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Original Article

A bibliometric study on research trends and hotspots of recurrent aphthous stomatitis

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Abstract *Background/purpose:* Recurrent aphthous stomatitis (RAS) is a common oral mucosal disease. Despite a variety of scientific articles have been available till date, merely a few scientometric analyses have been systematically carried out in this field. The objective of this study was to recognize the hotspots and research trends related to RAS via bibliometric approach.

Materials and methods: The Elsevier's Scopus database was searched to retrieve qualified literature through an advanced search strategy on 9 Feb 2023. The basic information was collected as following: article type, publication year, journals, impact factor, the count of citations, citation density, keywords, authors, contributing institutions and country.

Results: A list of 986 publications were identified from 1933 to 2022, and the number of citations for each paper varied from 0 to 283. A steady increasing trend in the number of documents could be observed each decade with the summit in 2010s. Controlled study (n = 334) and major clinical study (n = 192) were the most common types of study design. Scully C (n = 26) was identified as the most productive author. United States (n = 166) and Turkey (n = 101) top the list of dedicating countries.

Conclusion: This report would offer profound insight into the current status of RAS research and serve as a reference source for anyone planning to enhance the quality of future work.

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Introduction

Recurrent aphthous stomatitis (RAS), also known as canker sores, is a relatively common disease involved in the oral cavity. It afflicts approximately 20–25 % of the general population. The clinical manifestation is mainly characterized by a solitary or multiple discomforting spherical or ovoid ulcerations with confined margins. According to the number, size and distribution of the condition, RAS is classified into three subtypes: Minor RAS (Mikulicz's aphthae), Major RAS (Sutton's disease) and Herpetiform RAS. Although most cases last merely a few days, it may reappear at any time with a rate as high as 50 %, which can cause poor palatability and severely affect the quality of normal life.¹ Until now, although the pathogenesis and etiology of RAS is not fully understood, lots of risk factors have been proposed: immunological dysregulation, genetic tendency, psychological stress, hormonal alterations, mineral or vitamin deficiency, local trauma, and microbial imbalance. Currently, the goals of treatment tactics are to alleviate painful symptom, accelerate wound healing and prevent recurrence. Therapy strategies include both topical (analgesic, antibiotics, anti-inflammatory agents) and systemic medications (corticosteroids, antimicrobials, immunomodulators).² In the last century, a large number of researches related to RAS have been conducted that offered insights into pathophysiology, clinical features, treatment and prognosis.

Bibliometric analysis is an important method used to evaluate the academic impact of scientific publications in a specific field. This may not only help scholars to quickly identify research hotspots and updated trends within the designated field, but also lay a foundation for exploring new perspectives, direction, and priorities in a given discipline.³ In recent years, emerging scientometric studies have been implemented in the field of stomatology, such as periodontology, orthodontics, endodontics, oral cancer and maxillofacial surgery.^{4–7} However, an objective analysis focused on RAS research has not been undertaken yet. Thus, the present work aims to describe the characteristics of relevant medical literature on RAS, recognize the achievements in the chosen topic, and establish novel design viewpoint for future investigation.

Materials and methods

Data acquisition

Related publication data was retrieved on 9 February 2023 from Elsevier's Scopus database. The search terms and strategy were showed as following (TITLE (recurrent AND aphthous AND ulcer) OR TITLE (recurrent AND aphthous AND stomatitis) OR TITLE (oral PRE/2 ulcer) OR TITLE (oral PRE/2 ulceration) OR TITLE(canker AND sores)) AND (LIMIT TO (LANGUAGE, "English")) AND PUBYEAR <2023. Literature information was independently screened and reviewed by two investigators (X.X. and S.L.), who recorded and evaluated the relevant scientometric characteristics: document type, title, abstract, year of publication, number of papers, count of citation, keywords, contributing authors, institutions of origin, country or territory.

Another experienced expert (Z.S.) was consulted to reach a consensus in case of disagreement.

Data analysis

Descriptive statistics were performed to present the characteristics of these academic literature. The Bibliometrix biblioshiny R-package software (K-Synth Srl Inc., Naples, Italy) was utilized to evaluate the bibliographic indicators, which was an open-source tool for quantitative research in scientometrics and bibliometrics that included all the main bibliometric methods of analysis. A list of distinctive keywords was automatically identified in descending order based on their frequency by the database. The content of the analysis included the annual citation count, top-10 productive authors, top-10 prolific institutions and countries or regions, top-20 frequent keywords, top-10 active journals, and top-20 cited papers.

Results

General citation information

According to the search criteria, a total of 986 papers were collected in the Scopus database for the period of 1933–2022. As revealed in Fig. 1A, a gradual increasing trend was shown in the number of documents published each decade. Among these publications, there were 787 original articles (79.8 %), 102 reviews (10.3 %), 55 letters (5.6 %), 18 notes (1.8 %), 7 conference papers (0.7 %), 7 short surveys (0.7 %), 5 book chapters (0.5 %), 4 erratum (0.4 %) and 1 editorials (0.1 %) (Fig. 1B). All these papers were cited for a total of 18,315 times, with an overall *h*-index of 63 (Fig. 1C). The mean number of citations per document is 18.6 times, with a maximum count of 283. The accumulated citations raised from 0 to 4358 during the period of 1930s–2020s (Fig. 1D). The list of 20 most frequently cited manuscripts on RAS was summarized in Table 1. The basic characteristics of these literature included rank, title, first author, the year of publication, type, journal IF, citation count.

Research hotspots or trends, study design

To manifest an overview of the up-to-date topic of RAS study, top 20 distinctive keywords were identified with the highest frequency. Among them, treatment options were the most concerned field. For instance, drug efficacy (*n* = 87) was ranked at the first place. Treatment outcome (*n* = 77), corticosteroid (*n* = 60) and colchicine (*n* = 54) were top in the list. In addition, the particular areas focused on genetics (*n* = 72), immunology (*n* = 67), pain assessment (*n* = 48) and different diagnosis (*n* = 35) were also exhibited in the list (Fig. 2A).

For the study design, the top 10 ranks were listed according to the frequency of main keywords. Controlled study (*n* = 334), major clinical study (*n* = 192) and randomized controlled trial (*n* = 106) were the most common types, followed by comparative study (*n* = 75), follow up (*n* = 47), human cell (*n* = 32), systematic review (*n* = 30),

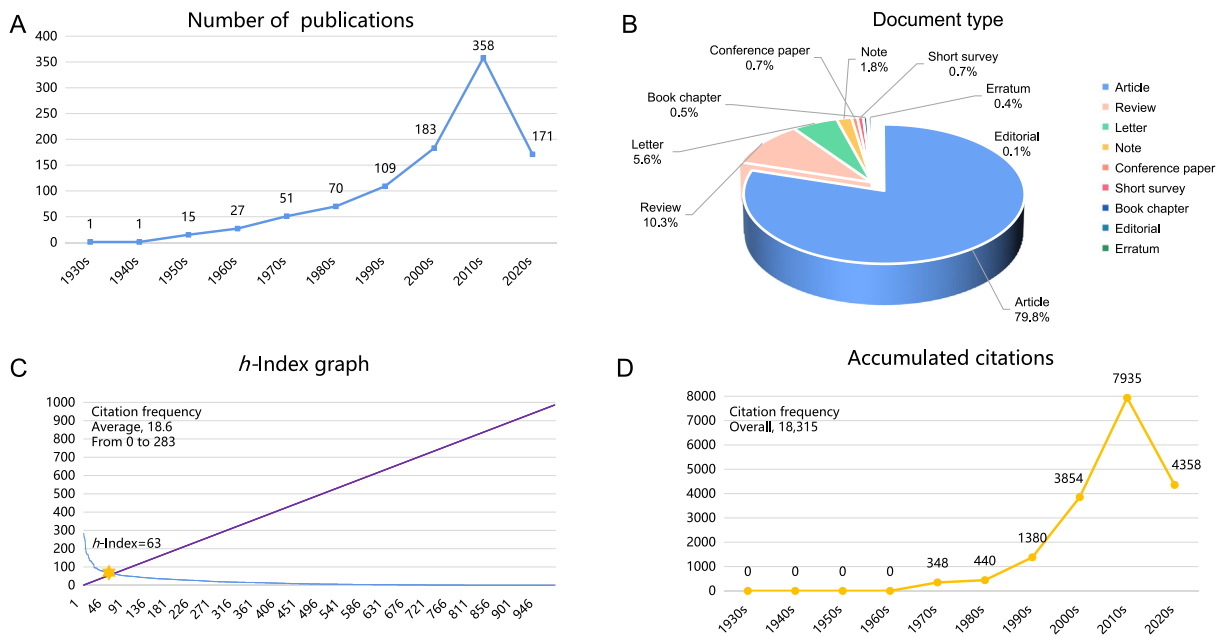


Figure 1 Citation analysis of the papers on recurrent aphthous stomatitis. (A) The number of papers by decade of publication. (B) The frequency of document type. (C) The *h*-index graph of the included papers. (D) The number of accumulated citations by decade of publication.

prospective studies ($n = 27$), cross-sectional study ($n = 25$), nonhuman ($n = 25$) (Fig. 2B).

Authors, institutions, countries and journal

The scientometric information on authors, institutions, countries of origin and journals was analyzed in detail. The top-10 high-prolific authors with the largest amount of publications were shown in Fig. 3A. These authors contributed 130 publications, accounting for 13.2 % (130/986). Scully C was identified as the most productive author with 26 prominent documents, followed by Sun A ($n = 18$), Rezaei N ($n = 12$), Kontinen YT ($n = 11$) and Mohammadzadeh M ($n = 11$). The top-10 high-output countries with the maximum number of papers were presented in Fig. 3B. Among these, United States made distinguished dedications to the development of RAS research with 166 papers, followed by Turkey ($n = 101$), United Kingdom ($n = 81$), India ($n = 77$) and China ($n = 71$).

The top-10 high-vibrant institutions with the largest count of literature were illustrated in Fig. 3C. Tehran University of Medical Sciences appeared to be the most active institutions with 26 academic publications, followed by Eastman Dental Institute ($n = 18$), National Taiwan University ($n = 14$), Helsingin Yliopisto ($n = 13$) and University College London ($n = 13$). The top-10 high-productive journals with the maximum number were exhibited in Fig. 3D. Probably 24 % of the documents were published in the top 10 prestigious journals (239/986). The Journal of Oral Pathology & Medicine (71 documents, impact factor [IF]: 3.3) published the most original articles, followed by Oral Surgery Oral Medicine Oral Pathology And Oral Radiology (53, IF: 2.9), Oral Diseases (27, IF:

3.8), Clinical Oral Investigations (17, IF: 3.4) and BMC Oral Health (14, IF: 2.9).

Discussion

The scientometric evaluation enables scholars to recognize research themes and historical perspective within a particular academic community.^{8–10} It's widely accepted that impact factors and citation counts are parameters for gauging the quality and influence of research products. Furthermore, Andersen indicated that an article cited more than 100 times was labeled as "classic".¹¹ Investigators might grasp the general situation of the designated area through comprehension of these classic papers. Twenty two publications with 100 or more citations in the present study were suggested to be classic. As far as we know, few literature concentrating on citation of papers regarding RAS have yet been reported so far. The current study was to identify and assess the citation information and track research evolution of articles involving RAS.

With the progression in RAS research, a steady growing trend in the number of scientific outputs could be detected each decade since its inception in 1933. The peak point was reached in 2010s with 358 literature (36.3 %). This observation contrasted with other findings, on different areas or specialties, in which the majority of the highly cited articles were published in 2000–2009 period.^{9,12} It's obvious that older papers are more likely to be cited than newly appeared articles regardless of their academic value. To avoid time deviation, we calculated citation density of each paper, and found that most papers with highest citation density were published in 2010–2019 period. This result could be partly ascribed to the rapid advancement of

Table 1 List of top-20 cited papers on recurrent aphthous stomatitis research.

Rank	First author	Title	Publication year	Document type	Study design	Source (abbreviated name)	Impact factor (2022 JCR)	Scopus citations	Citation density
1	Jurge et al.	Number VI: Recurrent aphthous stomatitis	2006	Review	Narrative review	Oral Dis.	3.8	283	16.6
2	Scully et al.	The diagnosis and management of recurrent aphthous stomatitis: A consensus approach	2003	Article	Narrative review	J. Am. Dent. Assoc.	3.9	264	13.2
3	Scully et al.	Oral mucosal disease: Recurrent aphthous stomatitis	2008	Article	Narrative review	Br. J. Oral Maxillofac. Surg.	1.8	256	17.1
4	Natah et al.	Recurrent aphthous ulcers today: A review of the growing knowledge	2004	Review	Narrative review	Int. J. Oral Maxillofac. Surg.	2.4	244	12.8
5	Ship et al.	Recurrent aphthous stomatitis	1996	Review	Narrative review	Oral Surg. Oral Med. Oral Pathol. Oral Radiol. Endod. Arch. Dermatol.	2.9	204	7.6
6	Revuz et al.	Crossover study of thalidomide vs placebo in severe recurrent aphthous stomatitis	1990	Article	Randomized controlled trials		NA	182	5.5
7	Embil et al.	Prevalence of recurrent herpes labialis and aphthous ulcers among young adults on six continents	1975	Article	Cross sectional study	Can. Med. Assoc. J.	17.4	173	3.6
8	Chavan et al.	Recurrent aphthous stomatitis: A review	2012	Review	Narrative review	J. Oral Pathol. Med.	3.3	170	15.5
9	Porter et al.	Recurrent aphthous stomatitis	1998	Review	Narrative review	Crit. Rev. Oral Biol. Med.	NA	168	6.7
10	Ship et al.	Recurrent aphthous stomatitis	2000	Article	Narrative review	Quintessence Int.	1.9	167	7.3
11	Rogers et al.	Recurrent aphthous stomatitis: Clinical characteristics and associated systemic disorders	1997	Conference paper	Narrative review	Sem. Cutaneous Med. Surg.	1.1	156	6.0
12	Preeti et al.	Recurrent aphthous stomatitis	2011	Review	Narrative review	J. Oral Maxillofac. Pathol.	NA	148	12.3
13	Akintoye et al.	Recurrent aphthous stomatitis	2014	Review	Narrative review	Dent. Clin. North Am.	NA	142	15.8
14	Scully et al.	Recurrent aphthous stomatitis: current concepts of etiology, pathogenesis and management	1989	Review	Narrative review	J. Oral Pathol. Med.	3.3	135	4.0
15	Barrons et al.	Treatment strategies for recurrent oral aphthous ulcers	2001	Review	Narrative review	Am. J. Health-Syst. Pharm.	2.7	134	6.1
16	Graykowski et al.	Recurrent aphthous stomatitis: Clinical, therapeutic, histopathologic, and hypersensitivity aspects	1966	Article	Narrative review	JAMA	120.7	132	2.3
17	Belenguer et al.	Treatment of recurrent aphthous stomatitis. A literature review	2014	Article	Narrative review	J. Clini. Exp. Dent.	NA	131	14.6

(continued on next page)

Table 1 (*continued*)

Rank	First author	Title	Publication year	Document type	Study design	Source (abbreviated name)	Impact factor (2022 JCR)	Scopus citations	Citation density
18	Buño et al.	Elevated levels of interferon gamma, tumor necrosis factor α , interleukins 2, 4, and 5, but not interleukin 10, are present in recurrent aphthous stomatitis	1998	Article	Case-control study	Arch. Dermatol.	NA	126	5.0
19	Rogers et al.	Lymphocytotoxicity in recurrent aphthous stomatitis: Lymphocytotoxicity for oral epithelial cells in recurrent aphthous stomatitis and Behcet syndrome	1974	Article	Case-control study	Arch. Dermatol.	NA	121	2.5
20	Ślebioda et al.	Etiopathogenesis of recurrent aphthous stomatitis and the role of immunologic aspects: Literature review	2014	Review	Narrative review	Arch. Immunol. Ther. Exp.	3.2	120	13.3

Abbreviations: NA, not available.

journals or databases in electronic format, thus favoring the circulation and access within the scientific community.

Strikingly, most of the top 20 highly cited articles were narrative review. And only one study carried out randomized controlled trials, which was in concordance with other finding.¹² This suggested that great importance should be given to enhance high-standard researches in this specific field. Meanwhile, we observed that the most cited article was only cited 283 times. This could be explained that citation index did not directly measure value or significance of a study. A wide range of factors may influence the citation count, such as the interest of subject, the potential to stimulate changes or guide further research.

All the documents included were written in English and the majority of them were attributed to authors and institutions from the United States ($n = 166$), in concordance with the result of other studies.^{13–15} The reason may be that the United States has a substantial influence on health care sciences, due to its large-scale financial support from public or private sectors. It's conspicuous that authors from Turkey ($n = 101$) and United Kingdom ($n = 81$) also made important devotion to this targeted field.

It's well known that scholars usually prefer to select journals with higher IF and wider readership for publishing their highly influential research. The positive association between IF of journals and citation count was confirmed in other bibliometric analysis on distinctive topics.^{16,17} However, in the current study, only 35 papers (3.5 %) were published in journals with high IF > 10, namely Lancet, New England, JAMA, British Medical Journal, Canadian Medical Association Journal, Journal of the American Academy of Dermatology, Allergy, Journal of Internal Medicine, Proceedings of the National Academy of Sciences of the United States of America, Medical Journal of Australia, The American Journal of Gastroenterology, Neurology, Drugs, British Journal of Dermatology, Mayo Clinic Proceedings. Notably, there is an increasing trend for investigators to choose specialty journals rather than general medical journals to expand their scientific influence. Our report also showed similar finding in that journals with the largest number of papers were specialty journals, such as Journal of Oral Pathology & Medicine, Oral Surgery Oral Medicine Oral Pathology And Oral Radiology, Oral Disease, Clinical Oral Investigations, BMC Oral Health, Archives of Oral Biology. Hence, this demonstrates that authors tend to acquire the latest knowledge about RAS from these distinguished journals.

Besides, we focused on the study design, themes, and hotspots of study in each included article on the grounds of keywords frequency. Our study indicated that major clinical studies were more common than basic research, in agreement with that of other reports.^{9,18} Indeed, basic science study could be very significant for disease research, thus, clinicians should employ more fundamental experiment research to achieve relevant information on RAS. With regard to topics, treatment efficacy of RAS and anti-inflammatory agents were on the top of the list, revealing the interest and concerns of study in this field. Progress in the treatment and prognosis of RAS will request intensive understanding of the pathogenic mechanisms, motivating the development of new therapeutic drugs. This would

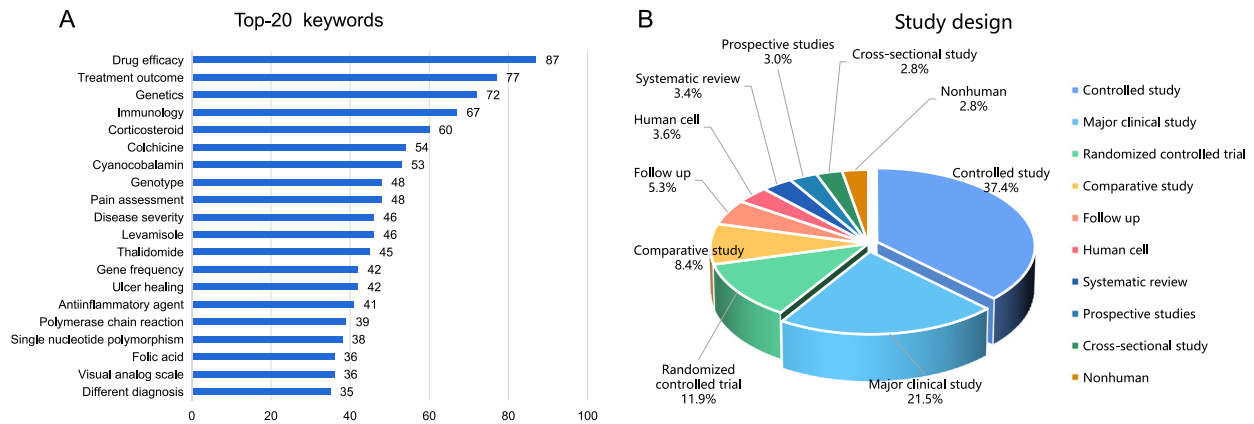


Figure 2 Study topic and design of the papers on recurrent aphthous stomatitis research. (A) The ranks of study topics based on top-20 distinctive keywords. (B) The distribution of study design.

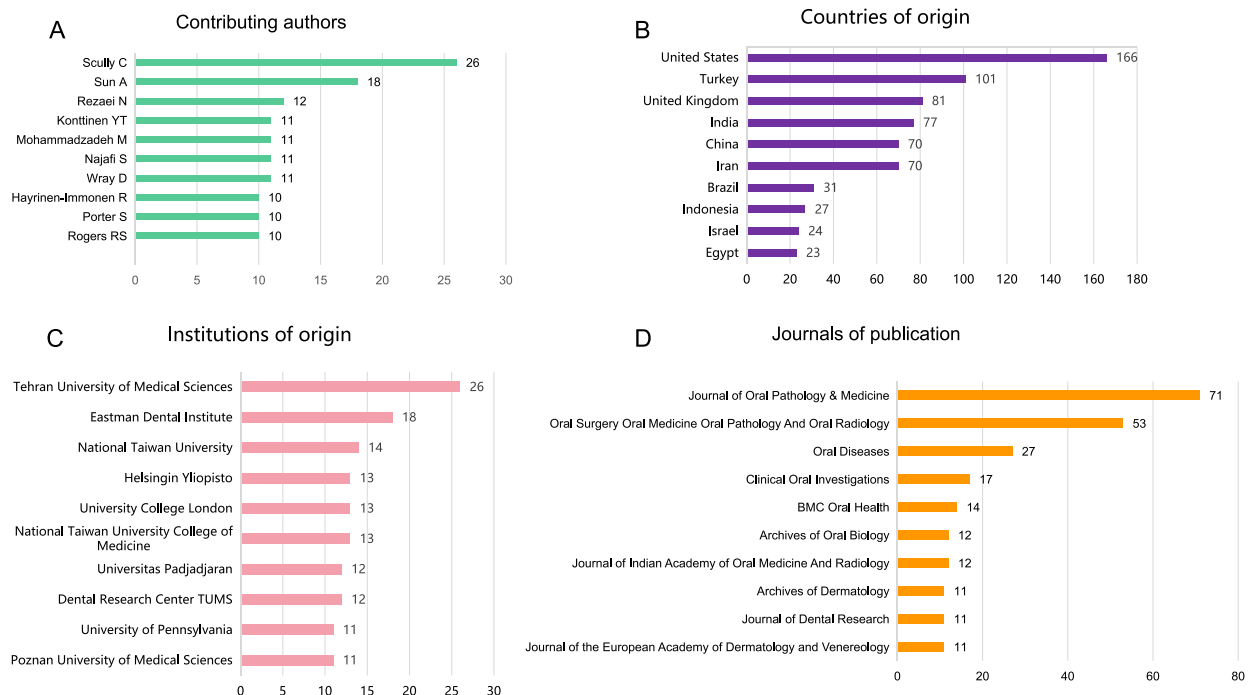


Figure 3 Bibliometric information on contributing authors (A), countries (B), institutions (C), and journals of publication (D) (rank 1–10).

provide guidance for future research direction and improve clinical practice.

There existed some possible restrictions in our citation analysis, even though we endeavoured to lessen the undesirable deficiency to the minimum. Since we used only Elsevier's Scopus database as a data source, certain omission of highly cited publications or additional citations from other different databases (Web of Science, Pubmed, Google Scholar) was ineludible. Thus, multiple databases should be considered in future research. Besides, the database keeps updating daily as well as the number of citation, which may distort the actual research condition and analysis outcomes. In addition, the search strategy was

steered to records that included the chosen terms in their title and limited to English language. Thus, some relevant articles that did not contain these keywords in their title may not be retrieved, affecting the final results. Broader medical terms or subject selection could expand the scope of search to obtain more eligible publications.

In summary, this study for the first time presented an overview of study achievements and progression of scientific outputs in the field of RAS. Our work revealed potential research directions that demand further attention and exploration. We hope this study would provide effective strategy for physicians and scholars to develop more excellent clinical interventions or therapy on RAS.

Declaration of competing interest

The authors have no conflicts of interest relevant to this article.

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