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ORIGINAL ARTICLE



# Top 100 cited systematic reviews and meta-analyses in dentistry

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**ABSTRACT**

**Objective:** The purpose of the present study was to identify the 100 top cited systematic reviews and meta-analyses on dental journals so as to gain insight into the influential publications in dentistry.

**Material and methods:** The Web of Science was used to comprehensively identify the 100 most cited papers without year and language restriction. Specific parameters regarding the title, journal, publication year, authors, country of origin, institution and university, collaborations, keyword analysis and field of study of each manuscript were retrieved.

**Results:** The citations ranged from 642 to 140. The most productive years were 2008 and 2009. The majority of top cited papers were published in Clinical Oral Implants Research and Journal of Clinical Periodontology. The leading countries were United States, followed by Switzerland. The University of Zurich was the most productive institution with 8 articles. Major topics of interest in the top 100 most-cited papers were dental implants and periodontology. The most frequently occurring keywords were systematic review, dental implants and meta-analyses.

**Conclusions:** Systematic reviews published in high impact factor Dental journals focused on implantology and periodontology had the highest citation rates. Obviously, the top cited list is dynamic, as scientific interests and research tendencies evolve over the years.

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**KEYWORDS**
Bibliometrics; citation analysis; meta-analysis; systematic review

## Introduction

'Bibliometrics' is an important scientific tool for the evaluation of the research performance of individual authors, institutions, journals or countries. The subject of bibliometrics was first defined by Pritchard as 'the application of mathematical and statistical methods to books and other media' [1]. According to De Bellis et al., bibliometrics is a set of methods to quantitatively analyze scientific and technological literature, while citation analysis is defined as 'the examination of the frequency, patterns, and graphs of citations in articles and books' [2]. Citation analysis is a commonly used bibliometric method which quantifies the number and relationship of references an article receives over time. Such analysis may inform research allocation, reorient research in particular directions, or enhance research productivity.

Citation analysis has been widely used in various fields of medicine, anesthesia and pain [3], back pain research [4], endocrinology and metabolism [5], cardiology [6], cancer immunotherapy [7], and in various fields of dentistry [8], orthodontics [9], oral and maxillofacial surgery [10], endodontics [11], regenerative endodontics [12] and implant dentistry [13]. Interestingly, several studies have been conducted to identify and analyze the most influential evidence level 1 articles, which is randomized controlled trials, systematic review, and meta-analyses [14,15]. Highly cited articles have been used in order to evaluate countries, institutions, authors and journals. However, bibliometric analysis does not measure the absolute quality of research output, but focuses rather on the impact of specific research. In other words, the number of citations that an article receives is sufficient to characterize the readership and the scientific interest but it does not necessarily reflect the academic quality.

The practice of evidence-based medicine (EBM) has been defined as integrating individual clinical expertise with the best available external clinical evidence from systematic research [16]. According to the Oxford Centre for Evidence-Based Medicine (OCEBM), systematic reviews and meta-analyses are graded with the highest quality, level 1, the top level of evidence for clinical science research [17]. With evidence-based medicine as their basis, they are focused on peer-reviewed publications about a specific health problem and use rigorous, standardized methods for selecting and assessing articles in order to analyze current concepts and conclude on a vast amount of supporting and sometimes conflicting scientific literature. Systematic reviews are generally considered better than individual studies as they include the application of strategies that limit bias in the assembly, critical appraisal, and synthesis of all relevant studies on a specific topic.

Up to the present, no citation analysis of published systematic reviews and meta-analyses in the field of dentistry has been conducted. The aim of the present study was to identify the 100 top-cited systematic reviews and meta-

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analyses across all peer-reviewed scientific dental journals. Analyzing the main characteristics of the most influential evidence level 1 articles to date in dentistry could provide data to identify future trends, and help establish future research directions and subsequent treatment.

## Material and methods

This retrospective analysis used bibliometric information retrieved from the most renowned citation database Clarivate Analytics' Web of Science. The Web of Science (WoS) Core Database was used to comprehensively identify the 100 most cited systematic reviews and meta-analyses without year and language restriction, and the literature search was limited in Science Citation Index Expanded (SCI-E). The Web of Science platform connects the WoS Core Collection to regional citation indexes, patent data, specialized subject indexes, and an index of research data sets.

On 10th May 2019, we performed a bibliometric analysis of the most highly cited systematic reviews and meta-analyses in 91 journals included in the category 'Dentistry, Oral Surgery, and Medicine' in the database of the Clarivate Analytics Journal Citation Reports 2018 [18]. Journal Citation Report represents a section of the Clarivate Analytics, which includes 11,655 total journals across 234 disciplines and 80 countries. The following search terms were used: 'systematic', 'systematic review*', 'meta-analys*' and 'meta analys*' in the title section. There was no restriction on the publication year or the language of the article. Editorial material, reprint publications and letter to the editor were excluded. The results included in the subsequent analysis were refined in the journals included in the Journal Citation Report 2018 in the WoS category of 'Dentistry, Oral Surgery, and Medicine'. Meeting abstracts, letter to the editors, editorial material, reprints, book reviews or corrections were excluded from the study. Publications were ranked according to the number of citations, using the option 'Times cited-highest to lowest' listed on the WoS and were downloaded into spreadsheet software using Microsoft Excel 2010. Two different investigators evaluated the papers independently and selected the top-cited systematic reviews and meta-analyses. Any disagreement was resolved by discussion or decided by the third author.

The most cited articles were further analyzed regarding the following information: number of citations, h-index, publication year, journals, authors, number of authors, methodological design, article topic, contributing institution and country. The country of origin of the article was defined by the address provided for the corresponding author, whereas the addresses of additional authors were noted to determine the collaboration type. The articles were classified into three types based on the country and university: (1) 'single university/country article,' if the researchers' addresses were from the same university and country (2) 'multi-university collaborative article' if authors were from different universities, but from the same country and (3) 'internationally collaborative article,' if the articles were co-authored by researchers from multiple countries. Important keywords were sorted by the number of articles where the keyword was mentioned. In addition, the reported impact factor (IF) for each journal was obtained from the Journal Citation Reports 2018. With the intention of eliminating time bias, average citations per year values (with reference to the year 2019) were also calculated for the publications.

## Results

The 100 top-cited systematic reviews and meta-analyses on Dental Journals are listed by rank order based on the number of citations in Table 1. Literature search identified 4096 articles published in journals included in the WoS category of 'Dentistry, Oral Surgery, and Medicine', while only 3794 were categorized as review, article, or proceedings paper. The most-cited article received 642 citations, and the least cited article received 140 citations. The mean number of citations per article was 226.17 and the majority of articles ($n = 77$) received more than 160 citations.

The h-index, which was developed in 2005 by Jorge Hirsch, a condensed-matter physicist at the University of California in San Diego, is used to quantify the impact and quality of individual scientist's research output. The h-index, or highly cited index, is a count of the maximum number of publications that have each been cited an equal or greater number of times [19,20]. Analysis of the total sample of documents in dental journals yielded an h-index of 122, which means that 122 papers have been cited in other papers at least 122 times.

Although an in-depth analysis of the characteristics of each article separately lies beyond the scope of this study, it would be inappropriate not to discuss the main characteristics of the first 4 studies which score more than 500 citations each. The main reason for the first 4 most cited papers being so widely referenced is that the findings or conclusions reported in these papers have had a formative historical influence on dental research. The most cited paper with 635 citations was 'Effects of titanium surface topography on bone integration: a systematic review' presented in 2nd Consensus Conference of the European Association for Osseointegration and published by Wennerberg & Albrektssons in 2009 with an average citation per annum of 57.73. This systematic review was the first confirmed report describing systematically the influence of implant surface topography to bone response [21]. Interestingly, the second-ranked paper, published in 2002 by Berglundh et al. received 578 citations and systematically reviewed the incidence of biological and technical complications in implant therapy reported in prospective longitudinal studies of at least 5 years. Implant loss was most frequently described (reported in about 100% of studies), followed by technical complications (in 60–80% of the studies) and biological complications (in only 40–60%) [22]. The third-ranked paper with 535 citations was 'A systematic review of the 5-year survival and complication rates of implant-supported single crowns', with an average citation per annum of 44.58 [23]. The fourth article, published in 2005 by Peumans et al. in Dental Materials, has been cited 503 times. This paper, reviewed current clinical trials on the clinical effectiveness of contemporary

**Table 1.** The top 100 cited systematic review and meta-analyses in dentistry.

| Rank | Article | Citations | Average citations |
|---|---|---|---|
| 1 | Wennerberg A, Albrektsson T. Effects of titanium surface topography on bone integration: a systematic review. Clin Oral Implants Res. 2009;20 Suppl 4:172–84. | 642 | 58.36 |
| 2 | Berglundh T, Persson L, Klinge B. A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years. J Clin Periodontol. 2002;29 Suppl 3:197–212. | 581 | 32.28 |
| 3 | Jung RE, Pjetursson BE, Glauser R, Zembic A, Zwahlen M, Lang NP. A systematic review of the 5-year survival and complication rates of implant-supported single crowns. Clin Oral Implants Res. 2008;19(2):119–30. | 536 | 44.67 |
| 4 | Peumans M, Kanumilli P, De Munck J, Van Landuyt K, Lambrechts P, Van Meerbeek B. Clinical effectiveness of contemporary adhesives: a systematic review of current clinical trials. Dent Mater. 2005;21(9):864–81. | 505 | 33.67 |
| 5 | Marcenes W, Kassebaum NJ, Bernabé E, Flaxman A, Naghavi M, Lopez A, et al. Global burden of oral conditions in 1990-2010: a systematic analysis. J Dent Res. 2013;92(7):592-7. | 449 | 64.14 |
| 6 | Pjetursson BE, Tan WC, Zwahlen M, Lang NP. A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. J Clin Periodontol. 2008;35(8 Suppl):216–40. | 431 | 35.92 |
| 7 | Conrad HJ, Seong WJ, Pesun IJ. Current ceramic materials and systems with clinical recommendations: a systematic review. J Prosthet Dent. 2007;98(5):389–404. | 383 | 29.46 |
| 8 | Polder BJ, Van't Hof MA, Van der Linden FP, Kuijpers-Jagtman AM. A meta-analysis of the prevalence of dental agenesis of permanent teeth. Community Dent Oral Epidemiol. 2004;32(3):217–26. | 380 | 23.75 |
| 9 | Del Fabbro M, Testori T, Francetti L, Weinstein R. Systematic review of survival rates for implants placed in the grafted maxillary sinus. Int J Periodontics Restorative Dent. 2004;24(6):565–77. | 368 | 23 |
| 10 | De Vos W, Casselman J, Swennen GR. Cone-beam computerized tomography (CBCT) imaging of the oral and maxillofacial region: a systematic review of the literature. Int J Oral Maxillofac Surg. 2009;38(6):609–25. | 360 | 32.73 |
| 11 | Moszner N, Salz U, Zimmermann J. Chemical aspects of self-etching enamel-dentin adhesives: a systematic review. Dent Mater. 2005;21(10):895–910. | 356 | 23.73 |
| 12 | Kassebaum NJ, Bernabé E, Dahiya M, Bhandari B, Murray CJ, Marcenes W. Global burden of severe periodontitis in 1990-2010: a systematic review and meta-regression. J Dent Res. 2014 Nov;93(11):1045–53. | 345 | 57.5 |
| 13 | Jung RE, Zembic A, Pjetursson BE, Zwahlen M, Thoma DS. Systematic review of the survival rate and the incidence of biological, technical, and aesthetic complications of single crowns on implants reported in longitudinal studies with a mean follow-up of 5 years. Clin Oral Implants Res. 2012;23 Suppl 6:2–21. | 341 | 42.63 |
| 14 | Paraskevas S, Huizinga JD, Loos BG. A systematic review and meta-analyses on C-reactive protein in relation to periodontitis. J Clin Periodontol. 2008;35(4):277–90. | 334 | 27.83 |
| 15 | Pjetursson BE, Tan K, Lang NP, Brägger U, Egger M, Zwahlen M. A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years - I. Implant-supported FPDs. Clin Oral Implants Res. 2004;15(6):625–42. | 321 | 20.06 |
| 16 | Braga RR, Ballester RY, Ferracane JL. Factors involved in the development of polymerization shrinkage stress in resin-composites: a systematic review. Dent Mater. 2005;21(10):962–70. | 309 | 20.6 |
| 17 | Miller CS, Johnstone BM. Human papillomavirus as a risk factor for oral squamous cell carcinoma: a meta-analysis, 1982-1997. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2001;91(6):622–35. | 281 | 14.79 |
| 18 | Shalabi MM, Gortemaker A, Van't Hof MA, Jansen JA, Creugers NH. Implant surface roughness and bone healing: a systematic review. J Dent Res. 2006;85(6):496–500. | 274 | 19.57 |
| 19 | Pjetursson BE, Thoma D, Jung R, Zwahlen M, Zembic A. A systematic review of the survival and complication rates of implant-supported fixed dental prostheses (FDPs) after a mean observation period of at least 5 years. Clin Oral Implants Res. 2012 Oct;23 Suppl 6:22–38. | 273 | 34.13 |
| 20 | Janket SJ, Baird AE, Chuang SK, Jones JA. Meta-analysis of periodontal disease and risk of coronary heart disease and stroke. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2003;95(5):559–69. | 273 | 16.06 |
| 21 | Van der Weijden F, Dell'Acqua F, Slot DE. Alveolar bone dimensional changes of post-extraction sockets in humans: a systematic review. J Clin Periodontol. 2009;36(12):1048–58. | 272 | 24.73 |
| 22 | Junker R, Dimakis A, Thoneick M, Jansen JA. Effects of implant surface coatings and composition on bone integration: a systematic review. Clin Oral Implants Res. 2009;20 Suppl 4:185–206. | 270 | 24.55 |
| 23 | Roccuzzo M, Bunino M, Needleman I, Sanz M. Periodontal plastic surgery for treatment of localized gingival recessions: a systematic review. J Clin Periodontol. 2002;29 Suppl 3:178–94. | 265 | 14.72 |
| 24 | Kassebaum NJ, Bernabé E, Dahiya M, Bhandari B, Murray CJ, et al. Global burden of untreated caries: a systematic review and metaregression. J Dent Res. 2015;94(5):650–8. | 264 | 52.8 |
| 25 | Sailer I, Pjetursson BE, Zwahlen M, Hämmerle CH. A systematic review of the survival and complication rates of all-ceramic and metal-ceramic reconstructions after an observation period of at least 3 years. Part II: Fixed dental prostheses. Clin Oral Implants Res. 2007;18 Suppl 3:86–96. | 259 | 19.92 |
| 26 | Tan WL, Wong TL, Wong MC, Lang NP. A systematic review of post-extractional alveolar hard and soft tissue dimensional changes in humans. Clin Oral Implants Res. 2012;23 Suppl 5:1–21. | 251 | 31.38 |
| 27 | Pjetursson BE, Sailer I, Zwahlen M, Hämmerle CH. A systematic review of the survival and complication rates of all-ceramic and metal-ceramic reconstructions after an observation period of at least 3 years. Part I: Single crowns. Clin Oral Implants Res. 2007;18 Suppl 3:73–85. | 250 | 19.23 |
| 28 | Cairo F, Pagliaro U, Nieri M. Treatment of gingival recession with coronally advanced flap procedures: a systematic review. J Clin Periodontol. 2008;35(8 Suppl):136–62. | 240 | 20 |

(*continued*)

**Table 1.** Continued.

| Rank | Article | Citations | Average citations |
|---|---|---|---|
| 29 | Nkenke E, Stelzle F. Clinical outcomes of sinus floor augmentation for implant placement using autogenous bone or bone substitutes: a systematic review. Clin Oral Implants Res. 2009;20 Suppl 4:124–33. | 236 | 21.45 |
| 30 | Azarpazhooh A, Leake JL. Systematic review of the association between respiratory diseases and oral health. J Periodontol. 2006;77(9):1465-82. | 233 | 16.64 |
| 31 | Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: systematic review of the literature - Part 2. Influence of clinical factors. Int Endod J. 2008;41(1):6–31. | 232 | 19.33 |
| 32 | Heintze SD, Rousson V. Survival of zirconia- and metal-supported fixed dental prostheses: a systematic review. Int J Prosthodont. 2010;23(6):493–502. | 227 | 22.7 |
| 33 | Kay EJ, Locker D. Is dental health education effective? A systematic review of current evidence. Community Dent Oral Epidemiol. 1996;24(4):231–5. | 227 | 9.46 |
| 34 | Moynihan PJ, Kelly SA. Effect on caries of restricting sugars intake: systematic review to inform WHO guidelines. J Dent Res. 2014;93(1):8–18. | 226 | 37.67 |
| 35 | Al-Amleh B, Lyons K, Swain M. Clinical trials in zirconia: a systematic review. J Oral Rehabil. 2010;37(8):641–52. | 225 | 22.5 |
| 36 | Esposito M, Grusovin MG, Coulthard P, Worthington HV. The efficacy of various bone augmentation procedures for dental implants: a Cochrane systematic review of randomized controlled clinical trials. Int J Oral Maxillofac Implants. 2006;21(5):696–710. | 225 | 16.07 |
| 37 | Rocchietta I, Fontana F, Simion M. Clinical outcomes of vertical bone augmentation to enable dental implant placement: a systematic review. J Clin Periodontol. 2008;35(8 Suppl):203–15. | 224 | 18.67 |
| 38 | Derks J, Tomasi C. Peri-implant health and disease. A systematic review of current epidemiology. J Clin Periodontol. 2015;42 Suppl 16:S158–71. | 219 | 43.8 |
| 39 | Tan WC, Lang NP, Zwahlen M, Pjetursson BE. A systematic review of the success of sinus floor elevation and survival of implants inserted in combination with sinus floor elevation. Part II: transalveolar technique. J Clin Periodontol. 2008;35(8 Suppl):241–54. | 211 | 17.58 |
| 40 | Tan K, Pjetursson BE, Lang NP, Chan ES. A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years- III. Conventional FPDs. Clin Oral Implants Res. 2004;15(6):654–66. | 209 | 13.06 |
| 41 | Herrera D, Sanz M, Jepsen S, Needleman I, Roldán S. A systematic review on the effect of systemic antimicrobials as an adjunct to scaling and root planing in periodontitis patients. J Clin Periodontol. 2002;29 Suppl 3:136–59. | 209 | 11.61 |
| 42 | Chaffee BW, Weston SJ. Association between chronic periodontal disease and obesity: a systematic review and meta-analysis. J Periodontol. 2010;81(12):1708–24. | 208 | 20.8 |
| 43 | Knobloch K, Yoon U, Vogt PM. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) statement and publication bias. J Craniomaxillofac Surg. 2011;39(2):91–2. | 202 | 22.44 |
| 44 | Savage A, Eaton KA, Moles DR, Needleman I. A systematic review of definitions of periodontitis and methods that have been used to identify this disease. J Clin Periodontol. 2009;36(6):458–67. | 202 | 18.36 |
| 45 | Machtei EE. The effect of membrane exposure on the outcome of regenerative procedures in humans: a meta-analysis. J Periodontol. 2001;72(4):512–6. | 198 | 10.42 |
| 46 | Vignoletti F, Matesanz P, Rodrigo D, Figuero E, Martin C, Sanz M. Surgical protocols for ridge preservation after tooth extraction. A systematic review. Clin Oral Implants Res. 2012;23 Suppl 5:22–38. | 195 | 24.38 |
| 47 | Atieh MA, Ibrahim HM, Atieh AH. Platform switching for marginal bone preservation around dental implants: a systematic review and meta-analysis. J Periodontol. 2010 ;81(10):1350–66. | 195 | 19.5 |
| 48 | Hämmerle CH, Jung RE, Feloutzis A. A systematic review of the survival of implants in bone sites augmented with barrier membranes (guided bone regeneration) in partially edentulous patients. J Clin Periodontol. 2002;29 Suppl 3:226–31. | 192 | 10.67 |
| 49 | Raigrodski AJ, Hillstead MB, Meng GK, Chung KH. Survival and complications of zirconia-based fixed dental prostheses: a systematic review. J Prosthet Dent. 2012;107(3):170–7. | 191 | 23.88 |
| 50 | Schneider D, Marquardt P, Zwahlen M, Jung RE. A systematic review on the accuracy and the clinical outcome of computer-guided template-based implant dentistry. Clin Oral Implants Res. 2009;20 Suppl 4:73–86. | 190 | 17.27 |
| 51 | Ren Y, Maltha JC, Kuijpers-Jagtman AM. Optimum force magnitude for orthodontic tooth movement: a systematic literature review. Angle Orthod. 2003;73(1):86–92. | 190 | 11.18 |
| 52 | Borgnakke WS, Ylöstalo PV, Taylor GW, Genco RJ. Effect of periodontal disease on diabetes: systematic review of epidemiologic observational evidence. J Clin Periodontol. 2013;40 Suppl 14:S135–52. | 183 | 26.14 |
| 53 | den Hartog L, Slater JJ, Vissink A, Meijer HJ, Raghoebar GM. Treatment outcome of immediate, early and conventional single-tooth implants in the aesthetic zone: a systematic review to survival, bone level, soft-tissue, aesthetics and patient satisfaction. J Clin Periodontol. 2008;35(12):1073–86. | 183 | 15.25 |
| 54 | O'Rorke MA, Ellison MV, Murray LJ, Moran M, James J, Anderson LA. Human papillomavirus related head and neck cancer survival: a systematic review and meta-analysis. Oral Oncol. 2012;48(12):1191–201. | 180 | 22.5 |
| 55 | Manfredini D, Guarda-Nardini L, Winocur E, Piccotti F, Ahlberg J, Lobbezoo F. Research diagnostic criteria for temporomandibular disorders: a systematic review of axis I epidemiologic findings. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2011;112(4):453–62. | 178 | 19.78 |
| 56 | Scurria MS, Bader JD, Shugars DA. Meta-analysis of fixed partial denture survival: prostheses and abutments. J Prosthet Dent. 1998 Apr;79(4):459–64. | 178 | 8.09 |
| 57 | Papaspyridakos P, Chen CJ, Singh M, Weber HP, Gallucci GO. Success criteria in implant dentistry: a systematic review. J Dent Res. 2012;91(3):242–8 | 177 | 22.13 |

(*continued*)

**Table 1.** Continued.

| Rank | Article | Citations | Average citations |
|---|---|---|---|
| 58 | Sculean A, Nikolidakis D, Schwarz F. Regeneration of periodontal tissues: combinations of barrier membranes and grafting materials - biological foundation and preclinical evidence: a systematic review. J Clin Periodontol. 2008;35(8 Suppl):106–16. | 177 | 14.75 |
| 59 | Pjetursson BE, Tan K, Lang NP, Brägger U, Egger M, Zwahlen M. A systematic review of the survival and complication rates of fixed partial (FPDs) after an observation period of at least 5 years - IV. Cantilever or extension FPDs. Clin Oral Implants Res. 2004;15(6):667–76. | 177 | 11.06 |
| 60 | Atieh MA, Alsabeeha NH, Faggion CM Jr, Duncan WJ. The frequency of peri-implant diseases: a systematic review and meta-analysis. J Periodontol. 2013;84(11):1586–98. | 176 | 25.14 |
| 61 | Esposito M, Grusovin MG, Felice P, Karatzopoulos G, Worthington HV, Coulthard P. The efficacy of horizontal and vertical bone augmentation procedures for dental implants - a Cochrane systematic review. Eur J Oral Implantol. 2009;2(3):167–84. | 176 | 16 |
| 62 | Bächle M, Kohal RJ. A systematic review of the influence of different titanium surfaces on proliferation, differentiation and protein synthesis of osteoblast-like MG63 cells. Clin Oral Implants Res. 2004;15(6):683–92. | 176 | 11 |
| 63 | Weltman B, Vig KW, Fields HW, Shanker S, Kaizar EE. Root resorption associated with orthodontic tooth movement: a systematic review. Am J Orthod Dentofacial Orthop. 2010;137(4):462–76. | 175 | 17.5 |
| 64 | Opdam NJ, van de Sande FH, Bronkhorst E, Cenci MS, Bottenberg P, Pallesen U, et al. Longevity of posterior composite restorations: a systematic review and meta-analysis. J Dent Res. 2014;93(10):943–9. | 173 | 28.83 |
| 65 | Sailer I, Philipp A, Zembic A, Pjetursson BE, Hämmerle CH, Zwahlen M. A systematic review of the performance of ceramic and metal implant abutments supporting fixed implant reconstructions. Clin Oral Implants Res. 2009;20 Suppl 4:4–31. | 172 | 15.64 |
| 66 | Dietschi D, Duc O, Krejci I, Sadan A. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature, Part II (Evaluation of fatigue behavior, interfaces, and in vivo studies). Quintessence Int. 2008;39(2):117–29. | 171 | 14.25 |
| 67 | Janket SJ, Wightman A, Baird AE, Van Dyke TE, Jones JA. Does periodontal treatment improve glycemic control in diabetic patients? A meta-analysis of intervention studies. J Dent Res. 2005;84(12):1154–9. | 170 | 11.33 |
| 68 | Hunt O, Burden D, Hepper P, Johnston C. The psychosocial effects of cleft lip and palate: a systematic review. Eur J Orthod. 2005;27(3):274–85. | 170 | 11.33 |
| 69 | Quinn JB, Quinn GD. A practical and systematic review of Weibull statistics for reporting strengths of dental materials. Dent Mater. 2010;26(2):135–47. | 169 | 16.9 |
| 70 | Strietzel FP, Reichart PA, Kale A, Kulkarni M, Wegner B, Küchler I. Smoking interferes with the prognosis of dental implant treatment: a systematic review and meta-analysis. J Clin Periodontol. 2007;34(6):523–44. | 169 | 13 |
| 71 | Tong DC, Rioux K, Drangsholt M, Beirne OR. A review of survival rates for implants placed in grafted maxillary sinuses using meta-analysis. Int J Oral Maxillofac Implants. 1998;13(2):175–82. | 167 | 7.59 |
| 72 | Lindh T, Gunne J, Tillberg A, Molin M. A meta-analysis of implants in partial edentulism. Clin Oral Implants Res. 1998;9(2):80–90. | 164 | 7.45 |
| 73 | Mustapha IZ, Debrey S, Oladubu M, Ugarte R. Markers of systemic bacterial exposure in periodontal disease and cardiovascular disease risk: a systematic review and meta-analysis. J Periodontol. 2007;78(12):2289–302. | 163 | 12.54 |
| 74 | Chambrone L, Sukekava F, Araújo MG, Pustiglioni FE, Chambrone LA, Lima LA. Root-coverage procedures for the treatment of localized recession-type defects: a Cochrane systematic review. J Periodontol. 2010;81(4):452–78. | 162 | 16.2 |
| 75 | Andreiotelli M, Wenz HJ, Kohal RJ. Are ceramic implants a viable alternative to titanium implants? A systematic literature review. Clin Oral Implants Res. 2009;20 Suppl 4:32–47. | 162 | 14.73 |
| 76 | Buchalla W, Attin T. External bleaching therapy with activation by heat, light or laser–a systematic review. Dent Mater. 2007;23(5):586–96. | 162 | 12.46 |
| 77 | Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, et al. Caries-preventive effect of fluoride toothpaste: a systematic review. Acta Odontol Scand. 2003;61(6):347–55. | 160 | 9.41 |
| 78 | Lang NP, Pun L, Lau KY, Li KY, Wong MC. A systematic review on survival and success rates of implants placed immediately into fresh extraction sockets after at least 1 year. Clin Oral Implants Res. 2012;23 Suppl 5:39–66. | 159 | 19.88 |
| 79 | Bader JD, Shugars DA. A systematic review of the performance of a laser fluorescence device for detecting caries. J Am Dent Assoc. 2004;135(10):1413–26. | 159 | 9.94 |
| 80 | Heitz-Mayfield LJ, Trombelli L, Heitz F, Needleman I, Moles D. A systematic review of the effect of surgical debridement vs non-surgical debridement for the treatment of chronic periodontitis. J Clin Periodontol. 2002;29 Suppl 3:92–102. | 159 | 8.83 |
| 81 | Manfredini D, Lobbezoo F. Relationship between bruxism and temporomandibular disorders: a systematic review of literature from 1998 to 2008. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2010;109(6):e26–50. | 157 | 15.7 |
| 82 | Van der Weijden GA, Timmerman MF. A systematic review on the clinical efficacy of subgingival debridement in the treatment of chronic periodontitis. J Clin Periodontol. 2002;29 Suppl 3:55–71. | 156 | 8.67 |
| 83 | Syrjänen S, Lodi G, von Bültzingslöwen I, Aliko A, Arduino P, Campisi G, et al. Human papillomaviruses in oral carcinoma and oral potentially malignant disorders: a systematic review. Oral Dis. 2011;17 Suppl 1:58–72. | 155 | 17.22 |
| 84 | Lee H, So JS, Hochstedler JL, Ercoli C. The accuracy of implant impressions: a systematic review. J Prosthet Dent. 2008;100(4):285–91. | 155 | 12.92 |
| 85 | Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: systematic review of the literature - part 1. Effects of study characteristics on probability of success. Int Endod J. 2007;40(12):921–39. | 155 | 11.92 |

(*continued*)

Table 1. Continued.

| Rank | Article | Citations | Average citations |
|---|---|---|---|
| 86 | Lang NP, Pjetursson BE, Tan K, Brägger U, Egger M, Zwahlen M. A systematic review of the survival and complication rates of fixed partial dentures (FPDs) after an observation period of at least 5 years. II. Combined tooth–implant-supported FPDs. Clin Oral Implants Res. 2004;15(6):643–53. | 155 | 9.69 |
| 87 | Emami E, Heydecke G, Rompré PH, de Grandmont P, Feine JS. Impact of implant support for mandibular dentures on satisfaction, oral and general health-related quality of life: a meta-analysis of randomized-controlled trials. Clin Oral Implants Res. 2009;20(6):533–44. | 154 | 14 |
| 88 | Chávarry NG, Vettore MV, Sansone C, Sheiham A. The relationship between diabetes mellitus and destructive periodontal disease: a meta-analysis. Oral Health Prev Dent. 2009;7(2):107–27. | 154 | 14 |
| 89 | Donos N, Mardas N, Chadha V. Clinical outcomes of implants following lateral bone augmentation: systematic assessment of available options (barrier membranes, bone grafts, split osteotomy). J Clin Periodontol. 2008;35(8 Suppl):173–202. | 151 | 12.58 |
| 90 | Gunsolley JC. A meta-analysis of six-month studies of antiplaque and antigingivitis agents. J Am Dent Assoc. 2006;137(12):1649–57. | 151 | 10.79 |
| 91 | Trombelli L, Heitz-Mayfield LJ, Needleman I, Moles D, Scabbia A. A systematic review of graft materials and biological agents for periodontal intraosseous defects. J Clin Periodontol. 2002;29 Suppl 3:117–35. | 151 | 8.39 |
| 92 | Emmerich D, Att W, Stappert C. Sinus floor elevation using osteotomes: a systematic review and meta-analysis. J Periodontol. 2005;76(8):1237–51. | 147 | 9.8 |
| 93 | Schwendicke F, Dörfer CE, Schlattmann P, Foster Page L, Thomson WM, Paris S. Socioeconomic inequality and caries: a systematic review and meta-analysis. J Dent Res. 2015;94(1):10–8. | 146 | 29.2 |
| 94 | Bader JD, Shugars DA, Bonito AJ. A systematic review of the performance of methods for identifying carious lesions. J Public Health Dent. 2002;62(4):201–13. | 146 | 8.11 |
| 95 | Sailer I, Makarov NA, Thoma DS, Zwahlen M, Pjetursson BE. All-ceramic or metal-ceramic tooth-supported fixed dental prostheses (FDPs)? A systematic review of the survival and complication rates. Part I: Single crowns (SCs). Dent Mater. 2015;31(6):603–23. | 145 | 29 |
| 96 | Patton LL, Epstein JB, Kerr AR. Adjunctive techniques for oral cancer examination and lesion diagnosis: a systematic review of the literature. J Am Dent Assoc. 2008;139(7):896–905. | 144 | 12 |
| 97 | Plachokova AS, Nikolidakis D, Mulder J, Jansen JA, Creugers NH. Effect of platelet-rich plasma on bone regeneration in dentistry: a systematic review. Clin Oral Implants Res. 2008;19(6):539–45. | 144 | 12 |
| 98 | Jung RE, Schneider D, Ganeles J, Wismeijer D, Zwahlen M, Hämmerle CH, et al. Computer technology applications in surgical implant dentistry: a systematic review. Int J Oral Maxillofac Implants. 2009;24 Suppl:92–109. | 143 | 13 |
| 99 | Esposito M, Grusovin MG, Willings M, Coulthard P, Worthington HV. The effectiveness of immediate, early, and conventional loading of dental implants: a Cochrane systematic review of randomized controlled clinical trials. Int J Oral Maxillofac Implants. 2007;22(6):893–904. Int J Oral Maxillofac Implants. 2007;22(6):893–904. | 142 | 10.92 |
| 100 | Javed F, Romanos GE. Impact of diabetes mellitus and glycemic control on the osseointegration of dental implants: a systematic literature review. J Periodontol. 2009;80(11):1719–30. | 140 | 12.73 |

adhesives when used to restore cervical non-carious class-V lesions [24]. The paper with the largest average citation rate of 63.71, dated from 2013 and was cited 446 times. This systematic review published in Journal of Dental Research quantified the global burden of untreated caries, severe periodontitis, and severe tooth loss in 2010. According to this study the burden of oral conditions seemed to have increased in the past 20 years due to untreated caries and severe periodontitis, whereas severe tooth loss decreased [25].

The top 100 articles were published between 1996 and 2015, with most articles ($n = 72$) published after 2005. Years 2008 and 2009 were the most productive years, marking the publication of 14 top-cited reviews each, followed by years 2002, 2004, 2007, 2010 and 2012 ($n = 8$). Figure 1 illustrates the distribution of the 100 articles over the years, and their citations per publication (CPP).

The most cited articles were published in 26 journals, issued by five countries including 12 journals from the USA, United Kingdom ($n = 7$), Denmark ($n = 6$) and one from Norway. The impact factors for journals with the top 100 cited review articles ranged from 0.902 to 5.125. Fifteen journals contained only one article; 6 journals contained 2–4 articles; 1 journal contained six articles; 4 journals contained more than 9 articles, and accounted for 60% of the total articles. The journal with the highest number of top 100 cited articles was Clinical Oral Implants Research ($n = 22$), followed by Journal of Clinical Periodontology ($n = 20$), while their impact factors were 3.825 and 4.164, respectively (Table 2). Journal of Dental Research as well as Journal of Periodontology contributed 9 articles each to the top-cited systematic review list.

The results of author analysis have identified 310 researchers who contributed to 100 top-cited articles. Among them, 262 authors (84%) published one article; 25 authors (8.0%) published two articles; 23 authors published three or more of the 100 most cited articles. In addition to these findings, the number of authors per paper ranged from 2 to 14. Twenty four articles had four authors, followed by 21 articles with three authors, 18 articles with two and 17 papers with five authors. Fifteen articles were written by 6 authors. Table 3 lists the most productive authors with three or more articles, showing that most contributions were made by three individuals Zwahlen M ($n = 14$), followed by Pjetursson BE ($n = 13$) and Lang NP ($n = 9$). Hammerle CHF, Jung RE and Needleman I authored five articles, each.

Based on the institutional address of the corresponding author, there were 19 different countries of origin and 50 institutions responsible for the highly cited systematic review articles. The leading country was the United States of

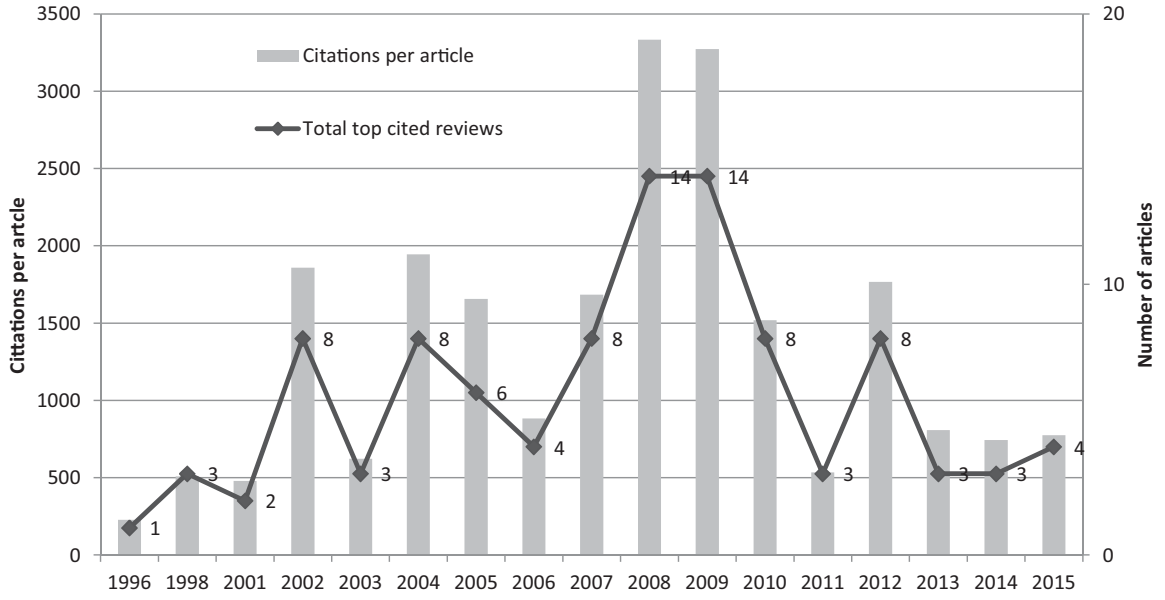


**Figure 1.** Number of articles and citations per article in dentistry.

**Table 2.** Dental journals published the 100 top cited articles.

| Journal name | No of articles | 2018 IF |
|---|---|---|
| Clinical Oral Implants Research | 22 | 3.825 |
| Journal of Clinical Periodontology | 20 | 4.164 |
| Journal of Dental Research | 9 | 5.125 |
| Journal of Periodontology | 9 | 2.768 |
| Dental Materials | 6 | 4.440 |
| International Journal of Oral & Maxillofacial Implants | 4 | 1.734 |
| Journal of Prosthetic Dentistry | 4 | 2.787 |
| Oral Surgery Oral Medicine Oral Pathology Oral Radiology & Endodontology | 4 | 1.690 |
| Journal of the American Dental Association | 3 | 2.572 |
| Community Dentistry and Oral Epidemiology | 2 | 2.278 |
| International Endodontic Journal | 2 | 3.331 |
| Acta Odontologica Scandinavica | 1 | 1.565 |
| American Journal of Orthodontics & Dentofacial Orthopedics | 1 | 1.911 |
| Angle Orthodontist | 1 | 1.880 |
| European Journal of Oral Implantology | 1 | 2.513 |
| European Journal of Orthodontics | 1 | 1.841 |
| International Journal of Oral and Maxillofacial Surgery | 1 | 1.961 |
| International Journal of Periodontics & Restorative Dentistry | 1 | 1.228 |
| International Journal of Prosthodontics | 1 | 1.533 |
| Journal of Cranio-Maxillofacial surgery | 1 | 1.942 |
| Journal of Oral Rehabilitation | 1 | 2.341 |
| Journal of Public Health Dentistry | 1 | 1.350 |
| Oral Diseases | 1 | 2.625 |
| Oral Health & Preventive Dentistry | 1 | 0.902 |
| Oral Oncology | 1 | 3.730 |
| Quintessence International | 1 | 1.392 |

**Table 3.** Authors of the top cited systematic reviews and meta-analyses.

| Author | First author | Co author | Total |
|---|---|---|---|
| Zwahlen M | 0 | 14 | 14 |
| Pjetursson BE | 5 | 8 | 13 |
| Lang NP | 2 | 7 | 9 |
| Hammerle CHF | 1 | 4 | 5 |
| Jung RE | 3 | 2 | 5 |
| Needleman I | 0 | 5 | 5 |
| Sailer I | 3 | 1 | 4 |
| Tan K | 1 | 3 | 4 |
| Zembic A | 0 | 4 | 4 |

**Table 4.** Countries of origin of the 100 top cited systematic reviews and meta-analyses.

| Country | No. of articles |
|---|---|
| USA | 18 |
| Switzerland | 15 |
| United Kingdom | 12 |
| Netherlands | 12 |
| Germany | 7 |
| Italy | 6 |
| Sweden | 6 |
| Brazil | 3 |
| Iceland | 3 |
| New Zealand | 3 |
| Belgium | 2 |
| Canada | 2 |
| Ireland | 2 |
| Liechtenstein | 2 |
| Peoples R China | 2 |
| Spain | 2 |
| Finland | 1 |
| Israel | 1 |
| Singapore | 1 |

America with 18 articles, followed by Switzerland ($n = 15$), United Kingdom ($n = 12$), Netherlands ($n = 12$), Germany ($n = 7$), while Italy and Sweden contributed 6 publications each, to the top-cited list (Table 4). The rest of the countries had less than 3 publications. The 12 leading institutions are shown in Table 5. The University of Zurich from Switzerland was found to be the most productive institution ($n = 8$), followed by Radboud University Nijmegen (Netherlands) ($n = 7$) and the University of Bern (Switzerland) ($n = 5$). The University College in London, the University of Manchester, the University of North Carolina and the Academic Center for Dentistry Amsterdam contributed 4 articles in the top-cited list each. Of the total 100 articles, 43 articles came from international collaborations, while 36 from independent institutions and 21 from multi-university collaborations.

Twenty-six articles were proceeding papers, presented mainly in European Workshop on Periodontology ($n = 14$) and in Consensus Conferences- European Association for

**Table 5.** Institutions of origin with 3 or more top cited systematic reviews and meta-analyses.

| Institution | No. of articles |
|---|---|
| University of Zurich | 8 |
| Radboud University Nijmegen | 7 |
| University of Bern | 5 |
| University College London | 4 |
| Academic Center for Dentistry Amsterdam | 4 |
| University of Manchester | 4 |
| University of North Carolina | 4 |
| Harvard University | 3 |
| University of Freiburg | 3 |
| University of Iceland | 3 |
| Queen Mary University London | 3 |
| University of Otago | 3 |

**Table 6.** Field of study of the 100 top cited systematic reviews and meta-analyses.

| Field of study | No. of articles |
|---|---|
| Implants | 34 |
| Periodontology | 23 |
| Prosthetics | 12 |
| Operative dentistry | 7 |
| Oral conditions | 6 |
| Materials | 6 |
| Endodontics | 3 |
| Orthodontics | 3 |
| Temporomandibular Disorders | 2 |
| Dental agenesis | 1 |
| Dental health education | 1 |
| Radiology | 1 |
| Recommendations | 1 |

**Table 7.** Keyword analysis of the top cited systematic reviews and meta-analyses.

| Keywords | Frequency |
|---|---|
| Systematic review | 47 |
| Dental implants | 21 |
| Meta-analysis | 20 |
| Survival | 18 |
| Success | 16 |
| Complication/ complication rates | 13 |
| Biological complication | 11 |
| Failures | 11 |
| Longitudinal | 11 |
| Technical complication | 10 |
| Periodontal disease | 9 |
| Peri-implantitis | 8 |
| Periodontitis | 7 |
| Review | 7 |

Osseointegration ($n = 6$). Regarding the study design review articles, 78 were entitled as systematic reviews (4 of them top-cited as Cochrane systematic reviews), 12 were entitled as meta-analyses and 10 were combined systematic review and meta-analyses.

The major topics of interest covered in highly cited systematic reviews and meta-analyses were dental implants ($n = 34$), periodontology ($n = 23$), prosthodontics ($n = 12$), followed by operative dental topics ($n = 7$) (Table 6). In 100 top-cited review articles, a total of 300 unique words were identified. Thriteen papers did not enclose any keywords. The most frequently occurring keywords were systematic review ($n = 47$), dental implants ($n = 21$), meta-analysis ($n = 20$) and followed by survival, success and complication (Table 7).

## Discussion

In dental research, an enormous quantity of information is produced daily, a fact that leads to the evolution of a large volume of published articles. Consequently, the substantial amount of high-graded original research in the field of dentistry serves as material for systematic reviews. Furthermore, developments in evidence-based dentistry have endorsed the conduction of evidence-based systematic reviews and meta-analyses. Considering that this study design represents the highest level of evidence contributing in many ways of dentistry, we performed the current study. The purpose of the present study was to identify and characterize the 100 top-cited systematic reviews and meta-analyses in dentistry. Citation analysis, which provides a view of the citation frequency of the most influential articles, is one feasible method of assessing the history, the advances and trends in particular scientific fields. Patterns of authorship, publication, and use of these publications facilitate an understanding of the major contributions and findings that are driving the evolution of research. The list of the most cited articles is dynamic, and the papers that are included will change over time as research continuously evolves and changes.

The practice of evidence-based medicine utilizes the best available evidence in order to make accurate and knowledgeable treatment decisions. Basic requirements for making the right clinical decisions are integration of clinical knowledge, clinical expertise and judgement, patient values with the best available research evidence [26]. Evidence-Based Dentistry has been defined as an approach to oral health care that requires the judicious integration of systematic assessments of clinically relevant scientific evidence, relating to patient's oral & medical condition & history, with the dentists clinical expertise & the patient's treatment needs & preferences [27]. Thus, dental scientists should be able to identify, critique and categorize literature, and place it into a so-called hierarchy of evidence, with systematic reviews and meta-analyses of RCT's at the top contributing to the highest level of evidence, followed by randomized clinical trials (RCTs), non-RCTs, cohort studies, case-control studies, cross-over studies, cross-sectional studies, case studies, and expert opinions and uncontrolled studies or opinion at the bottom [28]. Systematic reviews summarize the large body of literature on a particular topic with the intention to analyze the data in published articles in an effort to provide scientific evidence to the clinician for the practice of healthcare. Meta-analysis may be defined as a statistical synthesis of data obtained from original research articles previously gathered by means of a systematic review in which data are comparable [29]. A systematic review may or may not include a meta-analysis, which is a quantitative summary of the results. Among the research method advantages they include, a format of clear research questions, risk of bias assessment, comprehensive literature search, and critical analysis of the results that provide extensive information on a specific issue. Nevertheless, study designs have also limitations. These include the incorporation of invalid conclusions of studies with low scientific evidence, methodological errors in meta-analysis and the lack of heterogeneity assessment. Perhaps

one of the most important issues to be addressed when evaluating a systematic review refers to the clarity of the primary research question and the ability of adhesion to an ideal study protocol on a specific scientific field [30].

The Science Citation Index (SCI) from the database Clarivate Analytics Web of Science collects information gathered from scholarly journals, books, book series, reports and conferences in a variety of disciplines. According to the WoS Core Collection, the Science Citation Index Expanded includes over than 8850 of the world's leading scientific and technical journals across 150 scientific disciplines, providing access to current information and retrospective data from 1900 onwards. Thus, this multidisciplinary database remains the most important and frequently used source database of choice for bibliometric and citation analyses in all fields of study.

A number of citation analyses have been conducted in dentistry as well as in different fields of dentistry [10–13]. The previous citation analysis of most cited papers in dental journals published in 2014 by Feijoo et al. concluded that there is a predominance of low-evidence level clinical studies, such as case series and narrative reviews/expert opinions, published in the highest impact factor dental journals and focused mainly on periodontology and implantology [8]. Muniz et al. described the trends in review articles published between 2000 and 2015 in Dentistry [31]. They chose randomly 30 reviews per year and compared citation patterns between systematic and narrative reviews. According to their results, there is a substantial increase in the number of systematic reviews, with a trend for lower citations, which is time affected.

The top 100 systematic review articles in dentistry were cited between 142 and 635 times. The large difference in the number of citations between the first and last ranked papers may be attributed to the rapidly evolving nature of science in conjunction with the preference of authors to cite the review articles. H-index has been used as an indicator for quantifying the research productivity of scientists, scientific fields and journals [19,20]. In the present study, an h-index of 122 was found, which means that 122 papers, published in dentistry, have at least 122 citations.

The top-cited articles were published between 1996 and 2015, with 75% of them published after 2005. This may be attributed to the development of evidence-based dentistry, stimulating the conduction of the highest level of evidence systematic reviews and meta-analyses. However, the peak period, when 73 of the top 100 cited articles were published, was between 2004 and 2012. Although older publications normally are more likely to receive more citations than recent papers, 18 articles were published during the last 6 years.

The 100 top-cited articles were published in 26 journals, predominantly in Clinical Oral Implants Research and Journal of Clinical Periodontology, followed distantly by the Journal of Dental Research and Journal of Periodontology. As expected the most highly cited papers were more likely to be published in journals with high impact factor. These results are in accordance with the fact that the predominant subjects of top-cited systematic reviews were implantology (34%) and periodontology (23%). The rest focus of the highly cited systematic reviews and meta-analyses has been on prosthodontics (12%) and operative dentistry (7%), which is consistent with the results of top-cited original articles in dental journals published by Feijoo et al. [8].

The results of the present study showed that the majority of the top-cited papers were entitled as systematic reviews, and only 22 were entitled as meta-analyses. The above finding is not a surprise because of difficulties in conducting well-designed meta-analyses such as insufficient number of clinical trials with good scientific evidence. It is worth noting, that only 4 Cochrane reviews were included in the top-cited systematic review list. Cochrane reviews are systematic reviews of primary research in human health care and are internationally recognized as the highest standard in evidence-based medicine [32]. They investigate the effects of interventions for prevention, treatment and rehabilitation and they also assess the accuracy of a diagnostic test for a given condition in a specific patient group and setting.

The 100 articles were published by 310 authors from 50 institutions in 19 countries. Nine authors contributed four or more top-cited articles. The list of authors was led by Zwahlen M, who dominated with 14 articles and was followed by Pjetursson BE, who authored or co-authored 13 top-cited papers.

Consistent with many other citation analyses [6–11], the majority of most cited publications (18%) originated from academic institutions in the United States, which has been attributed to the presence of a large number of researchers and the availability of adequate research budgets for scientific investigation. Although the United States was the leading country by number of highly cited dental research publications, there was an increasing number of highly cited publications by authors residing in Europe (70 articles). It is also worth noting that 36 of the articles originating from Europe resulted from international collaborations, while the rest of them were produced either by one institution (26 articles) or by multi-university collaborations (12 papers).

As shown in previous studies [33,34], collaboration played an important role in enhancing the impact of original articles and it is clear that highly cited papers involve more collaborative research than the general norm [35]. Indeed, collaboration was also obvious for the top-cited systematic reviews in dental science (64 out of 100) (43 internationally collaborative and 21 multi-university papers). The most active institute in the production of top-cited systematic reviews was the University of Zurich in Switzerland followed by Radboud University Nijmegen in the Netherlands.

Analysis by keywords can provide clues about popular topics in specific fields, and help determine research emphases and priorities. They play an important role in the identification of a research paper and must reflect the central topic of the report. A proper choice of the keywords will help the paper to be retrieved easily during a literature search. Unfortunately, 13 articles in the present study did not contain keywords. Based on the analysis of keywords, the predominant MeSH terms were 'systematic review ($n = 47$)',

'dental implants ($n = 21$)' and 'meta-analysis ($n = 20$)' in the top-cited systematic reviews. Therefore, it is imperative to choose and include keywords that can be readily searched to identify accurately and precisely relevant references, while conducting literature research to support a deeper understanding of research directions in the future.

Although there are several limitations inherent to this type of analysis, including the bias associated with relying exclusively on the Web of Science and single citation counting, the drawbacks of the database used, the exclusion of textbooks, the biased citing, including self-citation or negative citation [36], it is widely accepted that this is, as yet, the only available method for evaluating the recognition of an investigator or scientific research in a particular field. More specifically, the search of the highly cited work in this study was performed by using only one electronic medical bibliographic resource, a fact that might have affected the final top list. According to research methodology, we only used the Web of Science in order to identify the 100 most cited systematic reviews and we did not perform research in Cochrane database, which limits the results of the present study to the inclusion of only four Cochrane reviews. Additionally, it is worth noting that, there is a tendency of authors to cite a publication that is already abundantly cited rather than re-assessing its relevance and quality. Another limitation includes the effect of time, meaning that such methods favour older studies and omits or undervalues the important articles from the last 10 years [37]. On the contrary, the disadvantage of time was not so obvious in the present citation analysis. Thus, we observed that many top-cited articles were published within the last 10 years. Finally, the results of the study should be explained with caution, as there may be some missed literature. Research was refined in systematic reviews including the search terms only in 'title' and not in 'topic'. Consequently, some influential papers with a high number of citations were unavoidably excluded by the methodology used in this investigation. For example, the systematic review by Teughels et al. about the impact of surface characteristics on the de novo biofilm formation, with 497 citations [38], or the online systematic review by Aghaloo and Moy identifying the most successful technique to provide the necessary alveolar bone to place a dental implant and support long-term survival, with 471 citations [39], were excluded, as they were not entitled as 'systematic reviews'.

The number of citations that an article receives does not necessarily reflect the quality of the research, but the present study gives some clues to the topics and authors contributing to major advances in Dentistry. This study was the first scientometric report of the most cited highest level of evidence systematic reviews and meta-analyses in dentistry that analyzed the main characteristics of papers and provided a historical perspective on scientific progress and displayed key trends in dental research as well as clinical practice. Obviously, this top-cited list is constantly changing with time, according to progress in knowledge and techniques and developments in scientific interests and priorities.

## Disclosure statement

The authors report no conflict of interest.

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