608
Nihon University	51	Japan	2173
UNC-CH Adams School of Dentistry	51	USA	2161
National University of Singapore, Faculty of Dentistry	51	Singapore	614
Departement Mondgezondheidswetenschappen	49	Belgium	351
Istanbul University	48	Turkey	947
Tufts University School of Dental Medicine	48	USA	1689
Selçuk University	47	Turkey	587
Gazi University	47	Turkey	910
Ankara University	46	Turkey	893
Klinikum der Universität Regensburg und Medizinische Fakultät	46	Germany	379
Osaka University	46	Japan	2008
University of Iowa	45	USA	2539
Universität Freiburg im Breisgau	45	Germany	834
Universiteit van Amsterdam	44	Netherlands	1490
Nova Southeastern University	43	USA	537
Alma Mater Studiorum Università di Bologna	43	Italy	1236
Universidade Federal Fluminense	41	Brazil	925
Aristotle University of Thessaloniki	41	Greece	1102

Table 2b. Institutions publishing composite resin restoration

Institute name	Number of citations	Country	Number of publications
University of Maryland Dental School	41	USA	996
New York University	41	USA	1556
National and Kapodistrian University of Athens	41	Greece	1644
Indiana University School of Dentistry	41	USA	1940
University of Texas Health Science Center at San Antonio	40	USA	3044
Herman Ostrow School of Dentistry of USC	40	USA	971
Universidade Federal do Rio de Janeiro	38	Brazil	1418
University of Bern	38	Switzerland	2652
University of Copenhagen, School of Dentistry	38	Denmark	1646
The University of Alabama at Birmingham	38	USA	1923
University of Texas Health Science Center at Houston	38	USA	1777
Universidad de Granada	37	Spain	854
Mashhad University of Medical Sciences	36	Iran	586
King Abdulaziz University	36	Saudi Arabia	707
Ondokuz Mayıs University	36	Turkey	664
Universität Heidelberg	36	Germany	744
Shiraz University of Medical Sciences	36	Iran	506
Melbourne Dental School	36	Australia	623
Faculty of Biology, Medicine and Health	36	USA	901
University of Groningen	35	Netherlands	1138
National Institute of Standards and Technology	35	USA	456
Radboud University Nijmegen	34	Netherlands	1050
University of Michigan, Ann Arbor	34	USA	4018
Graduate School of Medicine, Dentistry and Pharmaceutical Sciences	34	Japan	922
Cairo University	33	Egypt	683
Tehran University of Medical Sciences	33	Iran	868
Chulalongkorn University	33	Thailand	673
Universidade Federal de Minas Gerais	33	Brazil	1603
University of Birmingham, College of Medical and Dental Sciences	33	England	374
NYU College of Dentistry	33	USA	1572
Case Western Reserve University	32	USA	1226
University of Groningen, University Medical Center Groningen	32	Netherlands	1074
Universidade Federal do Ceara	32	Brazil	505
Universidade de Passo Fundo	32	Brazil	281
Atatürk University	31	Turkey	523
Vrije Universiteit Amsterdam	31	Netherlands	1145
Seoul National University	31	South Korea	1624
Prince Philip Dental Hospital	31	China	954
Universität Regensburg	31	Germany	370
Forsyth Institute	30	USA	1484
The University of Adelaide	30	Australia	1898
Universidade de Pernambuco	30	Brazil	620
Baskent Universitesi	30	Turkey	489
University of Belgrade	30	Serbia	446
Faculdade Sao Leopoldo Mandic	30	Brazil	747
Universidade do Oeste de Santa Catarina	29	Brazil	101
The Ohio State University	29	USA	2248
Hebrew University of Jerusalem	29	Israel	1821
Universidad de Chile	29	Chile	630
Philipps-Universität Marburg	29	Germany	402
Cardiff University	29	England	1348
School of Dentistry	29	USA	607
Dalhousie University	28	Canada	715
Sichuan University	28	China	1534
Departement Beeldvorming & Pathologie	28	Belgium	539
University of G. d'Annunzio Chieti and Pescara	27	Italy	1138
Mahidol University	27	Thailand	551
West China School/Hospital of Stomatology Sichuan University	27	China	1393
Nippon Dental University	26	Japan	1102
University of Maryland, Baltimore	26	USA	1375



Table 2c. Institutions publishing composite resin restoration

Institute name	Number of citations	Country	Number of publications
Tabriz University of Medical Sciences	26	Iran	363
Universidade Positivo	26	Brazil	337
State Key Laboratory of Oral Disease	26	China	1123
Yeditepe University	25	Turkey	421
Università degli Studi di Napoli Federico II	25	Italy	991
Okayama University	25	Japan	1016
KU Leuven– University Hospital Leuven	25	Belgium	622
Augusta University	25	USA	458
University College Cork Dental School & Hospital	24	Ireland	352
UNMC College of Dentistry	24	USA	362
University Dental Hospital of Manchester	24	England	1267
Nagasaki University	24	Japan	797
School of Dentistry	24	Iran	388
Universidade Luterana do Brasil	23	Brazil	384
Tel Aviv University	23	Israel	1748
Universität Leipzig	23	Germany	418
Indiana University-Purdue University Indianapolis	23	USA	1016
Adelaide Dental School	23	Australia	1027
Humboldt-Universität zu Berlin	22	Germany	319
Hokkaido University	22	Japan	830
Isfahan University of Medical Sciences	22	Iran	567
Universidade Federal de Goias	22	Brazil	557
University at Buffalo, The State University of New York	22	USA	2083
Süleyman Demirel Üniversitesi	21	Turkey	370
Klinikum der Universität München	21	Germany	236
Universidade do Estado do Rio de Janeiro	21	Brazil	762
University of Tanta	21	Egypt	204
Universidade de Uberaba	21	Brazil	124
Pontificia Universidade Católica do Rio Grande do Sul	21	Brazil	663
Rheinisch-Westfälische Technische Hochschule Aachen	21	Germany	592
Tufts University	21	USA	351
Tsurumi University	21	Japan	973
Texas A&M College of Dentistry	21	USA	2226
University of Illinois at Chicago	21	USA	2007
Wuhan University	21	China	853
Jordan University of Science and Technology	21	Jordan	650
School of Stomatology Wuhan University	21	China	755
Université de Paris	21	France	886
The University of Manchester	20	England	1059
Trinity College Dublin	20	Ireland	629

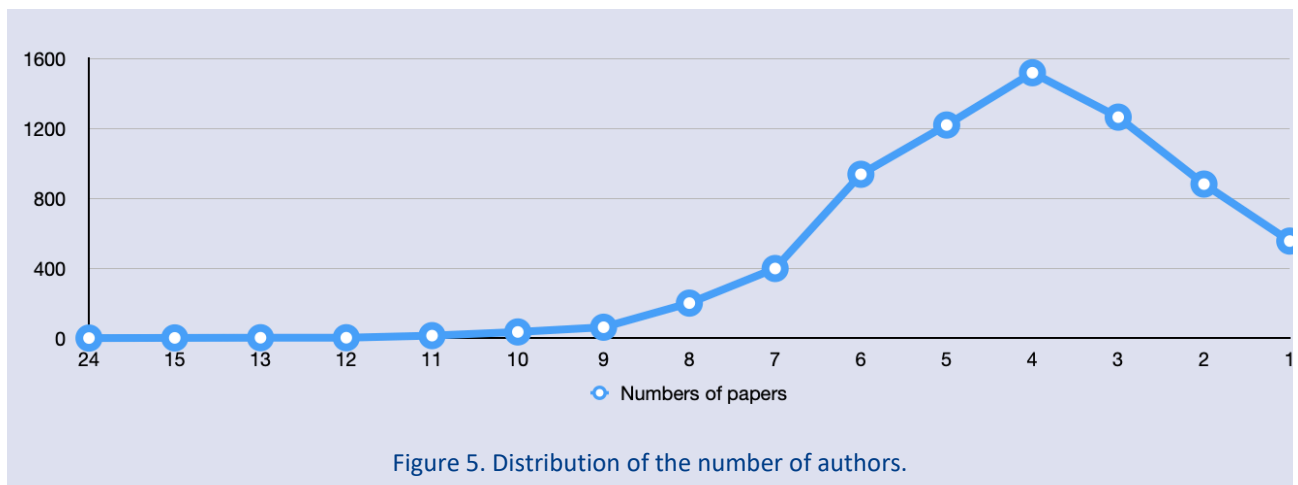


Figure 5. Distribution of the number of authors.

Table 3. Top 10 most cited articles

Author	Country	Year	NC	Journal	h index
Ferracane (Ferracane JL. Resin composite--state of the art. Dent Mater. 2011 Jan;27(1):29-38)	USA	2011	913	Dental Materials	66
Blatz (Blatz MB, Sadan A, Kern M. Resin-ceramic bonding: a review of the literature. J Prosthet Dent. 2003 Mar;89(3):268-74)	USA	2003	605	Journal of Prosthetic Dentistry	27
Mitra (Mitra SB, Wu D, Holmes BN. An application of nanotechnology in advanced dental materials. J Am Dent Assoc. 2003 Oct;134(10):1382-90)	USA	2003	571	American Dental Association	11
Hashimoto (Hashimoto M, Ohno H, Kaga M, Endo K, Sano H, Oguchi H. In vivo degradation of resin-dentin bonds in humans over 1 to 3 years. J Dent Res. 2000 Jun;79(6):1385-91)	Japan	2000	502	Journal of Dental Research	32
Wiegand (Wiegand A, Buchalla W, Attin T. Review on fluoride-releasing restorative materials--fluoride release and uptake characteristics, antibacterial activity and influence on caries formation. Dent Mater. 2007 Mar;23(3):343-62)	Germany	2007	470	Dental Materials	36
Tay (Tay FR, Pashley DH, Suh BI, Carvalho RM, Itthagarun A. Single-step adhesives are permeable membranes. J Dent. 2002 Sep-Nov;30(7-8):371-82)	USA	2002	464	Journal of Dentistry	104
Demarco (Demarco FF, Corrêa MB, Cenci MS, Moraes RR, Opdam NJ. Longevity of posterior composite restorations: not only a matter of materials. Dent Mater. 2012 Jan;28(1):87-101)	Brazil	2012	454	Dental Materials	41
Pashley (Pashley DH, Tay FR. Aggressiveness of contemporary selfetching adhesives. Part II: etching effects on unground enamel. Dent Mater. 2001 Sep;17(5):430-44)	USA	2001	428	Dental Materials	118
Van Meerbeek (Van Meerbeek B, Peumans M, Poitevin A, Mine A, Van Ende A, Neves A, De Munck J. Relationship between bond-strength tests and clinical outcomes. Dent Mater. 2010 Feb;26(2):e100-21)	Belgium	2010	416	Dental Materials	81
Tyas (Tyas MJ, Anusavice KJ, Frencken JE, Mount GJ. Minimal intervention dentistry--a review. FDI Commission Project 1-97. Int Dent J. 2000 Feb;50(1):1-12)	Australia	2000	410	International Dental Journal	41

NC: Number of citations

The most recent article to date is the two articles published in 2015. These; `` Mechanical properties of resin-ceramic CAD / CAM restorative materials “published by Awada and Nathanson in the Journal of Prosthetic Dentistry and 171 cited in Dental Materials, published by Nedeljkovic *et al.* with composites a material-based problem?´´.

The total impact factor of the first 20 publications with the most citations is 1565, and the number of citations is 4.966. However, within the first 20 publications, there are 2 journals with the same number of citations (Dental Materials Journal and Journal of Esthetic and Restorative Dentistry, 215). The number of citations of the first 20 journals is in the range of 86-734, as can be seen, there is a significant difference between the number of citations of the first and 20th journal. The most cited 10 articles are shown in Table 3.

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