ORIGINAL RESEARCH

Bibliometric Study of Periodontitis and Alzheimer's Disease: Trends, Collaboration, and Emerging Patterns

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Abstract

Aim: To perform a bibliometric study of periodontal disease and Alzheimer's disease (AD) focusing on trends, collaborative efforts, and emerging patterns.

Materials and methods: From January 2018 to May 2024, an observational study was carried out utilizing metadata extracted from the Scopus database. A search methodology, specifically designed for this database, was developed using MeSH terms combined with Boolean operators such as "AND" and "OR". The Bibliometrix tool was employed to facilitate the study, using indicators including the number of citations and publications, the authorship of the publication, the country of origin, the year of publication, the type of publication, the H-index, WorldMap, Sankey diagram, keyword analysis, topic evolution, and scientific findings.

Results: A total of 50.7 and 27.3% of the publications were in Q1 and Q2 quartile journals. The University of Central Lancashire has the most publications (17), but the University of California at San Francisco has the highest impact (1545 citations per publication). The journal Periodontology 2000 had a total of 643 citations per publication. Sim Kaur Singhrao (16) and Ingar Olsen (10) were the authors with the most publications, whereas Eric C Reynolds had the highest impact with 1,300 citations.

Conclusions: This bibliometric study found a gradual growth in publications, with the highest number of studies during 2021 and 2022, followed by a decrease in subsequent years, with Q1 and Q2 journals predominating. In terms of scientific productivity, the United States is the leading country in this area of research. The journal Periodontology 2000 had the highest number of citations, demonstrating the particular interest of periodontology in studying the association between periodontal disease and systemic diseases.

Clinical significance: The present study is significant because the relationship between periodontitis and Alzheimer is currently considered a novel multidisciplinary research opportunity, given that it includes both medical and dental specialties. This research also provides a valuable contribution to academics, universities, and research centers because it will allow us to understand trends and new research horizons and identify the most productive authors.

Keywords: Alzheimer's disease, Bibliometric study, Periodontal disease.

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Introduction

Periodontitis is defined as an inflammatory and chronic multifactorial periodontal disease, related to a pathogenic biofilm and modified by the immune-inflammatory response, lifestyle, and environmental factors of the host, which causes gradual destruction of the periodontium (gingiva, alveolar bone, periodontal ligament, and cementum).[1,2] At present, it ranks as the second most prevalent oral disease, impacting 743 million individuals worldwide, which constitutes 11% of the global population. This disease predominantly affects adults and the elderly.[1] For this reason, it is an important public health burden because it can lead to disability due to impaired masticatory function, phonetics, and esthetics, as well as its association with systemic conditions.[3]

Previous studies have confirmed a link between periodontitis and cardiovascular diseases, type 2 diabetes, and respiratory infections.[3–5] These conditions can be initiated or worsened by periodontitis, with the chronic inflammatory process serving as the shared catalyst.[3] Likewise, the literature also indicates that rheumatoid arthritis, osteoporosis, inflammatory bowel disease, chronic kidney disease, cancer, and Alzheimer's disease (AD) have a possible, but not yet confirmed, association.[4] However, There is significant curiosity among healthcare professionals and dentists who treat Alzheimer's patients regarding the potential neurodegenerative harm caused by the local inflammatory and infectious processes of periodontal disease.[5]

Alzheimer's disease is a long-term, advancing, and non-reversible brain degenerative condition, recognized as the primary cause of senile dementia, typified by memory deterioration and other cognitive ability deficits.[6] Currently, AD stands as the leading

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cause of dementia and is progressively becoming one of the most expensive, severe, and deadly diseases of our time.[7] Regarding its pathogenesis, different hypotheses have been proposed to define its onset and evolution, of which the following stand out: The amyloid cascade hypothesis (Accumulation of β amyloid in the brain); the inflammatory hypothesis (Inflammatory process), and the pathogenic hypothesis (induced by pathogenic microorganism).[6]

While the association between periodontitis and AD remains unconfirmed, several potential mechanisms have been suggested to elucidate their interaction. One such mechanism involves bacteremia, where subgingival bacteria migrate into the systemic circulation via the ulcerated epithelium of the periodontal pocket, leading to infections in other areas. Another proposed mechanism suggests that bacterial products and inflammatory mediators diffuse into the systemic circulation through the ulcerated wall of the periodontal pocket, thereby triggering a systemic inflammatory response.[8] On the other hand, several studies have demonstrated a possible link between both diseases, mainly manifested as the onset and progression of AD resulting in increased inflammation and bacteria associated with periodontal disease, yet the literature is inconsistent.[5]

In exploring the relationship between AD and periodontitis, it is essential to consider the potential mechanisms underlying their interaction. One proposed involves bacteremia, where bacteria from periodontal pockets enter the systemic circulation, potentially leading to infections in other areas, including the brain. Another theory suggests that bacterial products and inflammatory mediators from periodontal disease can diffuse into the systemic circulation, triggering a systemic inflammatory response that may contribute to the development or progression of AD. Although these are still under investigation, they offer a compelling direction for further research into the link between these two diseases.[5,9,10]

Thus, the aim of this research was to perform a bibliometric study of periodontal disease and AD focusing on trends, collaborative efforts, and emerging patterns.

Materials and Methods

Study Design

A descriptive, observational analysis was carried out using a bibliometric approach. Metadata were extracted from the Scopus database related to periodontal disease and Alzheimer's disease. The search covered the period from January 2018 to May 2024.

Selection of Studies

Inclusion criteria encompassed English-language publications indexed in Scopus focused on periodontal disease and Alzheimer's disease, published between January 2018 and May 2024. Exclusion criteria included studies published in other databases outside of Scopus. Metadata of articles not available in SciVal.

Information Search

This search strategy was carried out using the Scopus database. MeSH terms and Boolean operators, such as "AND" and "OR" were selected to determine the following search strategy: TITLE-ABS ("periodontal disease" OR "periodontitis" OR "gum disease" OR "gingivitis" OR "parodontitis" OR "perio disease" OR "periodontal condition" OR "periodontal disorder" OR "periodontal infection" OR "periodontal inflammation" OR "alveolar pyorrhea" OR "alveolar pyorrhea" OR "disease affecting gums" OR "disease attacking gums" OR "gum infection" OR "inflammation of gums" OR "oral inflammation" OR "parodontosis" OR "periodontal conditions" OR "periodontal syndrome" OR "periodontoclasia" OR "gum disease" OR "periodontitis" OR "periodontal infection" OR "gingival disease" OR "periodontal disorder" OR "gum infection") AND TITLE-ABS ("Alzheimer's disease" OR "AD" OR "senile dementia" OR "old timer's disease" OR "senile psychosis" OR "presenile dementia" OR "dementia" OR "derangement" OR "Alzheimer's" OR "mental illness" OR "mental decay" OR "mental deterioration" OR "mental disorder" OR "personality change" OR "senile dementia" OR "mental confusion" OR "softening of the brain" OR "Alzheimer's" OR "second childhood" OR "Alzheimer's disease" OR "Alzheimer's" OR "Senile dementia of the Alzheimer type (SDAT)" OR "Dementia of the Alzheimer type (DAT)" OR "Alzheimer's dementia" OR "Alzheimer's syndrome").

During the period from January 2018 to May 2024, we identified a sample size of 507 documents. The most prevalent type of document was original articles, accounting for 321 of the totals. Additionally, we discovered 157 reviews, 12 book chapters, 6 notes, 3 conference papers, 2 books, 1 letter, 3 surveys, and 2 documents of other types.

Bibliometric Procedure

For metadata analysis, the SciVal program (Elsevier) and Bibliometrix (R Studio) software was used to export the bibliometric information of scientific publications to files. In addition, both frequencies and percentages were estimated and represented to analyze categorical variables, and a tenure graph was prepared using Microsoft Excel 2019.

Results

The bibliometric study covered the period from January 2018 to May 2024, and a total of 507 papers were included with an annual growth rate of 6.8; each paper received an average of 17.7 citations and a total of 2,976 references. The total number of authors was 2,404, with an average of 5.95 co-authors per paper (Table 1).

Table 1: Scientific production characteristics on periodontitis and AD

Description	*Results*
Timespan	January 2018 to May 2024
Sources	284
Documents	507
Annual growth %	6.8
Document average age	2.66
Average citations per doc	17.7
References	29,076
Keywords plus	3,786
Author's keywords	1,201
Authors	2,404
Authors of single-authored docs	19
Single-authored docs	22
Co-authors per doc	5.95
International co-authorships %	28.4
Article	321
Book	2
Book chapter	12

(Contd...)

Table 1: *(Contd...)*

Description	*Results*
Conference paper	3
Erratum	2
Letter	1
Note	6
Review	157
Short survey	3

Table 2: Analysis of publications impact on periodontitis and AD

CiteScore quartile	*Overall**	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*
Q1	241	15	16	32	53	53	51	21
Q2	130	6	11	24	28	28	20	13
Q3	49	3	7	4	12	12	6	5
Q4	55	4	6	9	10	16	6	4
Total	475	28	40	69	103	109	83	43

*An average of 32 manuscripts could not be exported to Scival due to errors in the metadata that were not available for analysis

The first quartile (Q1) consistently had the highest number of publications throughout the years 2018 to 2024, with a total of 241 publications. The year 2022 saw the highest number of Q1 publications, with a count of 53. The second quartile (Q2) had a total of 130 publications, with the most in 2021 and 2022, each having 28 publications. The third and fourth quartiles (Q3 and Q4) had fewer publications, with totals of 49 and 55, respectively (Table 2).

The University of Central Lancashire in the United Kingdom had the highest scholarly output with 17 publications, which received an average of 30.7 views per publication and a total of 313 citations. The University of California at San Francisco and Harvard University in the United States had the highest field-weighted citation impact (FWCI) with 5.6 and 6.68, respectively, indicating a high impact of their research in the field. These institutions also had the highest citation counts, with the University of California at San Francisco leading with 1,545 citations. The Jagiellonian University in Kraków, Poland, also showed a high FWCI of 5.77 and a substantial number of citations (1,219), indicating the significant impact of its research. Other notable institutions include the Karolinska Institute in Sweden, Kyushu University in Japan, and the University of Oslo in Norway, all of which demonstrated a strong scholarly output and impact in their respective regions (Table 3).

The authors, Sim Kaur Singhrao, 16 articles, Ingar Olsen, 10 articles, Alice Harding, 8 articles, and Jan S Potempa with 8 articles, Zhou Wu with 8 articles, Zhongchen Song with 7 articles, Jaime Díaz-Zúñiga with 6 articles, Sigrun Eick with 6 articles, Samanta Melgar-Rodríguez with 6 articles, Mark I. Ryder with 6 articles and Wei Zhou with 6 articles are the authors with the most publications; while Eric C Reynolds had the highest impact, with 1,300 citations (Table 4).

The journals Journal of Alzheimer's Disease with 16 publications, International Journal of Environmental Research and Public Health with 14 publications, Periodontology 2000 with 12 publications, Frontiers in Immunology with 11 publications, International Journal of Molecular Sciences with 10 publications, Clinical Oral Investigations with 9 publications, Journal of Clinical Periodontology with 8 publications, Journal of Periodontal Research with 8 publications, PLoS ONE 8 publications, and Advances in AD with 7 publications presented higher academic production; however, the journal Periodontology 2000 had 643 citations (Table 5).

Among the global collaborations, a higher frequency of China was found in the United States, China in Japan, and the United States in Brazil. The best international collaborations were for the United States and China.

The United States, China, and Japan have the most publications on periodontal disease and Alzheimer's disease, with the United States having more citations than the global average (Fig. 1).

From 2018 to 2020, the focus was on biomarkers and chronic periodontitis, with a shift towards periodontal disease and AD in 2021. The term 'dementia' was also prevalent, linking to oral health and periodontitis, in 2021. In 2021, AD became a prominent theme, transitioning towards periodontal diseases and *Porphyromonas gingivalis* in 2022–2023. The term 'periodontitis' was consistently present throughout the years, with a strong association with Alzheimer's disease, inflammation, and oral health. From 2022 to 2023, the focus shifted towards microbiome and neurodegenerative diseases, with a continued emphasis on periodontitis and periodontal diseases. By 2024, the focus had shifted towards aging and chronic periodontitis, with *Porphyromonas gingivalis*, Alzheimer's disease, and neuroinflammation remaining significant themes. These trends indicate a growing interest in the potential links between periodontal disease, Alzheimer's disease, inflammation, and the oral microbiome, suggesting these will continue to be key areas of focus in future research (Fig. 2).

Discussion

Several studies have shown a possible link between periodontitis and AD, especially in the onset and progression of the latter, with the effects of increased inflammation and bacteria associated with periodontal disease; despite this, the literature is not consistent.[5] For this reason, the aim of this study was to perform a bibliometric analysis of periodontal disease and AD with respect to trends, collaboration, and emerging patterns. Bibliometric indicators are data calculated from bibliographic characteristics observed and published in the scientific and academic fields. The following indicators were used for this study: number of citations and publications, author of the publication, country of origin, year, type of publication, h-index, World Map, Sankey diagram, keyword analysis, topic development, and scientific results.

According to the results obtained during January 2018 to May 2024, a steady increase in scientific production was evidenced, with a growth peak in 2021 and 2022. In addition, the studies were published in journals of high scientific demand (Q1 and Q2), and the training institutions made a greater effort to generate research on this topic.[10,11] The United States has the highest number of institutions with the highest scientific production on periodontal disease and AD. However, the universities with the greatest number of publications were the University of Central Lancashire (United Kingdom) and Karolinska Institute (Sweden); nevertheless, the University of California at San Francisco stood out for its greater impact, with 1,545 citations. On the other hand, the Journal of AD obtained first place in Scopus, and Periodontology 2000 had the highest impact. Finally, Singhal, Sim Kaur, was the author with the highest number of studies, although it is important to highlight the role of American author Eric C Reynolds, who obtained a scientific production with the highest impact. Therefore, the results of this bibliometric analysis revealed a strong interest in periodontal disease and AD.

Table 3: Institutions with the highest scientific production on periodontitis and AD

Institution	*Country/region*	*Scholarly output*	*Views per publication*	*FWCI*	*Citation count*
University of Central Lancashire	United Kingdom	17	30.7	1.32	313
Karolinska Institutet	Sweden	12	28.2	1.93	250
Shanghai jiao Tong University	China	12	15.2	0.66	64
University of California at San Francisco	United States	12	69.6	5.6	1,545
Harvard University	United States	11	54.2	6.68	1239
Kyushu University	Japan	11	42.4	1.99	253
University of Oslo	Norway	11	40	2.33	357
Jagiellonian University in Kraków	Poland	10	57.9	5.77	1,219
Universidad de Chile	Chile	10	32.1	1.72	150
Department of Veterans Affairs	United States	9	21	2.66	98

Table 4: Authors with the highest scientific production on periodontitis and AD

Author	*Affiliation*	*Country/region*	*Scholarly output*	*h-index*	*FWCI*	*Citation count*
Singhrao, Sim Kaur	University of Central Lancashire	United Kingdom	16	35	1.49	313
Olsen, Ingar	University of Oslo	Norway	10	52	1.49	355
Harding, Alice	University of Central Lancashire	United Kingdom	8	8	1.53	34
Potempa, Jan S	Jagiellonian University in Kraków	Poland	8	70	6.34	1,216
Wu, Zhou	Kyushu University	Japan	8	35	2.41	219
Song, Zhongchen	Shanghai Jiao Tong University	China	7	19	0.37	24
Díaz-Zúñiga, Jaime	Universidad de Chile	Chile	6	13	2.6	130
Eick, Sigrun	University of Bern	Switzerland	6	40	2.13	145
Melgar-Rodríguez, Samanta	Universidad de Chile	Chile	6	17	2.6	130
Ryder, Mark I	University of California at San Francisco	United States	6	28	8.2	1,162

Table 5: Scientific Journals with the highest production on periodontitis and AD

Scopus source	*Scholarly output*	*CiteScore 2022*	*SNIP 2022*	*Citation count*
Journal of Alzheimer's Disease	16	6.4	0.98	291
International Journal of Environmental Research and Public Health	14	5.4	1.28	427
Periodontology 2000	12	23.1	4.51	643
Frontiers in Immunology	11	9.4	1.49	239
International Journal of Molecular Sciences	10	7.8	1.26	118
Clinical Oral Investigations	9	6.3	1.52	258
Journal of Clinical Periodontology	8	12.3	2.8	158
Journal of Periodontal Research	8	6.4	1.05	84
PLoS ONE	8	6	1.25	337
Advances in Alzheimer's Disease	7	0	0.03	0

According to the available evidence, several bibliometric analyses have been conducted, such as Zhao et al.,[11] Liu X and Li[12] Chen et al.,[13] Alqahtani et al.,[14] which mention an increase in the number of research studies on periodontitis and AD in the last 5 years, with a peak of growth between 2021 and 2022.[11–14] Similar to the aforementioned studies, Ahmad et al.[15] indicated that the majority of scientific output was conducted and published by universities or research centers.[11–15] Ahmad et al.,[15] Zhang et al.,[16] Dong et al.,[17] and Chen et al.[18] reported that the United States ranked first in terms of the number of institutions or universities contributing to this research. While there were differences among the bibliometric analyses regarding the universities with the highest number of publications and impact, these studies consistently found that the United States produced the greatest scientific output.[15–18]

Some studies concluded that the journal related to the area of Periodontology with the highest number of publications was Journal Clinical Periodontology, in contrast to Periodontology 2000, which had a higher impact.[15,19] Conversely, Zhao et al.,[11] Chen et al.,[13] and Zhang et al.[16] presented the Journal of AD as the journal with the highest number of studies related to AD, which contrasts with our results.[11,13,16]

Regarding authors or authors with the most research production related to the topic, similar results were not found according to the bibliometric analyses available, as mentioned above. This could be justified by the fact that there is a diverse number of researchers interested in AD and periodontitis, as well as in both diseases separately, which may be causing this inequality of results.[11,13,15,16,18]

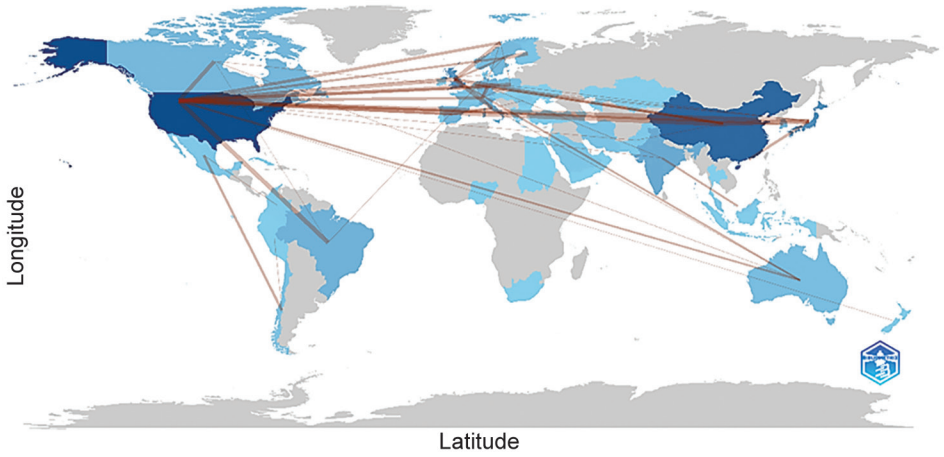

Fig. 1: Country collaboration map on periodontitis and AD

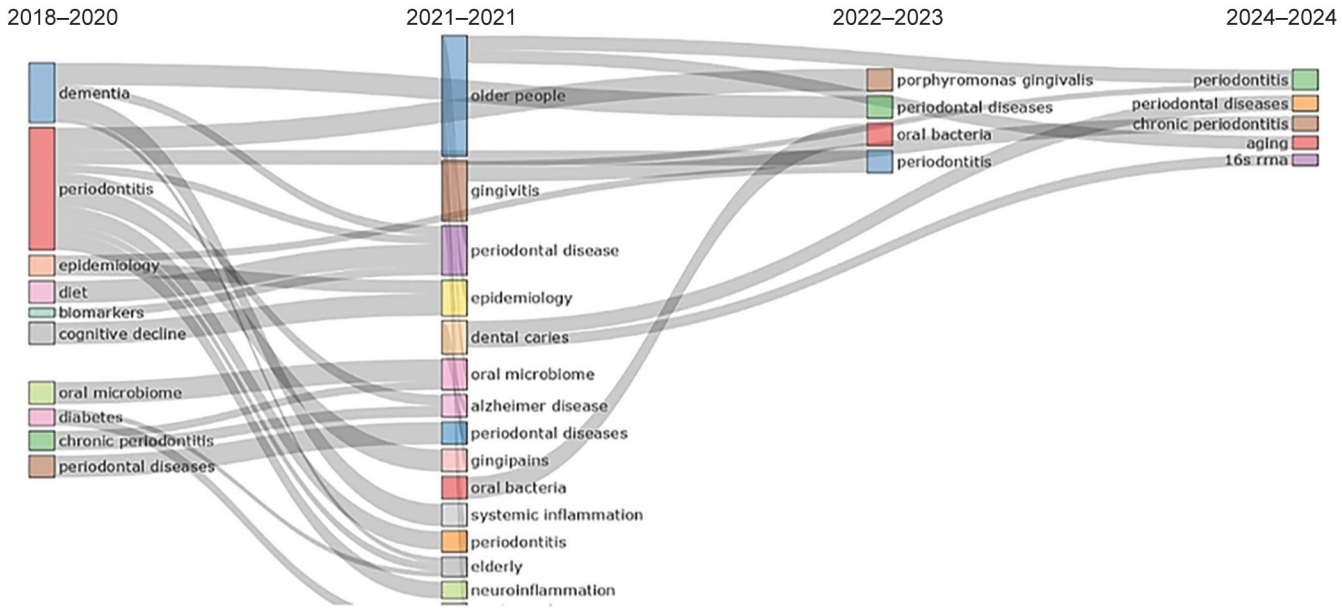

Fig. 2: Thematic evolution on periodontitis and AD

Based on the analysis, future research on periodontal disease and Ad could focus on several promising areas. These include the identification of biomarkers for early detection, understanding the link between chronic periodontitis and AD, exploring the role of systemic inflammation, investigating changes in the oral microbiome, conducting epidemiological studies, examining the connection with neurodegeneration, and studying the impact of aging. These areas represent significant opportunities to advance our understanding of these diseases and develop new prevention and treatment strategies. The present study is of significant importance because the relationship between periodontitis and AD is currently considered a novel multidisciplinary research opportunity, given that it encompasses medical as well as dental specialties.[5] Likewise, there are few bibliometric studies referring to the research topic, so our study provides a valuable contribution for academics, universities, and research centers because it will allow us to understand trends and new research horizons and identify the most productive authors.[14] The nature of this study was also considered relevant since it was based on an analysis of the characteristics of scientific production to define its impact. In contrast to review studies that synthesized the available literature to provide clarity and highlight the importance of a topic.

In the pursuit of conducting a thorough bibliometric analysis, it is acknowledged that there were some inevitable limitations. Firstly, the information was sourced from a single database, Scopus, which may not encompass all the scientific production available on the subject. Therefore, it is recommended that future studies should seek productivity, visibility, and global trends in other databases such as Web of Science, Embase, Medline, among others. Secondly, the inclusion criteria were limited to articles published in English, which could potentially overlook significant studies published in other languages. Lastly, potential errors in the indexing of metadata could lead to the under- or overestimation of certain bibliometric indicators. These limitations highlight areas for improvement in future research endeavors. Finally, it is likely that the loss of indexing of scientific journals, such as self-citation, could have affected the

productivity indexes and impact indexes. For these reasons, readers should be aware that biases may exist in our results.[20]

Conclusion

This bibliometric study found a gradual growth in publications with the highest number of studies during 2021 and 2022, followed by a decrease during the following years, with Q1 and Q2 journals predominating. In terms of scientific productivity, the United States is the leading country in this area of research. The journal Periodontology 2000 had the highest number of citations, demonstrating the particular interest of periodontology in studying the association between periodontal disease and systemic diseases.

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