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Short Communication

A scientometric study on research trends and characteristics of halitosis

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Abstract *Background/purpose:* Halitosis is a condition characterized by unpleasant odors originating from the oral cavity. The purpose of this study was to analyze the scientometric characteristics and research trends of halitosis.
Materials and methods: All the papers on halitosis were comprehensively retrieved from the Scopus database. The years of publication were divided into before 2015 and after 2015 in the analysis of research trends.
Results: There were 1252 papers on halitosis, with total citations of 26,932 and the *h* index of 76. Poor oral hygiene, periodontitis, periodontal disease, gingivitis, dental caries, xerostomia, periodontics, and smoking were halitosis-related conditions. The trend of clinical investigations has changed to prospective study, single blind procedure, tongue coating, complication, sensation, and quality of life after 2015. The trend of treatment, mainly drug therapy such as antiinfective agent, cetylpyridinium salt, chewing gum, zinc, and triclosan before 2015, has changed to photodynamic therapy, plant extract, and probiotic agent after 2015. Moreover, the trend of laboratory investigation has changed to biological marker, genetics, microbiome, and microflora after 2015. There have always been common keywords such as controlled study, mouth hygiene, sulfur compounds, hydrogen sulfide, microbiology, breath analysis, mouthwash, questionnaire, breath tests, and gas chromatography.

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Conclusion: This scientometric study elucidated the current scenario and research trends of halitosis, and would help in improving in reciprocal collaboration and communication for investigations on this condition.

Introduction

Halitosis is a condition characterized by unpleasant odors originating from the oral cavity.[1] It is a community health problem that often causes severe psychosocial embarrassment, and persistent halitosis can adversely affect social life and self-esteem, making it essential to seek help if needed.[2] Halitosis was reported to be the most prevalent cause for individuals seeking dental care, followed by dental caries and periodontal diseases.[2] Halitosis is either physiologic or pathological. Pathological halitosis is subdivided into intra-oral or extra-oral pathological processes. About 80—90 % of halitosis is caused by intra-oral factors, with tongue coating, periodontal diseases, and poor oral hygiene practices being the predominant causes, and 10—20 % of halitosis is induced by extra-oral factors associated with systemic diseases, such as diabetes, respiratory, gastrointestinal, liver, and kidney diseases.[2] Hence, halitosis is a symptom that might be associated to distinct physiologic and pathological processes, demanding multidisciplinary approaches for its diagnosis and treatment.

Increased medical awareness is needed to determine the actual pathophysiological process of halitosis in otherwise healthy individuals.[2] Since it has a multifactorial etiology being of interest by different health areas, there have been thousands of the papers regarding various aspects of halitosis. Scientometrics is a useful tool that utilizes citation and bibliometric data to measure scientific output and research trend of a specific research field.[3–5] Although an analysis of only top-100 most-cited articles on halitosis has been newly reported,[6] there was lack of a comprehensive overview of the publications on this condition. This analysis indicated the need for citing studies with more robust designs in order to provide better scientific evidence of citations in etiology, diagnosis and treatment. Therefore, the purpose of this study was to analyze the scientometric characteristics and research trends of all the papers on halitosis, with emphasis on the analysis of the keywords that can reflect research directions and topics of concern.

Materials and methods

As per the methodology described previously,[4,5] all the papers on halitosis in the Scopus database were retrieved on 16 Feb 2025. We used medical subject terms "halitosis" OR "oral odor" OR "oral malodor" OR "breath odor" OR "breath malodor" OR "bad breath" in the Title in literature search, without restriction to paper type and year of publication. Only English literature was included because it is an international knowledge-exchange language. The scientometric characteristics of all the eligible papers were recorded for the following information: title, keyword, citation count, publication year, journal of publication, authorship, affiliation, and country/region of origin. Data search and extraction were performed independently by two investigators, and any discrepancy of results was resolved in a consensus symposium. The years of publication were divided into before 2015 and after 2015, so that the number of papers can be to some extent compared in the analysis of research trends. Microsoft Office Excel 365 was used for index model building, and the Bibliometrix Biblioshiny R-package software was used for bibliometric statistics. In this descriptive study, variables were presented as numbers and percentages. No comparisons were made, and thus no *P*-values were set.

Results

Citation characteristics

With the search strategy algorithm, a total of 1252 papers on halitosis were retrieved in the Scopus database. As presented in Fig. 1A, the most type of papers on halitosis was article (n = 932), followed by review (n = 151) and conference paper (n = 51). The total citation count (after removal of self-citations) was 26,932 (25,184) and the *h* index was 76 (73) for all the papers. To further concretize the trends of scientific output, we assessed the annual number and accumulated citations of the papers during 2005—2024 (Fig. 1B). The annual number of the papers on halitosis stably raised from 36 to 74 during 2005—2024. The accumulated citations (after removal of self-citations) of the papers increased from 354 (319) to 2247 (2122) during 2005—2024. Supplementary Tables S1 presents the detailed information on publication year, authors, title, abstract, journal of publication, citation count, institutions, and keywords of the 100 most-cited papers.

Bibliometric characteristics

Fig. 1C displays cloud graphs of journals of publications, contributing authors, institutions, and countries/regions of origin of the papers on halitosis, which were divided into before 2015 (667 papers) and after 2015 (585 papers), so that the number of papers can be to some extent compared in the analysis. Before 2015, the journal of publication, contributing author, institution and country of origin with largest number of papers was *Journal of Breath Research* (29 papers), Rosenberg, M (30 papers), Tel Aviv University (32 papers) and United States (147 papers), respectively. After 2015, the journal of publication, contributing author, institution and country of origin with maximum number was

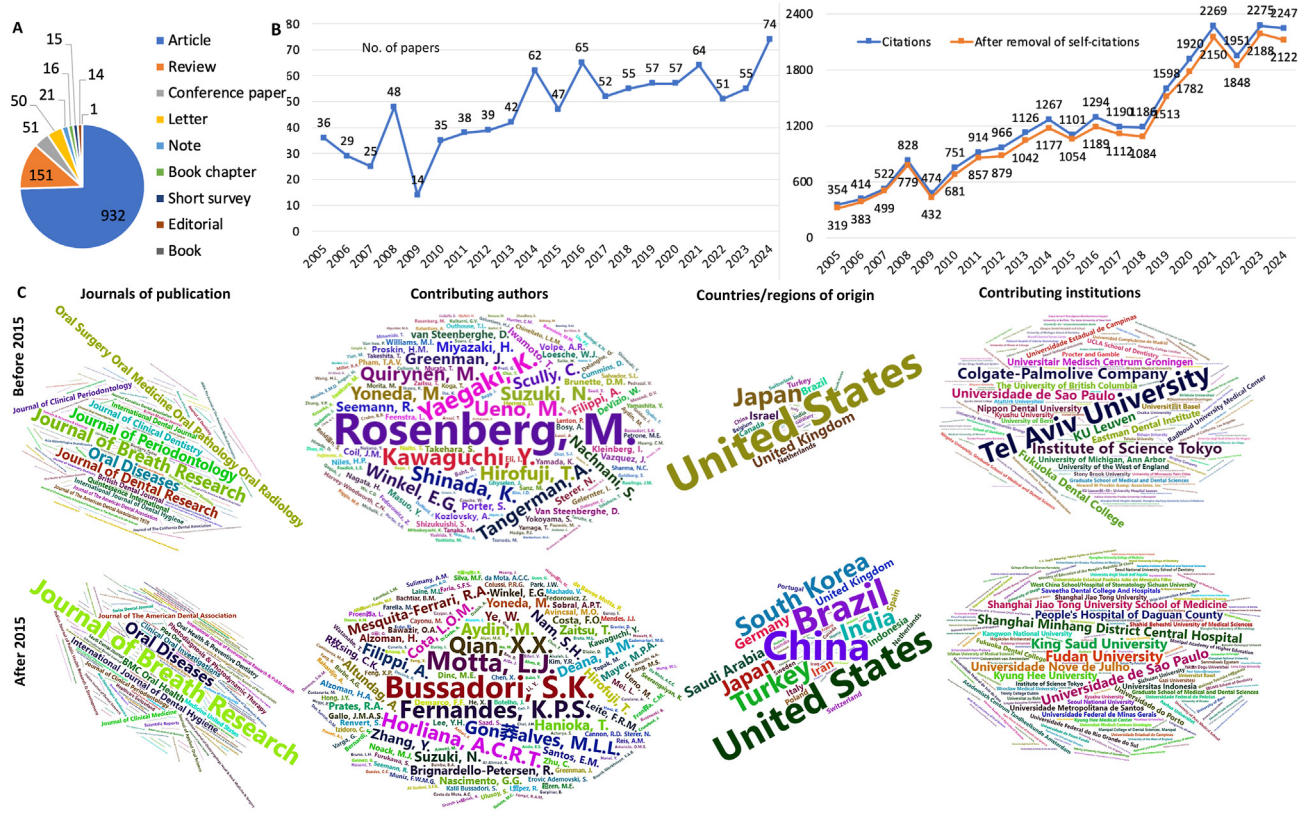

Figure 1 Bibliometric characteristics of the papers on halitosis (**A**) The numbers of different paper types (**B**) The annual number and accumulated citations of the papers during 2005–2024 (**C**) Cloud graphs of journal of publication, contributing authors, countries and institutions of origin regarding halitosis publications before 2015 and after 2015. The font size indicates the number of papers; a larger size means more papers in the cloud graphs.

Journal of Breath Research (30 papers), Bussadori, S.K. (15 papers), Fudan University (16 papers) and China (68 papers), respectively. Supplementary Table S2 presents the journals, contributing authors, institutions, and countries/regions with largest number of papers (rank, 1–10).

Research characteristics

Based on the frequency of the keywords in all the papers on halitosis (Fig. 2A), a list of the common keywords is automatically recognized by the database. The most common study design was controlled study, followed by cross-sectional study, cross-over study, and follow-up study. Oral hygiene, periodontitis, periodontal disease, gingivitis, *Porphyromonas gingivalis*, dental caries, xerostomia, *Fusobacterium nucleatum*, anaerobic bacterium, periodontics, and smoking were the keywords of the disease cause (Fig. 2B). Mouthwashes, chlorhexidine, antiinfective agent, probiotic agent, cetylpyridinium salt, zinc, plant extract, chewing gum, triclosan, anti-bacterial agents, and photodynamic therapy were the keywords of the treatment aspect (Fig. 2C). Sulfur derivative, sulfur compounds, hydrogen sulfide, sulfhydryl compounds, thiol derivative, dimethyl sulfide, volatile organic compound, and volatile sulphur compounds were the keywords of the malodorous molecules (Fig. 2D). Before 2015 and after 2015, there have always been the same common keywords such as controlled study, mouth hygiene, tongue, sulfur compounds, hydrogen sulfide, microbiology, breath analysis, mouthwash, questionnaire, periodontitis, breath tests, and gas chromatography.

Based on the keywords of papers on halitosis published in different years (Fig. 2E), the more common keywords can basically reflect research trends. Before 2015, clinical investigations on correlation analysis, time factors, dental devices, home care, diabetes mellitus, diagnosis, psychological aspect, smell, anaerobic bacterium, benzoylarginine-2-naphthylamide, sensitivity and specificity were more common. Drug keywords including topical antiinfective agent, cetylpyridinium salt, chewing gum, zinc, triclosan, dentifrices, and fluoride sodium were more frequent. After 2015, clinical investigations on prospective study, single blind procedure, tongue coating, complication, disease severity, epidemiology, fragrance, sensation, and quality of life were more common. Concerning treatment, photodynamic therapy, photosensitizing agent, plant extract, and probiotic agent were more frequent keywords. Moreover, biological marker, genetics, microbiome, microflora, *Prevotella intermedia*, *Tannerella forsythia*, *Streptococcus mutans*, *Treponema denticola*, and real time polymerase chain reaction, and methyl mercaptan were also more frequent keywords after 2015.

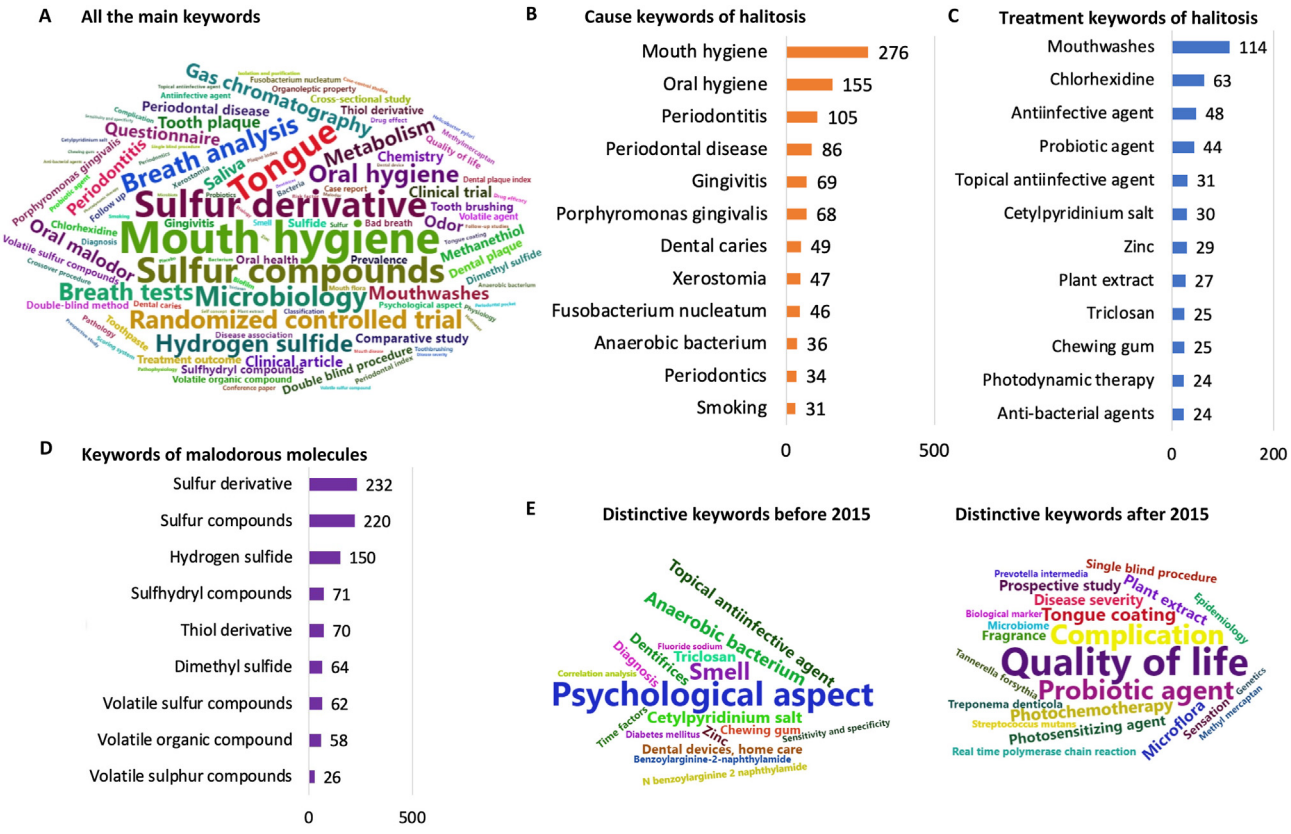

Figure 2 Research characteristics of the papers on halitosis (**A**) Cloud graph of all the main keywords (**B**) The cause-related keywords (**C**) The keywords of treatment (**D**) The keywords of malodorous molecules (**E**) Cloud graphs of distinctive keywords of papers published before 2015 and after 2015. The font size indicates the number of papers; a larger size means more papers in the cloud graphs.

Discussion

Halitosis is defined as a noticeable malodor with a severity exceeding a socially acceptable level.[2] This scientometric study attempted to analyze the bibliometric characteristics and research trends of all the publications on halitosis retrieved from the Scopus database. The increasing annual number and citations of the papers on halitosis suggest that this condition has governed increasing attention and investigation. Especially in the last decade, the number of papers was approximately equal to that before 2015, indicating that research on halitosis is undergoing a rapid developmental stage. Bibliometric characteristics including journals of publications, contributing authors, institutions and countries of origin, and keywords were identified in sequence. These would aid clinicians and researchers in choosing target journals, finding potential collaborators or partner institutions, as well as promoting mutual understanding and more reciprocal cooperation regarding halitosis research. Importantly, we identified the keywords of halitosis and associated causes, malodorous molecules, treatment modalities, and common keywords such as mouth hygiene, sulfur compounds, breath analysis, microbiology, periodontitis, and mouthwash (Fig. 2A–D).[7–10] These would provide a better comprehensive understanding of the cause and management strategies of halitosis.

The strength of this scientometric study was to perform the chronological comparison (before 2015 versus after 2015) based on all the papers on halitosis. According to the frequency of the keywords in the papers on halitosis, the trend of clinical investigations on correlation analysis, dental devices, anaerobic bacterium, and psychological aspect before 2015 has changed to prospective study, single blind procedure, tongue coating, complication, sensation, and quality of life after 2015.[11–13] The trend of treatment, mainly drug therapy such as topical antiinfective agent, cetylpyridinium salt, chewing gum, zinc, and triclosan before 2015, has changed to photodynamic therapy, plant extract, and probiotic agent after 2015.[14–16] Moreover, the trend of laboratory investigation has changed to biological marker, genetics, microbiome, and microflora after 2015. Due to poor oral hygiene or antibiotic use, disruption of microbial communities can result in dysbiosis, inflammation, and halitosis. Enhancing oral hygiene habits, using antimicrobial drugs, or administering probiotics could help regulate oral or intestinal flora, thereby improving halitosis and overall oral health.

In summary, this scientometric study for the first time elucidated the current scenario and research trends in the field of halitosis. Regarding the limitations of the current study, we only searched all the English papers from the Scopus database and thus may overlook important research

published in other languages and other databases. Moreover, the more recent papers could not accumulate a large number of citations at the time of this study. Overall, finding the scientometrics would elucidate the comprehensive identification and recognition of the important research topics concerned, and help in improving in reciprocal collaboration and communication for investigations on halitosis.

Declaration of competing interest

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

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jds.2025.03.020.

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