Top 100 Cited Publications in the Field of Temporomandibular Disorders: A Bibliometric Analysis

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Background: The aim of this bibliometric research was to identify and analyze the top 100 cited publications in the field of temporomandibular disorders (TMD) in order to guide any professional level with interest in this topic by mapping the current trends in the field of TMD.

Materials and Methods: The Clarivate Analytics’ Web of Science database was used to find the top 100 most cited papers in the field of TMD, published from the year 2000 to November 18, 2021, with MeSH terms in the search strategy. Data extracted were ranking, title, main author, institution, publication year, a total of citations, citation average per year, the journal the study was published, journal impact factor, and the number of studies that each journal published. Further, also the percentage of the different study designs, the number of studies regarding a specific area within the field of TMD, and the number of studies per country were also calculated. A ranking of authors was also performed.

Results: The top cited paper was a study on diagnostic criteria for TMD, with 1,287 citations published in 2014 in the Journal of Oral and Facial Pain and Headache which also had most of the top 100 cited publications. Eighty-one percent of the most cited studies were from the USA and Europe and 33% of the included studies were review articles.

Conclusion: Taken together, since all papers were considered classic, one can draw the conclusion that researchers in 2000 onward in the field of TMD are interested in (a) diagnostic criteria, (b) TMD symptoms and mainly pain-related symptoms, (c) etiology and risk factors of TMD and mainly bruxism, and (d) treatment of TMD. However, topics such as imaging, occlusion, tissue engineering, and disk displacements are presently not as popular.

Keywords: temporomandibular disorders, citation, bibliometric analyses, etiology, temporomandibular joint
INTRODUCTION

There is a wish among scientists in the field of dental medicine, as in all other fields, to reach out with their research findings to other scientists, practitioners, students, to the community, and to decision-makers due to the hope that their findings can be used to increase the knowledge and understanding about conditions and treatments, to be part of the education, to affect decisions in the clinic, and also to guide the decision-makers [1].

In order to investigate if the publications do reach out, if they have any impact in the research field of interest, or even if they affect decision making [2], one has to conduct scientometrics. Scientometrics, or bibliometrics as it is called in the field of science, is commonly used since the 1960s to show what impact publications have [3]. One type of bibliometrics is citation analysis, which is an analysis that quantifies how many times a publication has been cited after its publication. One can say that the more cited a publication is, the greater impact it has in its specific field [4]. Hence, citation analysis can be an efficient tool to use to evaluate what impact a publication has in a specific field and therefore how important this publication is in that specific field [4]. However, one has to be cautious since there are indications that errors or misinterpretations from one publication can become a cited "truth" that can be transferred and continued with repeated citations, which in turn can negatively influence practice and policy [1]. Finally, one has also to consider that citation analysis only can be used to assess the impact the specific publication has on its field by quantifying the recognition, importance, and popularity of the topic, but it cannot show any indication of the quality of the content in the specific publication [5, 6].

There are many pain related and jaw (dys)functional conditions that can affect the orofacial region. The orofacial region is one of the most frequent locations for chronic pain conditions, with a prevalence of 7–11% [7]. These conditions are embraced under the umbrella term temporomandibular disorders (TMD) which include not just chronic pain conditions in the orofacial region affecting the temporomandibular joint (TMJ), the masticatory muscles (myalgia), and their associated structures, but also jaw functional limitations and occlusal aspects [8]. Painful TMDs are associated with restricted mouth opening capacity, pain upon chewing, muscle and joint soreness, and headache, i.e., impaired chewing ability [7]. Further, pain is a subjective individual experience that includes sensory, cognitive, emotional, and social dimensions [9], which, in other words, means that painful TMDs do not only lead to an unpleasant sensory experience, but is also accompanied by an unpleasant emotional experience with feelings of failure, misery, guilt, alienation, and even depression, i.e., a decreased quality of life [10].

In the field of TMD, there was a very important publication during the year 2014 that resulted in the worldwide accepted and used new diagnostic criteria for TMD for both clinicians and research [7]. The previous ones were from 1992, and they were mainly used for research in the field of TMD [11]. Although TMD is a broad field of dental medicine with a large amount of conducted research, there is still limited knowledge when it comes to etiology, pathophysiology, sex, age, and/or tissue differences, and treatment approaches to the various TMD conditions ([12]). Hence, it is of great interest not just for scientists, but also for clinicians and decision-makers to map the current trends in the field of TMD. To our knowledge, there are no studies that have performed such an analysis. Therefore, this bibliometric research aimed to identify and analyze the top 100 cited publications in the field of TMD to guide any professional level with interest in this topic by mapping the current trends in the field of TMD.

MATERIALS AND METHODS

A bibliometric analysis was performed to rank the top 100 cited papers related to the field of TMD. This study followed the same methodology applied in previous studies that analyzed the top 100 cited papers in robotic [13] and oral and maxillofacial surgery [14]. The search strategy was performed on November 18, 2021. The Clarivate Analytics’ Web of Science database was used to find the top 100 most cited papers, and the following MeSH terms were used in the search strategy: "Disorder, Temporomandibular Joint," “Disorders, Temporomandibular Joint,” “Joint Disorder, Temporomandibular,” “Joint Disorders, Temporomandibular”, “Temporomandibular Joint Disorder,” “TMJ Disorders,” “Disorder, TMJ,” “Disorders, TMJ,” “TMJ Disorder,” “Temporomandibular Disorders,” “Disorder, Temporomandibular,” “Disorders, Temporomandibular,” “Temporomandibular Disorder.”

In this bibliometric analysis, studies published from 2000 to the date of data extraction and the following study types were included: literature reviews, systematic reviews, cross-sectional cohort and case-control studies, randomized clinical trials, diagnostic accuracy studies, comparative studies, laboratory studies, technical report, genetic studies, methodological studies, questionnaire development, and animal studies.

However, some study types, namely, case reports, letters to the Editor, and papers not related to TMD, were excluded. Further, studies that were impossible to retrieve in full were also excluded. There was no restriction in language or journal of publication. The papers were sequentially screened from the most cited until a complete number of 100 papers were included. The screening process included reading titles, abstracts, and full text articles.

After screening each of the top 100 cited studies, the following data were collected: (1) ranking; (2) title; (3) the main author; (4) institution; (5) publication year; (6) total of citations; and (7) citation average per year. Further, (8) the name of the journals; (9) the journal impact factors, and (10) the number of studies that each journal published were also extracted. From the top 100 cited studies included, (11) the percentage of the different study designs; (12) the number of studies regarding a specific area within the field of TMD, and (13) the number of studies per country was also calculated. A ranking of authors was also performed. The authors who have published more than two studies were identified. Their main institution, country, number of studies published among the top 100 cited, and their total of citations were extracted.

Graphs were performed through Microsoft excel 2003. The field of investigation, study design, and the number of studies per country were graphed.
| Rank | Title                                                                 | Main author                  | Institution               | Year | Citations | Total Average |
|------|----------------------------------------------------------------------|------------------------------|----------------------------|------|-----------|---------------|
| 1    | Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) for     | E. Schiffman                 | University of Minnesota    | 2014 | 1,287     | 160.88        |
|      | Clinical and Research Applications: Recommendations of the International |                            |                            |      |           |               |
|      | RDC/TMD Consortium Network and Orofacial Pain Special Interest Group |                            |                            |      |           |               |
| 2    | Overlapping conditions among patients with chronic fatigue syndrome,  | L. A. Aaron                  | University of Washington   | 2000 | 383       | 17.41         |
|      | fibromyalgia, and temporomandibular disorder                        |                            |                            |      |           |               |
| 3    | Bruxism physiology and pathology: an overview for clinicians        | G. J. Lavigne                | Université de Montréal     | 2008 | 380       | 27.14         |
| 4    | Degenerative disorders of the temporomandibular joint: etiology,    | E. Tanaka                    | University of Tokushima    | 2008 | 374       | 26.71         |
|      | diagnosis, and treatment                                            |                            |                            |      |           |               |
| 5    | Mediators, moderators, and predictors of therapeutic change in       | J. A. Turner                 | University of Washington   | 2007 | 330       | 22            |
|      | cognitive-behavioral therapy for chronic pain                        |                            |                            |      |           |               |
| 6    | Research diagnostic criteria for temporomandibular disorders (RDC/TMD): | A. Mansur                    | University of Minnesota    | 2009 | 325       | 25            |
|      | development of image analysis criteria and examiner reliability for image analysis | | | | | |
| 7    | Research diagnostic criteria for temporomandibular disorders: a      | D. Manfredini                | University of Padova       | 2011 | 305       | 27.73         |
|      | systematic review of axis I epidemiologic findings                   |                            |                            |      |           |               |
| 8    | Medical Progress: Temporomandibular Disorders                       | S. J. Scrivani               | Massachusetts General Hospital | 2008 | 299       | 21.36         |
| 9    | Bruxism is mainly regulated centrally, not peripherally            | F. Lobbezoo                  | Academic Center for Dentistry Amsterdam (ACTA) | 2001 | 280     | 13.33        |
| 10   | Changes in temporomandibular pain and other symptoms across the     | L. LeResche                  | University of Washington   | 2003 | 260       | 13.68         |
|      | menstrual cycle                                                     |                            |                            |      |           |               |
| 11   | Idiopathic pain disorders - Pathways of vulnerability              | L. Diatchenko                | University of North Carolina | 2006 | 259       | 16.19         |
| 12   | International consensus on the assessment of bruxism: Report of a   | F. Lobbezoo                  | Academic Center for Dentistry Amsterdam (ACTA) | 2018 | 254     | 63.5         |
|      | work in progress                                                    |                            |                            |      |           |               |
| 13   | Review of aetiological concepts of temporomandibular pain disorders:| T. I. Suvinen                | University of Helsinki     | 2005 | 236       | 13.88         |
|      | toward a biopsychosocial model for integration of physical disorder  |                            |                            |      |           |               |
|      | factors with psychological and psychosocial illness impact factors  |                            |                            |      |           |               |
| 14   | Role of Psychosocial Factors in the Etiology of Bruxism            | D. Manfredini                | University of Padova       | 2009 | 233       | 17.92         |
| 15   | Risk factors for diagnostic subgroups of painful temporomandibular  | G. J. Huang                  | University of Washington   | 2002 | 233       | 11.65         |
|      | disorders (TMD)                                                     |                            |                            |      |           |               |
| 16   | Relationship between bruxism and temporomandibular disorders: a     | D. Manfredini                | University of Padova       | 2010 | 222       | 18.5          |
|      | systematic review of literature from 1998 to 2008                   |                            |                            |      |           |               |
| 17   | Craniofacial muscle pain: Review of mechanisms and clinical         | P. Svensson                  | Aalborg University         | 2001 | 222       | 10.57         |
|      | manifestations                                                      |                            |                            |      |           |               |
| 18   | Epidemiology of Bruxism in Adults: A Systematic Review of the       | D. Manfredini                | University of Padova       | 2013 | 218       | 24.22         |
|      | Literature                                                           |                            |                            |      |           |               |
| 19   | A longitudinal epidemiologic study of signs and symptoms of         | T. Magnusson                 | Jönköping University      | 2000 | 212       | 9.64          |
|      | temporomandibular disorders from 15 to 35 years of age              |                            |                            |      |           |               |
| 20   | Prevalence of temporomandibular disorder subtypes, psychologic      | A. U. J. Yap                 | University of Singapore   | 2003 | 211       | 11.11         |
|      | distress, and psychosocial dysfunction in Asian patients             |                            |                            |      |           |               |
| 21   | Enhanced Medial Prefrontal-Default Mode Network Functional           | A. Kucyi                     | University of Toronto      | 2014 | 210       | 26.25         |
|      | Connectivity in Chronic Pain and Its Association with Pain Rumination |                            |                            |      |           |               |
| 22   | Deficiency in endogenous modulation of prolonged heat pain in patients with Irritable Bowel Syndrome and Temporomandibular Disorder | C. D. King                  | University of Florida      | 2009 | 206       | 15.85         |
| 23   | Painful Temporomandibular Disorder: Decade of Discovery from        | G. D. Slade                  | University of North Carolina | 2016 | 185       | 30.83         |
|      | OPPERA Studies                                                      |                            |                            |      |           |               |
| 24   | Psychological Factors Associated With Development of TMD: The       | R. B. Fillingim              | University of Florida      | 2013 | 184       | 20.44         |
|      | OPPERA Prospective Cohort Study                                    |                            |                            |      |           |               |
| 25   | Management of TMD: evidence from systematic reviews and meta-        | T. List                      | Malmö University           | 2010 | 183       | 15.25         |
|      | analyses                                                            |                            |                            |      |           |               |
| 26   | Oro-facial pain in the community: prevalence and associated impact  | T. V. Macfarlane             | University of Manchester   | 2002 | 181       | 9.05          |
| 27   | Radiographic examination of the temporomandibular joint using cone  | K. Tsiklakis                  | University of Athens       | 2004 | 179       | 9.94          |
|      | beam computed tomography                                            |                            |                            |      |           |               |

(Continued)
| Rank | Title | Main author | Institution | Year | Citations | Total | Average |
|------|-------|-------------|-------------|------|-----------|-------|---------|
| 28   | Clinical Findings and Pain Symptoms as Potential Risk Factors for Chronic TMD: Descriptive Data and Empirically Identified Domains from the OPPERA Case-Control Study | R. Ohrbach | University at Buffalo | 2011 | 178       | 16.18 |
| 29   | Prevalence of temporomandibular dysfunction and its association with Malocclusion in children and adolescents: An epidemiologic study related to specified stages of dental development | B. Thilander | Göteborg University | 2002 | 178       | 8.9   |
| 30   | Short- and long-term efficacy of brief cognitive-behavioral therapy for patients with chronic temporomandibular disorder pain: A randomized, controlled trial | J. Á. Turner | University of Washington | 2006 | 176       | 11    |
| 31   | Relationship of pain and symptoms to pubertal development in adolescents | L. LeResche | University of Washington | 2005 | 172       | 10.12 |
| 32   | High prevalence of temporomandibular joint arthritis at disease onset in children with juvenile idiopathic arthritis, as detected by magnetic resonance imaging but not by ultrasound | P. F. Weiss | University of Pennsylvania | 2008 | 170       | 12.14 |
| 33   | A systematic review of the effectiveness of physical therapy interventions for temporomandibular disorders | M. L. McNeely | University of Alberta | 2006 | 170       | 10.63 |
| 34   | A Randomized clinical trial using Research Diagnostic Criteria for Temporomandibular Disorders-Axis II to target clinic cases for a tailored self-care TMD treatment program | S. F. Dworkin | University of Washington | 2002 | 163       | 8.15  |
| 35   | Temporomandibular disorders and oral health-related quality of life. A systematic review | L. Dahlstrom | Göteborg University | 2010 | 162       | 13.5  |
| 36   | Temporomandibular disorders and hormones in women | M. P. Warren | Columbia University | 2001 | 161       | 7.67  |
| 37   | Current Understanding of Pathogenesis and Treatment of TMJ Osteoarthritis | X. D. Wang | Peking University | 2015 | 156       | 22.29 |
| 38   | A prospective investigation over two decades on signs and symptoms of temporomandibular disorders and associated variables. A final summary | T. Magnusson | Jönköping University | 2005 | 155       | 9.12  |
| 39   | Sleep Disorders and their Association with Laboratory Pain Sensitivity in Temporomandibular Joint Disorder | M. T. Smith | Johns Hopkins University | 2009 | 154       | 11.85 |
| 40   | Reliability, validity, and clinical utility of the Research Diagnostic Criteria for Temporomandibular Disorders Axis II scales: Depression, non-specific physical symptoms, and graded chronic pain | S. F. Dworkin | University of Washington | 2002 | 153       | 7.65  |
| 41   | Group differences in pain modulation: pain-free women compared to pain-free men and to women with TMD | E. E. Bragdon | University of North Carolina | 2002 | 151       | 7.55  |
| 42   | Assessment of bruxism in the clinic | K. Koyano | Kyushu University | 2008 | 150       | 10.71 |
| 43   | Different Pain, Different Brain: Thalamic Anatomy in Neuropathic and Non-Neuropathic Chronic Pain Syndromes | S. M. Gustin | University of Sydney | 2011 | 148       | 13.45 |
| 44   | Early diagnosis of temporomandibular joint involvement in juvenile idiopathic arthritis: a pilot study comparing clinical examination and ultrasound to magnetic resonance imaging | L. Mueller | University of Zürich | 2009 | 148       | 11.38 |
| 45   | A randomized clinical trial of a tailored comprehensive care treatment program for temporomandibular disorders | S. F. Dworkin | University of Washington | 2002 | 148       | 7.4   |
| 46   | Pathophysiology of TMD pain - basic mechanisms and their implications for pharmacotherapy | B. E. Cairns | University of British Columbia | 2010 | 147       | 12.25 |
| 47   | The etiology of temporomandibular disorders: Implications for treatment | C. S. Greene | University of Illinois | 2001 | 146       | 6.95  |
| 48   | A systematic review of the effectiveness of exercise, manual therapy, electrotherapy, relaxation training, and biofeedback in the management of temporomandibular disorder | M. S. Medicott | University of British Columbia | 2006 | 145       | 9.06  |
| 49   | Expanding the taxonomy of the diagnostic criteria for temporomandibular disorders | C. C. Peck | University of Sydney | 2014 | 143       | 17.88 |
| 50   | Temporomandibular disorders in relation to craniofacial dimensions, head posture and bite force in children selected for orthodontic treatment | L. Sonnesen | University of Copenhagen | 2001 | 143       | 6.81  |
| 51   | Reliability of clinical temporomandibular disorder diagnoses | M. T. John | University of Leipzig | 2005 | 142       | 8.35  |

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| Rank | Title                                                                 | Main author             | Institution                  | Year | Citations | Total | Average |
|------|-----------------------------------------------------------------------|-------------------------|------------------------------|------|-----------|-------|---------|
| 52   | Potential Psychosocial Risk Factors for Chronic TMD: Descriptive Data | R. B. Fillingim         | University of Florida        | 2011 | 141       | 12.82 |
|      | and Empirically Identified Domains from the OPPERA Case-Control       |                         |                              |      |           |       |         |
|      | Study                                                                  |                         |                              |      |           |       |         |
| 53   | The Research Diagnostic Criteria for Temporomandibular Disorders. V:  | E. L. Schiffman         | University of Minnesota      | 2010 | 141       | 11.75 |
|      | Methods Used to Establish and Validate Revised Axis I Diagnostic      |                         |                              |      |           |       |         |
|      | Algorithms                                                             |                         |                              |      |           |       |         |
| 54   | Influence of psychological factors on risk of temporomandibular       | G. D. Slade             | University of Adelaide       | 2007 | 141       | 9.4   |
|      | disorders                                                              |                         |                              |      |           |       |         |
| 55   | Three major haplotypes of the beta 2 adrenergic receptor define       | L. Diatchenko           | University of North Carolina | 2006 | 141       | 8.81  |
|      | psychological profile, blood pressure, and the risk for development of |                         |                              |      |           |       |         |
|      | a common musculoskeletal pain disorder                                |                         |                              |      |           |       |         |
| 56   | Depression and somatization in patients with temporomandibular       | A. U. J. Yap            | University of Singapore      | 2002 | 140       | 7     |
|      | disorders                                                              |                         |                              |      |           |       |         |
| 57   | Orofacial Pain Prospective Evaluation and Risk Assessment Study -     | W. Maixner              | University of North Carolina | 2011 | 135       | 12.27 |
|      | The OPPERA Study                                                       |                         |                              |      |           |       |         |
| 58   | Pain Sensitivity Risk Factors for Chronic TMD: Descriptive Data and   | J. D. Greenspan         | University of Maryland       | 2011 | 133       | 12.09 |
|      | Empirically Identified Domains from the OPPERA Case Control Study     |                         |                              |      |           |       |         |
| 59   | The Research Diagnostic Criteria for Temporomandibular Disorders. I:  | E. L. Schiffman         | University of Minnesota      | 2010 | 132       | 11    |
|      | Overview and Methodology for Assessment of Validity                   |                         |                              |      |           |       |         |
| 60   | Are headache and temporomandibular disorders related? A blinded study | V. Ballegaard           | University of Copenhagen     | 2008 | 131       | 9.36  |
| 61   | Contributing factors to chronic myofascial pain: a case-control study | A. M. Velly             | McGill University           | 2003 | 130       | 6.84  |
| 62   | Temporomandibular joint disk displacement: Comparison in              | T. A. Larheim          | University of Oslo           | 2001 | 130       | 6.19  |
|      | asymptomatic volunteers and patients                                   |                         |                              |      |           |       |         |
| 63   | Quantification and validation of predictive values of occlusal variables | A. G. Pullinger         | University of California     | 2000 | 130       | 5.91  |
|      | in temporomandibular disorders using a multifactorial analysis        |                         |                              |      |           |       |         |
| 64   | Chronic myofascial temporomandibular pain is associated with neural   | J. W. Younger           | University of California     | 2010 | 128       | 10.67 |
|      | abnormalities in the trigeminal and limbic systems                    |                         |                              |      |           |       |         |
| 65   | Bruxism: its multiple causes and its effects on dental implants - an  | F. Lobbezoo             | Academic Center for Dentistry| 2006 | 125       | 7.81  |
|      | updated review                                                         |                         |                              |      |           |       |         |
| 66   | TMJ disorders: Future innovations in diagnostics and therapeutics     | S. Wadhwa               | University of Connecticut   | 2008 | 123       | 8.79  |
| 67   | Symptoms of Temporomandibular Disorders in the Population: An        | D. A. de Godoi          | University of São Paulo      | 2010 | 122       | 10.17 |
|      | Epidemiological Study                                                 | Goncalves               |                              |      |           |       |         |
| 68   | Drugs and bruxism: A critical review                                  | E. Winocur              | Tel Aviv University          | 2003 | 122       | 6.42  |
| 69   | Oral health-related quality of life in patients with temporomandibular| M. T. John              | University of Leipzig        | 2007 | 120       | 8     |
|      | disorders                                                              |                         |                              |      |           |       |         |
| 70   | Predictors of onset of facial pain and temporomandibular disorders in| L. LeResche             | University of Washington     | 2007 | 120       | 8     |
|      | early adolescence                                                     |                         |                              |      |           |       |         |
| 71   | A 20-year follow-up of signs and symptoms of temporomandibular        | I. Egermark             | Göteborg University          | 2003 | 118       | 6.21  |
|      | disorders and malocclusions in subjects with and without orthodontic  |                         |                              |      |           |       |         |
|      | treatment in childhood                                                |                         |                              |      |           |       |         |
| 72   | A 20-year longitudinal study of subjective symptoms of               | I. Egermark             | Göteborg University          | 2001 | 118       | 5.62  |
|      | temporomandibular disorders from childhood to adulthood               |                         |                              |      |           |       |         |
| 73   | Analysis of stimulus-evoked pain in patients with myofascial         | P. Svensson             | Aalborg University           | 2001 | 117       | 5.57  |
|      | temporomandibular pain disorders                                      |                         |                              |      |           |       |         |
| 74   | Depression, pain, exposure to stressful life events, and long-term    | S. M. Auerbach          | Virginia Commonwealth        | 2001 | 116       | 5.52  |
|      | outcomes in temporomandibular disorder patients                        |                         | University                   |      |           |       |         |
| 75   | Diagnosis and Treatment of Temporomandibular Disorders                | R. L. Gauer             | Womack Medical Center        | 2015 | 115       | 16.43 |
|      |                                                                        |                         |                              |      |           |       |         |
| 76   | Oral parafunctions as risk factors for diagnostic TMD subgroups       | A. Michelotti           | University of Naples         | 2010 | 115       | 9.58  |
|      |                                                                        |                         |                              |      |           |       |         |
| 77   | Headache and Symptoms of Temporomandibular Disorder: An              | D. A. G. Goncalves      | University of São Paulo      | 2010 | 115       | 9.58  |
|      | Epidemiological Study                                                 |                         |                              |      |           |       |         |
| 78   | Bilateral Widespread Mechanical Pain Sensitivity in Women With        | C. Fernandez-de-las-Penas- | Universidad Rey Juan Carlos | 2009 | 115       | 8.85  |
|      | Myofascial Temporomandibular Disorder: Evidence of Impairment in      |                         |                              |      |           |       |         |
|      | Central Nociceptive Processing                                        |                         |                              |      |           |       |         |

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TABLE 1 | Continued

| Rank | Title                                                                 | Main author               | Institution                      | Year | Citations |
|------|-----------------------------------------------------------------------|---------------------------|----------------------------------|------|-----------|
|      | Total                                                                  |                           | Average                          |      |           |
| 79   | Development of a brief and effective temporomandibular disorder pain  | Y. M. Gonzalez            | University of Buffalo            | 2011 | 114       |
|      | screening questionnaire Reliability and validity                      |                           |                                  |      | 10.36     |
| 80   | Viscoelastic characterization of the porcine temporomandibular joint   | K. D. Allen               | Rice University                  | 2006 | 114       |
|      | disc under unconfinned compression                                    |                           |                                  |      | 7.13      |
| 81   | The role of parafunctions, emotions and stress in predicting facial    | A. G. Glaros              | Kansas City University           | 2005 | 114       |
|      | pain                                                                   |                           |                                  |      | 6.71      |
| 82   | Potential Genetic Risk Factors for Chronic TMD: Genetic Associations    | Smith, Shad B             | University of North Carolina     | 2011 | 112       |
|      | from the OPPERA Case Control Study                                    |                           |                                  |      | 10.18     |
| 83   | The roles of beliefs, catastrophizing, and coping in the functioning   | Turner, JA                | University of Washington         | 2001 | 112       |
|      | of patients with temporomandibular disorders                          |                           |                                  |      | 5.33      |
| 84   | Temporomandibular Disorders: A Review of Etiology, Clinical Management,| Murphy, Meghan K         | University of California         | 2013 | 111       |
|      | and Tissue Engineering Strategies                                     |                           |                                  |      | 12.33     |
| 85   | Evidence for up-regulated central nociceptive processing in patients   | Sarlani, E                | University of Maryland           | 2004 | 111       |
|      | with masticatory myofascial pain                                      |                           |                                  |      | 6.17      |
| 86   | Longitudinal outcome of temporomandibular disorders: A 5-year         | Rammelsberg, P            | University of Heidelberg         | 2003 | 111       |
|      | epidemiologic study of muscle disorders defined by Research Diagnostic |                           |                                  |      | 5.84      |
|      | Criteria for Temporomandibular Disorders                              |                           |                                  |      |           |
| 87   | Widespread pain as a risk factor for dysfunctional temporomandibular   | John, MT                  | Martin Luther University         | 2003 | 111       |
|      | disorder pain                                                          |                           |                                  |      | 5.84      |
| 88   | A comparison of human umbilical cord matrix stem cells and             | Bailey, Mark M            | University of Kansas             | 2007 | 110       |
|      | temporomandibular joint condylar Chondrocytes for tissue engineering   |                           |                                  |      | 7.33      |
|      | temporomandibular joint condylar cartilage                            |                           |                                  |      |           |
| 89   | Importance of proinflammatory cytokines in synovial fluid from 121     | K. Kaneyama               | Kanazawa Medical University      | 2002 | 109       |
|      | joints with temporomandibular disorders                               |                           |                                  |      | 5.45      |
| 90   | The relationship between headache and symptoms of                      | R. Cianciaglini           | University of Milan              | 2001 | 109       |
|      | temporomandibular disorder in the general population                  |                           |                                  |      | 5.19      |
| 91   | Adrenergic Dysregulation and Pain With and Without Acute Beta-Blockade | K. C. Light               | University of Utah               | 2009 | 108       |
|      | in Women With Fibromyalgia and Temporomandibular Disorder              |                           |                                  |      | 8.31      |
| 92   | The efficacy of traditional, low-cost and nonsplint therapies for      | E. Truelove               | University of Washington         | 2006 | 108       |
|      | temporomandibular disorder: A randomized controlled trial             |                           |                                  |      | 6.75      |
| 93   | Efficacy of temporomandibular joint arthrocentesis with and without    | G. H. Alpaslan            | Gazi University                  | 2001 | 108       |
|      | injection of sodium hyaluronate in treatment of internal derangements |                           |                                  |      | 5.14      |
| 94   | Oral appliances in the management of temporomandibular disorders       | G. D. Klasser             | University of Illinois           | 2009 | 107       |
|      |                                                                        |                           |                                  |      | 8.23      |
| 95   | Temporomandibular Joint and Muscle Disorder-type Pain in US Adults:   | U. Isong                  | University of California         | 2008 | 107       |
|      | The National Health Interview Survey                                  |                           |                                  |      | 7.64      |
| 96   | Temporomandibular joint arthritis in juvenile idiopathic arthritis:   | A. D. Billau              | University of Leuven             | 2007 | 107       |
|      | Prevalence, clinical and radiological signs, and relation to dentofacial|                           |                                  |      | 7.13      |
|      | morphology                                                            |                           |                                  |      |           |
| 97   | Counseling and physical therapy as treatment for myofascial pain of    | A. De Laat                | University of Leuven             | 2003 | 107       |
|      | the masticatory system                                                 |                           |                                  |      | 5.63      |
| 98   | Systematic review of population-based epidemiological studies of       | T. V. Macfarlane          | University of Manchester         | 2001 | 107       |
|      | oro-facial pain                                                        |                           |                                  |      | 5.1       |
| 99   | Need for occlusal therapy and prosthodontic treatment in the           | J. A. De Boever           | University of Gent               | 2000 | 107       |
|      | management of temporomandibular disorders, Part I. Occlusal            |                           |                                  |      | 4.86      |
|      | interferences and occlusal adjustment                                  |                           |                                  |      |           |
| 100  | Situational Versus Dispositional Measurement of Catastrophizing:      | C. M. Campbell            | Johns Hopkins University         | 2010 | 106       |
|      | Associations With Pain Responses in Multiple Samples                  |                           |                                  |      | 8.83      |

RESULTS

The initial search identified 8,927 publications. The 100 top-cited studies related to TMD are listed by rank order based on the number of citations in Table 1. The top-cited study was a review article related to diagnosis published in 2014 in the Journal of Oral and Facial Pain and Headache [7]. This study was finalized at the University of Minnesota (USA) and had 1,287 citations with the highest average citation per year (160.88 citations/year). The oldest study included was published in 2000, while the youngest in 2018. The top-cited author was “Schiffman EC” from the University of Minnesota, and this author published a total of three studies among the top 100 cited and had a total of 1,560 citations (Table 2).
A total of 17,434 citations were found among the included studies. Of the 100 top-cited, 46 were published by researchers from the USA, followed by Sweden with a total of 7 published studies. Fifty-four publications were from America, 36 from Europe, 7 from Asia, and 3 from Oceania (Figure 1).

A total of 36 journals were found among the 100 top-cited papers. The Journal of Orofacial Pain had 18 published studies among the top 100 cited, or, in fact, 19 since it changed its name to Journal of Oral and Facial Pain and Headache in 2014. The highest impact factor found was from one publication in the journal New England Journal of Medicine (91.253) followed by the journal Archives of Internal Medicine (17.333) (Table 3).

Thirty-three percent of the studies included were review papers, 43% were observational studies, and 12% were clinical studies (Figure 2).

When it comes to the field of investigation, i.e., which topic within the field of TMD, the most common topic was “pain” with a total of 15 publications, followed by the topic “treatment” and bruxism with a total of 10 publications (Figure 3). When it comes to bruxism, six out of the 18 cited studies concerned that topic.

**DISCUSSION**

In this bibliometric analysis, the top cited paper in the field of TMD the last 20 years, i.e., from the millennial shift (the year 2000), is an American publication setting new and improved diagnostic criteria for TMD (DC/TMD) [7]. This was not a surprising finding, since these diagnostic criteria are used worldwide by both clinicians and researchers in the field of TMD. Further, journals in the field of TMD, for instance, the Journal of Oral and Facial Pain and Headache (http://www.quintpub.com/journals/ofph/index.php), require researchers to adhere to the methodology, terminology, and diagnostic criteria as set by this top-cited study by Schiffman et al. [7].

As in the field of oral and maxillofacial surgery [14], most (81 of 100) of the top-cited studies were from the USA and Europe. However, this was not a surprising finding since it has been shown that most of the top-cited or top-ranked studies are conducted in countries with better economic rankings [15, 16]. This finding can also explain the fact that 13 of the 15 most cited authors are from the USA and Europe. Further,
TABLE 3 | Ranking of journal based on number of publications.

| Rank | Journal                                                                 | Impact factor | Number of papers published |
|------|--------------------------------------------------------------------------|---------------|----------------------------|
| 1    | Journal of orofacial pain                                               | 2.824         | 18                         |
| 2    | Pain                                                                     | 6.961         | 14                         |
| 3    | Journal of oral rehabilitation                                          | 3.837         | 10                         |
| 4    | Journal of pain                                                         | 5.828         | 9                          |
| 5    | Journal of dental research                                               | 6.116         | 5                          |
| 6    | Oral surgery oral medicine oral pathology oral radiology and endodontology | 1.457         | 4                          |
| 7    | Acta odontologica Scandinavica                                           | 2.331         | 3                          |
| 8    | Journal of the American Dental Association                               | 3.634         | 3                          |
| 9    | Journal of neuroscience                                                  | 6.167         | 2                          |
| 10   | Angle orthodontist                                                       | 2.079         | 2                          |
| 11   | Physical therapy                                                        | 3.140         | 2                          |
| 12   | Journal of prosthetic dentistry                                          | 3.426         | 2                          |
| 13   | Journal of oral and maxillofacial surgery                                | 1.895         | 2                          |
| 14   | Journal of dentistry                                                     | 4.379         | 2                          |
| 15   | Journal of oral and facial pain and headache                            | 1.871         | 1                          |
| 16   | Archives of internal medicine                                           | 17.333        | 1                          |
| 17   | New England journal of medicine                                         | 91.253        | 1                          |
| 18   | European journal of pain                                                | 3.934         | 1                          |
| 19   | Community dentistry and oral epidemiology                                | 3.383         | 1                          |
| 20   | Dentomaxillofacial radiology                                             | 2.419         | 1                          |
| 21   | Arthritis and rheumatism                                                | 7.379         | 1                          |
| 22   | Cells tissues organs                                                    | 2.481         | 1                          |
| 23   | Sleep                                                                    | 5.849         | 1                          |
| 24   | Rheumatology                                                             | 7.580         | 1                          |
| 25   | European journal of orthodontics                                         | 3.934         | 1                          |
| 26   | American journal of medical genetics part b-neuropsychiatric genetics    | 3.588         | 1                          |
| 27   | Cephalalgia                                                              | 6.295         | 1                          |
| 28   | Radiology                                                                | 11.105        | 1                          |
| 29   | Journal of dental education                                              | 2.264         | 1                          |
| 30   | American family physician                                                | 3.292         | 1                          |
| 31   | Headache                                                                 | 5.887         | 1                          |
| 32   | Journal of biomechanics                                                 | 2.712         | 1                          |
| 33   | International journal of oral and maxillofacial implants                 | 2.804         | 1                          |
| 34   | Tissue engineering                                                       | 3.508         | 1                          |
| 35   | British journal of oral and maxillofacial surgery                        | 1.651         | 1                          |
| 36   | Journal of rheumatology                                                 | 4.666         | 1                          |

although the publications are spread between 36 journals, one journal has attracted as many as 20% of the top 100 cited studies. One explanation could be that it is the “Official Journal of the American Academy of Orofacial Pain, the European Academy of Orofacial Pain and Dysfunction, the Asian Academy of Cranio-facial Disorders, and the Australian and New Zealand Academy of Orofacial Pain” (http://www.quintpub.com/journals/ofph/index.php). Still, this is surprising since authors strive to publish their studies in journals with high impact factors since a high impact factor also is considered as an indication of a study with great impact and high quality [5, 6]. However, considering all 36 journals among the 100 top cited studies, this analysis shows that authors in the field of TMD tend to strive for journals with high impact factors and, when possible, also choose journals that have higher impact factors although not TMD specific, such as New England Journal of Medicine and Archives of Internal Medicine. This is possible due to the multifaceted character of TMD conditions and the multidisciplinary nature of the therapeutic approach to these conditions [7, 8, 10]. This is also consistent with the fact that researchers tend to cite studies from journals with higher impact factors, where the journal impact factor answers for 59% of the variation in the number of citations [17].

Researchers in all fields of science aim to communicate their findings to other scientists, clinicians, and decision-makers [1]. Using this citation analysis report to assess the impact the specific articles have on the field of TMD, its importance, and popularity, one can understand why the new diagnostic criteria (DC/TMD)
FIGURE 2 | Percentage distribution of study types. Some of the studies could not be referred to a specific study type, thus they were clustered based on the content, e.g., diagnostic accuracy, questionnaire development, and review article (non-systematic reviews of any kind). RCT, randomized controlled trial.

FIGURE 3 | Topics within the field of temporomandibular disorders covered in the 100 top-cited studies.
by Schiffman et al. [7] is top cited. It is a study providing sensitive and specific protocols to examine and diagnose patients with TMD for undergraduate dental students and clinicians worldwide, for researchers for the possibility to compare results and outcomes from different studies in different countries, and for decision-makers to use for treatment guidelines. However, this report cannot reflect the quality of the content in the specific studies [5, 6].

It was not surprising that the majority of the top cited studies were published between the years of 2007 and 2011 since it has been shown that studies are cited just sparingly with few citations in the first years, followed by a peak of citations just before a study-age of 10 years [18]. Although the outcome of bibliometric analyses of this kind are criticized for being affected by the impact of time [19], this is not the case in this study since the bulk of most cited papers are from the years 2007 to 2018 and not from 2000 to 2006.

Another interesting finding was that all of the top 100 cited studies had 100 citations or more, and are thus classic studies [2]. Classic studies are considered to have a great impact [2], of which their outcomes can be used to affect decisions and guide the readers in their decision making [1]. One must not forget the possibility of self-citations to be a possible explanation to the high number of classical studies. However, previous studies have discussed this and came to the conclusion that there is no need for any revision of the journal citation metrics used in bibliometric analysis since the extent of self-citations were not related either to the number of co-authors or to the authors’ productivity [20, 21].

Taken together, since all papers are considered classic ones, we can conclude that researchers in the year 2000 and onward in the field of TMD are interested in (a) diagnostic criteria, (b) TMD symptoms and mainly pain-related symptoms, (c) etiology and risk factors of TMD and mainly bruxism, and (d) treatment of TMD. However, topics such as imaging, occlusion, tissue engineering, and disk displacements are presently not as popular.

**AUTHOR CONTRIBUTIONS**

All authors contributed equally in this manuscript, thus participating in data collection, analysis, and interpretation, also authoring the introduction, methods, results, discussion, and read and approved the final version of the manuscript.

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