

# World Workshop on Oral Medicine VIII: barriers to research in oral medicine: lessons learned from a bibliometric analysis of the oral potentially malignant disorders literature

Luiz Alcino Gueiros, DDS, PhD,<sup>a</sup> Giulia Ottaviani, DDS, PhD,<sup>b</sup> Maryam Jessri, DDS, PhD,<sup>c,d</sup> Caroline Shiboski, DDS, PhD,<sup>e</sup> Arwa Farag, DDS, PhD,<sup>f</sup> Thomas P. Sollecito, DDS,<sup>g</sup> Saman Warnakulasuriya, DDS, PhD,<sup>h</sup> and Alexander Ross Kerr, DDS<sup>i</sup>

**Objective.** This study aimed to assess the impact of oral medicine (OM) practitioners on the literature regarding oral potentially malignant disorders (OPMDs), focusing on oral leukoplakia.

**Study Design.** Using a bibliometric approach on the Scopus database until September 1, 2022, the top 100 cited articles were analyzed for article type, subtopic, specialty contributions, author metrics, and keywords. The Bibliometrix package for R and VOSviewer were used to evaluate interactions and generate science maps.

**Results.** OM practitioners, comprising 39% of contributors, played a significant role in studies related to nomenclature and screening of OPMDs. Notably, 4 OM specialists ranked among the most prolific authors, demonstrating denser collaboration with OM co-authors compared to other cancer specialists. However, there was a scarcity of OPMD management studies authored by OM practitioners.

**Conclusions.** Despite the paucity of OM practitioners, the findings underscored the substantial contribution of OM practitioners in developing OPMD nomenclature and classification, emphasizing the need for increased collaboration with cancer specialists to conduct comprehensive clinical trials for OPMD management. The study highlights the importance of standardized criteria in OPMDs research for better data comparison and encourages further efforts from the OM scientific community. (Oral Surg Oral Med Oral Pathol Oral Radiol 2024;138:46–65)

Oral medicine (OM) is defined by the American Academy of Oral Medicine (AAOM)<sup>1</sup> and the European Association of Oral Medicine (EAOM)<sup>2</sup> as the specific area of competence concerned with the health and diseases of the oral and peri-oral structures, including oral health care of medically complex patients and

the diagnosis and management of medically related diseases, disorders, and conditions affecting the oral and maxillofacial region. OM training programs vary across the globe, but almost all encompass skills in diagnosing and/or managing a wide variety of orofacial conditions such as oral mucosal diseases (including oral cavity cancer and oral potentially malignant disorders [OPMDs]), orofacial pain, salivary gland disorders, and oral manifestations of systemic diseases. The World Workshop on Oral Medicine (WWOM) VIII proposed to explore the barriers to research in OM, by performing 2 projects: a global survey to understand factors influencing research interest and productivity, and perceived barriers to conducting research by OM practitioners,<sup>3</sup> and the present project, a bibliometric analysis of the top 100 cited papers on OPMDs, highlighting the contributions of OM to this field.

OPMDs are defined as “any oral mucosal abnormality that is associated with a statistically increased risk of developing oral cancer.”<sup>4</sup> The topic of OPMDs was

<sup>a</sup>Department of Clinic and Preventive Dentistry & Oral Medicine Unit, Hospital das Clínicas, Federal University of Pernambuco, Recife, Brazil.

<sup>b</sup>Department of Surgical, Medical and Health Sciences, University of Trieste, Trieste, Italy.

<sup>c</sup>Oral Medicine Department, Metro North Oral Health Services, Herston, QLD, Australia.

<sup>d</sup>Oral Medicine Department, School of Dentistry, The University of Queensland, Herston, QLD, Australia.

<sup>e</sup>Department of Orofacial Sciences, School of Dentistry, University of California, San Francisco, San Francisco, CA, USA.

<sup>f</sup>Division of Oral Medicine, Department of Oral Diagnostic Sciences, King AbdulAziz University Faculty of Dentistry, Jeddah, Saudi Arabia.

<sup>g</sup>Department of Oral Medicine, University of Pennsylvania School of Dental Medicine, Philadelphia, PA, USA.

<sup>h</sup>Faculty of Dentistry, Oral & Craniofacial Sciences, Department of Oral Medicine, King’s College London, London, UK.

<sup>i</sup>Department of Oral & Maxillofacial Pathology, Radiology and Medicine, New York University College of Dentistry, New York, NY, USA.

Corresponding author: Luiz Alcino Gueiros E-mail address: [luiz.gueiros@ufpe.br](mailto:luiz.gueiros@ufpe.br)

## Statement of Clinical Relevance

Oral potentially malignant lesions are a cornerstone of oral medicine practice. Practitioners made significant contributions to research, shaping nomenclature, classification, and understanding natural history. Collaborating with other specialties is vital to address the current scarcity of intervention studies.

selected because it is globally impactful and this topic has been a strong clinical focus for the OM specialty for several decades. Other dental and medical specialties, such as oral and maxillofacial pathology, and head and neck oncology share an interest in this topic, specifically related to the important subcategories of OPMDs, such as oral leukoplakia, oral erythroplakia, and proliferative verrucous leukoplakia. Therefore, exploring OPMDs literature may highlight the collaboration of OM with other specialties.

Bibliometric analysis is a “scientific computer-assisted review methodology that can identify core research and/or authors, as well as their relationship, by covering all the publications related to a given topic or field.”<sup>5-7</sup> This method can provide a systematic, objective, reliable, and reproducible review process based on the assessment of science, scientists, or scientific activity using statistical testing when relevant.<sup>8</sup> Aside from ranking authors, units, institutions, and countries, bibliometric analyses may also allow qualitative review of a topic by examining types of articles, their subtopics, and implications for research. Additionally, bibliometric studies may reveal and identify rapidly evolving areas within a field and/or effectively pinpoint barriers to research in well-established fields. There are many bibliometric analyses of highly cited articles on OPMDs<sup>9-13</sup>; however, the aim of this study was to highlight the contribution of OM practitioners to the OPMD literature, identify possible barriers to research, and provide insights into future potential collaborative international research opportunities between OM and other dental and medical “specialties.”

## MATERIALS AND METHODS

### Selection strategy

This investigation followed the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.<sup>14</sup> Ethical approval was not necessary as only published literature found in the public domain was evaluated. An electronic bibliometric search was performed using the Scopus database, maintained by Elsevier (Amsterdam, the Netherlands). Data collection started from the database launch dates up to September 1, 2022.

The search was focused on OPMDs. All MESH terms synonyms used in the literature since 1970s were included by the Boolean separator “OR” as follows: (“potentially malignant oral disorders” OR “potentially premalignant oral lesions” OR “pre-malignant oral lesions” OR “oral premalignant lesions” OR “oral premalignancy” OR “oral precancer” OR “pre-malignant lesions of the oral cavity” OR “potentially malignant disorders of the oral mucosa” OR “pre-malignant oral mucosal disease” OR “potentially premalignant oral epithelial lesions” OR “pre-malignant oral tissue” OR

“pre-malignant oral mucosa” OR “oral potentially malignant disorder” OR “oral precancerous condition” OR “potentially premalignant disorder” OR “oral precancer” OR “pre-malignant lesions” OR “oral dysplasia” OR “oral epithelial dysplasia” OR “oral erythroplakia” OR “oral leukoplakia” OR “erythroplakia” OR “leukoplakia” OR “proliferative verrucous leukoplakia” OR “OPMD” OR “OPML” OR “PVL”).

We decided not to include search terms for the newer subcategories of OPMDs, including “actinic cheilitis,” “oral lichen planus,” “oral lichenoid lesions,” “oral graft versus host disease,” and “oral submucous fibrosis.”

### Selection criteria

The bibliometric review was performed on Scopus and included articles in all languages, articles in 27 different International Scientific Index categories of medical science, and articles whose title, abstracts or the keywords included at least one of the MeSH terms mentioned above. Three investigators (LAG, GO, and MJ) independently verified data entry and collection and then reformulated the dataset for bibliometric analyses after excluding non-relevant articles. Any disagreement was discussed and resolved by consensus between 2 investigators (GO and MJ), and if not reached, 2 further investigators (LAG and SW) were consulted to adjudicate the decision. Documents listed in the database were ranked in descending order by citation index and the list was merged into a final document with the top 100 cited articles. Narrative and systematic reviews were included to represent the current body of high cited articles and their distribution between OM and other dental and medical “specialties.”

### Data extraction

Two reviewers (GO and MJ) independently reviewed all the papers and evaluated their adherence to the inclusion criteria by importing all articles in Rayyan software.<sup>15</sup> The following data categories were extracted or calculated: (a) article type; (b) article subtopic; (c) contributions by OM and other dental or medical “specialties” among first and last authors; (d) author metrics; and (e) keywords.

Articles that were based on original research were denoted as “primary” which included clinical trials, case-control studies, cohort studies, case series, *in vivo* animal studies, and *in vitro* studies. Articles based on reviews of pre-existing data were denoted as “secondary” which included narrative reviews, and systematic reviews with or without meta-analysis. Main article subtopics included nomenclature, epidemiology, screening, diagnosis, and management. These subtopics were further classified into adjunctive

techniques, chemoprevention, clinical features, histological features, malignant transformation, molecular biomarkers, and risk factors, to allow deeper analysis. The term “specialty” was defined as the area best associated with the clinical practice of an author and was captured by identifying and equally weighing (one point each) the specialty of the first and last authors of each article (for single-authored papers, the author’s specialty was double-weighted, i.e., 2 points) for a total of 200 points for the top 100 articles. The interaction of OM with other specialties (i.e., Oral and Maxillofacial Pathology (OP), and specialties including head and neck oncologic surgery, radiation oncology, medical oncology, basic science, medical pathology, and epidemiology/biostatistics) was also tabulated according to the article type and subtopics. Author-related metrics were extracted as follows: complete authorship, publication title, publication year, number of citations, citation density, journal, and its impact factor (Web of Science, 2021 Journal of Citation Reports), average citations, institution and country of the first author and last author, number of authors, number of centers, countries of the corresponding author, top prolific authors, and each author’s bibliometric indices (h-index, g-index, m-index). The h-index with self-citations was extracted from the Scopus database and corresponded to the number of articles on a list of publications ranked in descending order by the times cited with N or more citations.<sup>16</sup> Given a set of articles ranked in decreasing order of the number of citations that they received, the g-index was defined as the largest unique number such that the top g articles received at least  $g^2$  citations.<sup>17</sup> The m-index was calculated by dividing the h-index by the number of years a scientist has been active.<sup>18</sup> A word cloud was generated based on the keywords used by the authors. The authors’ specialties were manually checked at the Scopus, then double-checked by 2 senior authors with extensive international collaboration (SW and RK) on OPMD and oral cancer research.

Information on funding declared by the authors was retrieved from the Scopus generated list, and included the funding agency and its country.

### Statistical analysis

Data analysis was performed using descriptive statistics calculated using Excel software (Microsoft Inc). Bibliometrix package for R, an open-source tool designed for performing comprehensive science mapping analysis, was used to retrieve all lists related to articles, authors, countries and their interactions. Also, it was used to generate statistical graphs and science maps.<sup>19</sup> Additionally, VOSviewer<sup>20</sup> version 1.6.17 was used to generate science maps to complement the Bibliometrix information.

## RESULTS

### Study characteristics

Using the search strategy algorithm, 21,069 articles on the topic of OPMDs were retrieved from Scopus. The top 100 most cited articles included in the bibliometric analysis are shown in [Table I](#). The top 100 articles were published between 1968 and 2021, and were cited between 118 and 933 times. Among these articles, 69% were primary and 31% were secondary. The primary articles were distributed as follows: 21 cohort studies (13 prospective and 8 retrospective), 12 clinical trials of which 6 were randomized clinical trials (RCTs), 12 diagnostic accuracy studies, 8 descriptive studies, 7 case series, 4 screening studies, 3 case-control studies, and 2 cross-sectional studies. The secondary articles included 24 narrative reviews and 7 systematic reviews.

Within the subtopic of diagnosis, categories emerged: 25 articles were related to the molecular biomarkers in OPMDs; 9 articles each on histologic features, clinical features, and diagnostic adjunctive techniques; 3 articles on general features, and one article each on risk factors and malignant transformation. Within the subtopic of management, 13 articles were related to chemoprevention, 2 focused on photodynamic therapy, 2 on surgery/laser surgery, and 3 on other strategies. Within the subtopic of epidemiology, malignant transformation was the most frequent issue ( $n = 13$ ), followed by histopathologic features ( $n = 2$ ) and prevalence ( $n = 2$ ). Within the subtopic of nomenclature, all articles focused on clinical features ( $n = 6$ ). Within the subtopic of screening, the articles were equally distributed as clinical features ( $n = 2$ ) and risk factors ( $n = 2$ ). The mean citation index (MCI) of each subtopic was calculated to clarify their relevance among the top-cited papers. Nomenclature (MCI = 525.8) and epidemiology (MCI = 253.1) were the most cited topics while screening (MCI = 152.8) was the least cited.

The most relevant keywords found in the investigated articles were: leukoplakia ( $n = 26$ ); oral cancer ( $n = 14$ ), erythroplakia ( $n = 9$ ), epithelial dysplasia ( $n = 8$ ), and malignant transformation ( $n = 7$ ) ([Fig. 1](#)).

In terms of OM contribution to the top 100 articles ([Table II](#)), it was noted that OM practitioners had authorship on 39 publications. OM contributed a total of 62/200 points for first and last authors (31% of the point contribution) while OP contributed 55/200 (27.5%) of the total points. The remaining “specialties,” including basic science, epidemiology, head and neck surgical oncology, medical oncology, medical pathology, and radiation oncology, collectively contributed 83/200 (41.5%) of the total points. OM practitioners authored 21 primary articles (30% of all primary studies, 34/138 author points) and

**Table I.** Top 100 most cited articles included in the bibliometric analysis

<i>Rank</i>	<i>Citations</i>	<i>First author</i>	<i>Country (first author)</i>	<i>Last author</i>	<i>Country (last author)</i>	<i>Title</i>	<i>Year</i>	<i>Journal</i>
1	933	Warnakulasuriya S.	UK	Van Der Waal I.	Netherlands	Nomenclature and classification of potentially malignant disorders of the oral mucosa	2007	Journal of Oral Pathology and Medicine
2	923	Kramer I.R.H.	UK	Sobin L.H.	USA	Definition of leukoplakia and related lesions: An aid to studies on oral precancer	1978	Oral Surgery, Oral Medicine, Oral Pathology
3	873	Neville B.W.	USA	Day T.A	USA	Oral cancer and precancerous lesions	2002	CA-A Cancer Journal for Clinicians
4	832	Silverman S.	USA	Lozada F.	USA	Oral leukoplakia and malignant transformation. A follow-up study of 257 patients	1984	Cancer
5	736	Hong W.K.	USA	Strong S.	USA	13-cis-Retinoic Acid in the Treatment of Oral Leukoplakia	1986	New England Journal of Medicine
6	550	van der Waal I.	Netherlands	Sole author	-	Potentially malignant disorders of the oral and oropharyngeal mucosa; terminology, classification and present concepts of management	2009	Oral Oncology
7	447	Mao L.	USA	Hong W.K.	USA	Frequent microsatellite alterations at chromosomes 9p21 and 3p14 in oral premalignant lesions and their value in cancer risk assessment	1996	Nature Medicine
8	435	Warnakulasuriya S.,	UK	Dabelsteen E.	Denmark	Oral epithelial dysplasia classification systems: Predictive value, utility, weaknesses and scope for improvement	2008	Journal of Oral Pathology and Medicine
9	432	Reibel J.	Denmark	Sole author	-	Prognosis of oral pre-malignant lesions: Significance of clinical, histopathological, and molecular biological characteristics	2003	Critical Reviews in Oral Biology and Medicine
10	379	Miller C.S	USA	Johnstone B.M.	USA	Human papillomavirus as a risk factor for oral squamous cell carcinoma: A meta-analysis, 1982-1997	2001	Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics
11	377	Lotan R.	USA	Hong W.K.	USA	Suppression of retinoic acid receptor— $\beta$ in pre-malignant oral lesions and its up-regulation by isotretinoin	1995	New England Journal of Medicine
12	376	Silverman S.	USA	Pindborg J.J.	Denmark	Studies in oral leukoplasias VII. Further investigations on the effects of vitamin A on keratinization	1963	Acta Odontologica Scandinavica

*(continued)*

**Table I.** Continued

<i>Rank</i>	<i>Citations</i>	<i>First author</i>	<i>Country (first author)</i>	<i>Last author</i>	<i>Country (last author)</i>	<i>Title</i>	<i>Year</i>	<i>Journal</i>
13	367	Napier S.S.	UK	Speight P.M.	UK	Natural history of potentially malignant oral lesions and conditions: An overview of the literature	2008	Journal of Oral Pathology and Medicine
14	367	Sridharan G.	India	Vijayaraghavan R.	India	Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma	2019	Journal of Oral Pathology and Medicine
15	364	Rosin M.P.	Canada	Zhang L.	Canada	Use of allelic loss to predict malignant risk for low-grade oral epithelial dysplasia	2000	Clinical Cancer Research
16	357	Gupta P.C.	India	Daftary D.K.	India	Incidence rates of oral cancer and natural history of oral precancerous lesions in a 10-year follow-up study of Indian villagers	1980	Community Dentistry and Oral Epidemiology
17	356	Lumerman H.	USA	Kerpel S.	USA	Oral epithelial dysplasia and the development of invasive squamous cell carcinoma	1995	Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and
18	352	Hunter K.D.	UK	Harrison P.R.	UK	Profiling early head and neck cancer	2005	Nature Reviews Cancer
19	350	Lee J.J., et al.	USA	Lippman S.M.	USA	Predicting cancer development in oral leukoplakia: Ten years of translational research	2000	Clinical Cancer Research
20	328	Axéll T.	Sweden	Van Der Waal I.	Netherlands	Oral white lesions with special reference to precancerous and tobacco-related lesions: Conclusions of an international symposium held in Uppsala, Sweden, May 18-21 1994	1996	Journal of Oral Pathology and Medicine
21	307	Holmstrup P.	Denmark	Stoltze K.	Denmark	Long-term treatment outcome of oral premalignant lesions	2006	Oral Oncology
22	278	Hansen L.S.	USA	Silverman Jr. S.	USA	Proliferative verrucous leukoplakia. A long-term study of thirty patients	1985	Oral Surgery, Oral Medicine, Oral Pathology
23	277	Schepman K.P.	Netherlands	Van Der Waal I.	Netherlands	Malignant transformation of oral leukoplakia: A follow-up study of a hospital-based population of 166 patients with oral leukoplakia from The Netherlands	1998	Oral Oncology
24	276	Waldron C.A.	USA	Shafer W.G.	USA	Leukoplakia revisited. A clinicopathologic study 3256 oral leukoplakias	1975	Cancer
25	252	Mehanna H.M.	UK	McConkey C.C.	UK	Treatment and follow-up of oral dysplasia - A systematic review and meta-analysis	2009	Head and Neck

*(continued)*

**Table I. Continued**

<i>Rank</i>	<i>Citations</i>	<i>First author</i>	<i>Country (first author)</i>	<i>Last author</i>	<i>Country (last author)</i>	<i>Title</i>	<i>Year</i>	<i>Journal</i>
26	242	Kujan O.	UK	Sloan P.	UK	Evaluation of a new binary system of grading oral epithelial dysplasia for prediction of malignant transformation	2006	Oral Oncology
27	235	Sciubba J.J.	USA	Sole author	-	Improving detection of precancerous and cancerous oral lesions: Computer-assisted analysis of the oral brush biopsy	1999	Journal of the American Dental Association
28	233	Xu X.-C.	USA	Hong W.K.	USA	Differential Expression of Nuclear Retinoid Receptors in Normal, Premalignant, and Malignant Head and Neck Tissues	1994	Cancer Research
29	233	Van Der Waal I.	Netherlands	Smeele L.E.	Netherlands	Oral leukoplakia: A clinicopathological review	1997	Oral Oncology
30	231	Syrjänen S.	Finland	Jontell M.	Sweden	Human papillomaviruses in oral carcinoma and oral potentially malignant disorders: A systematic review	2011	Oral Diseases
31	230	Abbey L.M.	USA	Cushing M.	USA	Intraexaminer and inter-examiner reliability in the diagnosis of oral epithelial dysplasia	1995	Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and
32	229	Bouquot J.E.,	USA	Gorlin R.J.	USA	Leukoplakia, lichen planus, and other oral keratoses in 23,616 white Americans over the age of 35 years	1986	Oral Surgery, Oral Medicine, Oral Pathology
33	219	Lee C.-H.	Taiwan	Lin L.-M.	Taiwan	The precancer risk of betel quid chewing, tobacco use and alcohol consumption in oral leukoplakia and oral submucous fibrosis in southern Taiwan	2003	British Journal of Cancer
34	215	Trivedy C.R.	UK	Warnakulasuriya S.	UK	The oral health consequences of chewing areca nut	2002	Addiction Biology
35	214	Stich H.F.	Canada	Nair M.K.	USA	Remission of oral leukoplakias and micronuclei in tobacco/betel quid chewers treated with beta-carotene and with beta-carotene plus vitamin A	1988	International Journal of Cancer
36	214	Patton L.L.	USA	Kerr A.R.	USA	Adjunctive techniques for oral cancer examination and lesion diagnosis a systematic review of the literature	2008	Journal of the American Dental Association
37	212	Speight P.M.	UK	Kujan O.	Australia	Oral potentially malignant disorders: risk of progression to malignancy	2018	Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology

*(continued)*

**Table I.** Continued

<i>Rank</i>	<i>Citations</i>	<i>First author</i>	<i>Country (first author)</i>	<i>Last author</i>	<i>Country (last author)</i>	<i>Title</i>	<i>Year</i>	<i>Journal</i>
38	209	Petti S.	Italy	Sole author	-	Pooled estimate of world leukoplakia prevalence: A systematic review	2003	Oral Oncology
39	199	Warnakulasuriya S.	UK	Ariyawardana A.	Australia	Malignant transformation of oral leukoplakia: A systematic review of observational studies	2016	Journal of Oral Pathology and Medicine
40	194	Pindborg J.J.	Denmark	Roed-Petersen B.	Denmark	Studies in oral leukoplakia: a preliminary report on the period prevalence of malignant transformation in leukoplakia based on a follow-up study of 248 patients.	1968	Journal of the American Dental Association
41	194	Miller C.S.,	USA	White D.K.	USA	Human papillomavirus expression in oral mucosa, premalignant conditions, and squamous cell carcinoma A retrospective review of the literature	1996	Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics
42	189	Karabulut A.	Denmark	Dabelsteen E.	Denmark	Observer variability in the histologic assessment of oral premalignant lesions	1995	Journal of Oral Pathology and Medicine
43	186	Fan K.F.M.I	UK	Bown S.G.	UK	Photodynamic therapy using 5-aminolevulinic acid for premalignant and malignant lesions of the oral cavity	1996	Cancer
44	185	Tsao A.S.	USA	Papadimitrakopoulou V.	USA	Phase II randomized, placebo-controlled trial of green tea extract in patients with high-risk oral premalignant lesions	2009	Cancer Prevention Research
45	178	Silverman Jr. S.	USA	Gorsky M.	Israel	Proliferative verrucous leukoplakia	1997	Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics
46	178	Reichart P.A.	Germany	Philipsen H.P.	Denmark	Oral erythroplakia - A review	2005	Oral Oncology
47	178	Hsue S.-S.	Taiwan	Lin L.-M.	Taiwan	Malignant transformation in 1458 patients with potentially malignant oral mucosal disorders: A follow-up study based in a Taiwanese hospital	2007	Journal of Oral Pathology and Medicine
48	173	Einhorn J.	Sweden	Wersäll J.	Sweden	Incidence of oral carcinoma in patients with leukoplakia of the oral mucosa	1967	Cancer
49	172	Califano J.	USA	Sidransky D.	USA	Genetic progression and clonal relationship of recurrent premalignant head and neck lesions	2000	Clinical Cancer Research

*(continued)*

**Table I. Continued**

<i>Rank</i>	<i>Citations</i>	<i>First author</i>	<i>Country (first author)</i>	<i>Last author</i>	<i>Country (last author)</i>	<i>Title</i>	<i>Year</i>	<i>Journal</i>
50	168	Bouda M.	Greece	Kittas C.	Greece	'High risk' HPV types are frequently detected in potentially malignant and malignant oral lesions, but not in normal oral mucosa	2000	Modern Pathology
51	165	Garewal H.S.	USA	Steinbronn K.	USA	Response of oral leukoplakia to beta-carotene	1990	Journal of Clinical Oncology
52	163	Ogden G.R.	UK	Lane D.P.	UK	Assessment of p53 protein expression in normal, benign, and malignant oral mucosa	1992	The Journal of Pathology
53	159	Shafer W.G	USA	Waldron C.A.	USA	Erythroplakia of the oral cavity	1975	Cancer
54	159	Lodi G.	Italy	Carrassi A.	Italy	Interventions for treating oral leukoplakia.	2006	Cochrane database of systematic reviews (Online)
55	159	Kawaguchi H.	Japan	Mao L.	USA	Podoplanin: A novel marker for oral cancer risk in patients with oral premalignancy	2008	Journal of Clinical Oncology
56	152	Bánóczy J.	Hungary	Sole author	-	Follow-up studies in oral leukoplakia	1977	Journal of Maxillofacial Surgery
57	152	Stich H.F.	Canada	Krishnan Nair M.	India	Response of oral leukoplakias to the administration of vitamin A	1988	Cancer Letters
58	152	Wei J.,	China	Jia W.	China	Salivary metabolite signatures of oral cancer and leukoplakia	2011	International Journal of Cancer
59	150	Speight P.M.	UK	Sole author	-	Update on oral epithelial dysplasia and progression to cancer	2007	Head and Neck Pathology
60	149	Shear M.	South Africa	Pindborg J.J.	Denmark	Verrucous hyperplasia of the oral mucosa	1980	Cancer
61	149	Papadimitrakopoulou V.	USA	Mao L.	USA	Frequent inactivation of p16(INK4 $\alpha$ ) in oral premalignant lesions	1997	Oncogene
62	144	Li N.	China	Chen J.	China	The chemopreventive effects of tea on human oral precancerous mucosa lesions	1999	Proceedings of the Society for Experimental Biology and Medicine
63	143	Shiu M.N.	Taiwan	Hahn L.J.	Taiwan	Risk factors for leukoplakia and malignant transformation to oral carcinoma: A leukoplakia cohort in Taiwan	2000	British Journal of Cancer
64	143	Warnakulasuriya S.	UK	Johnson N.W.	Australia	Oral potentially malignant disorders: A consensus report from an international seminar on nomenclature and classification, convened by the WHO Collaborating Centre for Oral Cancer	2021	Oral Diseases

*(continued)*



**Table I. Continued**

<i>Rank</i>	<i>Citations</i>	<i>First author</i>	<i>Country (first author)</i>	<i>Last author</i>	<i>Country (last author)</i>	<i>Title</i>	<i>Year</i>	<i>Journal</i>
65	142	Mehta F.S.	India	Daftary D.K.	India	Epidemiologic and histologic study of oral cancer and leukoplakia among 50,915 villagers in India	1969	Cancer
66	142	Braakhuis B.J.M.	Netherlands	Brakenhoff R.H.	India	A genetic progression model of oral cancer: Current evidence and clinical implications	2004	Journal of Oral Pathology and Medicine
67	141	Epstein J.B.	Canada	Rosin M.	Canada	Advances in the diagnosis of oral premalignant and malignant lesions.	2002	Journal (Canadian Dental Association)
68	138	Warnakulasuriya S.	UK	Møller H.	UK	Factors predicting malignant transformation in oral potentially malignant disorders among patients accrued over a 10-year period in South East England	2011	Journal of Oral Pathology and Medicine
69	137	Awan K.H.	UK	Warnakulasuriya S.	UK	Evaluation of an auto-fluorescence based imaging system (VELscope™) in the detection of oral potentially malignant disorders and benign keratoses	2011	Oral Oncology
70	136	Silverman S., Jr.	USA	Malaowalla A.M.	India	Malignant transformation and natural history of oral leukoplakia in 57,518 industrial workers of Gujarat, India	1976	Cancer
71	134	Benner S.E.	USA	Hong W.K.	USA	Regression of oral leukoplakia with $\alpha$ -tocopherol: A community clinical oncology program chemoprevention study	1993	Journal of the National Cancer Institute
72	134	Thomson P.J.	UK	Sole author	-	Field change and oral cancer: New evidence for widespread carcinogenesis?	2002	International Journal of Oral and Maxillofacial Surgery
73	134	Mithani S.K.	USA	Califano J.A.	USA	Molecular genetics of premalignant oral lesions	2007	Oral Diseases
74	134	Messadi D.V.	USA	Sole author	-	Diagnostic aids for detection of oral pre-cancerous conditions	2013	International Journal of Oral Science
75	134	Dionne K.R.	Malaysia	Cheong S.C.	Malaysia	Potentially malignant disorders of the oral cavity: Current practice and future directions in the clinic and laboratory	2015	International Journal of Cancer
76	133	Pindborg J.J.,	Denmark	Holmstrup P.	Denmark	Subjectivity in evaluating oral epithelial dysplasia, carcinoma in situ and initial carcinoma	1985	Journal of Oral Pathology and Medicine

*(continued)*

**Table I. Continued**

<i>Rank</i>	<i>Citations</i>	<i>First author</i>	<i>Country (first author)</i>	<i>Last author</i>	<i>Country (last author)</i>	<i>Title</i>	<i>Year</i>	<i>Journal</i>
77	133	Kim M.M., et al.	USA	Califano J.A.	USA	Mitochondrial DNA quantity increases with histopathologic grade in premalignant and malignant head and neck lesions	2004	Clinical Cancer Research
78	132	Kujan O., et al.	UK	Sloan P.	UK	Why oral histopathology suffers inter-observer variability on grading oral epithelial dysplasia: An attempt to understand the sources of variation	2007	Oral Oncology
79	129	Zhang L., et al.	Canada	Rosin M.P.	Canada	Toluidine blue staining identifies high-risk primary oral premalignant lesions with poor outcome	2005	Cancer Research
80	127	White J.M	USA	Silverman Jr. S.	USA	Nd:YAG and CO2 laser therapy of oral mucosal lesions	1998	Journal of Clinical Laser Medicine and Surgery
81	126	Holmstrup P et al.	Denmark	Stoltze K.	Denmark	Oral premalignant lesions: Is a biopsy reliable?	2007	Journal of Oral Pathology and Medicine
82	126	Zhang L.	Canada	Rosin M.P.	Canada	Loss of heterozygosity (LOH) profiles-validated risk predictors for progression to oral cancer	2012	Cancer Prevention Research
83	125	Batsakis J.G.	USA	El-Naggar A.K.	USA	Proliferative verrucous leukoplakia and its related lesions	1999	Oral Oncology
84	125	Rudin C.M.	USA	Vokes E.E.	USA	An attenuated adenovirus, ONYX-015, as mouthwash therapy for premalignant oral dysplasia	2003	Journal of Clinical Oncology
85	124	Warnakulasuriya S.	UK	Johnson N.W.	Australia	Sensitivity and specificity of OraScan toluidine blue mouthrinse in the detection of oral cancer and precancer	1996	Journal of Oral Pathology and Medicine
86	124	Sankaranarayanan R., et al.	India	Nair P.P.	USA	Chemoprevention of oral leukoplakia with vitamin A and beta carotene: An assessment	1997	European Journal of Cancer Part B: Oral Oncology
87	124	Mao L., et al.	USA	Hong W.K.	UK	Phenotype and genotype of advanced premalignant head and neck lesions after chemopreventive therapy	1998	Journal of the National Cancer Institute
88	124	Onofre M.A., et al.	Brazil	Navarro C.M.	Brazil	Reliability of toluidine blue application in the detection of oral epithelial dysplasia and in situ and invasive squamous cell carcinomas	2001	Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics

*(continued)*

**Table I. Continued**

<i>Rank</i>	<i>Citations</i>	<i>First author</i>	<i>Country (first author)</i>	<i>Last author</i>	<i>Country (last author)</i>	<i>Title</i>	<i>Year</i>	<i>Journal</i>
89	124	Brennan M., et al.	USA	van der Waal I.	Netherlands	Management of oral epithelial dysplasia: a review	2007	Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology
90	124	Pitiyage G., et al.	Sri Lanka	Warnakulasuriya S.	UK	Molecular markers in oral epithelial dysplasia: Review	2009	Journal of Oral Pathology and Medicine
91	123	D'Costa J., et al.	USA	Mehta, A.R.	India	Detection of HPV-16 genome in human oral cancers and potentially malignant lesions from India	1998	Oral Oncology
92	121	Axéll T.	Sweden	Sole author	-	Occurrence of leukoplakia and some other oral white lesions among 20 333 adult Swedish people	1987	Community Dentistry and Oral Epidemiology
93	121	Armstrong W.B., et al.	USA	Meyskens F.L., Jr.	USA	Clinical modulation of oral leukoplakia and protease activity by Bowman-Birk inhibitor concentrate in a phase IIa chemoprevention trial	2000	Clinical Cancer Research
94	120	Gupta P.C., et al.	India	Pindborg J.J.	Denmark	An epidemiologic assessment of cancer risk in oral precancerous lesions in India with special reference to nodular leukoplakia	1989	Cancer
95	120	Poh C.F., et al.	Canada	Rosin M.P.	Canada	Direct fluorescence visualization of clinically occult high-risk oral premalignant disease using a simple hand-held device	2007	Head and Neck
96	119	Ha P.K., et al.	USA	Califano J.A.	USA	Real-time quantitative PCR demonstrates low prevalence of human papillomavirus type 16 in premalignant and malignant lesions of the oral cavity	2002	Clinical Cancer Research
97	119	Chung C.-H., et al.	Taiwan	Warnakulasuriya S.	UK	Oral precancerous disorders associated with areca quid chewing, smoking, and alcohol drinking in southern Taiwan	2005	Journal of Oral Pathology and Medicine
98	118	Warnakulasuriya S.,	UK	Johnson N.W.	Australia	Expression of p53 mutant nuclear phosphoprotein in oral carcinoma and potentially malignant oral lesions	1992	Journal of Oral Pathology and Medicine

*(continued)*

**Table I.** Continued

Rank	Citations	First author	Country (first author)	Last author	Country (last author)	Title	Year	Journal
99	118	Grant W.E., et al.	UK	Bown S.G.	UK	Photodynamic therapy of malignant and premalignant lesions in patients with 'field cancerization' of the oral cavity	1993	The Journal of Laryngology & Otology
100	118	McCullough M., et al.	UK	Porter S.R.	UK	Oral yeast carriage correlates with presence of oral epithelial dysplasia	2002	Oral Oncology

18 secondary articles (13 narrative reviews and 5 systematic reviews (56% of all secondary articles, 28/62 author points). OM contributed to a higher proportion of articles related to the subtopics of OPMD nomenclature (5/6 articles, of which 4 were authored exclusively by OM providers, 9/12 author points) and screening (2/4 articles, both authored exclusively by OM, 4/8 author points); and contributed to a lower proportion of articles to the subtopics of OPMD epidemiology (7/16 articles, 5 authored exclusively by OM, 11/32 author points), diagnosis (21/57 articles, 10 authored exclusively by OM, 30/114 author points) and management (4/17 articles, 3 authored exclusively by OM, 7/34 author points). No RCTs were authored by OM practitioners. A deeper look at the subtopic of OPMD diagnosis revealed that OM practitioners were either first or last author on 7 out of the 9 diagnostic adjunctive techniques articles (11/18 author points), and yet were either the first or last author on only 6 out of 25 molecular aspects of OPMDs articles (7/50 author points).

In terms of citation impact, a similar picture to the complete list emerged where the most cited OM-authored papers were related to nomenclature (MCI = 446.4) and epidemiology (MCI = 196.5), while

screening (MCI = 120) was the least cited. Collectively, OM authors were both first and last authors on 23 of the 39 papers (59%) and co-authored with other specialties on 16 papers (41%), of which 9 and 7 were with OP and medical specialties, respectively.

In terms of authors, institutions, country of origin of the corresponding author, and journals, a total of 367 authors contributed to the 100 most cited articles. The number of authors ranged from 1 and 17, with a mean of 3.67 authors per publication. Nine articles had a single author. Table III shows the point scores by specialty and subtopic respectively. OM authors had the highest score (62/200), followed by OP (55/200), head and neck surgeons (25/200), medical oncologists (21/200), basic science researchers (19/200), epidemiologists (9/200), medical pathologists (7/200), and radiation oncologists (2/200).

The most prolific authors were Warnakulasuriya S. (13 articles); Hong W.K. (10 articles); Lippman S. and Pindborg J.J. (8 articles each); El-Nagar A.K., Lee J.J., Mao L., and Reibel J. (6 articles each); and Van Der Waal I., Epstein J.B., Lee J.S., Rosin M.P., Speight P. M., and Zhang L. (5 articles each). Among the 15 most prolific authors, 7 (50%) were OM practitioners (Warnakulasuriya S., Pindborg J.J., Van Der Waal I., and

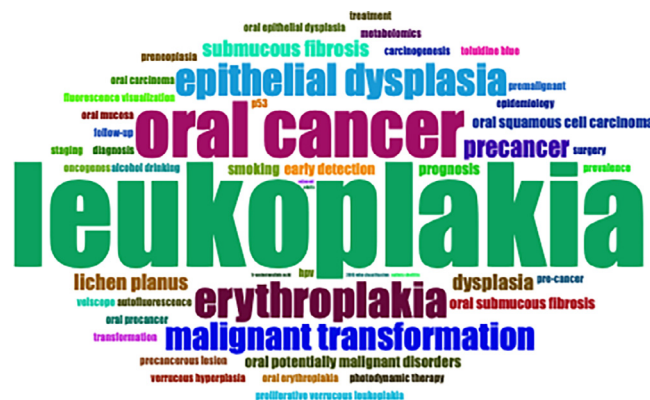


Figure 1. Word cloud on the most frequently used keywords in the top 100 included articles (leukoplakia [n = 26], oral cancer [n = 14], erythroplakia [n = 9], epithelial dysplasia [n = 8], malignant transformation [n = 7], precancer [n = 5], dysplasia [n = 4], lichen planus [n = 4], and submucous fibrosis [n = 4]).

**Table II.** Main characteristics of the articles first or last authored by oral medicine specialists: subtopic and category, number of citations, year of publication, author names, type of study, specialty of first and last author, mean CI, and percentage of oral medicine double-authored articles

<i>Subtopic</i>	<i>Category</i>	<i>Cited by</i>	<i>Year</i>	<i>First author</i>	<i>Last author</i>	<i>Article type</i>	<i>Specialty first author</i>	<i>Specialty last author</i>	<i>Mean CI</i>	<i>OM/OM</i>
Diagnosis	Histological features	435	2008	Warnakulasuriya S.	Dabelsteen E.	Narrative review	Oral Medicine	Oral Pathology	183	40.91%
	Molecular biomarkers	379	2001	Miller C.	Johnstone B.	Systematic review	Oral Medicine	Oral Medicine		
	Molecular biomarkers	233	1994	Xu X.-C.	Hong W.K.	Descriptive study	Oral Medicine	Medical Oncology		
	General features	233	1997	Van Der Waal I.	Smeele L.E.	Narrative review	Oral Medicine	H&N Surgical Oncology		
	Molecular features	231	2011	Syrjänen S.	Jontell M.	Systematic review	Oral Pathology	Oral Medicine		
	Clinical features	215	2002	Trivedy C.	Warnakulasuriya S.	Narrative review	Oral Medicine	Oral Medicine		
	Review of multiples methods	214	2008	Patton L.	Kerr A. R.	Systematic review	Oral Medicine	Oral Medicine		
	Molecular biomarkers	194	1996	Miller C.	White D.	Narrative review	Oral Medicine	Oral Pathology		
	Clinical features	178	1997	Silverman Jr. S.	Gorsky M.	Cohort study (prospective)	Oral Medicine	Oral Medicine		
	Clinical features	178	2005	Reichart P.	Philipsen H.	Narrative review	Oral Medicine	Oral Pathology		
	Malignant transformation	143	2000	Shiu M.	Hahn L.	Case-control study	Oral Medicine	Oral Medicine		
	Adjunctive technique	141	2002	Epstein J.	Rosin M.	Narrative review	Oral Medicine	Basic Science		
	Adjunctive technique	137	2011	Awan K.	Warnakulasuriya S.	Diagnostic study	Oral Medicine	Oral Medicine		
	Adjunctive technique	134	2013	Messadi D.	Sole author	Narrative review	Oral Medicine	Sole author		
	Histological features	126	2007	Holmstrup P.	Stoltze K.	Cohort study (retrospective)	H&N Surgical Oncology	Oral Medicine		
	Adjunctive technique	124	2001	Onofre	Navarro C.	Diagnostic study	Oral Medicine	Oral Medicine		
	Adjunctive technique	124	1996	Warnakulasuriya S.	Johnson N.	Diagnostic study	Oral Medicine	Oral Pathology		
	Molecular biomarkers	124	2009	Pitiyage G.	Warnakulasuriya S.	Narrative review	Medical Pathology	Oral Medicine		
	Adjunctive technique	120	2007	Poh C.	Rosin MP	Case series	Oral Medicine	Basic Science		
	Risk factors	118	2002	McCullough M.	Porter S.R.	Cross-sectional	Oral Medicine	Oral Medicine		
Molecular biomarkers	118	1992	Warnakulasuriya S.	Johnson N.	Case series	Oral Medicine	Oral Pathology			
Epidemiology	Malignant transformation	832	1984	Silverman Jr. S.	Lozada F.	Case series	Oral Medicine	Oral Medicine	298	71.43%
	Malignant transformation	307	2006	Holmstrup P.	Stoltze K.	Cohort study (retrospective)	Oral Medicine	Oral Medicine		
	Malignant transformation	277	1998	Schepman K.	Van Der Waal I.	Cohort study (prospective)	Oral Medicine	Oral Medicine		
	Malignant transformation	199	2016	Warnakulasuriya S.	Ariyawardana A.	Systematic review	Oral Medicine	Oral Medicine		
	Malignant transformation	194	1968	Pindborg J.	Roed-Petersen B.	Cohort study	Oral Medicine	Oral Pathology		
	Malignant transformation	138	2011	Warnakulasuriya S.	Møller H.	Cohort study	Oral Medicine	Epidemiology/ Biostatistics		
	Malignant transformation	136	1976	Silverman Jr. S.	Malaowalla A.	Case series	Oral Medicine	Oral Medicine		
Management	Chemoprevention	376	1963	Silverman Jr. S.	Pindborg J.	Case series	Oral Medicine	Oral Pathology	197	75.00%
	Management	159	2006	Lodi G.	Carrassi A.	Systematic review	Oral Medicine	Oral Medicine		
	Laser surgery	127	1998	White J.	Silverman Jr. S.	Case series	Oral Medicine	Oral Medicine		
	Laser surgery	124	2007	Brennan M.	van der Waal I.	Narrative review	Oral Medicine	Oral Medicine		

(continued on next page)

**Table II.** Continued

Subtopic	Category	Cited by	Year	First author	Last author	Article type	Specialty first author	Specialty last author	Mean CI	OM/OM
Nomenclature	Clinical features	933	2007	Warnakulasuriya S.	van der Waal I.	Narrative review	Oral Medicine	Oral Medicine	446	80.000%
	Clinical features	550	2009	van der Waal I.	Sole author	Narrative review	Oral Medicine	Sole author		
	Clinical features	328	1996	Axéll et al.	Sole author	Narrative review	Oral Medicine	Oral Medicine		
	Clinical features	278	1985	Hansen, L.	Silverman Jr. S.	Cohort study (retrospective)	Oral Medicine	Oral Medicine		
Screening	Clinical features	143	2021	Warnakulasuriya S.	Johnson N.W.	Narrative review	Oral Medicine	Oral Pathology		
	Clinical features	121	1987	Axéll T.	Sole author	Screening study	Oral Medicine	Sole author	120	100%
	Risk factors	119	2005	Chung C.-H.	Warnakulasuriya S.	Screening study	Oral Medicine	Oral Medicine		

**Table III.** Main results based on the author-point system and distribution of research subtopics by specialty as first or last author

	No. of publications	Point score
First or last author OM specialist	39	62/200
First author OM specialist	36	36/200
Last author OM Specialist	23	23/200
Both first and last authors OM	23	23/200
Any author OM (not first or last)	5	5/200
First or last author OP (no OM)	45	45/200
First or last author other specialty (no OM)	141	141/200
OM first or last/OP first or last	9	9/200
OM first or last/other specialties first or last	16	16/200
Any OM/medical specialties (no OP)	7	7/200

Publication subtopic/category (no. of publications)	Point score		
	OM	OP	Other specialty
Diagnosis (n = 57)	30	38	46
Molecular markers (n = 25)	7	7	36
Histologic features (n = 9)	2	14	2
Adjunctive techniques (n = 9)	11	4	3
Clinical features (n = 9)	5	10	3
General features (n = 3)	1	3	2
Other (n = 2)	4	0	0
Management (n = 17)	7	1	26
Chemoprevention (n = 10)	1	1	18
Photodynamic therapy (n = 2)	0	0	4
Surgery/laser surgery (n = 2)	2	0	2
Other (n = 3)	4	0	2
Epidemiology (n = 16)	12	11	9
Malignant transformation (n = 13)	12	9	5
Histopathologic features (n = 2)	0	2	2
Prevalence (n = 1)	0	0	2
Nomenclature (n = 6)	9	2	1
Clinical features (n = 6)	9	2	1
Screening (n = 4)	4	3	1
Clinical features (n = 2)	2	2	0
Risk factors (n = 2)	2	1	1

Epstein J.B.) or OP (Reibel J., Speight P.M., and Zhang L.). Additionally, authors from other “specialties” were identified including medical oncologists (Hong W.K. and Lippman S.), medical pathology (El-Nagar A.K.), epidemiology (Lee J.J.), and basic scientists (Mao L., Rosin M.P., and Lee J.S.). The relevant information of the most prolific authors is summarized in [Table IV](#). The top-authors’ production over time is shown in [Figure 2](#). The line represents the interval of publication of the included authors, and the dots represent the year/number of papers published.

The United States of America was the highest contributing country to the list of top 100 most cited articles with 37 first authors and 31 last authors (68/200 points); followed by the United Kingdom (20 first authors and 14 last authors, 34/200 points) and Canada (7 first authors and 5 last authors, 12/200 points). The United States and the United Kingdom were hubs of

**Table IV.** Details of the 16 most prolific authors included in the 100 most cited articles on oral potentially malignant disorders

Rank	Name	Specialty/ Discipline	Listed papers	First author	Coauthor	Last author	h-index	g-index	m-index
1	Warnakulasuriya, S.	OM	13	7	2	4	65	131	1.63
2	Hong, W.K.	Medical Oncology	10	1	5	4	46	115	1.24
4	Silverman Jr., S.	OM	8	4	2	2	58	109	0.89
5	Pindborg, J.J.	OP	8	2	3	3	55	101	0.71
6	Mao, L.	Basic science	6	2	2	2	64	119	2.21
7	Van Der Waal, I.	OM	6	2	1	3	64	126	1.21
8	Lee, J.J.	Epidemiology	6	1	5	0	104	208	2.81
9	Reibel, J.	OP	6	1	5	0	32	63	0.71
10	Lippman, S.	Medical Oncology	8	0	7	1	105	237	2.39
11	El-Nagar, A.K.	Medical pathology	6	0	5	1	113	231	2.31
12	Speight, P.M.	OP	5	2	2	1	56	101	1.37
13	Zhang, L.	OP	5	2	2	1	34	62	0.94
14	Epstein, J.B.	OM	5	1	4	0	79	124	1.61
15	Rosin, M.P.	Basic Sciences	5	1	1	3	47	83	1.02
16	Lee, J.S.	Basic Sciences	5	0	5	0	62	120	1.68

OM, oral medicine; OP, oral pathology.

H-index based on Web of Science database, g-index, and m-index were calculated.

scientific production in this field. The United States interacted more globally (South America, Asia, and Europe), while the United Kingdom presented a higher interaction with European countries.

The top 5 contributing institutions were M.D. Anderson Cancer Center, University of Texas, Houston, USA (22/200 points), King’s College, London, UK (12/200 points), the University of California, San Francisco, USA (10/200 points), the University of Amsterdam, Netherlands (9/200 points), and the Johns Hopkins University/Medical School, Baltimore, USA (8/200 points). The research contributions by M.D. Anderson and Johns Hopkins appear to have ceased (since 2008). Most of the primary articles were studies conducted at a single center, with a ratio of single-center to multi-center studies of 2.1 to 1.

The scientific interaction among authors of the top 100 cited papers identified was analyzed (Figure 3). Seven clusters of authors emerged, and 5 of them were dentistry-based (characterized by the larger dot/author of the cluster), 2/7 were OM-based. Dentistry cluster interactions (yellow, green, purple, orange, and darker blue) were more intense than the medical clusters (red and light blue), and OM authors occupied key positions in the interaction process (see Epstein, Warnakulasuriya, and Silverman).

The top 100 cited articles on OPMDs were published in 36 different scientific journals (Table IV). The *Journal of Oral Pathology and Medicine* contained the highest number of cited articles (16 articles), followed by *Oral Oncology* (12 articles) and *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology* (11

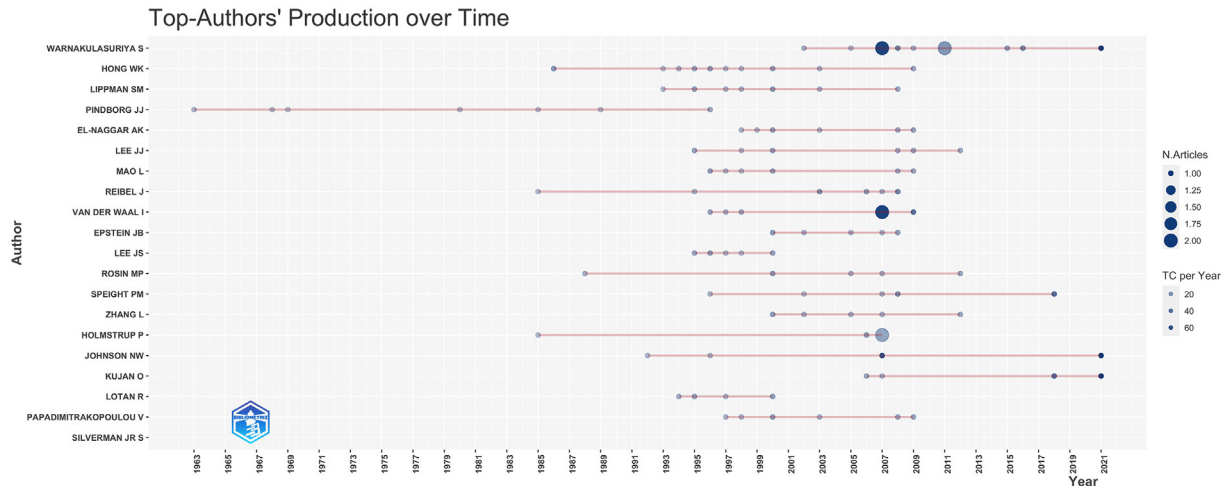


Figure 2. Top-authors’ production over time.

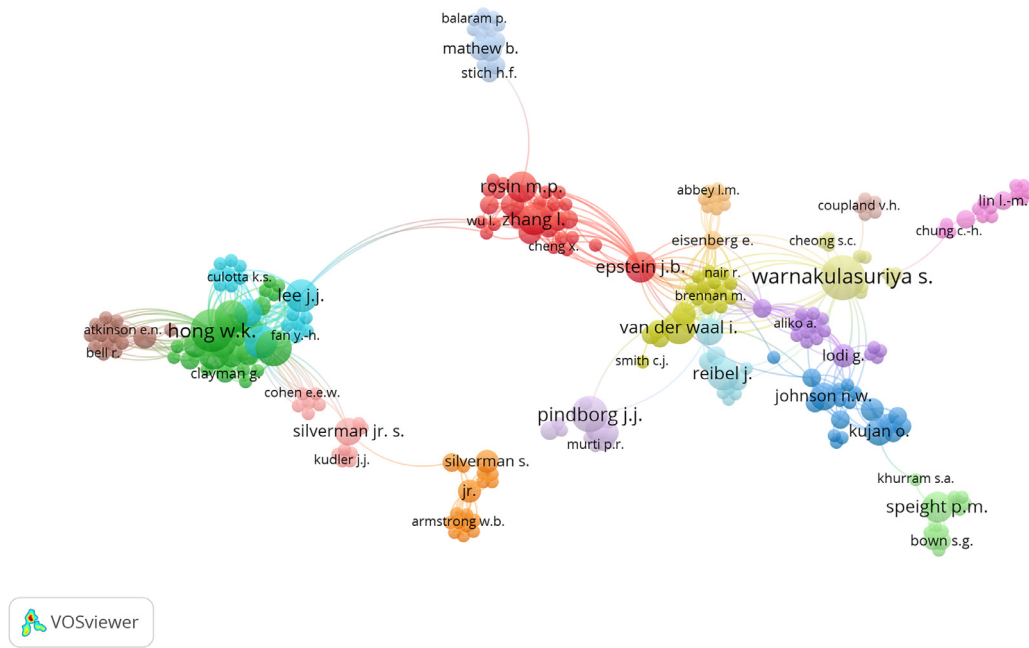


Figure 3. Author interaction analysis (per author) among authors generated from the analysis of the 100 papers included for data analysis.

articles). The impact factor of the publishing journals ranged from 1.348 (*Journal of the Canadian Dental Association*) to 286.13 (*CA: A Cancer Journal for Clinicians*) with a median of 3.539. The highest cited article (933 citations) was a workshop document focusing on definition and terminology of OPMDs and was published in the *Journal of Oral Pathology and Medicine* in 2007 (impact factor: 3.539). The second most highly cited article (923 citations), was also a workshop document focusing on definition and terminology, published in *Oral Surgery, Oral Medicine, Oral Pathology Journal* in 1978 (impact factor: 2.538).

The *Journal of Oral Pathology and Medicine* contained the highest number of cited articles among the top 100 cited OPMD articles (16 articles), followed by *Oral Oncology* with 12 articles and *Oral Surgery, Oral Medicine, Oral Pathology (Oral Radiology, and Endodontics)* with 11 articles (Table V).

Fifty papers (50%) received grants to fund research activities, and most of the funding agencies were based in the United States. The US National Cancer Institute funded 10 studies, followed by US National Institutes of Health (6 studies) and the WHO (5 studies). It is worth noting that 7 of the top 10 cited papers were supported by a funding agency or sponsored by the WHO. Additionally, the funded studies had a higher MCI (257.2) than the nonfunded ones (210.3). Regarding the study design, case series (9 studies, 50%), case-control studies (7 studies, 50%), and workshop documents (5 studies, 83.3%) were the commonly funded studies. On the other hand, only 4 out of 8 RCTs (50%) had funding details available.

## DISCUSSION

Over the past 4 decades, the WWOM has focused on appraising topics relevant to the OM community. In addition to performing systematic reviews related to

**Table V.** Top contributing journals

Rank	Journal	No. of articles	OM/OP articles	Non-OM/OP articles	Impact factor 2023	Mean citation index
1	Journal of Oral Pathology and Medicine	16	12	4	3.3	221.25
2	Oral Oncology	12	9	3	4.8	219.25
3	Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology	11	10	1	2.9	293.40
4	Cancer	9	8	1	6.2	241.45
5	Clinical Cancer Research	6	1	5	11.5	209.83

OM, oral medicine; OP, oral pathology; Non-OM/Non-OP, other dental/medical specialties.



clinical practice, WWOM has dedicated time and effort to broader “blue sky” projects.<sup>21</sup> Along this vein, WWOM VIII assembled a group to critically analyze barriers to research in OM and to identify gaps and future opportunities. This group conducted an international survey of OM practitioners describing these barriers,<sup>3</sup> and in addition has performed this bibliometric review to elucidate the role OM has played in OPMD research, a topic we selected because of its high interest and applicability to the OM community.

The diagnosis and management of patients with OPMDs is integral to the training and clinical practice of OM practitioners in most parts of the world. This study specifically concentrates on oral leukoplakia, oral erythroplakia, and proliferative verrucous leukoplakia (PVL). Other subcategories of OPMDs were excluded from the study due to their infrequency or very low risk of malignant transformation. The finding that OM authors, as a single “specialty,” had both the highest author participation (39%) and aggregate “point score” (31% of the total points) speaks to the leadership role of OM on this topic. Yet, the OPMD topic has many facets requiring the expertise of other specialties/disciplines both from a clinical and a research perspective. As an example, histopathological diagnosis and research on pathology biomarkers would not typically be performed or conducted by OM practitioners but rather by oral and/or head and neck pathologists or molecular biologists. Furthermore, our medical colleagues, such as head and neck oncologic surgeons, have overlapping clinical and research interests in the management of patients with OPMDs. As such, this topic also allows a deeper exploration of how OM has collaborated with our dental and medical colleagues.

Before discussing the results of this bibliometric review on OPMDs, we need to bring attention to the fact that OM is a relatively new specialty with significant global variations in specialty recognition, training, and scope of practice. This was highlighted by Al-Ahmad et al,<sup>3</sup> who reported such differences, and further described variability in research training and resources/infrastructure to conduct research. Additionally, in some nations, OM is a combined specialty with OP and such programs provide graduates with a pathway to specialize in either or both fields. In Canada where the Canadian Academy of Oral and Maxillofacial Pathology and OM (CAOMPOM) is the governing body representing both specialties, 2 of the recognized OM training programs (University of Toronto and University of British Columbia) offer a combined degree while the University of Alberta program solely focuses on OM. For decades, OM and OP were considered a joint specialty in Australia with the graduates of combined programs registering both as OM practitioners and oral pathologist. Although the combined programs

have not been offered in Australia for more than a decade, OM graduates as recent as 2019 were being recognized as dually qualified. There are other examples in Europe, and collectively, this lack of clear recognition results in confusion in the attribution of a researcher’s specialty. However, in this bibliometric review, the included authors had the specialty manually checked at the Scopus, then double-checked by 2 senior authors with extensive international collaboration (SW and RK). This is why we have used the term OM “practitioner” throughout in order to recognize the ongoing evolution of OM as a specialty and that OM is neither a distinct nor a recognized specialty across the world.

Our bibliometric review generated several important findings worthy of discussion. In terms of primary versus secondary studies, within the top 100 articles, OM practitioners principally authored (i.e., first or last author) 25% of all primary articles on OPMDs compared to 44% of secondary articles. This is contrary to our collective group of medical colleagues who published 49% and 27% of primary and secondary articles respectively. This is likely related to possible barriers to perform primary research in smaller dental settings versus large medical centers and therefore favoring the publication of secondary studies, such as systematic reviews, which meet scholarly requirements for academic promotion by OM practitioners in dental school settings, particularly for those practitioners on clinical academic tracks. Deeper exploration into the types of primary studies principally authored by OM practitioners reveals that greater than 70% were accuracy studies exploring the utility of diagnostic adjunctive techniques to triage patients with OPMDs. Furthermore, in those accuracy studies authored by OPs, OM practitioners were co-authors or had contributed to the collection of clinical data. This highlights the access to patients with OPMDs and the clinical expertise of OM practitioners in the risk stratification and diagnosis of OPMDs. One of the other subtopics where OM practitioners have played a prominent role is on retrospective cohort studies exploring the epidemiology of malignant transformation of patients with OPMDs, principally authoring more than half of these studies (Table II). This also highlights OM’s expertise in the surveillance of this patient population. Remarkably only 6 articles emanating from randomized clinical trials are included on the top 100 article list, none of which were principally authored by OM practitioners. Such trials were interventional studies for the treatment of OPMDs and were conducted exclusively by our medical colleagues with little to no involvement of OM practitioners. The lack of RCTs conducted by OM practitioners suggests 2 possible explanations. First, we lag behind our colleagues in medicine. This is hardly surprising given the

comparative size of medicine and greater access to research infrastructure and funding. Second, OM practitioners have limited visibility and have not been able to sufficiently engage with our medical colleagues to collaborate. The results of this bibliometric review may not accurately portray the current status, as there are a number of ongoing interventional RCTs on patients with OPMDs initiated by OM practitioners, or where OM is part of the investigator team. It will be interesting to gauge our development in this regard by conducting future bibliometric reviews. As a global community with the required skills and experience, we can leverage funding opportunities through the formation of large cooperative networks.<sup>3</sup>

Types of research studies aside, co-authorship (i.e., any authorship) with our OP and/or medical colleagues was limited with 8 and 6 articles, respectively. The collaboration between OM and OP generated 4 primary articles (one descriptive case series, one prospective cohort, and one diagnostic study) and 5 secondary articles (4 narrative reviews and one systematic review). The subtopic of diagnosis/molecular biomarkers was the most common shared interest. The OM/medical interaction generated 4 primary articles (2 cohort studies, one case series and one descriptive study) and 3 secondary articles (both narrative reviews). Adjunctive techniques was the most common category (n = 2). Conducting narrative reviews were the main approach to OM authors interact with other colleagues from different specialties, followed by several articles with distinctive study designs. Additionally, those OM authors who did collaborate were typically affiliated with academic medical/cancer centers, which suggests that the academic collaboration seems to increase where there are active clinical collaborations. On the other hand, this identifies an important issue, the paucity of OM practitioner involvement in medical/cancer centers.

Among the 367 authors who contributed to the 100 most cited articles, 4 OM practitioners were included in the top 15, namely Saman Warnakulasuriya, Sol Silverman, Isaac Van der Waal, and Joel Epstein, and each demonstrated both multicenter collaboration (largely among fellow OM colleagues), and importantly, interdisciplinary collaboration (i.e., both with OP and medical colleagues). From the VOSviewer analysis, it could be noted as an example that Warnakulasuriya interacted with 8 out of the 16 interaction clusters, with the closest collaboration with Isaac Van der Waal (Figure 3). In this scenario, it can be inferred that there is a strong correlation between the level of interaction among OM authors and their seniority and prominence within the field. In essence, the degree of interaction among OM authors appears to be intricately tied to their significance in the field, and it might not

merely be an outcome but a driving force behind their accomplishments. Ultimately, this interaction serves as the cornerstone of OM, acting as the vital link between medicine and dentistry. Therefore, effective communication and collaboration are imperative for fostering a robust clinical and research routine.

Conversely, medical specialists from other disciplines, especially those affiliated with major cancer centers, do not experience the same imperative for extensive interaction. Notably, the most frequently cited medical specialists identified in this review, predominantly originate from the same institution and exhibit limited collaboration beyond their institutional boundaries. This cluster of authors formed a relatively insular group with no OM specialists as co-authors. The ability to perform high caliber RCTs in the 1990s and early 2000s is a tribute not only to these authors but also to the strong and established institutional culture and infrastructure for research coupled with access to a large pipeline of patients with OPMDs. The M.D. Anderson cluster is emblematic of the opportunity for OM collaboration within strong research-based cancer centers. We believe that OM presence in such cancer centers is growing globally since several positive examples can be found including but not limited to, University Medical Center Groningen (The Netherlands), São Paulo State Cancer Center (ICESP, Brazil), Memorial Sloan Kettering Cancer Center (United States), and Dana Farber Cancer Center (United States). These centers have a track record of high-quality scientific output, although not all are conducting research on OPMDs. Analysis of the presence of OM practitioners in major cancer centers might be explored in future projects.

Pooling of data sets across multiple centers is particularly attractive for epidemiological studies and longitudinal research, such as powered studies exploring infrequent events (such as malignant transformation) or clinically meaningful outcome measures for RCTs. While there is some evidence of one multicenter study with OM authorship (e.g., the chemopreventive trial published by Rudin et al in 2003<sup>22</sup>), such studies with OM collaboration were conducted in single centers. It is clear that the connections of the OM author clusters are established internationally yet formal networks to conduct such research are not. This is a golden opportunity for future collaboration, and one that the WWOM has identified as an actionable project.

An interesting finding was that *Journal of Oral Pathology and Medicine* attracted the highest number of highly cited articles (n = 16); compared to *Oral Oncology*. Even though the former is much older (1972) than the latter (1992), most of the papers in *Journal of Oral Pathology and Medicine* were published during 2000 and 2010 decades, reinforcing it as

a leading journal in the field, albeit with a readership that is not considered as multidisciplinary (i.e., dental and medical specialties) as *Oral Oncology*. *Oral Medicine, Oral Pathology and Oral Radiology*, which is the official journal of both the American Academy of Oral Medicine and the American Academy of Oral and Maxillofacial Pathology, was listed in the third place. These findings reinforce the relevance of OM/OP journals to this topic, the close association between the 2 specialties, and also the significance of these publications to the OM/OP readership. On the other hand, it might represent a circular focus, so that most research in the field is generated and consumed by the same group of researchers. Even though this is expected, considering the multidisciplinary aspect of the topic, some effort could be made to expand the range of journals and spread the knowledge to other colleagues.

The top-ranked paper in the list (CI = 933) is a narrative review/consensus report conducted by the WHO Collaborating Centre for Oral Cancer and Precancer to define the nomenclature and classification of OPMDs in 2007. The most recent publication to the top 100 list is the sequel narrative review/consensus report published in 2021, with 12 international contributors.<sup>4</sup> Although a narrative review, the high citation of these 2 articles elucidates the importance of consensus on the diagnostic criteria for OPMDs in order to assure consistent inclusion criteria are used across OPMD studies thereby facilitating the pooling of data for meaningful meta-analysis. Indeed, OM practitioners have played a leadership role in defining the nomenclature together with OP colleagues.

One element missing from this bibliometric review is evidence of translational research among OM practitioners. The relationship of OM to basic scientists and molecular biologists is critical and creating synergies (similar to what the SICCA project represents to Sjogren syndrome<sup>21</sup>) that effectively contribute to expanding the frontiers of knowledge in this area seems to be a reasonable next step. Interestingly, basic scientists were involved not only with biomarkers research (10/19 studies), but also with chemoprevention RCTs (4/19 studies) and cohort studies (3/19), reinforcing the relevance of collaboration on this topic. Moreover, the lack of OM involvement with RCTs reflects the need of stronger multi-institutional endeavors to provide more and adequate evidence to support the clinical decision-making process. We still do not have enough RCTs to inform clinical practice, such that management of OPMDs is based on biased data originating from observational studies.

### Limitations

A bibliometric study's natural and expected limitations apply to the current work. Counting the number of

citations, be it for an author, a journal, or an article, is inherently flawed as a true reflection of the influence of the research or researcher. Previously highly cited articles tend to be cited more frequently and well-known authors with higher h-index with better-established careers are generally favored and attract more confidence and interest in collaboration, funding, and citation. One may argue that, with enough time and exposure, the work or author may supersede its actual academic weight at some point. This may partly explain the high number of low-level evidence narrative reviews in the top 100 OPMD articles cited. Small inconsistencies in author names across journals have an impact on the Scopus analysis, and this was reflected by the Bibliometrix or VoxViewer software evaluation.

In conclusion, this bibliometric study provides a critical identification of the collaborative activities and some of the barriers to research in the oral medicine field. Strong international collaborations are currently reflected by isolated initiatives such as the periodic revision of the nomenclature and classification of OPMDs performed by the WHO Collaborating Centre for Oral Cancer<sup>4,23</sup>, the Cochrane collaboration on screening/diagnostic aids<sup>24,25</sup> and management.<sup>26</sup> Additional endeavors should consider producing primary studies on unanswered questions on the topic of OPMDs. This might include observational studies, such as large multinational screening studies, and robust RCTs designed to impact clinical practice. Ultimately, larger and more structured studies are linked to OM's capacity to play the leadership role in the diagnosis and management of patients with OPMDs. This involves growing the specialty globally and ensuring that training programs offer a robust education with exposure to research. This also will require close collaboration with other dental and medical colleagues. As we claim our rightful position within both medicine and dentistry, and forge these meaningful connections with our local, national, and international colleagues we can help to turn our blue-sky objectives into achievable aims.

### ACKNOWLEDGMENTS

The WWOM VIII Steering Committee provided the conceptual framework and logistical support to produce the WWOM VIII Conference in May 2022 in Memphis, Tennessee, USA. In addition, the Steering Committee provided scientific and editorial critiques of this manuscript. The WWOM VIII Steering Committee is listed below, in alphabetical order: Arwa M. Farag (Saudi Arabia/USA), Timothy A. Hodgson (UK), Catherine Hong (Singapore), Siri Beier Jensen (Denmark), A. Ross Kerr (USA), Giovanni Lodi (Italy), Richeal Ni Riordain (Ireland), Thomas P. Sollecito (USA).

The WWOM VIII Steering Committee gratefully acknowledges the following organizations, companies, and individuals that provided financial support for WWOM VIII: American Academy of Oral Medicine, European Association of Oral Medicine, Church & Dwight Co. Inc., Colgate Palmolive, and patients of Dr. Ross Kerr.

## DECLARATION OF INTERESTS

None.

## DISCLOSURE

None to declare.

## CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

**Luiz Alcino Gueiros:** Writing – review & editing, Writing – original draft, Software, Methodology, Conceptualization, Formal analysis. **Giulia Ottaviani:** Writing – original draft, Formal analysis, Conceptualization. **Maryam Jessri:** Writing – original draft, Formal analysis, Conceptualization. **Caroline Shiboski:** Writing – review & editing, Conceptualization. **Arwa Farag:** Writing – review & editing. **Thomas P. Sollecito:** Writing – review & editing. **Saman Warnakulasuriya:** Methodology, Conceptualization, Project administration, Writing – review & editing. **Alexander Ross Kerr:** Conceptualization, Methodology, Project administration, Writing – review & editing.

## REFERENCES

1. American Academy of Oral Medicine. *Definition of Oral Medicine*. 2023. AAOM; 2023 [www.aom.com](http://www.aom.com)2023.
2. European Association of Oral Medicine. *Definition of Oral Medicine*. 2023. EAOM; 2023 [www.eaom.eu](http://www.eaom.eu).
3. Al-Amad SH, Bankvall M, Okoh M, et al. World Workshop on Oral Medicine VIII: barriers to research in oral medicine: results from a global survey. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2023;136:584-594.
4. Warnakulasuriya S, Kujan O, Aguirre-Urizar JM, et al. Oral potentially malignant disorders: a consensus report from an international seminar on nomenclature and classification, convened by the WHO Collaborating Centre for Oral Cancer. *Oral Dis*. 2021;27:1862-1880.
5. Moed HF. New developments in the use of citation analysis in research evaluation. *Arch Immunol Ther Exp (Warsz)*. 2009;57:13-18.
6. van Wesel M. Evaluation by citation: trends in publication behavior, evaluation criteria, and the strive for high impact publications. *Sci Eng Ethics*. 2016;22:199-225.
7. Wu Y, Jin X, Xue Y. Evaluation of research topic evolution in psychiatry using co-word analysis. *Medicine (Baltimore)*. 2017; 96:e7349.
8. Fortuna G, Aria M, Iorio C, Mignogna MD, Klasser GD. Global research trends in complex oral sensitivity disorder: a systematic

9. bibliometric analysis of the framework. *J Oral Pathol Med*. 2020;49:555-564.
9. Foy JP, Bertolus C, Goudot P, et al. Bibliometric analysis of a century of research on oral erythroplakia and leukoplakia. *J Oral Pathol Med*. 2018;47:388-395.
10. Gondivkar SM, Sarode SC, Gadobail AR, Gondivkar RS, Chole R, Sarode GS. Bibliometric analysis of 100 most cited articles on oral submucous fibrosis. *J Oral Pathol Med*. 2018;47: 781-787.
11. Hassona Y, Qutachi T. A bibliometric analysis of the most cited articles about squamous cell carcinoma of the mouth, lips, and oropharynx. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2019;128:25-32.e26.
12. Liu W, Zhang Y, Wu L, Yang X, Shi L. Characteristics and trends of oral leukoplakia research: a bibliometric study of the 100 most cited articles. *Medicine (Baltimore)*. 2019;98: e16293.
13. Liu W, Ma L, Song C, Li C, Shen Z, Shi L. Research trends and characteristics of oral lichen planus: a bibliometric study of the top-100 cited articles. *Medicine (Baltimore)*. 2020;99: e18578.
14. Page MJ, McKenzie JE, Bossuyt PM, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021;372:n71.
15. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. *Syst Rev*. 2016;5:210.
16. Hirsch JE. An index to quantify an individual's scientific research output. *Proc Natl Acad Sci U S A*. 2005;102:16569-16572.
17. Egghe L. Theory and practise of the g-index. *Scientometrics*. 2006;69:131-152.
18. Thompson DF, Callen EC, Nahata MC. New indices in scholarship assessment. *Am J Pharm Educ*. 2009;73:111.
19. Aria M, Cuccurullo C. Bibliometrix: an R-tool for comprehensive science mapping analysis. *J Informetrics*. 2017;11:959-975.
20. van Eck N, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*. 2010;84:523-538.
21. Khatri B, Tessneer KL, Rasmussen A, et al. Genome-wide association study identifies Sjögren's risk loci with functional implications in immune and glandular cells. *Nat Commun*. 2022; 13:4287.
22. Rudin CM, Cohen EE, Papadimitrakopoulou VA, et al. An attenuated adenovirus, ONYX-015, as mouthwash therapy for premalignant oral dysplasia. *J Clin Oncol*. 2003;21:4546-4552.
23. Warnakulasuriya S, Johnson NW, van der Waal I. Nomenclature and classification of potentially malignant disorders of the oral mucosa. *J Oral Pathol Med*. 2007;36:575-580.
24. Walsh T, Macey R, Kerr AR, Lingen MW, Ogden GR, Warnakulasuriya S. Diagnostic tests for oral cancer and potentially malignant disorders in patients presenting with clinically evident lesions. *Cochrane Database Syst Rev*. 2021;7:Cd010276.
25. Walsh T, Warnakulasuriya S, Lingen MW, et al. Clinical assessment for the detection of oral cavity cancer and potentially malignant disorders in apparently healthy adults. *Cochrane Database Syst Rev*. 2021;12:Cd010173.
26. Lodi G, Franchini R, Warnakulasuriya S, et al. Interventions for treating oral leukoplakia to prevent oral cancer. *Cochrane Database Syst Rev*. 2016;7:Cd001829.