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H-classic: a new method to identify classic articles in Implant Dentistry, Periodontics, and Oral Surgery

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Abstract

Introduction: The study of classic papers permits analysis of the past, present, and future of a specific area of knowledge. This type of analysis is becoming more frequent and more sophisticated. Our objective was to use the *H-classics* method, based on the h-index, to analyze classic papers in Implant Dentistry, Periodontics, and Oral Surgery (ID, P, and OS).

Material and methods: First, an electronic search of documents related to ID, P, and OS was conducted in journals indexed in Journal Citation Reports (JCR) 2014 within the category 'Dentistry, Oral Surgery & Medicine'. Second, Web of Knowledge databases were searched using Mesh terms related to ID, P, and OS. Finally, the *H-classics* method was applied to select the classic articles in these disciplines, collecting data on associated research areas, document type, country, institutions, and authors.

Results: Of 267,611 documents related to ID, P, and OS retrieved from JCR journals (2014), 248 were selected as *H-classics*. They were published in 35 journals between 1953 and 2009, most frequently in the Journal of Clinical Periodontology (18.95%), the Journal of Periodontology (18.54%), International Journal of Oral and Maxillofacial Implants (9.27%), and Clinical Oral Implant Research (6.04%). These classic articles derived from the USA in 49.59% of cases and from Europe in 47.58%, while the most frequent host institution was the University of Gothenburg (17.74%) and the most frequent authors were J. Lindhe (10.48%) and S. Socransky (8.06%).

Conclusion: The *H-classics* approach offers an objective method to identify core knowledge in clinical disciplines such as ID, P, and OS.

Citation classics refers to a bibliometric technique designed to identify publications with greatest impact on the scientific community in a given discipline (Garfield 1977), providing the basis for developing new theories, techniques, and research lines. This approach has been adopted in many areas of medicine, including urology (Hennessey et al. 2009), orthopedic trauma and surgery (Lefavre et al. 2010, 2011), pediatrics (Ruttenstock et al. 2012), neurosurgery (Ponce & Lozano 2010), suicidology (Stack 2012), occupational health (Smith 2009), complementary medicine (Tam et al. 2012), Parkinson disease (Ponce & Lozano 2011), critical care medicine (Rosenberg et al. 2010), epilepsy (Ibrahim et al. 2012), arthroscopy (Cassar-Gheiti et al. 2012), and dentistry (Feijoo et al. 2014). It has also been applied in other areas of knowledge, including information and library sciences (Levitt & Thelwall 2009) and social work (Ho 2014).

The definition of 'classic papers' has been a controversial issue across disciplines. Proposals have included selection of the 100 most cited (Hennessey et al. 2009; Ponce & Lozano 2010; Lefavre et al. 2011) or 50 most cited (Baldwin et al. 2012; Wong et al. 2013) articles. Another suggested criterion has been the accomplishment of a certain number of citations, for example, at least 400 (Ponce & Lozano 2010, 2011). However, arbitrary thresholds take no account of the variability among research areas in the number of highly influential papers or of the fact that the achievement of many hundreds of citations may be commonplace in some areas and difficult to attain in others.

The marked growth in research in dentistry, supported by well-developed and consolidated scientific and clinical communities, has increased interest in bibliometric studies to assess the research output and to identify

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the most reliable sources of scientific knowledge and the most influential institutions and authors. Thus, studies of this type have been carried out in orthodontics (Hui et al. 2013), periodontics (Nieri et al. 2007), and endodontics (Fardi et al. 2011), among others. Feijoo (Feijoo et al. 2014) compiled the 100 most frequently cited papers in dentistry, using the *Web of Science Core Collection* (*WoS Core Collection*) and Journal Citation Report (JCR) 2010. The 'top' article had 2050 citations and the 100th article 326, suggesting that a large number of representative papers may have been excluded; they did not provide data on the distribution of citations or on the relative contribution of different journals and authors in their study.

Martinez (Martinez et al. 2014) proposed the selection of classic papers based on the h-index (Hirsch 2005) and h-core concept (Rousseau 2005), providing objective criteria in each specific area of knowledge. Advantages of this *H-Classics* method include the collection in a single procedure of the number of papers published in a given field and their impact. It is also simple to compute and is sensitive to differences among areas in the impact of papers (Martinez et al. 2014).

Feijoo and co-workers (Feijoo et al. 2014) reported that papers on Implant Dentistry, Periodontics, and Oral Surgery (ID, P and OS) were among the most highly cited articles in the area of dentistry. The objective of this study was to use the *H-classics* (Martinez et al. 2014) method to determine classic articles in ID, P, and OS and to establish the relative importance of specific journals, countries, institutions, and authors in this scientific production.

Material and methods

Figure 1 depicts the search procedures adopted to select the *H-Classics*. One electronic search procedure was conducted of documents related to ID, P, and OS in the 88 journals indexed by the 2014 Journal Citation Report (JCR) in the category 'Dentistry, Oral Surgery & Medicine'. It comprised four different searches to maximize the number of documents gathered in the areas of interest, retrieving: (i) the names of journals in the area 'Dentistry, Oral Surgery & Medicine' of the 2014 JCR; (ii) the ISSN of these journals; (iii) the different names historically adopted by journals, using PubMed and Ulrich's database; and (iv) the ISSN assigned to journals with different names in their history.

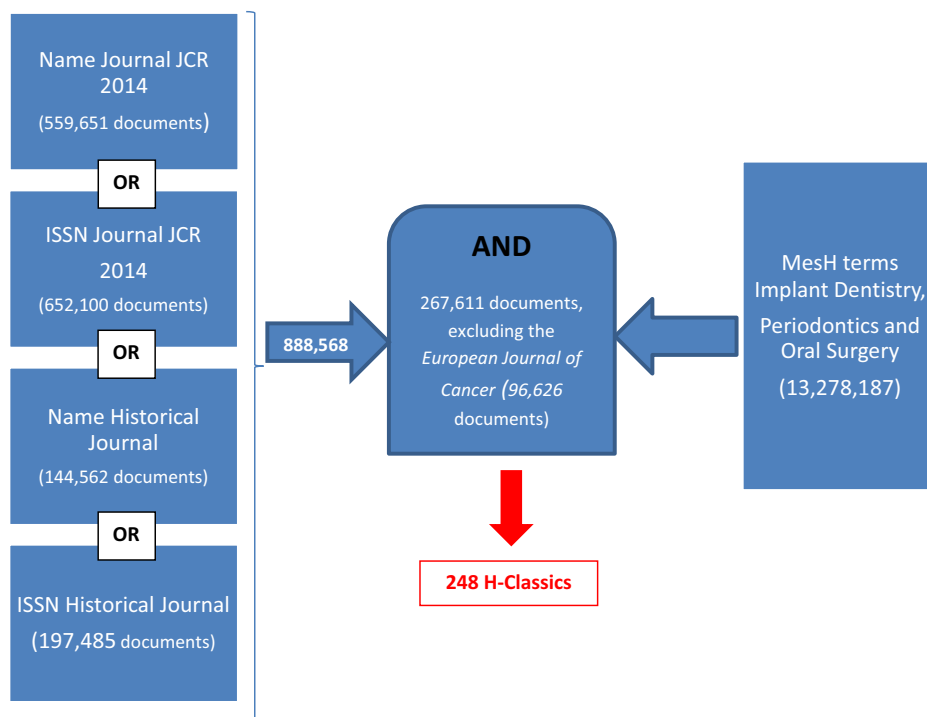


Fig. 1. Chart of Search Strategies. The search was conducted in databases of the Web of Knowledge. The 248 *H-Classics* were localized in the *Web of Science* (*WoS*) *Core Collection*, *BioSIS Citation Index*, and *MEDLINE* databases.

In the other search procedure, the *WoS Core Collection*, *MEDLINE*, and *BioSIS Citation Index* databases of the Web of Knowledge were searched as follows, using all Mesh terms related to ID, P, and OS and with the addition of the terms bisphosphonates or diphosphonates, given their relevance in dental surgery:

TS = ((Alveolar Bone Grafting) OR (Alveolar Ridge Augmentation) OR (Alveolectomy) OR (Alveoloplasty) OR (Apicoectomy) OR (Plaque Index) OR (Prophylaxis) OR (Scaling) OR (DMF Index) OR (Gingiv*) OR (Glossectomy) OR (Guided Tissue Regeneration) OR (Implant*) OR (Jaw Fixation Techniques) OR (Mandibular Advancement) OR (Mandibular Prosthesis Implantation) OR (Maxillofacial Prosthesis Implantation) OR (Oral Hygiene Index) OR (Oral Surg*) OR (Orthognathic Surgery) OR (Orthognathic Surgical Procedures) OR (Osteotomy Le Fort) OR (Osteotomy Sagittal Split Ramus) OR (Perio*) OR (Root Planning) OR (Serial Extraction) OR (Sinus Floor Augmentation) OR (Subgingival Curettage) OR (Tooth Extraction) OR (Tooth Replantation) OR (Vestibuloplasty) OR (BISPHOSPHONAT*) OR (Diphosphonat*) OR (Alendronate) OR (Clodronic Acid) OR (Etidronic Acid) OR (Technetium Tc 99 m Medronate) OR (Organophosphorus Compounds) OR (Osteonecrosis)).

As shown in Fig. 1, the results of the two search procedures were then considered together (using the AND command), recording the articles or papers in common in the two lists. These papers were then sorted according to the number of references in order to establish the h-index for this area, which served as the cutoff point for the number of citations required to be considered an *H-classic* (Martinez et al. 2014).

The list of *H-classics* in ID, P, and OS was identified using the *WoS Core Collection* and a filtering tool provided by this database, manually processing articles in *BioSIS* or *MEDLINE* but not in the *WoS Core Collection*. The *WoS Core Collection* was selected because it yielded the largest number of documents and has been widely used by other researchers for this purpose. We recorded their publication year, number of citations, research areas, document type, journal, country, institution(s), and author(s). All countries included in the affiliations section of papers were counted. We analyzed the institutions and authors with at least five *H-Classics*.

Results

As shown in Fig. 1, the search of journals in the 2014 JCR, taking account of all name

Table 1. List of the 248 H-Classics in Implant Dentistry, Periodontics, and Oral Surgery based on the h-index

Titles	TC
Silness J, Loe H. (1964) Periodontal disease in pregnancy. II. Correlation between oral hygiene and periodontal condition. <i>Acta Odontol Scand</i> 22:121–35.	3105
Loe H, Silness J. (1963) Periodontal disease in pregnancy. I. Prevalence and severity. <i>Acta Odontol Scand</i> 21:533–51.	2976
Birkedalhansen H, Moore WGI, Bodden MK, Windsor LJ, Birkedalhansen B, Decarlo A, et al. (1993) Matrix Metalloproteinases – a review. <i>Critical Reviews in Oral Biology & Medicine</i> 4:197–250.	2225
Adell R, Lekholm U, Rockler B, Branemark PI. (1981) A 15-year study of Osseointegrated implants in the treatment of the edentulous jaw. <i>Int J Oral Surg</i> 10:387–416.	2158
Loe H, Theilade E, Jensen SB. (1965) Experimental gingivitis in man. <i>J Periodontol</i> 36:177–&.	1646
Loe H. (1967) Gingival Index Plaque Index and Retention Index Systems. <i>J Periodontol</i> 38:610–&.	1596
Socransky SS, Haffajee AD, Cugini MA, Smith C, Kent RL. (1998) Microbial complexes in subgingival plaque. <i>J Clin Periodontol</i> 25:134–144.	1423
Alobretsson T, Zarb G, Worthington P, Eriksson AR. (1986) The long-term efficacy of currently used dental implants: a review and proposed criteria of success. <i>Int J Oral Maxillofac Implants</i> 1:11–25.	1376
Adell R, Eriksson B, Lekholm U. (1990) A Long-Term Follow-Up Study of Osseointegrated Implants in the Treatment of Totally Edentulous Jaws. <i>International Journal of Oral and Maxillofacial Implants</i> 5:347–359.	1149
Donath K, Breuner G. (1982) A Method for the Study of Undecalcified Bones and Teeth with Attached Soft-Tissues – the Sage-Schliff (Sawing and Grinding) Technique. <i>Journal of Oral Pathology & Medicine</i> 11:318–326.	1108
Marx RE, Carlson ER, Eichstaedt RM, Schimmele SR, Strauss JE, Georgeff KR. (1998) Platelet-rich plasma – Growth factor enhancement for bone grafts. <i>Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics</i> 85:638–646.	1021
Ainamo J, Bay I. (1975) Problems and Proposals for Recording Gingivitis and Plaque. <i>Int Dent J</i> 25:229–235.	915
Marx RE. (2003) Pamidronate (Aredia) and zoledronate (Zometa) induced avascular necrosis of the jaws: A growing epidemic. <i>Journal of Oral and Maxillofacial Surgery</i> 61:1115–1117.	913
Ruggiero SL, Mehrotra B, Rosenberg TJ, Engroff SL. (2004) Osteonecrosis of the jaws associated with the use of bisphosphonates: A review of 63 cases. <i>Journal of Oral and Maxillofacial Surgery</i> 62:527–534.	912
Mombelli A, van Oosten MA, Schurch EJ, Land NP. (1987) The microbiota associated with successful or failing osseointegrated titanium implants. <i>Oral Microbiol Immunol</i> 2:145–51.	766
Oleary TJ, Naylor JE, Drake RB. (1972) Plaque Control Record. <i>J Periodontol</i> 43:38.	743
Gold OG, Jordan HV, Vanhoute J. (1973) Selective Medium for Streptococcus–Mutans. <i>Arch Oral Biol</i> 18:1357–1364.	730
Boyne PJ, James RA. (1980) Grafting of the Maxillary Sinus Floor with Autogenous Marrow and Bone. <i>Journal of Oral Surgery</i> 38:613–616.	727
Beck J, Garcia R, Heiss G, Vokonas PS, Offenbacher S. (1996) Periodontal disease and cardiovascular disease. <i>J Periodontol</i> 67:1123–1137.	723
Slots J, Genco RJ. (1984) Black-Pigmented Bacteroides Species, Capnocytophaga Species, and Actinobacillus-Actinomycetemcomitans in Human Periodontal-Disease – Virulence Factors in Colonization, Survival, and Tissue Destruction. <i>J Dent Res</i> 63:412–421.	710
Buser D, MericskeStern R, Bernard JP, Behneke A, Behneke N, Hirt HP, et al. (1997) Long-term evaluation of non-submerged ITI implants .1. 8-year life table analysis of a prospective multi-center study with 2359 implants. <i>Clin Oral Implants Res</i> 8:161–172.	701
Slade GD, Spencer AJ. (1994) Development and evaluation of the Oral Health Impact Profile. <i>Community Dent Health</i> 11:3–11.	687
Zambon JJ. (1985) Actinobacillus-Actinomycetemcomitans in Human Periodontal-Disease. <i>J Clin Periodontol</i> 12:1–20.	673
Tanner ACR, Haffer C, Brathall GT, Visconti RA, Socransky SS. (1979) Study of the Bacteria Associated with Advancing Periodontitis in Man. <i>J Clin Periodontol</i> 6:278–307.	667
Urist MR, Delange RJ, Finerman GAM. (1983) Bone Cell-Differentiation and Growth-Factors. <i>Science</i> 220:680–686.	664
Nyman S, Lindhe J, Karring T, Rylander H. (1982) New Attachment Following Surgical-Treatment of Human Periodontal-Disease. <i>J Clin Periodontol</i> 9:290–296.	658
Branemark PI. (1983) Osseointegration and its Experimental Background. <i>J Prosthet Dent</i> 50:399–410.	642
Marx RE, Sawatari Y, Fortin M, Broumand V. (2005) Bisphosphonate-induced exposed bone (osteonecrosis/osteopetrosis) of the jaws: Risk factors, recognition, prevention, and treatment. <i>Journal of Oral and Maxillofacial Surgery</i> 63:1567–1575.	636
Turesky S, Gilmore ND, Glickman I. (1970) Reduced Plaque Formation by Chloromethyl Analogue of Vitamin-C. <i>J Periodontol</i> 41:41–&.	636
Kornman KS, Crane A, Wang HY, diGiovine FS, Newman MG, Pirk FW, et al. (1997) The interleukin-1 genotype as a severity factor in adult periodontal disease. <i>J Clin Periodontol</i> 24:72–77.	620
Greene JC, Vermillion JR. (1964) Simplified Oral Hygiene Index. <i>J Am Dent Assoc</i> 68:7–&.	607
Socransky SS, Haffajee AD. (1992) The Bacterial Etiology of Destructive Periodontal-Disease – Current Concepts. <i>J Periodontol</i> 63:322–331.	603
Grossi SG, Zambon JJ, Ho AW, Koch G, Dunford RG, Machtei EE, et al. (1994) Assessment of Risk for Periodontal-Disease .1. Risk Indicators for Attachment Loss. <i>J Periodontol</i> 65:260–267.	600
Jaffin RA, Berman CL. (1991) The Excessive Loss of Branemark Fixtures in Type-Iv Bone – a 5-Year Analysis. <i>J Periodontol</i> 62:2–4.	584
Gottlow J, Nyman S, Lindhe J, Karring T, Wennstrom J. (1986) New Attachment Formation in the Human Periodontium by Guided Tissue Regeneration – Case-Reports. <i>J Clin Periodontol</i> 13:604–616.	564
Marx RE. (2004) Platelet-rich plasma: Evidence to support its use. <i>J Oral Maxillofacial Surg</i> 62:489–496.	559
Quigley GA. (1962) Comparative Cleansing Efficiency of Manual and Power Brushing. <i>J Am Dent Assoc</i> 65:26–29.	559
Slots J, Listgarten MA. (1988) Bacteroides-Gingivalis, Bacteroides-Intermedius and Actinobacillus-Actinomycetemcomitans in Human Periodontal-Diseases. <i>J Clin Periodontol</i> 15:85–93.	553
Haffajee AD, Socransky SS. (1994) Microbial etiological agents of destructive periodontal diseases. <i>Periodontol</i> 2000 5:78–111.	552
Ainamo J, Barmes D, Beagrie G, Cutress T, Martin J, Sardoinfirri J. (1982) Development of the World-Health-Organization (Who) Community Periodontal Index of Treatment Needs (Cpita). <i>Int Dent J</i> 32:281–291.	551
Esposito M, Hirsch JM, Lekholm U, Thomsen P. (1998) Biological factors contributing to failures of osseointegrated oral implants – (II). Etiopathogenesis. <i>Eur J Oral Sci</i> 106:721–764.	551
Corah NL. (1969) Development of a Dental Anxiety Scale. <i>J Dent Res</i> 48:596–&.	550
Theilade E, Wright WH, Jensen SB, Loe H. (1966) Experimental gingivitis in man. II. A longitudinal clinical and bacteriological investigation. <i>J Periodont Res</i> 1:1–13.	547
Offenbacher S, Katz V, Fertik G, Collins J, Boyd D, Maynor G, et al. (1996) Periodontal infection as a possible risk factor for preterm low birth weight. <i>J Periodontol</i> 67:1103–1113.	545
Sodek J, Ganss B, McKee MD. (2000) Osteopontin. <i>Critical Reviews in Oral Biology & Medicine</i> 11:279–303.	541
Listgarten MA, Hellden L. (1978) Relative Distribution of Bacteria at Clinically Healthy and Periodontally Diseased Sites in Humans. <i>J Clin Periodontol</i> 5:115–132.	540
Le Guehennec L, Soueidan A, Layrolle P, Amouriq Y. (2007) Surface treatments of titanium dental implants for rapid osseointegration. <i>Dental Materials</i> 23:844–854.	533

Table 1. (continued)

Titles	TC
Esposito M, Hirsch JM, Lekholm U, Thomsen P. (1998) Biological factors contributing to failures of osseointegrated oral implants (I). Success criteria and epidemiology. <i>Eur J Oral Sci</i> 106:527–551.	528
Hirschfeld L, Wasserman B. (1978) Long-Term Survey of Tooth Loss in 600 Treated Periodontal Patients. <i>J Periodontol</i> 49:225–237.	526
Slots J. (1979) Subgingival Microflora and Periodontal-Disease. <i>J Clin Periodontol</i> 6:351–382.	523
Cawood JI, Howell RA. (1988) A Classification of the Edentulous Jaws. <i>Int J Oral Maxillofac Surg</i> 17:232–236.	518
Ashimoto A, Chen C, Bakker I, Slots J. (1996) Polymerase chain reaction detection of 8 putative periodontal pathogens in subgingival plaque of gingivitis and advanced periodontitis lesions. <i>Oral Microbiol Immunol</i> 11:266–273.	511
Loe H, Schiott CR. (1970) The Effect of Mouth Rinses and Topical Application of Chlorhexidine on the Development of Dental Plaque and Gingivitis in Man. <i>J Periodont Res</i> 5:79–83.	510
Russell AL. (1956) A system of classification and scoring for prevalence surveys of periodontal disease. <i>J Dent Res</i> 35:350–9.	492
Dzink JL, Socransky SS, Haffajee AD. (1988) The Predominant Cultivable Microbiota of Active and Inactive Lesions of Destructive Periodontal-Diseases. <i>J Clin Periodontol</i> 15:316–323.	486
Haraszthy VI, Zambon JJ, Trevisan M, Zeid M, Genco RJ. (2000) Identification of periodontal pathogens in atheromatous plaques. <i>J Periodontol</i> 71:1554–1560.	486
Tallgren A. (1972) Continuing Reduction of Residual Alveolar Ridges in Complete Denture Wearers – Mixed-Longitudinal Study Covering 25 Years. <i>J Prosthet Dent</i> 27:120–8.	481
Page RC. (1991) The Role of Inflammatory Mediators in the Pathogenesis of Periodontal-Disease. <i>J Periodont Res</i> 26:230–242.	480
Buser D, Broggini N, Wieland M, Schenk RK, Denzer AJ, Cochran DL, et al. (2004) Enhanced bone apposition to a chemically modified SLA titanium surface. <i>J Dent Res</i> 83:529–533.	477
Nyman S, Gottlow J, Karring T, Lindhe J. (1982) The Regenerative Potential of the Periodontal-Ligament - an Experimental-Study in the Monkey. <i>J Clin Periodontol</i> 9:257–265.	474
Gottlow J, Nyman S, Karring T, Lindhe J. (1984) New Attachment Formation as the Result of Controlled Tissue Regeneration. <i>J Clin Periodontol</i> 11:494–503.	473
Petersen PE. (2003) The World Oral Health Report 2003: continuous improvement of oral health in the 21st century – the approach of the WHO Global Oral Health Programme. <i>Community Dent Oral Epidemiol</i> 31:3–23.	461
Melcher AH. (1976) Repair Potential of Periodontal Tissues. <i>J Periodontol</i> 47:256–260.	459
Socransky SS. (1977) Microbiology of Periodontal-Disease - Present Status and Future Considerations. <i>J Periodontol</i> 48:497–504.	444
Socransky SS, Haffajee AD. (2005) Periodontal microbial ecology. <i>Periodontol</i> 2000 38:135–187.	440
Buser D, Braegger U, Lang NP, Nyman S. (1990) Regeneration and enlargement of jaw bone using guided tissue regeneration. <i>Clin Oral Implants Res</i> 1:22–32.	438
Slots J, Bragd L, Wikstrom M, Dahlen G. (1986) The Occurrence of Actinobacillus-Actinomycetemcomitans, Bacteroides-Gingivalis and Bacteroides-Intermedius in Destructive Periodontal-Disease in Adults. <i>J Clin Periodontol</i> 13:570–577.	427
Urist MR, Strates BS. (1971) Bone Morphogenetic Protein. <i>J Dent Res</i> 50:1392–8.	422
Schropp L, Wenzel A, Kostopoulos L, Karring T. (2003) Bone healing and soft tissue contour changes following single-tooth extraction: A clinical and radiographic 12-month prospective study. <i>Int J Periodontics Restorative Dent</i> 23:313–323.	421
Araujo MG, Lindhe J. (2005) Dimensional ridge alterations following tooth extraction. An experimental study in the dog. <i>J Clin Periodontol</i> 32:212–218.	418
Moore WE, Moore LV. (1994) The bacteria of periodontal diseases. <i>Periodontol</i> 2000 5:66–77.	416
Goodson JM, Tanner ACR, Haffajee AD, Sornberger GC, Socransky SS. (1982) Patterns of Progression and Regression of Advanced Destructive Periodontal-Disease. <i>J Clin Periodontol</i> 9:472–481.	414
Socransk.Ss. (1970) Relationship of Bacteria to Etiology of Periodontal Disease. <i>J Dent Res</i> 49:203–8.	414
Badersten A, Nilveus R, Egelberg J. (1984) Effect of Nonsurgical Periodontal Therapy .2. Severely Advanced Periodontitis. <i>J Clin Periodontol</i> 11:63–76.	413
Grossi SG, Genco RJ, Machtei EE, Ho AW, Koch G, Dunford R, et al. (1995) Assessment of Risk for Periodontal-Disease .2. Risk Indicators for Alveolar Bone Loss. <i>J Periodontol</i> 66:23–29.	408
Socransky SS, Haffajee AD, Goodson JM, Lindhe J. (1984) New Concepts of Destructive Periodontal-Disease. <i>J Clin Periodontol</i> 11:21–32.	408
Loe H, Anerud A, Boysen H, Morrison E. (1986) Natural-History of Periodontal-Disease in Man - Rapid, Moderate and no Loss of Attachment in Sri-Lankan Laborers 14 to 46 Years of Age. <i>J Clin Periodontol</i> 13:431–440.	404
Sjogren U, Figdor D, Persson S, Sundqvist G. (1997) Influence of infection at the time of root filling on the outcome of endodontic treatment of teeth with apical periodontitis. <i>Int Endod J</i> 30:297–306.	398
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Quirynen M, Bollen CML. (1995) The Influence of Surface-Roughness and Surface-Free Energy on Supragingival and Subgingival Plaque-Formation in Man – a Review of the Literature. <i>J Clin Periodontol</i> 22:1–14.	391
Tarnow DP, Emtiaz S, Classi A. (1997) Immediate loading of threaded implants at stage 1 surgery in edentulous arches: Ten consecutive case reports with 1- to 5-year data. <i>Int J Oral Maxillofac Implants</i> 12:319–324.	386
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Birkedalhansen H. (1993) Role of Matrix Metalloproteinases in Human Periodontal-Diseases. <i>J Periodontol</i> 64:474–484.	379
Buser D, Weber H-, Lang NP. (1990) Tissue integration of non-submerged implants 1-year results of a prospective study with 100 ITI hollow-cylinder and hollow-screw implants. <i>Clin Oral Implants Res</i> 1:33–40.	378
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Jaffe HL. (1953) Giant-Cell Reparative Granuloma, Traumatic Bone Cyst, and Fibrous (Fibro-Osseous) Dysplasia of the Jawbones. <i>Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics</i> 6:159–175.	375
Huang GT-, Gronthos S, Shi S. (2009) Mesenchymal Stem Cells Derived from Dental Tissues vs. Those from Other Sources: Their Biology and Role in Regenerative Medicine. <i>J Dent Res</i> 88:792–806.	373
Axelsson P, Lindhe J. (1978) Effect of Controlled Oral Hygiene Procedures on Caries and Periodontal-Disease in Adults. <i>J Clin Periodontol</i> 5:133–151.	371
van Steenberghe D, Lekholm U, Bolender C, Folmer T, Henry P, Herrmann I, et al. (1990) Applicability of osseointegrated oral implants in the rehabilitation of partial edentulism: a prospective multicenter study on 558 fixtures. <i>Int J Oral Maxillofac Implants</i> 5:272–81.	371

Table 1. (continued)

Titles	TC
Birkedalhansen H. (1993) Role of Cytokines and Inflammatory Mediators in Tissue Destruction. <i>J Periodont Res</i> 28:500–510.	368
Albandar JM, Brunelle JA, Kingman A. (1999) Destructive periodontal disease in adults 30 years of age and older in the United states, 1988–1994. <i>J Periodontol</i> 70:13–29.	367
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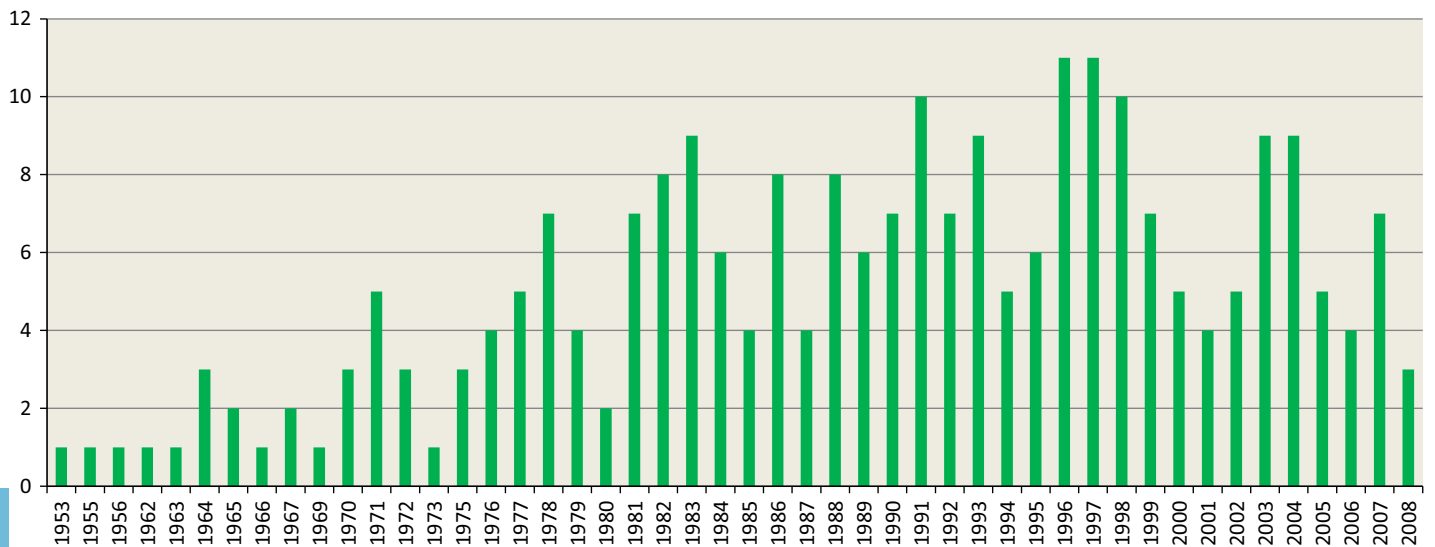


Fig. 2. Classic Articles per year. Classic articles were most frequently published in the 1990s, with 1996, 1997, 1991, and 1998 occupying the first four positions.

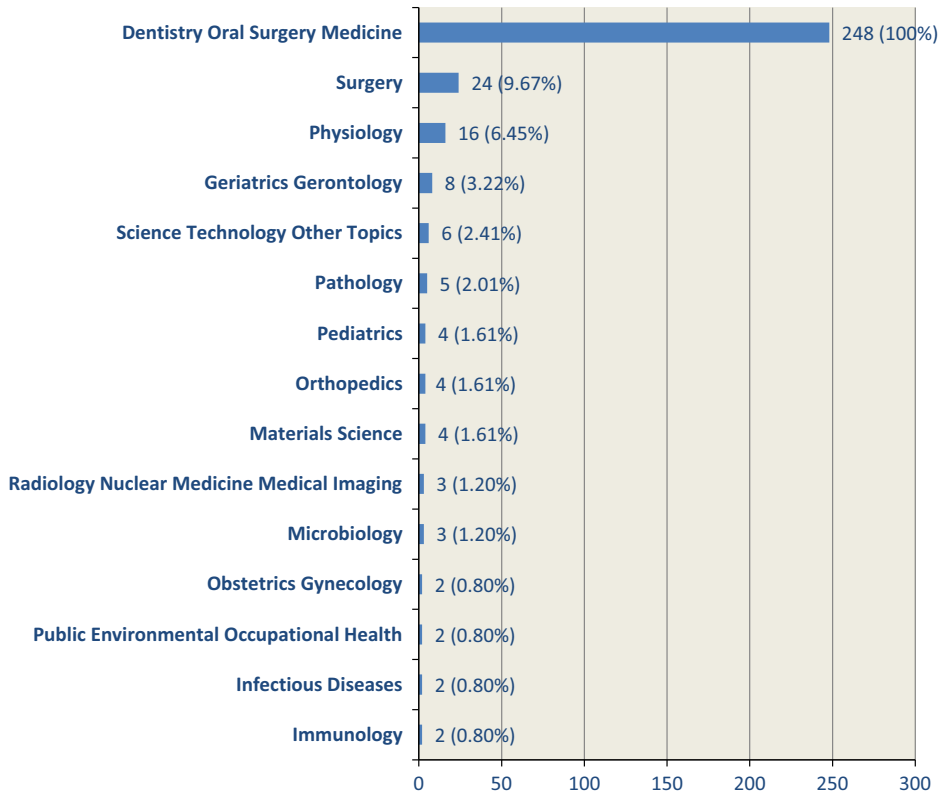


Fig. 3. Research Areas. Classic articles were associated with other research areas, notably Surgery (9.67%), Physiology (6.45%), reflecting a trend toward multidisciplinary research.

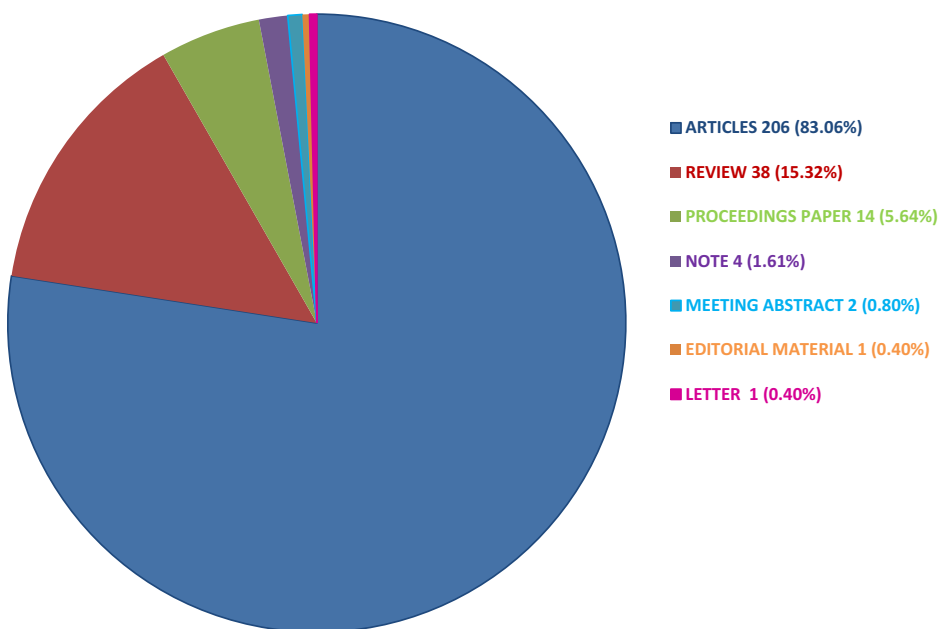


Fig. 4. Type of Documents. The classic papers were predominantly Articles, with no Meta-analyses. We highlight the number of proceedings papers in the list.

any date until August 12, 2015, and for any type of document. The 96,626 documents published in the *European Journal of Cancer* (MEDICINE area) were then excluded, because part B of the journal, which was devoted to oral oncology, became an independent journal (*Oral Oncology*) in 1997 (Annex 1). Analysis of the final sample of 267,611 documents in ID, P, and OS yielded an h-index of 248. Hence, the 248 most cited articles were selected as *H-classics*. They were all published between 1953 and 2009. No paper published in the past 6 years (to August 2015) received 248 or more citations (Table 1).

These 248 *H-Classics* were most frequently published in 1997 (11, 4.43%), 1996 (11, 4.43%), 1991, and 1998 (10, 4.56%) and were least frequently published in the first and last years searched (1953 and 2009) (Fig. 2). The highest number of citations for a paper was 3,105 (Silness & Loe 1964), followed by 2,976 (Loe & Silness 1963) and 2,225 (Birkedal-hansen et al. 1993). The lowest number of citations was 249 (Waerhaug 1978; Ross 1987; Engquist et al. 1988; Jeffcoat et al. 2001) (Table 1). The total number of citations of the 248 *H-classics* was 113,175. If self-citations are excluded, they were cited 58,712 times. The average number of citations per document was 449.11. The number of citations for papers in these areas increased between 1953 and 2008.

Of the 248 documents, some items were published in journals that are both categorized in dentistry and some other discipline outside the 'Dentistry, Oral Surgery & Medicine' area: 24 (9.67%) in *Surgery* journals, 16 (6.45%) in *Psychology* journals, and 8 (3.22%) in *Geriatrics Gerontology* (Fig. 3).

Of the 248 *H-Classics*, 206 (83.06%) were original articles, 38 (15.32%) were reviews, and 14 (5.64%) were 'proceedings papers'; none were Meta-Analyses (Fig. 4). The 'proceedings papers' included three documents from a symposium on the relation of periodontal infections to systemic diseases at the State University of New York, two from a symposium on periodontal diagnosis in Buffalo, New York, and three from a symposium on molecular perspectives of inflammation and periodontal pathology in Florida (Table 2).

The *H-Classics* were published in 35 of the 88 journals in the area of ID, P, and OS in the JCR of 2014, most frequently in the *Journal of Clinical Periodontology*, with 47 documents (18.95%), followed by the *Journal of Periodontology* with 46 documents (18.54%) (Table 3).

changes, retrieved a total of 888,568 documents. The search of WoS databases using MESH terms related to ID, P and Oral Surgery (plus the terms bisphosphonates or

diphosphonates) yielded a total of 13,278,187 documents. The combination of the two searches, using 'AND' gave a final result of 267,611 documents. The searches were from

Table 2. Symposium/Conference Titles

Conference titles	Records	% of 248
Symposium on the Relation of Periodontal Infections to Systemic Diseases In Honor of The 30th Anniversary of The State University of New York at Buffalo Oral Biology Graduate Program	3	1.20
Symposium on Periodontal Diagnosis Current Status Future Directions	2	0.80
Symposium on Current Perspectives on Molecular Mediators of Inflammation and Periodontal Pathology	2	0.80
International Workshop for Clinical Prosthodontic Teachers	1	0.40
Annual Meeting of the American College of Prosthodontists	1	0.40
9th International Conference on Periodontal Research	1	0.40
8th International Conference on Periodontal Research	1	0.40
4th European Workshop on Periodontology	1	0.40
2nd European Association of Osseointegration Consensus Conference 2009	1	0.40

Table 3. Journal titles. Of the 88 journals in the Dentistry, Oral Surgery & Medicine area of the 2014 JCR, 35 published the classic articles in Implant Dentistry, Periodontics, and Oral Surgery

Journal Title	Records	%	Country	Year first published
Journal of Clinical Periodontology	47	18.95	United Kingdom	1974
Journal of Periodontology (known as Periodontics 1963–1969)*	46	18.54	USA	1970
International Journal of Oral and Maxillofacial Implants	23	9.27	USA	1986
Clinical Oral Implants Research	15	6.048	USA	1990
Journal of Oral and Maxillofacial Surgery (known as Journal of Oral Surgery 1965–1982)*	13	5.24	USA	1982
Journal of Dental Research	12	4.83	USA	1919
Journal of Prosthetic Dentistry	10	4.03	USA	1951
Critical Reviews In Oral Biology And Medicine†	9	3.62	USA	1989–2005
Journal of Periodontal Research	9	3.62	USA	1966
Acta Odontologica Scandinavica	7	2.82	United Kingdom	1939
Periodontology 2000	7	2.82	USA	1993
The International Journal of Periodontics Restorative Dentistry	6	2.41	United Kingdom	1981
Journal of the American Dental Association	5	2.01	USA	1939
International Endodontic Journal	4	1.61	United Kingdom	1980
International Journal of Prosthodontics	4	1.61	USA	1992
Archives of Oral Biology	3	1.20	United Kingdom	1959
Dental Materials	3	1.20	USA	1982
International Journal of Oral and Maxillofacial Surgery (known as International Journal of Oral Surgery 1972–1986)*	3	1.20	Denmark	1986
Journal of Cranio Maxillofacial Surgery (known as Journal of Maxillofacial Surgery 1973–1987)*	3	1.20	Germany	1987
Journal of Endodontics	3	1.20	USA	1975
American Journal of Orthodontics and Dentofacial Orthopedics	2	0.80	USA	1988
European Journal of Oral Sciences	2	0.80	Denmark	1995
International Dental Journal	2	0.80	USA	1950
Journal of Oral Pathology Medicine	2	0.80	Denmark	1989
Oral Microbiology and Immunology (Currently Molecular Oral Microbiology)	2	0.80	Denmark	1986–2010
Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontics	2	0.80	USA	2012
Cleft Palate Journal	1	0.40	USA	1991
Community Dental Health	1	0.40	United Kingdom	1984
Community Dentistry and Oral Epidemiology	1	0.40	Denmark	1973
Dentomaxillofacial Radiology	1	0.40	United Kingdom	1972
Journal of Dentistry	1	0.40	United Kingdom	1972
Oral Oncology	1	0.40	United Kingdom	1997
The Cleft Palate Journal	1	0.40	Canada	1991

*Journals that have appeared under different names in the past; the current name is given in the table.

†Supplement of the Journal of Dental Research.

The selected papers derived from the USA in 49.59% of cases ($n = 123$), Europe in 47.58% ($n = 118$), Canada in 4.43% ($n = 11$), and Japan in 2.01% ($n = 5$). Among European countries, the most frequent was Sweden with 50 documents (20.16%), followed by Switzerland with 19 documents (7.66%) and Denmark with 16 (6.45%) (Fig. 5).

The most frequent host institution was the University of Gothenburg, with 44 documents (17.74%), followed by The Forsyth Institute with 19 documents (7.66%), the University of Bern, with 15 documents (6.04%) and the SUNY at Buffalo 14 (5.64%). Among the host institutions, seven were in the USA, five in Europe, and three in Canada (Fig. 6).

With regard to the authors, the most frequently published was J Lindhe ($n = 26$, 10.48%), followed by SS Socransky (sometimes spelt Socranssky) (20, 8.06%), and AD Haffajee (13, 5.24%). Of the total of 177 authors, five or more documents were published by 17 (Fig. 7). J Slots, SS Socransky, RJ Genco, and RE Marx were the sole authors of two articles each, and articles with only two authors were published by J Lindhe ($n = 7$ documents), SS Socransky ($n = 6$), AD Haffajee ($n = 4$), and H Loe ($n = 4$).

Discussion

The concept of classic articles is well understood by the scientific community, but the criteria for their definition remain controversial, because objective and reproducible parameters have not been established for all research areas. In this study, classic articles in the areas of ID, P, and OS were identified using the *H-Classics* method based on h-index properties, which yielded a list of 248 papers.

Efforts were also made to minimize some typical shortcomings of bibliometric studies, including changes in the names of journals over the years. For example, 'Oral Surgery, Oral Medicine and Oral Pathology' has changed its title seven times since its foundation. It was originally named International Journal of Orthodontia until 1919, then International Journal of Orthodontia and Oral Surgery from 1919 to 1922, International Journal of Orthodontia, Oral Surgery and Radiography from 1922 to 1933, International Journal of Orthodontia and Dentistry for Children from 1933 to 1936, International Journal of Orthodontia and Oral Surgery from 1936 to 1938, Oral Surgery, Oral Pathology, Oral Medicine from 1948 to 1995, Oral Surgery,

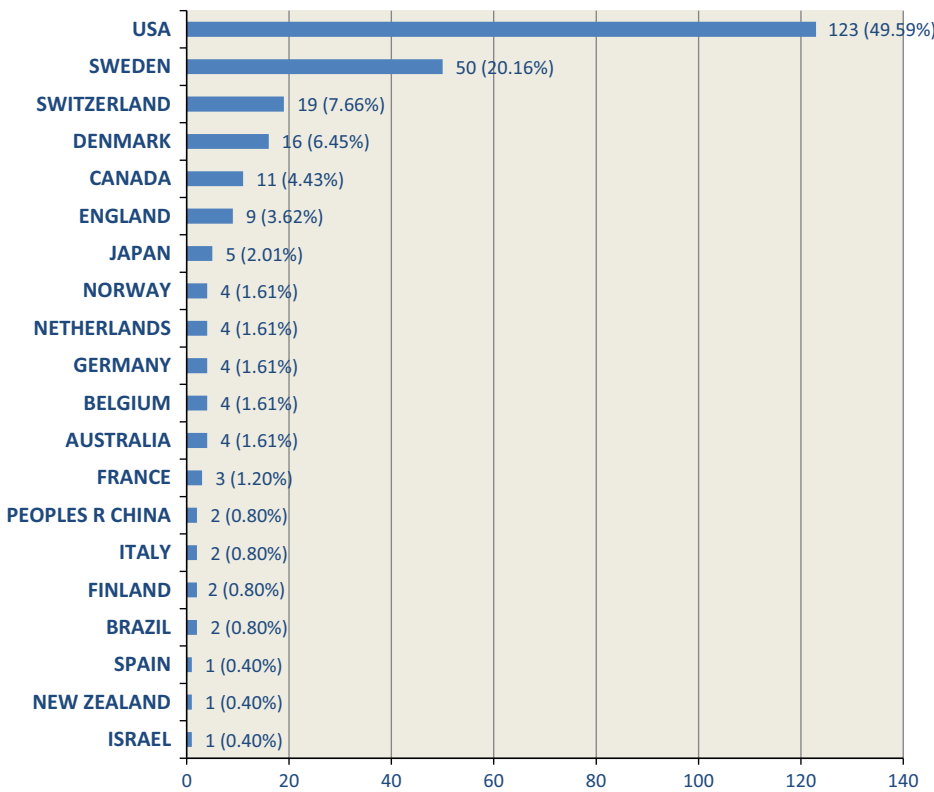


Fig. 5. Countries of origin of the 248 classic papers. Among these 20 countries, seven produced at least five papers.

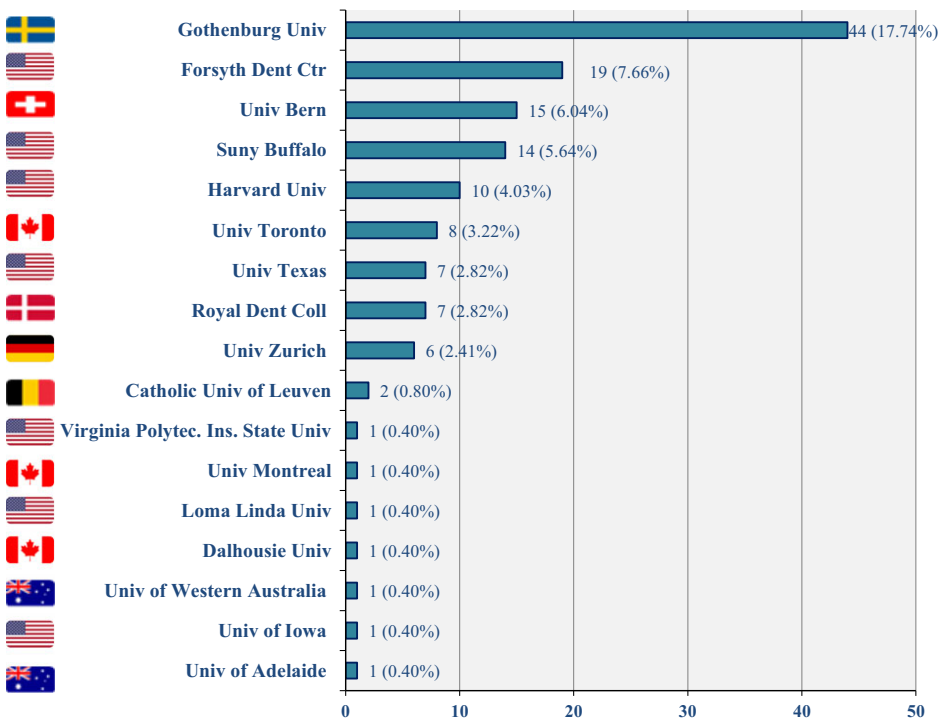


Fig. 6. Participation of institutions. Of the 17 institutions participating in the classic papers, seven are in the USA (41.17%), five in Europe (29.41%), three in Canada (17.64%), and two in Australia (11.76%).

was avoided by searching for the ISSN, thereby increasing the number of documents retrieved for each journal. A further problem can result from inconsistencies in ISSNs of the print, electronic, and 'link' formats of some journals, which was addressed by examining these ISSNs in PubMed and Ulrich databases (Franceschini et al. 2015). We also used multiple databases to track historical journals that may be older than some of the databases [e.g., WoS (1950) or Scopus (1996)] (Archambault et al. 2009).

Selection of the topic(s) poses another methodological question (Nieri et al. 2007, 2007). According to Piták-Arnop (Piták-Arnop 2014), the area of 'dentistry' is too wide, meaning that information on some subareas of the discipline is lost. Different analyses have therefore been undertaken of specific areas within dentistry (Fardi et al. 2011; Hui et al. 2013). Thus, Nieri and co-workers (Nieri et al. 2007) analyzed papers on Periodontics in Periodontology journals, but they used an arbitrary threshold of 100 citations, missed numerous papers published in other journals, and excluded articles published before 1990 (Nieri et al. 2007). Most classic articles previously listed in dentistry have been related to ID, P and OS (Feijoo et al. 2014), and these areas were selected for the current investigation.

The *H-classics* method takes account of the volume of production in a given area (Martinez et al. 2014), unlike the arbitrary requirement for a minimum of 100 citations (Nieri et al. 2007) or the selection of the 50 or 100 most frequently cited articles (Hui et al. 2013). Feijoo and co-workers (Feijoo et al. 2014) considered that selection of the 100 most cited papers does not provide a representative sample in the area of dentistry (Feijoo et al. 2014). Thus, the final position in their list was occupied by a paper with 326 citations, whereas the same paper was only attributed with 87 citations in an analysis by Fardi et al. (Fardi et al. 2011) of papers related to root canal treatment. If we had adopted the same strategy (100 most cited), we would have excluded more than half of the articles obtained with the *H-classics* method. On the other hand, if we had selected all papers with 100 or more citations, the sample of papers would have been too large and unwieldy. Unlike previous authors, we included all journals related to 'Dentistry, Oral Surgery & Medicine' in the JCR database, confirming that more specialized journals receive the highest number of citations, in accordance with Bradford's law (Bradford 1985). Our study also verified that

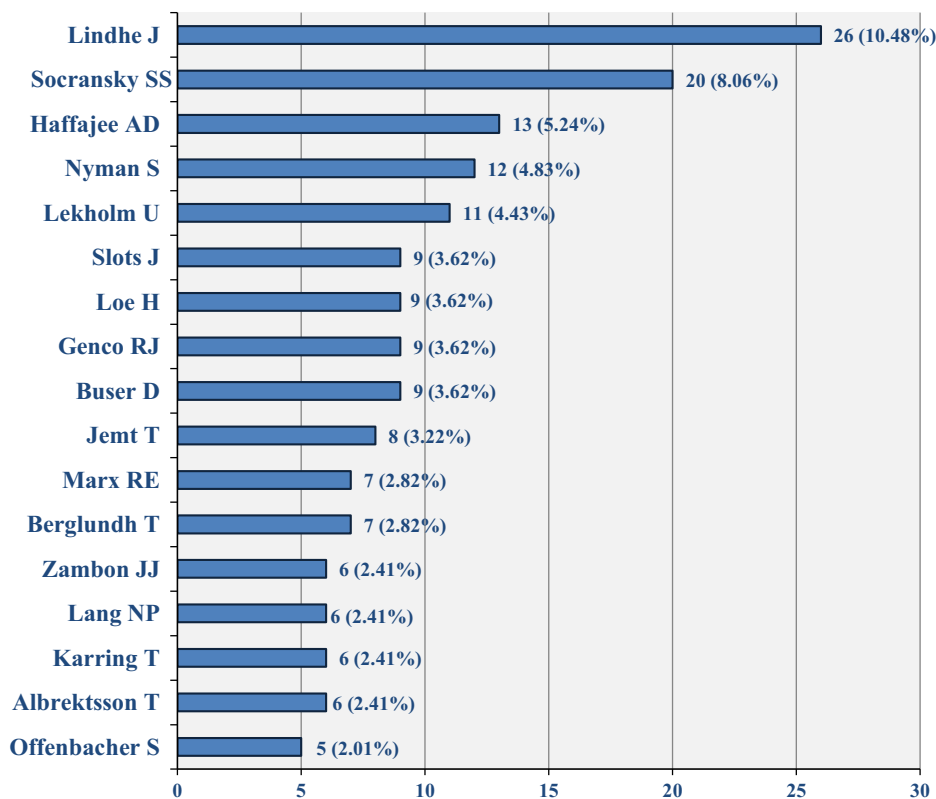


Fig. 7. Authors of at least five articles in the 248 classic papers. Of the total of 177 authors, 17 published at least five articles.

ID, P, and OS constitute the core of dental knowledge, with an h-Index of 248 in comparison with the h-index for dentistry as a whole of 291 (unpublished data).

The decade in which these *H-Classics* were most frequently published was the 1990s, as reported by others in dentistry (Feijoo et al. 2014) and other areas (Martínez et al. 2014, 2015). Evidently, citations accumulate over time, and it has been proposed that the true impact of a study becomes clear at least two decades after its publication (Baltussen & Kindler 2004; Feijoo et al. 2014; Pitak-Arnop 2014).

Two journals, the *Journal of Clinical Periodontology* and *Journal of Periodontology*, published 93 (37.5%) of the *H-classics* between them. These are the official journals of the European Federation of Periodontology and the American Society of Periodontology, two of the most important scientific societies in dentistry. The inclusion in our list of proceedings papers from meetings organized by the latter reflects its major influence. *Clinical Oral Implant Research*, which was launched in 1990, proved to be the most influential journal in the more recent area of Implant Dentistry, which is growing in importance and is particularly connected with Periodontology in relation to some

emerging topics such as peri-implantitis (Berglundh & Lindhe 1996).

The inclusion of reviews and the counting of self-citations have been controversial issues in the compilation of classic articles (Purvis 2006; van Raan 2008). We took the decision to consider reviews and meta-analyses, generally considered to meet the highest scientific standards, although only 38 (15.32%) reviews and no meta-analyses were finally included among the *H-classics*. The absence of meta-analyses indicates that the quality of evidence in dentistry is only grade IV, as also reported by Nieri et al. (Nieri et al. 2007). We included self-citations because they often represent the continuation of a research line.

The decision to combine ID, P and OS in this study was based on the close interrelationships among these areas, as illustrated by the central themes of the *H-Classics* in our list. Implant Dentistry brings these areas together in relation to the following: A) surgical techniques and bone wound healing around implants (osseointegration), including papers on implant surfaces and typology and on supporting bone structures (Adell et al. 1986; Albrektsson et al. 1988; Berglundh & Lindhe 1996; Berglundh et al. 2002); B) implant rehabilitation or prosthodontics; and

C) peri-implant health (Jemt et al. 1996) and periodontics, mainly from a microbiology approach (Mombelli et al. 1987), peri-implantitis, and guided tissue or bone regeneration procedures (Gottlow et al. 1984; Buser et al. 1990).

Within the specific topic of Periodontics, the *H-classics* include the following: microbiology studies by some leading researchers (Gold et al. 1973; Slots et al. 1986; Slots & Listgarten 1988; Socransky & Haffajee 1992; Haffajee & Socransky 1994; Socransky et al. 1998); studies on indicators of diseases such as gingivitis and periodontitis, (Quigley 1962; Loe 1967; O'Leary et al. 1972); and research within the recent discipline of Periodontal Medicine on the association of periodontitis with disease (Beck et al. 1996; Haraszthy et al. 2000) or premature delivery (Loe & Silness 1963; Silness & Loe 1964).

The basic sciences also play an important part in the *H-Classics*, above all in relation to branches of knowledge that seek to explain bone remodeling or wound-healing mechanisms and the factors that influence these processes (Birkedalhansen et al. 1993a,b,c; Kornman et al. 1997; Anitua 1999; Sodek et al. 2000; Marx 2004).

Finally, although a relatively recent topic, there has been a major increase in scientific production on research related to bone, and papers on bisphosphonates have achieved high citation values (Marx 2003; Marx et al. 2005, 2007).

With regard to the production in different countries, the USA was the affiliated country in around half of the *H-Classics*, followed very closely by Europe as a whole. Sweden, Switzerland, and Denmark predominated among European countries, befitting the role of their institutions in developing Periodontology in this continent. It should be borne in mind that the most influential journals are published in the USA or Europe. The institution appearing with greatest frequency in these *H-Classics* was the University of Gothenburg, to which Lindhe, Berglundh, Lekholm, and Albrektsson are affiliated, indicating the important role played by authors in the quality of their institutions. J Lindhe is the author with the largest number of *H-classics* ($n = 26$), although only two of these received more than 500 citations. Other authors, such as H Loe, SS Socransky, or J Slot, have fewer *H-Classics* papers but a much larger number of citations, with some of their papers occupying top positions in the list. This may be because their studies are relevant to the majority of journals in these areas, being lar-

gely on the definition of diagnostic/therapeutic indexes or classifications.

One limitation of our study was that it was conducted solely in journals in the JCR area of 'Dentistry, Oral Surgery, & Medicine'. Given the increasing trend toward multidisciplinary research, it would be of interest to consider other areas of medicine, where important articles with an elevated number of citations are published. However, an ordered analysis of articles in all other JCR areas would be highly challenging and would

be difficult to reproduce, breaking one of the cardinal rules of scientific investigation.

Conclusions

The *H-classics* method is an objective approach to categorize classic documents that takes account of the magnitude and history of citations in a given area. It provides useful information for developing lines of research and signaling key institutions and researchers in a field of knowledge. A total of 248 *H-classics*

were identified in Implant Dentistry, Periodontics, and Oral Surgery. In terms of the quality of scientific production, the most influential institution is the University of Gothenburg and the most frequently cited author is Professor Jan Lindhe.

Disclaimer

The authors do not have any financial interest, either directly or indirectly, in the products or information listed in the paper.

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