

TOP CITED PUBLICATIONS ON FLUORIDE IN RELATION TO ORAL HEALTH: A BIBLIOMETRIC ANALYSIS

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ABSTRACT: The citation count is one of the indications of a manuscript's impact. The objective of the current study was to identify and analyze the top cited articles published on fluoride in the context of oral health. The articles published from January 1997 to December 2017 on fluoride in the context of oral health were identified using the Scopus database. The 100 top cited articles were ranked based on the number of citations received. The manuscripts were also analyzed for the type of study, the name of the journal, the impact factor, the publication year, the author names, the institutional affiliation and the country of origin. The data analysis was performed using SPSS (version 20) statistical software (IBM, NY, USA). Among the top 100 most cited articles, the citation count ranged from 419 to 63. The two most prominent journals were *Caries research* (n=22) and *Journal of Dental Research* (n=16). The four year period with the greatest number of manuscripts published was 2001–2004 (n=37) and most of the papers originated from USA (n=25). The most frequent institutions were the University of Oslo, the University of California, San Francisco, the Justus Liebig University, and the Academic Centre for Dentistry Amsterdam (n=5 for each institution). The most frequent first author was Ganss C (n=7), and the most frequent coauthor was Klimek J (n=8). The majority of the studies were *in vitro* studies (n=40) and narrative reviews (n=23). This article reveals the progress of research on fluoride in oral health by identifying the topics, the institutions, and the authors contributing to fluoride research. There was a predominance of *in vitro* studies and narrative reviews among the highly cited manuscripts.

Keywords: Bibliometric study; Citations; Fluoride; Preventive dentistry; Public health; Scopus.

INTRODUCTION

The beneficial role of fluoride for dental health is widely accepted because of its anticariogenic and antimicrobial properties.¹⁻³ Fluoride, the ion of fluorine a member of the halogen group of fluorine, chlorine, bromine, iodine, astatine and possibly the artificially created element 117 tennessine, is widely present in the earth's crust.⁴ Considering the proven anticaries role of fluoride, a significant amount of research has been published in relation to oral health. For instance, fluoride has been incorporated into drinking water, oral hygiene products (toothpastes, mouthwashes), nanoparticles, bio-ceramics, glasses, composite materials, and surface coatings of dental implants.⁵⁻⁸ On the contrary, excessive fluoride ingestion is associated with numerous toxic effects including skeletal, non-skeletal, and dental fluorosis.⁹⁻¹¹ Additionally, a huge number of articles have been published hence requiring the quantitative and qualitative analyses of the intellectual impact of the published papers (bibliometric analysis). Bibliometrics is a specialty that deals with quantitative analysis of the academic literature including various measures such as citation analysis, publication counts, institutional affiliations, geographical distribution of the peer-reviewed published papers, and the impact factor of the publishing journals.^{12,13} When a researcher uses a publication, as a reference in a peer-reviewed publication, it

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is referred to as a citation.^{12,14} The number of times, a publication has been cited is used as an indicator of the impact of publication.¹⁴

For some academic disciplines, the bibliometric indicators have been useful in the measurement, assessment, and comparison of the research impact and output of individuals, groups, and institutions.¹⁴ The important databases that have been frequently used to collect bibliometric information include Scopus, Web of Science, and Google scholar.^{14,15} The bibliometric analysis of publications has been adopted in various domains of dentistry including traumatic dental injuries,^{16,17} maxillofacial trauma,^{18,19} dental implantology,^{20,21} cleft lip and palate,^{22,23} endodontics,^{24,25} and orthodontics.^{26,27} This approach has also been applied in medicine and some of the latest publications are in the specialities of cardiac computed tomography,²⁸ keratoplasty,²⁹ epilepsy,³⁰ and headache disorders³¹ To the best of our knowledge, no study has been undertaken to determine the most influential papers published on the role of fluoride in the context of oral and dental health. Therefore, the objective of the present study was to identify the top cited articles published on fluoride in the context of oral health. In addition, the characteristic features of the most influential papers have been analyzed and discussed.

MATERIAL AND METHODS

Search strategies: In January 2018, an advanced electronic search was performed to identify the published papers on fluoride in relation to oral health using the Scopus database, which is a scientific platform that provides bibliographic data. The search included papers published in peer-reviewed journals in the English language, categorized in dentistry, from January 1997 to December 2017. The exclusion criteria were papers published in a language other than English, articles published before or after the inclusion period, articles published in journals with a subject category other than dentistry, book chapters, and articles in which the focus was other than the role of fluoride in dentistry. The database search terms were agreed after independent pilot searches by two investigators. The terms were combined as “fluoride” or “fluorides” in the article titles, abstract and keywords and “dentistry” as the subject.

Data extraction and bibliometric analysis: The top cited articles were identified after reading the full text. The identified articles were sorted based on the total number of citations received. The top hundred identified papers were ranked by forming a list from (1 to 100) based on the citations count. When the same number of citations were found for two or more articles, the most recent was ranked higher. The information compiled for each article included the title of the paper, journal name, publication year, laboratory/institution name, and country of origin of the corresponding author. Each article was also classified according to the design of the study (narrative review, systematic review/meta-analysis, case study or case series, clinical trials, case-control studies, cohort studies, animal studies, and *in vitro* studies). The impact factor of the journal was retrieved from 2016 Journal Citation Reports (JCR), Web of Science (Clarivate Analytics, Philadelphia, USA). Two investigators did the scrutinizing and ranking of searched articles independently. In the case of a difference in the opinion, a third investigator resolved the differences in opinion until a consensus was reached.

Statistical analysis: The data were analyzed using the SPSS (version 20) statistical software (IBM, NY, USA). The characteristic features of articles were analyzed using

descriptive statistical measures (average, frequency, and percentage) to present quantitative and qualitative descriptions in a manageable form.

RESULTS

The initial search of the SCOPUS database found a total of 6,628 articles about fluoride in relation to oral health (Figure 1).

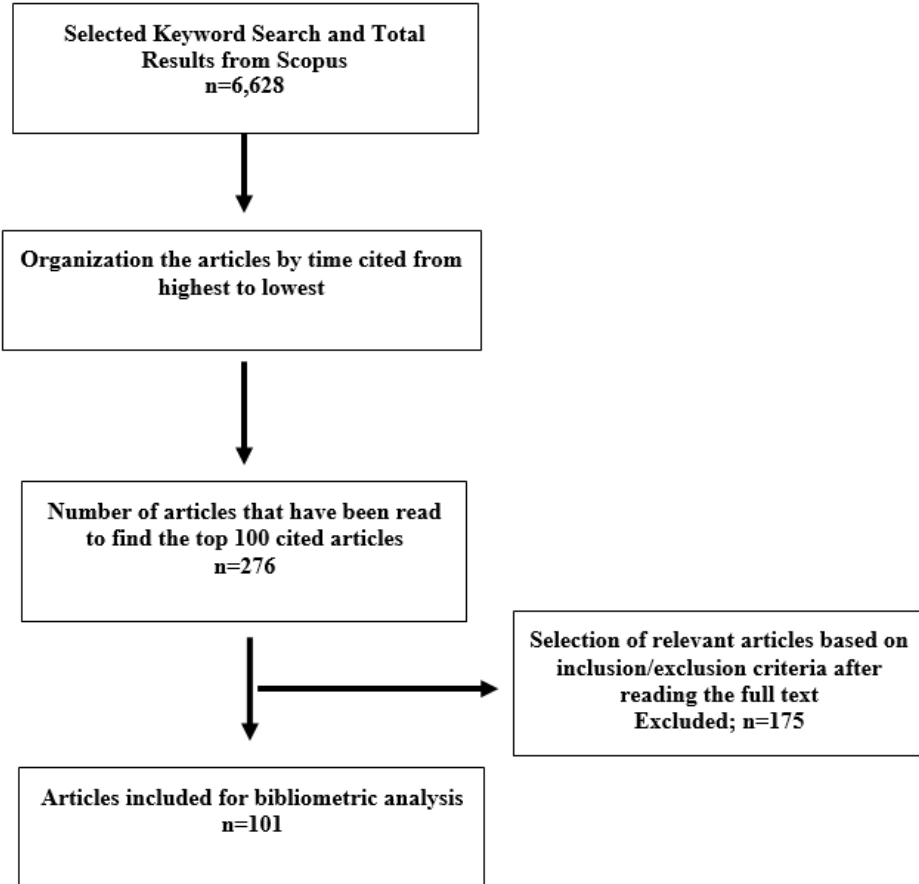


Figure 1. The flow diagram showing the details of the search strategies used for the bibliometric analysis in this study.

The total 6,628 articles initially found were reordered according to the number of citations, and the top 276 articles were assessed against the selection criteria resulting in the exclusion of another 175 articles. The remaining articles (n=101) were included in the bibliometric analysis (Tables 1a and 1b).

Ranking and type of articles: The 100 most cited of papers are have been listed in Tables 1a and 1b. The number of citations of the top cited 100 articles varied from 63 to 419 averaging 99.21 citations per article (Tables 1a and 1b). The number of papers exceeding 100 citations was 28. The majority of articles were original studies (n=67) and review articles (n=34). Amongst the original studies, 40 were *in vitro* studies, 18 were randomized control trials, four were cross-sectional studies, and three were animal studies. In the case of review articles (n=34), there were 23 narrative reviews, 8 systematic reviews, and one meta-analysis (Table 2). The top twenty articles were also ranked according to the average citations per year (Tables 3a and 3b).

Table 1a. List of the articles ranked 1–50 of the 100 most cited articles on fluoride, in relation to oral health (1997–2017)

Rank	Article	Total citations	Average no of citations/year
1	Featherstone JD, 1999. ³²	419	22.05
2	Wiegand A et al., 2007. ³³	330	30.00
3	Aoba T and Fejerskov O, 2002. ³⁴	233	14.56
4	Ten Cate JM 1999. ³⁵	227	11.95
5	Ellingsen JE et al., 2004. ³⁶	224	16.00
6	Nakagawa M et al., 1999. ³⁷	192	10.11
7	Reynolds E et al., 2008. ³⁸	176	17.60
8	Ten Cate JM, 1997. ³⁹	170	8.10
9	Weintraub JA et al., 2006. ⁴⁰	159	13.25
10	Ganss C et al., 2004. ⁴¹	155	11.07
11	Berglundh T et al., 2007. ⁴²	151	13.73
12	Twetman S et al., 2003. ⁴³	151	10.07
13	Ganss C et al., 2001. ⁴⁴	142	8.35
14	Griffin S et al., 2007. ⁴⁵	130	11.82
15	Attin T et al., 1997. ⁴⁶	123	5.86
16	Mascarenhas AK, 2000. ⁴⁷	121	6.72
17	Baysan A et al., 2001. ⁴⁸	119	7.00
18	Cochrane N et al., 2008. ⁴⁹	115	11.50
19	Beltrán-Aguilar ED et al., 2000. ⁵⁰	114	6.33
20	Øgaard B et al., 2001. ⁵¹	113	6.65
21	Chu C et al., 2002. ⁵²	111	6.94
22	Marinho V, 2009. ⁵³	110	12.22
23	Dickens SH et al., 2003. ⁵⁴	109	7.27
24	Levy SM et al., 2001. ⁵⁵	108	6.35
25	Larsen M and Richards A, 2002. ⁵⁶	105	6.56
26	Gorton J and Featherstone JD, 2003. ⁵⁷	103	6.87
27	Nakagawa M et al., 2001. ⁵⁸	103	6.06
28	Aoba T, 1997. ⁵⁹	103	4.90
29	Rosenblatt A et al., 2009. ⁶⁰	100	11.11
30	Browne D et al., 2005. ⁶¹	99	7.62
31	Lewinstein I et al., 2004. ⁶²	99	7.07
32	Everett E 2011, ⁶³	97	13.86
33	Tam L et al., 1997. ⁶⁴	95	4.52
34	Isa ZM et al., 2006. ⁶⁵	94	7.83
35	de Mello Vieira AE et al., 2005. ⁶⁶	94	7.23
36	Benson P et al., 2005. ⁶⁷	94	7.23
37	Nakagawa M et al., 2002. ⁶⁸	94	5.88
38	Hove L et al., 2008. ⁶⁹	93	9.30
38	Ganss C et al., 2008. ⁷⁰	93	9.30
39	Ten Cate JM, 2001. ⁷¹	93	5.47
40	Clarkson JJ and McLoughlin J, 2000. ⁷²	91	5.06
41	Weyant RJ et al., 2013. ⁷³	89	17.80
42	Cury JA et al., 2004. ⁷⁴	87	6.21
43	Attin T et al., 1998. ⁷⁵	86	4.30
44	Van Rijkom H et al., 2003. ⁷⁶	85	5.67
45	Everett E et al., 2002. ⁷⁷	85	5.31
46	Bronckers A et al., 2009. ⁷⁸	84	9.33
47	Queiroz CS et al., 2008. ⁷⁹	84	8.40
48	Mount G, 1999. ⁸⁰	84	4.42
49	Li L, 2003. ⁸¹	81	5.40
50	Pendrys DG, 2000. ⁸²	81	4.50

Table 1b. List of the articles ranked 51–100 of the 100 most cited articles on fluoride, in relation to oral health (1997–2017)

Rank	Article	Total citations	Average no of citations/year
51	Van Rijkom HM et al., 1998. ⁸³	80	4.00
52	Corona SAM et al., 2003. ⁸⁴	79	5.27
53	Todd MA et al., 1999. ⁸⁵	79	4.16
54	Heller KE et al., 1997. ⁸⁶	79	3.76
55	Ganss C et al., 2004. ⁸⁷	78	5.57
56	Fomon SJ et al., 2000. ⁸⁸	78	4.33
57	Marcusson A et al., 1997. ⁸⁹	78	3.71
58	Wong MCM et al., 2011. ⁹⁰	77	11.00
59	Schlueter N et al., 2007. ⁹¹	77	7.00
60	Itota T et al., 2004. ⁹²	76	5.43
61	Griffin SO et al., 2001. ⁹³	76	4.47
62	Shaw AJ et al., 1998. ⁹⁴	75	3.75
63	Ismail AI and Hasson H, 2008. ⁹⁵	74	7.40
64	Hara AT et al., 2003. ⁹⁶	74	4.93
65	Tranæus S et al., 2001. ⁹⁷	74	4.35
66	DenBesten PK, 1999. ⁹⁸	74	3.89
67	Sudjalim TR et al., 2007. ⁹⁹	73	6.64
68	Hughes JA et al., 2004. ¹⁰⁰	73	5.21
69	Ammari AB et al., 2003. ¹⁰¹	73	4.87
70	Dhar V and Bhatnagar M, 2009. ¹⁰²	71	7.89
71	Attin T et al., 1999. ¹⁰³	71	3.74
72	Ten Cate JM et al., 2008. ¹⁰⁴	70	7.00
73	Ikemura K et al., 2008. ¹⁰⁵	70	7.00
74	Lagerweij MD et al., 2006. ¹⁰⁶	70	5.83
75	Vieira A et al., 2005. ¹⁰⁷	70	5.38
76	Paes Leme AF et al., 2004. ¹⁰⁸	70	5.00
77	Eliades G et al., 1998. ¹⁰⁹	70	3.50
78	Watson PS et al., 2005. ¹¹⁰	69	5.31
79	Iazzetti G et al., 2000. ¹¹¹	69	3.83
80	Øgaard B. 2001. ¹¹²	68	4.00
81	Vemeersch G et al., 2001. ¹¹³	68	4.00
82	Zero DT, 1999. ¹¹⁴	68	3.58
83	Moretto MJ et al., 2010. ¹¹⁵	67	8.38
84	Ekstrand KR et al., 2010. ¹¹⁶	67	8.38
85	Dobaradaran S et al., 2008. ¹¹⁷	67	6.70
86	Ganss C et al., 2007. ¹¹⁸	67	6.09
87	Petersson LG et al., 2004. ¹¹⁹	67	4.79
88	Ritter AV et al., 2006. ¹²⁰	66	5.50
89	Koo H et al., 2005. ¹²¹	66	5.08
90	Friedl KH et al., 1997. ¹²²	66	3.14
91	Ganss C et al., 2010. ¹²³	65	8.13
92	Bradshaw DJ et al., 2002. ¹²⁴	65	4.06
93	Vorhies AB et al., 1998. ¹²⁵	65	3.25
94	Büyükilimaz T et al., 1997. ¹²⁶	65	3.10
95	Delbem ACB and Cury JA, 2002. ¹²⁷	64	4.00
96	Ganss C et al., 2011. ¹²⁸	63	9.00
97	Lawrence HP et al., 2008. ¹²⁹	63	6.30
98	Whelton HP et al., 2004. ¹³⁰	63	4.50
99	Cumow MMT et al., 2002. ¹³¹	63	3.94
100	Bishara SE et al., 2002. ¹³²	63	3.94

Table 2. The study designs of the top 100 most cited publications

Article type	Subtype	Publication count
Original Articles	<i>In vitro</i> study	40
	Randomized control trial	18
	Cross-sectional study	4
	Animal study	3
	Quasi experimental study	1
	Case-control study	1
	Total original articles	67
Reviews	Narrative review	23
	Systematic review	8
	Cochrane review	2
	Meta-analysis	1
	Total review articles	34

Table 3a. List of the articles ranked 1–10 of the top 20 articles according to the average number of citations per year

Rank	Articles	Average no of citations/year
1	Wiegand A et al., 2007. ³³	30.00
2	Featherstone JD, 1999. ³²	22.05
3	Weyant RJ et al., 2013. ⁷³	17.80
4	Reynolds E et al., 2008. ³⁸	17.60
5	Ellingsen JE et al., 2004. ³⁶	16.00
6	Aoba T and Fejerskov O, 2002. ³⁴	14.56
7	Everett E, 2011. ⁶³	13.86
8	Berglundh T, et al., 2007. ⁴²	13.73
9	Weintraub JA, et al., 2006. ⁴⁰	13.25
10	Marinho V, 2009. ⁵³	12.22

Table 3b. List of the articles ranked 11–20 of the top 20 articles according to the average number of citations per year

Rank	Articles	Average no of citations/year
11	Ten Cate JM, 1999. ³⁵	11.95
12	Griffin S et al., 2007. ⁴⁵	11.82
13	Cochrane N et al., 2008. ⁴⁹	11.50
14	Rosenblatt A et al., 2009. ⁶⁰	11.11
15	Ganss C et al., 2004. ⁴¹	11.07
16	Wong MCM et al., 2011. ⁹⁰	11.00
17	Nakagawa et al., 1999. ³⁷	10.11
18	Twetman S et al., 2003. ⁴³	10.07
19	Bronckers A et al., 2009. ⁷⁸	9.33
20=	Hove L et al., 2008. ⁶⁹	9.30
20=	Ganss C et al., 2008. ⁷⁰	9.30

Year of publication: The top cited articles were also classified according to the year of publication. The top cited articles were most frequently published during 2001–2004 (n=37), followed by 1997 to 2000 (n=27), and 2005 to 2008 (n=26) (Figure 2).

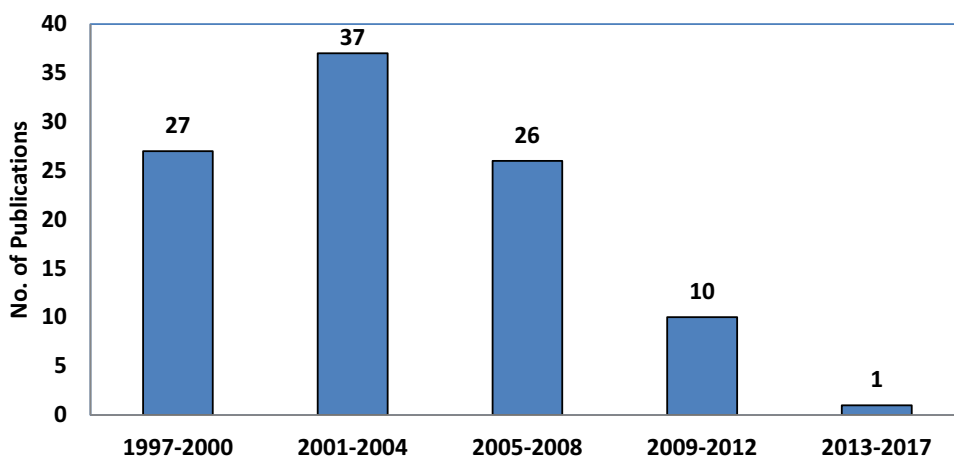


Figure 2. The top 100 most cited articles distributed across various time periods according to year of publication

In order to capture the recent important articles, a search was performed using the same search terms in the analysis of the 100 top ranked articles, but using the short time period 2016–2017. The top 20 articles from 2016–2017 are listed in Table 4. The number of citations in the last two years ranged from 12 to 4 (average number of citations = 6.43).

Table 4. The 20 most cited articles published during 2016–2017
(from Journal Citation Reports 2016).

Rank	Articles	Impact factor of the journal in which the article was published	Total no of citations
1	Cury JA et al., 2016. ¹³³	4	12
2	Gao SS et al., 2016. ¹³⁴	1.48	12
3	Duangthip D et al., 2016. ¹³⁵	3.4	11
4	Wright JT et al., 2016. ¹³⁶	2.1	10
5	Lenzi TL et al., 2016. ¹³⁷	2.1	9
6	Li R et al., 2016. ¹³⁸	3.4	8
7	Liu J et al., 2016. ¹³⁹	4	7
8	Nelson T et al., 2016. ¹⁴⁰	1.9	7
9	Haznedaroglu et al., 2016. ¹⁴¹	1	7
10	O'Mullane D et al., 2016. ¹⁴²	0.81	6
11=	Splieth CH et al., 2016. ¹⁴³	1.8	6
11=	Anderson M et al., 2016. ¹⁴⁴	1.8	6
12	McLaren L et al., 2016. ¹⁴⁵	2.3	5
13	Mei ML et al., 2016. ¹⁴⁶	1.3	5
14	Raggio DP et al., 2016. ¹⁴⁷	2.1	5
15	Crystal YO et al., 2017. ¹⁴⁸	2.1	4
16	Zhao IS et al., 2017. ¹⁴⁹	3.4	4
17	Kirschneck C et al., 2016. ¹⁵⁰	2.3	4
17	Simon MJ et al., 2016. ¹⁵¹	2.3	4
18=	Magalhães AC et al., 2016. ¹⁵²	1.8	4
18=	Memarpour M et al., 2016. ¹⁵³	1.8	4
19	Zhang Y et al., 2016. ¹⁵⁴	1.7	4
20	Altinci P et al., 2016. ¹⁵⁵	1.8	4

Journals: The 100 top ranked articles were published by a number of dentistry journals (n=29). They were most frequently published by *Caries Research* (n=22), followed by *Journal of Dental Research* (n= 16). The journals contributing two or more top 100 most cited articles and their impact factors are presented in Table 5.

Table 5. Journals with more than one publication among the top 100 most cited articles and their Impact factors (from Journal Citation Reports 2016)

Journal	Number of articles published in the journal	Impact factor of the journal
Caries Research	22	1.8
Journal of Dental Research	16	4.7
American Journal of Orthodontics and Dentofacial Orthopaedics	5	1.4
European Journal of Oral Sciences	5	1.5
Journal of the American Dental Association	5	2.1
Community Dentistry and Oral Epidemiology	4	2.3
Dental Materials	4	4
Journal of Oral Rehabilitation	4	2
Journal of Public Health Dentistry	4	1.3
Acta Odontologica Scandinavica	3	1.2
Critical Reviews in Oral Biology and Medicine	3	4.7
Dental Materials Journal	3	1
Operative Dentistry	3	2.8
Archives of Oral Biology	2	1.7
Brazilian Dental Journal	2	0
International Journal of Oral and Maxillofacial Implants	2	2.2
Journal of Dentistry	2	3.4

Authors, country of origin, and institution: The majority of the 100 top most cited fluoride articles were contributed by multiple authors (n=87) while only a small minority had a single author (n=14). The number of authors ranged from one to 17 with the average number of authors being 4. The most frequent first authors were Ganss C (n=7), Ten Cate JM (n=4), Nakagawa N (n=3), and Attin T (n=3). Among the coauthors, the most frequent were Klimek J (n=8) and Cury JA (n=6). The names of the first and the coauthors having more than two publications among the top 100 most cited articles are shown in Table 6. The 100 top most cited papers originated from 19 countries of which 13 countries contributed 2 or more papers (Figure 3). The four countries with the most frequently cited corresponding authors for the 100 top most cited papers were USA (n=25), Germany (n=13), UK (n=10), and Brazil (n=09) (Figure 3).

Table 6. Frequent authors and co-authors contributing to the top 100 most cited articles

Parameter	Name	Frequency
Frequent First Authors	Ganss C	7
	Ten Cate JM	4
	Nakagawa M	3
	Attin T	3
Frequent Co-Authors	Klimek J	8
	Cury JA	6
	Schlueter N	4
	Wefel JS	3
	Hellwig E	3
	Donly KJ	3
	Paes Leme AF	3
	Matsuya S	3

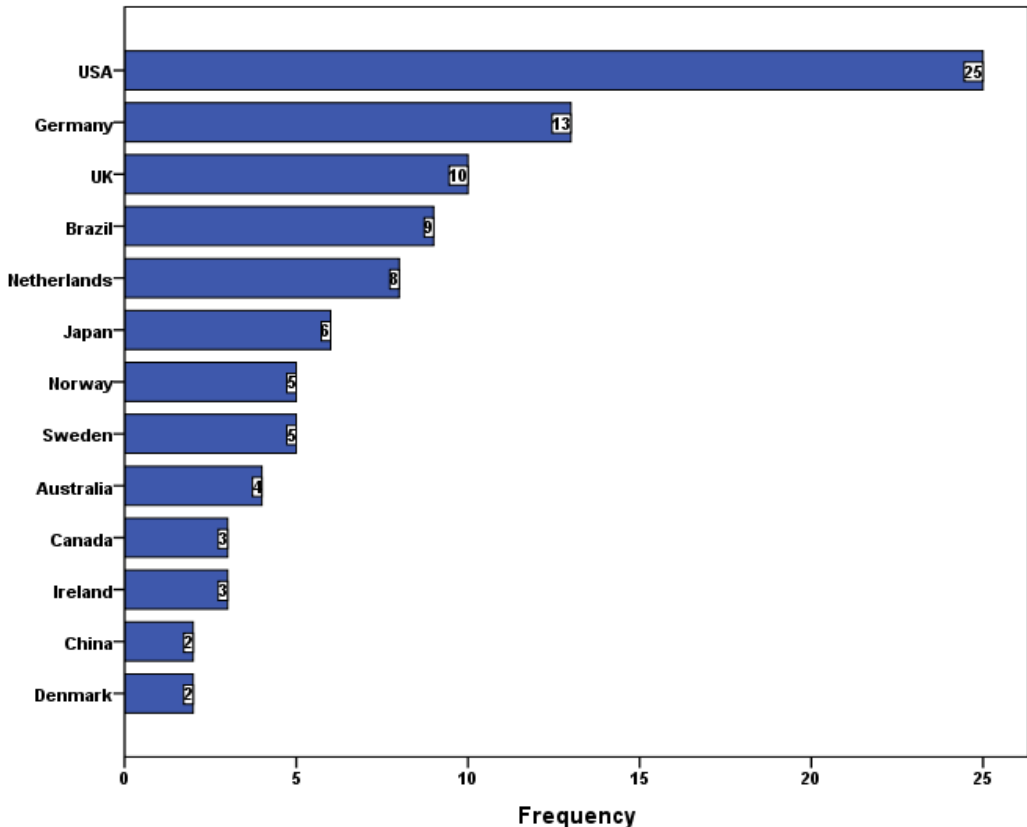


Figure 3. The countries of origin of the contributors publishing two or more articles among the top 100 most cited articles.

Regarding the institution, most of the papers were affiliated with one institution ($n=64$), while a smaller number had affiliations with two institutions ($n=25$) or with three or more institutions ($n=12$). Ten institutions contributed more than two publications. The University of Oslo, the University of California, San Francisco, the Justus Liebig University, and the Academic Centre for Dentistry jointly shared the most frequent position (5 articles from each) followed by the University of Iowa with 4 papers (Figure 4).

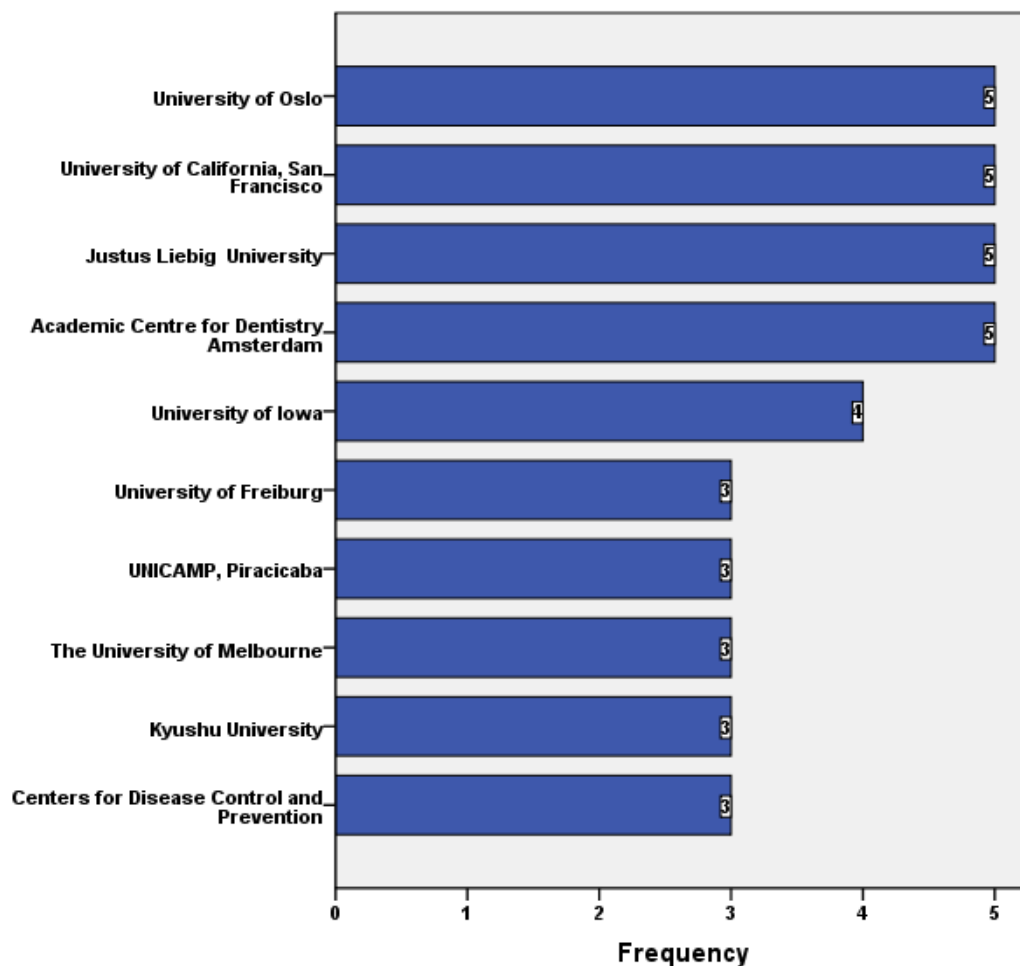


Figure 4. The institutions contributing three or more publications towards the top 100 most cited articles

DISCUSSION

This bibliometric study is the first of its kind aiming at identifying and analysing the top cited manuscripts and their main characteristic features on “fluoride” in the context of oral health. For this purpose, the articles’ bibliometric data were extracted using the Scopus Database. The analysis of these articles revealed exciting trends and identified directions for further research. Among the top cited hundred papers (Table 1a), the most cited paper was published by Featherstone JD³² in 1999 and it received 419 citations. The author focused on the pathogenesis of dental caries, the availability of fluoride from different sources, and the role of fluoride in the process of

remineralization. The second most cited manuscript, by Wiegand et al.,³³ was published in 2007 and received 330 citations. Wiegand et al.,³³ reviewed various aspects of the fluoride release and recharge. There are a variety of fluoride-releasing restorative materials for which there is evidence of a long-term beneficial anti-caries role.^{156,157} Wiegand et al.,³³ discussed the capability of fluoride-releasing restorative materials for preventing the development and progression of dental caries, in both *in vitro* and *in vivo*, and the factors that influence the release and recharge of fluoride from these materials. This manuscript was cited extensively by subsequent experimental studies and reviews published on the topic of fluoride release and recharge from restorative materials. Additionally, this manuscript was better in terms of average citations per year (30 citations per year) when compared to the manuscript published by Featherstone³² which received fewer citations per year (22 citations per year). The third most cited article, published 2002, was by Aoba and Fejerskov and it received 233 citations.³⁴ The authors provided an overview of the pathogenesis of dental fluorosis. They described how the presence of an excess of fluoride could retard the breakdown and removal of organic matrix. Fluoride interfered with the process of mineralization by binding with the calcium ions during enamel maturation and this impaired the function of the calcium-dependent proteases. This retardation of organic matrix removal and the decreased availability of free calcium during the maturation stage resulted in enamel fluorosis.

The majority of the top cited articles were published by *Caries Research* (Impact factor 1.8; Journal Citation Reports [JCR] 2016) and *Journal of Dental Research* (Impact factor 4.7; JCR 2016). Among the top cited articles, the contribution by these two journals was significantly higher than that of any other individual journal. These journals are considered to be among the leading journals in dentistry. *Caries Research* is ranked 32 out of 90 and *Journal of Dental Research* is ranked 2 out of 90 and their total citations were 3,922 and 17,285, respectively, in 2016 (JCR data 2016). These journals are the official publications of two important scientific societies contributing to dental research: the European Organization for Caries Research and the International Association of Dental Research.

The citations count is one of the variables by which articles can be assessed and it is an attractive method for evaluating research performance. However, it is important to note that citation is a dynamic process and the citation received by a publication may not always be in agreement with the author.¹⁵⁸ While measuring the performance based on citation count, other factors that should be kept into consideration are the authors' prestige, institutional affiliation, number of coauthors, length of manuscript, journal accessibility and prestige, language, the field of study, and the database used for the citation count.¹⁵⁹⁻¹⁶¹ We found that the United States is one of the top countries among top cited studies on fluoride in relation to oral health and this finding is in agreement with other bibliometric studies covering various specialities of medicine and dentistry.¹⁶²⁻¹⁶⁵ This reflects the economic stability and greater interest of the United States towards research and development through the availability of a skilled workforce, state funding, the presence of several research facilities, and the exchange of foreign students and research investigators.^{166,167}

Among the top cited papers, the majority of the manuscripts are *in vitro* studies followed by review articles. Although these two study designs are not considered

higher on the hierarchy of evidence,¹⁶⁸ these study designs are easier to conduct due to a negligible level of ethical issues and requiring only limited financial resources. These study designs can provide a summary of existing knowledge and provide preliminary data on the basis of which further studies with a higher level of evidence can be designed such as systematic reviews and randomized clinical trials. The majority of the top cited articles have authors with affiliations to more than one of the disciplines in dentistry suggesting that collaboration and interdisciplinary research are significant. Although a number of authors (Klimek J, Cury JA, and N. Schlueter N) were not listed as first authors in the majority of their publications, they contributed significantly to the top cited articles as coauthors and hence they can be considered to be important contributors in fluoride research in relation to oral health.

There are a few limitations to the present study. We have used only the Scopus database for our bibliometric analysis. Using additional databases, such as SciFinder, Web of Science, PubMed, and Google Scholar, may have allowed the tracking of more articles and given an additional insight into the subject. In the present bibliometric analysis, we have also included the authors' self-citations because these self-citations often represent the continuation of a research work.

The significance of this bibliometric analysis is that it helped to identify:

- (i) The principal researchers contributing to fluoride research in context of oral health.
- (ii) The identification of trends in the research and educational material on the topic of fluoride in relation to oral health.
- (iii) The reputable journals publishing in the field of fluoride in relation to oral health.

The identification of this information may be of assistance to academics, investigators, and readers for developing possible collaborations for future research.

CONCLUSIONS

This bibliometric study reported the one hundred top cited articles on the role of fluoride in relation to oral health. The leading journals where most top cited articles were published were *Caries Research* and *Journal of Dental Research*. In general, there is a predominance of original research studies (mainly *in vitro*) and researchers from the United States published the most influential articles. The authors Ganss C and Klimek J were the most frequent and leading researchers publishing on this topic. This manuscript provides researchers and clinicians with information on important research themes, key international researchers, and the institutions contributing to this speciality. The authors consider that researchers should focus on original studies with a higher level of evidence and on more multi-institutional and international collaborative research work.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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