



Research article

Research hotspots and trends of oral health in older adults from 2013 to 2023: A bibliometric and visual analysis

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ABSTRACT

Background: Oral health problems seriously affect the quality of life of older adults. It is of great significance to investigate the statuses of oral health in older adults. The study aimed to analyze the current status, hotspots and frontiers of global oral health research in older adults through bibliometrics to provide references and guidance for future research in this field.

Methods: Literature on oral health in older adults from 2013 to 2023 was retrieved from the Web of Science Core Collection (WoSCC) database. CiteSpace 6.2.R4 was used for bibliometric and visual analysis, including journal and co-cited journal, country/region, institution, author, co-cited references, and keyword analysis.

Results: A total of 1430 publications related to oral health in older adults were included. The number of publications has gradually increased over the past decade. The most widely published and cited journal was *Gerodontology*. The most prominent contribution came from the United States of America, and the University of London and Hirohiko Hirano were the most prolific institution and author, respectively. The current research hotspots were summarized as oral hygiene interventions, oral health-related quality of life and oral health issues in older adults. Cohort studies of oral health, the relationship between oral health and frailty, and the correlation between oral health and nutritional status may be emerging research trends.

Conclusions: This study systematically analyzed the hotspots and frontiers of oral health in older adults and called for increased collaboration among countries, institutions, and authors. In addition, oral hygiene interventions for older adults, oral health-related quality of life, oral health issues, cohort studies of oral health, and the relationship between oral health and frailty or nutritional status may be the focus of future research.

1. Introduction

Oral diseases have become a major public health problem that poses a serious threat to the physical and mental health of older

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adults worldwide [1]. The World Health Organization (WHO) defines oral health as "clean teeth, no cavities, no pain, normal gum color and no bleeding", and lists it as one of the top ten major standards of human health, which is closely related to well-being [2,3]. Oral health problems are important clinical indicators of disease progression in older adults [4].

Oral health problems are common among older adults, and the prevalence of poor oral health may be increased by a variety of factors including age [5], diseases or medications [6,7], and cognitive function [5,8]. These problems accumulate over a lifetime and are exacerbated by infrequent visits to oral health care professionals [9]. The most common oral problems in older adults include natural tooth loss, dry mouth, dental caries, periodontal disease, defective or inappropriate dentures, and oral cancer [10,11]. The number of remaining teeth is an important indicator of oral health, particularly in older adults, as it represents the cumulative effect of long-term exposure to dental caries and periodontitis. The WHO Global Oral Health Status Report stated that the global average prevalence of edentulism in people over 60 years of age was 22.7 %, meaning that almost a quarter of people > 60 years had no teeth [2]. A study of 892 people aged 60 years and older in Saudi Arabia found that the rate of missing teeth was 78.69 % and gum disorders accounted for 74.21 % [12]. In China, according to the results of the Fourth National Oral Health Survey, the oral health rate of the middle-aged and older population was less than 15 %, among which the prevalence of dental caries was as high as 98 % and the proportion of missing teeth was 86.1 % in the 65–74 age group [13].

Oral health problems can seriously affect the overall health and adversely affect disease development and quality of life in older adults [14]. Due to tooth loss or poor oral function, older adults may be restricted in eating (e.g., taste, chewing, swallowing, and digestion), resulting in inadequate nutritional intake, weight loss, low physical function, and geriatric disease [11,15]; tooth loss can also affect conversation and dental aesthetics, reduce enjoyment of meals with family and friends, and lead to low self-esteem, depression, and even suicidal thoughts in older adults [16]. Oral health was negatively correlated with frailty in older adults, with the risk of frailty increasing with poor oral health [17]. Both objective and subjective poor oral health were risk factors for mortality in older adults [18]. However, oral health is often overlooked when discussing the health of older adults [19]. To make matters worse, they are less likely to seek oral health services than other populations [9,20]. The oral health status of older adults worldwide is not optimistic and requires urgent attention from researchers and health care professionals.

Given the high prevalence of poor oral health and serious adverse health consequences among older adults, further research in this field is warranted. Although there have been some reviews on oral health in older adults, they do not explore the research hotspots in this field [21,22]. The CiteSpace software is a scientific research tool that applies the theories and methods of bibliometrics to conduct quantitative analysis of literature collections in specific fields, and dynamically displays the evolution of the knowledge structure in scientific fields in the form of a scientific knowledge map [23]. Therefore, in this study, from the perspective of bibliometrics, CiteSpace software was utilized to systematically explore the current status, hotspots, and frontiers of global oral health research in older adults over the past decade to provide certain guidance and reference for the development of oral health research in older adults and related disciplines.

2. Materials and methods

2.1. Data source and search strategy

This study retrieved literature from the Web of Science Core Collection (WoSCC) database on June 3, 2023. The search strategy was based on an overview of the literature on oral health in older adults, and the search was optimized using the following search terms: (1) oral health terms, including "oral health", "caries", "oral hygiene", etc.; (2) older adult terms, including "the aged", "the elderly", "senior*", "geriatric*", "old*", "elder*", and "ag\$ing". We searched for ARTICLES and REVIEWS published in English language between January 1, 2013 and June 1, 2023. The search strategy for this study is shown in Table 1. A total of 1977 publications were retrieved, and two researchers independently screened literature and manually removed 547 irrelevant publications, resulting in 1430 publications related to oral health in older adults. These retrieved studies were exported in plain text format and imported into CiteSpace 6.2.R4 software, and no duplicate records were found.

Table 1
Search strategy for the study of oral health in older adults.

Set	Results	Search Query
#1	356377	TI = (the aged OR the elderly OR senior* OR geriatric* OR old* OR elder* OR ag\$ing) AND DOP = (2013-01-01/2023-06-01) AND DT = (Article OR Review) AND LA = (English)
#1	47413	TI = (caries OR dental decay OR tooth decay OR denture* OR oral hygiene OR dental plaque OR oral health OR tooth loss OR dental prostheses OR periodont* OR dry mouth OR oral dryness OR xerostomia OR toothache* OR edentul* OR oral pain OR number of teeth OR dentin sensitivity OR tooth sensitivity OR oral ulcer* OR mouth ulcer* OR gingivitis OR gingival bleeding OR oral cancer* OR oropharyngeal cancer* OR oral dysbiosis OR oral frailty OR oral hypofunction OR dental pain) AND DOP = (2013-01-01/2023-06-01) AND DT = (Article OR Review) AND LA = (English)
#3	2715	#1 AND #2
#4	1977	#3 NOT (TI = (child* OR student* OR adolescent* OR teenager* OR schoolchildren OR infant* OR mice OR mouse OR rat* OR dog* OR animal* OR birth OR school OR babies OR reproductive OR breastfeeding OR working age))

Notes: # represents a prefix for serial numbers. **Abbreviations:** TI, title; DOP, publication data; DT, document type; LA, language.

2.2. Data analysis

GraphPad Prism 9 and CiteSpace 6.2.R4 software were used to analyze the included articles. GraphPad Prism software was used to draw bar charts and line graphs for the analysis of articles. CiteSpace was used for bibliometric and visual analysis, including journal and co-cited journal, country/region, institution, author, co-cited references, and keyword analysis. The different nodes in the visual knowledge map represent elements such as country, institution, author or cited reference; the links between the nodes represent collaboration, co-occurrence or co-citation relationships; the colors of the nodes and lines represent different years. Centrality measures how important a node is in the path connecting any pair of nodes in the network. CiteSpace uses purple rings to represent nodes with high centrality, where the thickness of the ring indicates the strength of its centrality. CiteSpace's parameters are set as follows: (1) time division from January 2013 to December 2023, year per slice = 1; (2) term source = title/abstract/author keywords/keywords plus; (3) node type = country/author/institution/reference/keyword; (4) selection of the top 10 % most cited items from each slice; (5) pruning = none; (6) visualization: static clustering, showing merged networks. Modularity $Q > 0.3$ indicates that the network is reasonably divided into loosely coupled clusters, and the mean Silhouette score > 0.7 indicates that the homogeneity of the clusters is significant on average [23].

3. Results

3.1. Publication volume analysis

A total of 1430 publications were extracted from the WoSCC database, including 1318 ARTICLES (92.2 %) and 112 (7.8 %) REVIEWS. Fig. 1 shows the annual distribution of publications on oral health in older adults from 2013 to 2023, and we can see that there is a general upward trend in the number of publications over the past decade. Trends in the number of publications on oral health in older adults can be categorized into three phases. In the first phase, from 2013 to 2014, the number of publications was less than 100, meaning that oral health in older adults received less attention. The second phase runs from 2015 to 2020, the line fluctuates but grows steadily, with the number of publications increasing from 101 in 2015 to 170 in 2020. Since 2021, the number of papers on this topic has skyrocketed, with more than 200 papers published annually. Although only the number of papers from January to June 1, 2023 was counted, the number of papers in 2023 is also expected to show an upward trend. These results indicate that the field has developed and received increasing attention over the past decade.

3.2. Journal and co-cited journal analysis

The top 10 most prolific and co-cited journals are listed in Tables 2 and 3. *Gerodontology* ($n = 147$, 10.28 %) was the most productive journals, followed by *BMC Oral Health* ($n = 60$, 4.20 %) and *International Journal of Environmental Research and Public Health* ($n = 55$, 3.85 %). Of the top 10 journals, their impact factor (IF) ranged from 2.0 to 6.3, 30 % of the journals were in the Journal Citation Reports (JCR) Q1 region, 40 % were in the Q2 region, and 20 % were in the Q3 region. The most cited journal was *Gerodontology* ($n = 942$), followed by *Community Dentistry and Oral Epidemiology* ($n = 857$) and *Journal of Dental Research* ($n = 779$). The top 10 cited journals had the highest IF of 7.6, and 50 % of the journals were located in the Q1 region.

The disciplinary distribution of journals is depicted by a dual-map overlay of journals (Fig. 2). Citing journals are shown on the left and cited journals are shown on the right, and citation relationships are represented by colored pathways. The figure identifies 7 major colored citation pathways, and we can see that the majority of citing journals and cited journals are concentrated in the field of dentistry.

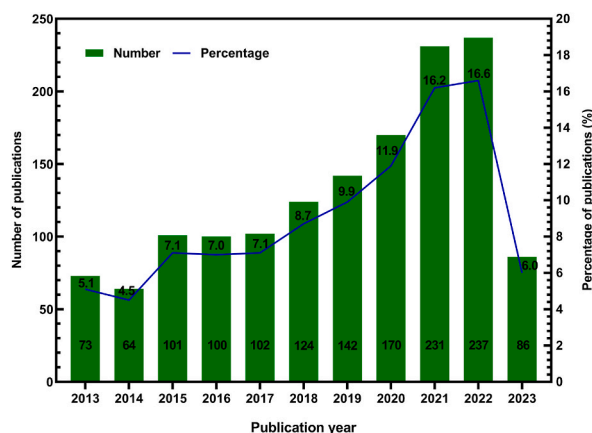


Fig. 1. The annual number of publications on oral health in older adults in the WoSCC database from 2013 to 2023.

Table 4

Top 10 countries/regions by number of publications related to oral health in older adults.

Rank	Country/Region	Count (%)	Country/Region	Centrality
1	USA	246 (17.20)	England	0.37
2	Japan	239 (16.71)	USA	0.34
3	Brazil	144 (10.07)	Australia	0.15
4	China	144 (10.07)	Germany	0.14
5	Australia	99 (6.92)	Scotland	0.14
6	England	94 (6.57)	Japan	0.11
7	South Korea	77 (5.38)	Spain	0.10
8	Sweden	76 (5.31)	Saudi Arabia	0.09
9	India	61 (4.27)	Romania	0.09
10	Germany	56 (3.92)	Croatia	0.09

nodes and 438 lines, with a network density of 0.1198. Centrality measures the importance of a country in the collaboration network. The top 6 countries with the highest centrality were: England (0.37), USA (0.34), Australia (0.15), Germany (0.14), Scotland (0.14), and Japan (0.11). The USA has an advantage in numbers, while England has an advantage in importance.

3.3.2. Institution collaboration analysis

The top 10 institutions are shown in Table 5. The University of London had the most publications (n = 60, 4.20 %). RLUK - Research Libraries UK (n = 48, 3.36 %) was in second place, followed by N8 Research Partnership (n = 37, 2.59 %) and Niigata University (n = 37, 2.59 %). The analysis of institutional collaborations revealed the collaborative relationships between institutions (Fig. 4). It consists of 314 nodes and 1133 lines, with a network density of 0.0231. Institutions with centrality > 0.1 were University of London (0.21), RLUK- Research Libraries UK (0.17), Harvard University (0.13), and N8 Research Partnership (0.12). The analysis of number of publications and centrality suggests that the most important research institutions in this field are University of London and RLUK - Research Libraries UK, which form the core of a complex collaborative network.

3.3.3. Author collaboration analysis

To explore the core authors of the research topic and their collaboration, the 10 most productive authors are listed in Table 6, this study mapped the author collaboration network (Fig. 5), which contains 481 nodes, 1065 links, and a network density of 0.0092. The most published paper was by Hirano Hirohiko (n = 21), followed by Wu Bei (n = 20), and Watanabe Yutaka (n = 19). 80 % of the top 10 authors are Japanese. Although the network density and centrality (both < 0.1) suggest less collaboration among scholars, there are

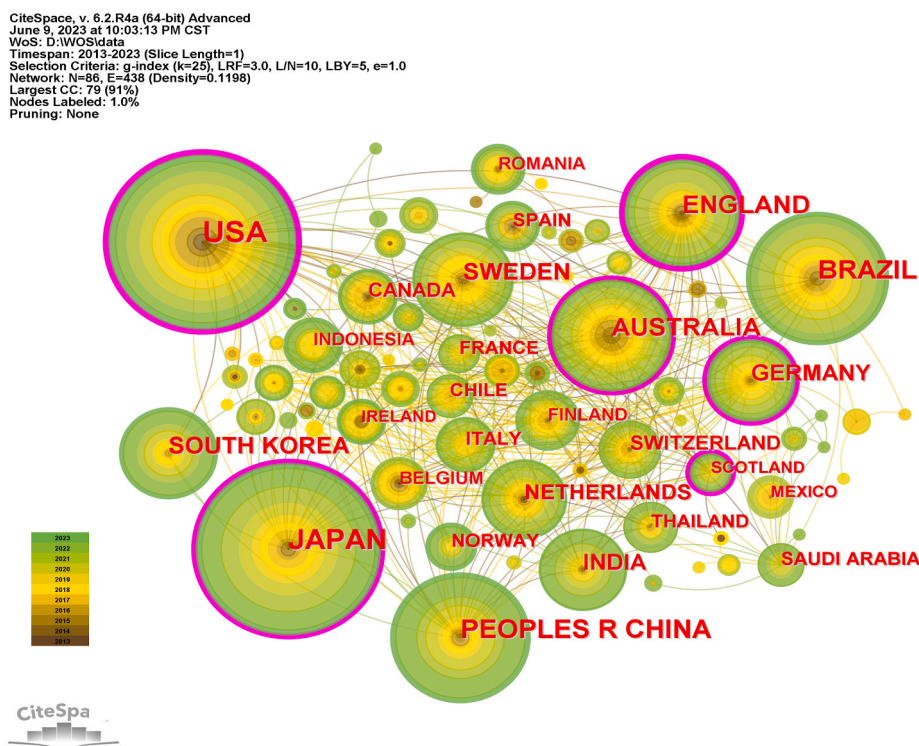


Fig. 3. Collaboration network of countries/regions of research on oral health in older adults from 2013 to 2023.

Table 5
Top 10 institutions by number of publications related to oral health in older adults.

Rank	Institution	Count (%)	Institution	Centrality
1	University of London	60 (4.20)	University of London	0.21
2	RLUK - Research Libraries UK	48 (3.36)	RLUK - Research Libraries UK	0.17
3	N8 Research Partnership	37 (2.59)	Harvard University	0.13
4	Niigata University	37 (2.59)	N8 Research Partnership	0.12
5	University College London	33 (2.31)	New York University	0.09
6	Tokyo Medical & Dental University	33 (2.31)	Universidade de Sao Paulo	0.09
7	Tohoku University	32 (2.24)	University College London	0.08
8	Tokyo Metropolitan Institute of Gerontology	30 (2.10)	University of Hong Kong	0.08
9	Universidade Federal do Rio Grande do Sul	27 (1.89)	University of Adelaide	0.07
10	New York University	26 (1.82)	Kristianstad University	0.07

CiteSpace, v. 6.2.R4a (64-bit) Advanced
 June 10, 2023 at 8:44:20 AM CST
 WoS: D:\WOS\data
 Timespan: 2013-2023 (Slice Length=1)
 Selection Criteria: g-index (k=25), LRF=3.0, L/N=10, LBY=5, e=1.0
 Network: N=314, E=1133 (Density=0.0231)
 Largest CC: 242 (77%)
 Nodes Labeled: 1.0%
 Pruning: None

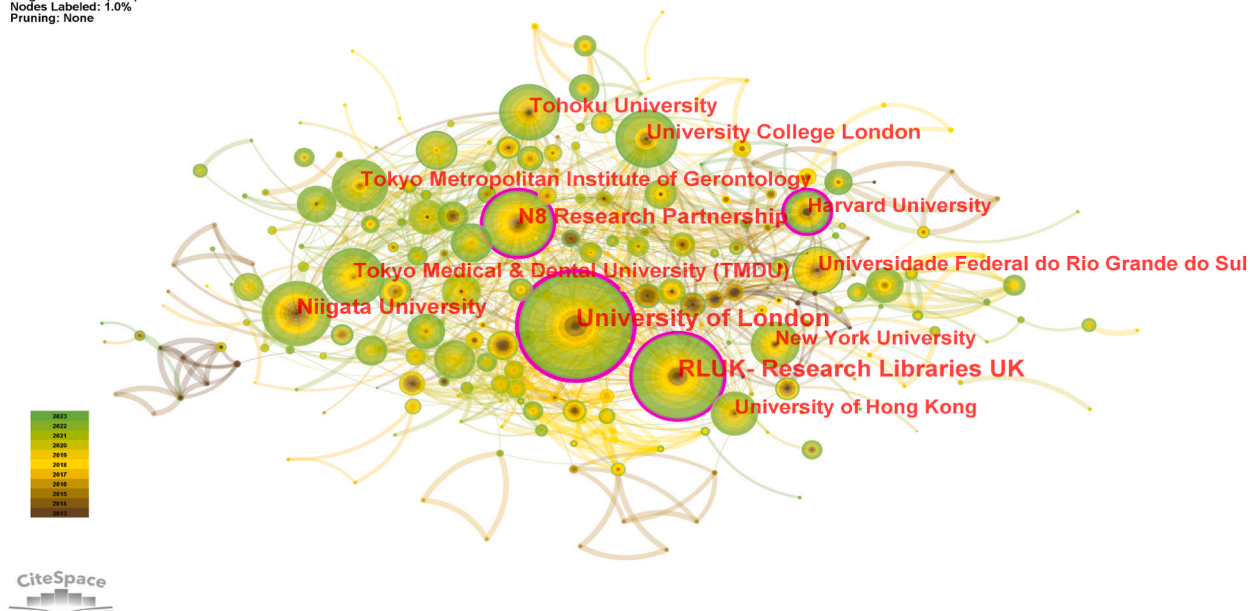


Fig. 4. Collaboration network of institutions of research on oral health in older adults from 2013 to 2023.

Table 6
Top 10 productive authors by number of publications related to oral health in older adults.

Rank	Author	Count	Country	Institution	Centrality
1	Hirano Hirohiko	21	Japan	Tokyo Metropolitan Institute of Gerontology	0.00
2	Wu Bei	20	USA	Duke University	0.00
3	Watanabe Yutaka	19	Japan	Tokyo Metropolitan Institute of Gerontology	0.00
4	Iwasaki Masanori	16	Japan	Niigata University	0.01
5	Aida Jun	16	Japan	Tohoku University	0.00
6	Ohara Yuki	15	Japan	Tokyo Medical & Dental University	0.00
7	Yoshihara Akihiro	14	Japan	Niigata University	0.00
8	Miyazaki Hideo	14	Japan	Niigata University	0.00
9	Tsakos Georgios	13	England	University College London	0.00
10	Edahiro Ayako	12	Japan	Tokyo Metropolitan Institute of Gerontology	0.00

still distinct node and team relationships in the network.

3.4. Co-cited references analysis

Table 7 lists 10 representative references related to oral health in older adults. These 10 references were published between 2017

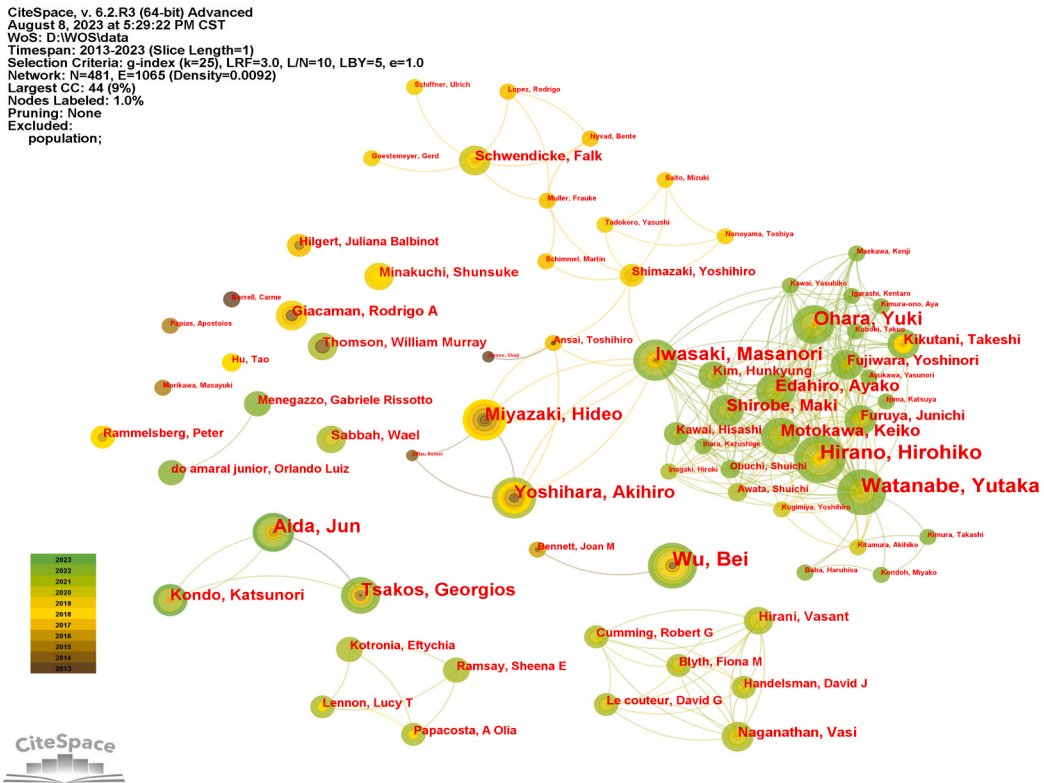


Fig. 5. Collaboration network of authors of research on oral health in older adults from 2013 to 2023.

and 2019. Approximately 80 % of these 10 references were published in the top Q1 journals. The longitudinal study by Tanaka T et al. showed that oral frailty is a risk factor for physical frailty and mortality. The study by Watanabe Y et al. explored the relationship between frailty and oral function. The study by Peres MA et al. described the scope of the global oral disease epidemic, and the impact of oral disease on individuals, families, and society.

Meanwhile, we performed a temporal co-citation analysis and plotted a timeline view of the co-cited literature (Fig. 6, the co-

Table 7

Top 10 co-cited references related to oral health in older adults.

Rank	Count	Title	Author	Journal (IF ^a , JCR Category)	Published Year
1	68	Oral frailty as a risk factor for physical frailty and mortality in community-dwelling elderly.	Tanaka T et al.	J Gerontol A Biol Sci Med Sci (5.1, Q1)	2018
2	46	Relationship between frailty and oral function in community-dwelling elderly adults.	Watanabe Y et al.	J Am Geriatr Soc (6.3, Q1)	2017
3	45	Oral diseases: a global public health challenge.	Peres MA et al.	Lancet (168.9, Q1)	2019
4	45	Influence of poor oral health on physical frailty: a population-based cohort study of older british men.	Ramsay SE et al.	J Am Geriatr Soc (6.3, Q1)	2018
5	41	Association between oral health and frailty: A systematic review of longitudinal studies.	Hakeem FF et al.	Gerodontology (2.0, Q3)	2019
6	36	Oral hypofunction in the older population: Position paper of the Japanese Society of Gerodontology in 2016.	Minakuchi S et al.	Gerodontology (2.0, Q3)	2018
7	32	Dental caries and periodontal diseases in the ageing population: call to action to protect and enhance oral health and well-being as an essential component of healthy ageing - Consensus report of group 4 of the joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases.	Tonetti MS et al.	J Clin Periodontol (6.7, Q1)	2017
8	31	Global, regional, and national prevalence, incidence, and disability-adjusted life years for oral conditions for 195 countries, 1990–2015: a systematic analysis for the global burden of diseases, injuries, and risk factors.	Kassebaum NJ et al.	J Dent Res (7.6, Q1)	2017
9	28	Oral disease and 3-year incidence of frailty in Mexican older adults.	Castrejón-Pérez RC et al.	J Gerontol A Biol Sci Med Sci (5.1, Q1)	2017
10	26	Relationship between oral health and Fried's frailty criteria in community-dwelling older persons.	Kamdern B et al.	BMC Geriatr (4.1, Q1)	2017

Notes: Abbreviations: IF, impact factor; JCR, Journal Citation Reports. ^a Data from the 2022 edition of Journal Citation Reports.

citation timeline network contained a total of 651 nodes with 2743 links and a network density of 0.013). The network was divided into 10 clusters. $Q = 0.6394$, $S = 0.8379$ and the clustering is reasonable. We found that "tooth loss" (Cluster 1), "Ghana" (Cluster 2), "oral health" (Cluster 7), and "GOHAI" (Cluster 9) were earlier research hotspots; "oral care" (Cluster 3), "stomatognathic diseases" (Cluster 5), and "oral health-related quality of life (OHRQoL)" (Cluster 6) were mid-term research hotspots; "cohort studies" (Cluster 0), "frailty" (Cluster 4), and "nutritional status" (Cluster 8) are currently new hotspots in the field.

3.5. Keyword analysis

3.5.1. Keyword co-occurrence analysis

The most frequent keywords related to oral health in older adults were "oral health", "older adults", "tooth loss", "quality of life", and "risk factors", etc. The top 5 keywords for centrality were "dental care", "root caries", "cary", "dental caries", and "periodontal diseases" (Table 8).

3.5.2. Keyword clustering analysis

Keyword clustering analysis was used to identify hotspots and emerging trends in oral health research among older adults. The clustered keyword network consisted of 458 nodes and 3687 connections, with a network density of 0.0352 (Fig. 7). The clustering was reasonable with $Q = 0.3398$ and $S = 0.6931$. The keywords were grouped into 7 clusters: "oral hygiene", "oral health-related quality of life", "tooth loss", "oral function", "classification", "oral cancer", and "dry mouth". From Fig. 7, we can conclude that current research hotspots mainly include oral hygiene interventions, oral health-related quality of life, and oral health issues in older adults.

4. Discussion

This study used CiteSpace software a bibliometric and visual analysis to identify the current status, hotspots, and trends in oral health research in older adults. The number of publications in this field has gradually increased over the past decade and is showing an upward trend. *Gerodontology* was the most published and cited journal in the field. The USA had the highest number of publications, while England had the highest centrality of publications in this field. The University of London was the largest contributor to the field, with the highest number of publications and the greatest impact. Among these authors, Hirano Hirohiko was the most prolific. The top 10 most cited references were published between 2017 and 2019 and focused on the relationship between oral health and frailty, and the current status and hazards of oral health issues in older adults, providing a solid foundation for the field of oral health research in older adults.

4.1. Cooperation is necessary

Although many countries, institutions and authors have invested a great deal of research in this field, the distribution of research is very uneven. Of the top 10 countries, all major producers are developed countries except Brazil, China and India. Most of the top 10 institutions are from England and Japan. Only one institution from a developing country – Brazil – is ranked ninth. Developing countries appear to account for only a small proportion of publications in the field. We hope that developing countries will strengthen their research and cooperation with other countries or institutions. Furthermore, in the network map of co-authors, collaborative networks of different densities are formed among authors, but most of them are limited to small groups, and collaboration is still decentralized and lacks stability. There are no high-centrality authors yet, which means that the level of collaboration and influence of authors is not yet sufficient. Therefore, it is necessary to expand the relationship among authors to deepen oral health research on older adults and produce high-quality literature. In this way, the research literature will become more globally applicable.

4.2. Research hotspots

Keywords are highly concise summaries of the literature, and clustering analysis can classify keywords based on algorithms. By combining keywords with clustering analysis, we summarize three research hotspots in this field.

4.2.1. Oral hygiene interventions

Poor oral hygiene increases the risk of aspiration pneumonia, and research has shown that suppressing oral microbes through effective oral hygiene is one way to prevent aspiration pneumonia [24]. However, oral hygiene practices among older adults are poor, and this population typically does not receive oral hygiene instruction to care for their natural teeth or dentures [25]. At the same time, the ability of older adults to maintain oral health may be diminished by cognitive decline, reduced hand function, sarcopenia, and loss of autonomy [26]. Because poor oral health can negatively impact the overall health of older adults and increase their healthcare costs, effective interventions are urgently needed to improve oral hygiene in this age group. Brushing with fluoride toothpaste (1100–1500 ppm) is the primary self-care method for preventing common oral diseases, as it regulates salivary flow and helps maintain oral homeostasis in older adults, thereby reducing caries, periodontal disease and tooth loss [25]. However, brushing alone is not sufficient to remove proximal plaque; the use of other interdental cleaning devices such as flossing, interdental brushes, and oral rinses is recommended [27,28]. It is recommended to clean the denture at least once a day with a suitable denture brush and denture cleaner or mild soap, and implement overnight denture care in dry storage [29]. In addition, oral mucosal cleansing with a combination of mouthwash and oral moisturizing gel was most effective for bacterial counts and moisture content on the tongue surface in older adults

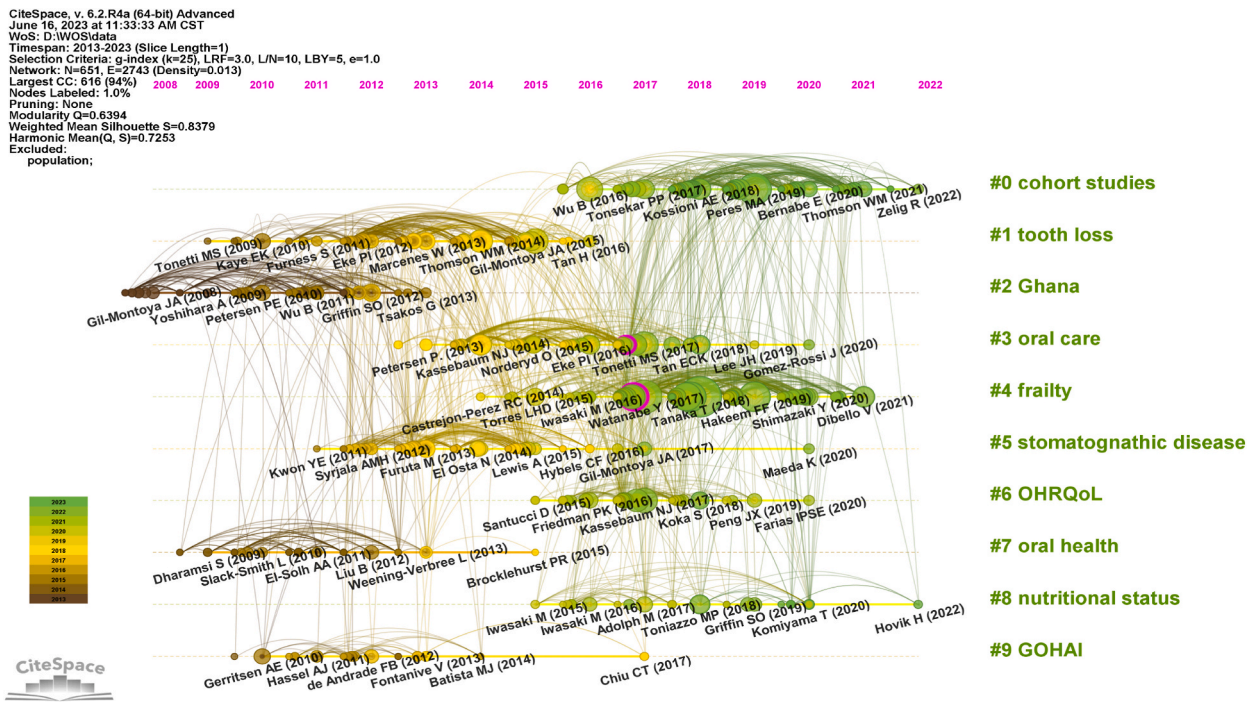


Fig. 6. Timeline view of co-cited references related to oral health in older adults. Notes: # represents a prefix for serial numbers. Abbreviations: OHRQoL, oral health-related quality of life.

Table 8
 Top 10 keyword co-occurrence frequency.

Rank	Keyword	Count	Keyword	Centrality
1	Oral health	610	Dental care	0.08
2	Older adults	446	Root caries	0.08
3	Tooth loss	346	Cary	0.07
4	Quality of life	261	Dental caries	0.06
5	Risk factors	261	Periodontal diseases	0.05
6	Association	232	Global burden	0.05
7	Periodontal diseases	197	Dental status	0.05
8	Diseases	184	Tooth loss	0.04
9	Prevalence	177	Risk factors	0.04
10	Care	145	Nutritional status	0.04

[30]. Current oral hygiene practices, when used properly and combined with regular professional care, can virtually prevent dental caries and most periodontal disease and maintain oral health in older adults. Individuals with Alzheimer’s disease tend to have a higher burden of oral disease. One promising approach is to improve oral health education for caregivers of older adults [26]. In addition, well-designed studies are necessary to confirm the implementation of caregiver oral health education and its long-term beneficial aspects for older adults with dementia.

4.2.2. Oral health-related quality of life

To comprehensively assess the impact of oral health on older adults, the concept of oral health-related quality of life (OHRQoL) has been proposed. OHRQoL is a self-reported oral health indicator that reflects individuals’ subjective perceptions of their overall oral health status, oral physiological function, oral psychological status, and satisfaction with and expectations for oral health care [31]. OHRQoL and clinical oral health examination indicators can both reflect individuals’ oral health, but the former is highly subjective and the latter is highly objective. At present, research on OHRQoL in older adults focuses mainly on assessing the current situation, the influencing factors and intervention measures [32,33]. A number of measurement tools have been developed and validated for OHRQoL, the most commonly used being the Oral Health Impact Profile (OHIP), Geriatric Oral Health Assessment Index (GOHAI), and Oral Impacts on Daily Performances (OIDP) [34]. OHRQoL is generally worse in older adults. A survey of 500 older adults in Poland showed a total OHIP-14 score of 8.01 ± 13.6 , and among the domains, participants most frequently reported physical pain and psychological discomfort [35]. It shows that the adverse effects of oral problems are mainly physical pain and psychological discomfort, resulting in a decrease in OHRQoL. The mean GOHAI score was 53.3 ± 4.7 , and about 81.6 % of older adults in Malaysia

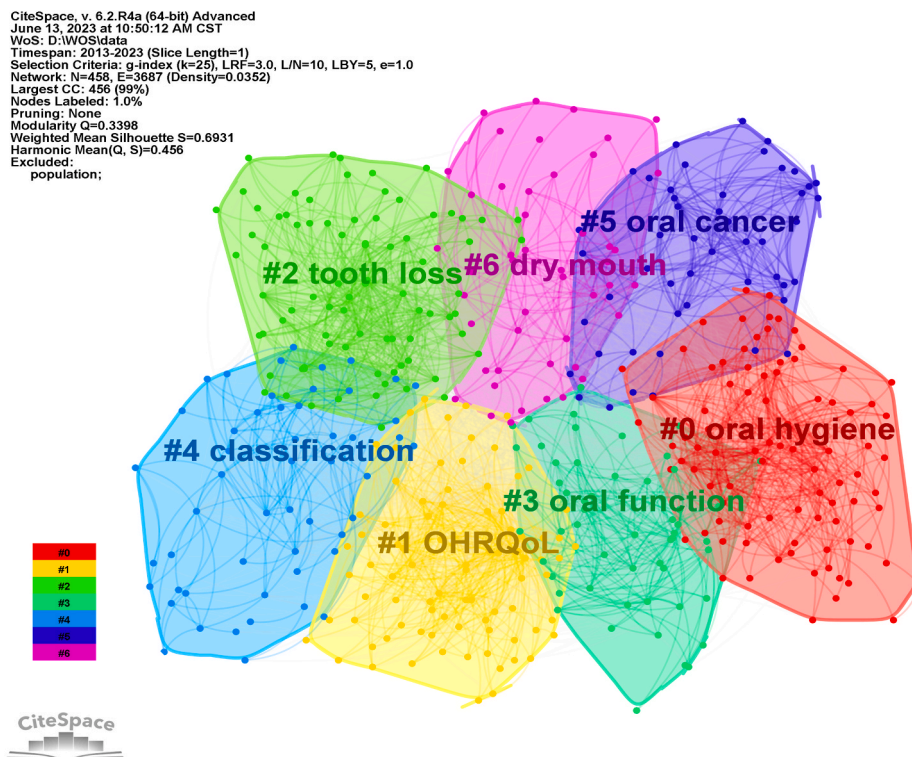


Fig. 7. The Cluster of Keywords Related to Oral Health in Older Adults.

Notes: # represents a prefix for serial numbers. Abbreviations: OHRQoL, oral health-related quality of life.

had moderate to low perception of oral health [36]. OHRQoL can have a range of negative impacts on the physical and mental health, social relationships, and well-being of older adults [37]. OHRQoL in older adults is influenced by a variety of factors, including oral health indicators, general health status, sociodemographic status (gender as female and age), and economic status [35,38,39]. There is a clear need to identify risk factors for poor OHRQoL in older adults and to develop interventions based on these factors. At present, interventions to address OHRQoL in older adults focus on the following areas: improving oral health awareness and skills among older adults, systematic treatment of oral diseases, and national policy support for oral health in older adults [34,40].

4.2.3. Oral health issues

Oral health issues are also a current research hotspot in the oral health of older adults. With the increase of age, the basic structure and physiological function of the oral cavity undergoes degenerative changes that can lead to a variety of oral health problems. Research has mainly focused on the prevalence of various oral health issues in older adults. The Fourth National Oral Health Survey showed that among people aged 65–74, the prevalence of dental caries was as high as 98.0 %, but only 4 % of dental caries was treated; only 9.3 % of older adults had no obvious periodontal problems; the detection rate of gingival bleeding was 82.6 %; and the average number of remaining natural teeth was 22.5, with nearly 4.5 % edentulous and the proportion of missing teeth filled only 63.2 % [13, 41]. A recent study showed that the global prevalence and incidence of oral diseases (i.e., untreated dental caries, periodontitis, edentulous jaws, and other oral disease) in older adults were estimated to be 77 % and 6 %, respectively [1]. The prevalence and incidence of tooth loss have also changed significantly over the past 40 years, with a dramatic decrease in the prevalence of edentulous jaws. However, untreated dental caries and chronic periodontal disease remain very common. For the foreseeable future, with large numbers of older adults retaining their teeth into old age, the burden of maintaining large numbers of restored teeth and root caries will be high [42]. Chronic periodontal disease complicated by systemic inflammatory disease will also continue to be a challenge in older adults. Older adults have high rates of tooth loss, dental caries, periodontal inflammation, and prosthetic treatment needs [43]. More countries will develop policy initiatives, long-term plans and innovative approaches to address the continuing oral health challenges of globally aging societies [44].

4.3. Research frontiers

The timeline of cited references shows that clusters #0 (cohort studies), #4 (frailty) and #8 (nutritional status) are the focus of current research, highlighting future directions in the field of oral health in older adults. Most current studies are cross-sectional, and cohort studies of oral health in older adults are necessary to draw deeper and more convincing conclusions.

4.3.1. Oral health and frailty

We found that current studies often explore association between oral health and frailty, a state of age-related decline in physiological reserve and increased susceptibility to adverse health events [45]. In the 2011–2014 National Health and Nutrition Examination Survey (NHANES) of 2368 older adults, tooth loss and periodontal disease were associated with frailty [46]. Older adults with tooth loss may avoid hard foods such as meat, fruits and vegetables, which are often the main source of protein, potentially leading to malnutrition and increased risk of frailty. Periodontal disease is an inflammatory process that can lead to elevated levels of gingival epithelial inflammatory markers interleukin, tumor necrosis factor-alpha, and histamine, which amplify inflammation and may lead to the progression of frailty [17]. Other oral health indicators, i.e., oral function, self-rated oral health, brushing habits, oral pain and masticatory dysfunction were significantly associated with frailty [47–50]. The intrinsic mechanisms by which oral health contributes to frailty in older adults include five main aspects: malnutrition, chronic inflammation, cognitive function, psychosocial factors, and neural pathways [51]. Gradually, a new term "oral frailty" emerged, referring to the phenomenon that older adults have fewer teeth, decreased oral function and hygiene, and less attention to oral health, which ultimately leads to eating dysfunction, and declining physical and mental function [52]. Oral frailty has been a hot research topic abroad in recent years, focusing on prevalence, relationship with nutrition and frailty, and intervention management. Several studies have shown that there is a bidirectional relationship between oral health and frailty, with older adults with poor oral health being more susceptible to frailty, which in turn may lead to poor oral health [53]. The oral health care of frail older adults can be severely compromised by frailty, as they may be unable to attend to personal hygiene or receive assistance from caregivers [53]. However, differences in outcome measures and study designs across studies limit the ability to draw strong conclusions about the relationship between oral health and frailty.

4.3.2. Oral health and nutritional status

Current research on oral health and nutritional status in older adults has focused on exploring the correlation between the two. A meta-analysis showed that the average number of teeth and functional tooth units were associated with nutritional status [54]. The biology of oral health and nutritional status is driven by the cumulative effect of oral disease across the lifespan. Missing teeth, dental caries, dysgeusia, periodontal disease, etc., reduce chewing function, decrease food and nutrient intake, and exacerbate the gastrointestinal burden, resulting in malnutrition in older adults [55,56]. Xerostomia has also been identified as a risk factor for poor nutritional status in older adults [57]. Xerostomia can affect nutritional status through oral discomfort, abnormal taste, dental caries, oral infections, and difficulty retaining dentures. Poor oral function, such as reduced chewing and swallowing ability, leads to unfavorable changes in food choices and poor food intake in terms of quantity and quality, which can lead to malnutrition in older persons. Most studies have found no association between the use of dentures and malnutrition in older adults [54], although subjects using denture demonstrated chewing ability and bite force reduced to 20 % in comparison to fully dentate individuals [58]. At the same time, malnutrition increases the risk of oral health problems in older adults by adversely affecting diet-related muscle mass and strength and by reducing the function of the host immune system. In addition, several nutrients such as carotenoids and vitamins C and E, have anti-inflammatory and antioxidant properties, so inadequate intake of these nutrients may increase the risk of periodontitis due to poor oral function [59]. However, the evidence for this correlation is limited, and comprehensive oral health has not been studied in detail, suggesting that more high-quality research is needed. Overall, nutritional status is not only affected by oral health, but also has a negative impact on oral health, forming a vicious cycle. Therefore, maintaining good oral health at an advanced age is important to prevent individuals from falling into such a negative cycle. The combined effects of dental and dietary interventions should also be further investigated through interventional studies.

4.4. Recommendations

Our study has implications for future research on oral health in older adults. This study found that future research trends in the field of oral health in older adults focus on the correlation studies between oral health and frailty, and oral health and nutritional status. (1) It is recommended that large-sample, multicenter cohort studies be conducted in the future to explore the relationship between oral health and frailty and nutritional status, and to provide a scientific basis for managing the health of older adults. (2) It is important to include a more comprehensive set of oral health indicators in the study of oral health in older adults and to assess oral health indicators using clinical parameters to avoid self-reported assessments. (3) Large-scale oral health interventions are needed in the future to mitigate adverse health outcomes, particularly frailty and malnutrition.

4.5. Limitations

Our study has several limitations. First, we only searched for publications from the WoSCC database; however, literature related to oral health in older adults from other large databases such as PubMed or Embase was not included. Second, only articles published in English in the last decade were included in this study, which may not be comprehensive enough. Finally, although we took into account the search terms chosen, we cannot guarantee that all literature was fully relevant to the topic, and we are not sure that all literature relevant to the topic was retrieved.

5. Conclusions

This is the first bibliometric and visual analysis to draw a map of scientific knowledge on oral health in older adults over the past 10 years. We systematically summarized research hotspots and trends in the field. We found that current research on oral health in older

adults focuses primarily on oral hygiene interventions for older adults, oral health-related quality of life, and oral health issues. While cohort studies of oral health, the relationship between oral health and frailty, and the correlation between oral health and nutritional status may become emerging trends in the future and deserve further attention. In addition, there is a need for greater collaboration among countries, institutions and authors to improve the oral health in older adults.

Ethics approval and informed consent

Not applicable. As this was an analysis of published research results, no ethical approval was required.

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CRediT authorship contribution statement

Jianjiao Yu: Writing – original draft, Visualization, Software, Methodology, Data curation, Conceptualization. **Huolan Zhu:** Writing – review & editing, Funding acquisition, Conceptualization. **Yulian Zhang:** Writing – review & editing. **Dan Wang:** Writing – review & editing. **Hua Guo:** Writing – review & editing. **Xiaomei Liu:** Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Abbreviations

WoSCC	Web of Science Core Collection
WHO	World Health Organization
TI	title
DOP	publication data
DT	document type
LA	language
IF	impact factor
JCR	Journal Citation Reports
OHRQoL	oral health-related quality of life
OHIP	Oral Health Impact Profile
GOHAI	Geriatric Oral Health Assessment Index
OIDP	Oral Impacts on Daily Performances

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