

Bibliometric Analysis of Periodontitis in Relation to Polycystic Ovary Syndrome (PCOS): Mapping the Research Landscape

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KEYWORDS

Periodontitis, polycystic ovary syndrome, bibliometric analysis, gingival inflammation, cytokines, periodontal health

ABSTRACT

This bibliometric analysis maps the research landscape of periodontitis in relation to polycystic ovary syndrome (PCOS), identifying research trends, contributions, and knowledge gaps. A comprehensive search of Web of Science, Scopus, Dimensions and Cochrane Library identified 32 articles published between 2010 and 2021. Bibliometrix in R was used to analyze publication trends, authorship, geographic distribution, citation impact and keyword co-occurrence. Original research accounted for 68.8% of publications, reviews 28.1% and editorial material 3.1%. Among original studies, 45.5% investigated the PCOS–periodontitis association, while 27.2% examined cytokines in gingival inflammation. Turkey and India were leading contributors, accounting for 40.2% of authorship. Articles received an average of 8.19 citations, with the most cited study examining periodontal status and oxidative stress in PCOS. Keyword clustering identified three major themes: the PCOS–periodontitis association, cytokines and C-reactive proteins. Only 3.1% of studies were classified as Level of Evidence I–III, highlighting a scarcity of high-level evidence. Overall, research on the PCOS–periodontitis relationship remains limited and underdeveloped, with potential links involving hormonal and inflammatory mechanisms. Larger, rigorous clinical studies and greater international collaboration are needed to clarify this association and inform clinical management and oral health outcomes in women with PCOS.

INTRODUCTION

Polycystic Ovary Syndrome (PCOS) is a prevalent hormonal disorder affecting 5–15% of women of reproductive age, characterized by elevated androgens, insulin resistance, and at least two of three diagnostic criteria: polycystic ovaries, clinical or biochemical hyperandrogenism, and chronic anovulation [1, 2]. Emerging evidence suggests a

bidirectional association between PCOS and periodontal diseases, including gingivitis and periodontitis, which involve inflammation and irreversible destruction of periodontal tissues [3]. This link may stem from shared pathophysiological mechanisms, such as chronic inflammation driven by hormonal imbalances and insulin resistance, which exacerbate immune responses and gingival inflammation in PCOS patients [4, 5]. Despite this, the precise mechanisms underlying the PCOS–periodontitis relationship remain poorly understood, and the research landscape is fragmented, with limited comprehensive analyses of existing studies.

While individual studies have explored the association, significant gaps persist in the literature. First, there is a lack of high-quality, original research, particularly randomized controlled trials,

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to establish causal relationships and clinical implications. Second, the scope of research is narrow, often focusing on specific inflammatory markers like cytokines or C-reactive proteins, with insufficient exploration of other factors such as microbiota or oxidative stress. Third, global research efforts appear uneven, with potential underrepresentation from certain regions, limiting the generalizability of findings. These gaps hinder the development of evidence-based clinical guidelines for managing periodontal health in PCOS patients. Bibliometric analysis, a robust method employing mathematical and statistical techniques to map research trends, offers a solution to these challenges [6]. By systematically analyzing publication patterns, author contributions, and keyword networks, bibliometric tools can identify key contributors, research foci, and underexplored areas within a field [7].

This study aims to address global research deficiencies by conducting a bibliometric analysis of global research on periodontitis in PCOS patients. The primary objective is to map the research landscape of periodontitis in relation to PCOS, quantifying publication trends, authorship, geographic distribution, and citation impact from 2010 to 2021. Secondary objectives include identifying dominant research themes, assessing the level of evidence, and pinpointing knowledge gaps to inform future research priorities.

This study is critical to consolidating the fragmented literature on PCOS and periodontitis, providing a comprehensive overview that highlights influential works and emerging trends. By elucidating the current state of research, it aims to guide clinicians and researchers toward evidence-based practices and targeted investigations, ultimately improving oral health outcomes for women with PCOS. The findings will serve as a foundation for fostering international collaboration and addressing critical gaps in this interdisciplinary field.

MATERIALS AND METHOD

Data collection

A systematic literature search was conducted across four electronic databases—Web of Science (WoS), Scopus, Dimensions, and Cochrane Library—to identify articles related to periodontitis and PCOS. The search was performed on 15 August 2021, covering publications from January 1, 2010, to July 30, 2021. The following search terms were used: “(((“polycystic ovary syndrome” OR (“polycystic” AND “ovary” AND “syndrome”) OR “polycystic ovary syndrome”)) AND (“periodontal”

OR “periodontally” OR “periodontically” OR “periodontics” OR “periodontic” OR “periodontitis” OR “periodontitides”)))”. This query was applied to titles, abstracts, and keywords in each database, with adaptations to accommodate platform-specific syntax (e.g., WoS uses Boolean operators in uppercase, while Scopus supports wildcard characters). To enhance retrieval, synonyms and related terms were tested during a pilot search, and the final query was validated by cross-checking results across databases. Search filters included English-language articles and peer-reviewed publications. The full search syntax for each database is provided in Supplementary Table S1.

Inclusion and Exclusion Criteria

Articles were included if they: (1) explicitly investigated the association between periodontitis (or related periodontal conditions) and PCOS, (2) were peer-reviewed journal articles published between 1 January 2010 and 30 July 2021, and (3) were written in English. Exclusion criteria encompassed: (1) conference abstracts, proceedings, books, book chapters, or non-peer-reviewed materials, (2) articles not directly addressing both PCOS and periodontitis (e.g., studies focusing solely on PCOS or general oral health), and (3) non-English articles. To account for potential discrepancies in publication dates (e.g., early online access), articles indexed within the specified timeframe were included, even if accepted or published online slightly earlier (e.g., late 2020).

Article Screening Process

The screening process followed a two-stage protocol. First, titles and abstracts were independently screened by two researchers (WGR & LZYJ). Discrepancies were resolved through discussion, with a third researcher consulted if consensus was not reached. Second, full texts of potentially eligible articles were retrieved and evaluated against the inclusion/exclusion criteria. A flow diagram of the selection process, including reasons for exclusion, is presented in Figure 1.

Data Extraction

Data were extracted from included articles using a standardized template developed in Microsoft Excel. Extracted variables included: (1) bibliographic details (title, authors, publication year, journal, DOI), (2) document type (original research, review, editorial), (3) author affiliations (institution, country), (4) citation counts (retrieved primarily from WoS, supplemented by Scopus if unavailable), (5) author keywords, and (6) abstract content. Data extraction was performed by one

researcher and independently verified by a second to ensure accuracy. Discrepancies were resolved through consensus.

Data Cleaning and Standardization

To ensure data consistency across databases, a rigorous cleaning process was implemented. First, duplicate records were identified and removed using EndNote X9, with manual verification to confirm unique entries based on DOI, title, and author lists. Second, inconsistencies in author names (e.g., variations in initials or spelling) were standardized by cross-referencing with ORCID profiles or institutional affiliations where available. Third, journal names and publication years were harmonized to match the WoS format for compatibility with bibliometric software. Missing data (e.g., keywords or affiliations) were retrieved from full texts or supplementary materials when

possible. A single, unified dataset was compiled in WoS plain-text format, containing all extracted variables, and visually inspected for errors using Bibliometrix package in R Studio (Version 2021.09.0, Build 351).

Evidence level and quality of the articles

The level of evidence (LOE) for each article was assessed by two independent reviewers using the Oxford Centre for Evidence-Based Medicine (OCEBM) 2011 Levels of Evidence framework [8]. Original research articles were classified from Level I (highest, e.g., systematic reviews of randomized trials) to Level V (lowest, e.g., case reports). Reviews and editorials were assigned Levels VI–VII, as appropriate. Disagreements were resolved through discussion, with a third reviewer consulted if needed. Results of the LOE assessment are summarized in Table 1.

Table 1 Summary of articles

	n = 32	%
Document type		
Original research article	22	68.8
Review	9	28.2
Editorial Material (Review)	1	3.1
Journals		
Journal of Periodontology	6	18.8
Journal of Clinical Medicine	2	6.3
Clinical Oral Investigations	2	6.3
Contemporary Clinical Dentistry	2	6.3
Others	20	62.3
Level of Evidence		
I-III	1	3.1
IV-V	27	84.4
VI-VII	4	12.5

Bibliometric analysis

Bibliometric Analysis was performed using Bibliometric R Package (7) in R Studio (Build 351). Before importing the data, the literature information (authors, title, publication name, document type, author keywords, abstract, year, number of citations and author affiliation) from various databases was downloaded and manually compiled into a single file in WOS BibTeX format. The data import process and graphical visualization were conducted according to Bibliometrix package instructions (7). The descriptive and network analysis were conducted in Biblioshiny, a graphical user interface of the Bibliometric package. The main results were to describe the publication number, authors, countries, sources and number of citations. Citation counts for the paper were primarily retrieved from Web of Science, and where

this was not available, citation counts from other databases were used. This approach allows us to provide reliable and consistent citation information for the paper analysis. Additionally, the author's keywords co-occurrence analysis was done to map and cluster the keywords extracted from articles.

RESULTS

Article selection

A total of 85 articles were identified from a systematic search in four electronic databases. After removal of duplicated records and exclusion of articles that did not meet the criteria, a set of 32 articles was included in the final complete list for the analysis. Figure 1 shows the flow diagram and selection process.

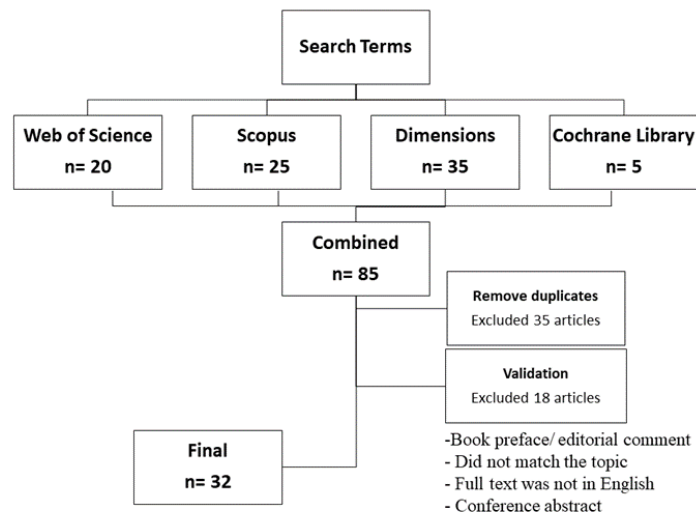


Figure 1 Flowchart illustrating the search strategy and the process of study selection for the bibliometric analysis

Regarding the research topics of the 22 original research articles, 10 (45.5%) of the articles studied the association between periodontal status and PCOS and 6 (27.2%) of the articles studied the role of cytokines in gingival inflammation among PCOS patients. There was only one randomized controlled trial evaluate the effect of non-surgical periodontal therapy on the level of a serologic marker of inflammation in women with PCOS [9]. The remaining articles focused on other aspects of periodontitis in PCOS patients, such as microbiota [10], obesity [11], oxidative status [12] and C-reactive proteins [13]. It is also worth noting that all nine review articles included in the analysed dataset focused on the association between periodontitis and PCOS.

Publication and author analysis

Figure 2 provides a summary of the publications and author analysis conducted in the present study. The findings reveal that the analysed articles were published in 24 journals between 1st January 2010 and 30th July 2021; the highest number of articles was published in 2020 (Figure 2(A)). Journal of Periodontology has published the highest number of articles (n=6), followed by Clinical Oral Investigations, Contemporary Clinical Dentistry and

Journal of Clinical Medicine, each contributing 2 articles (n=2).

There were 93 authors affiliated with 69 institutions from 16 countries. The number of authors per article ranged from 1 to 10, with an average of 2.91 authors per article. Furthermore, the production over time analysis reveals that Akcali A and Bududeli N from Ege University, Türkiye, were the top contributors by number of publications in this field. However, since then, new groups of researchers such as Balu P from India and Betelho J from Portugal have emerged as more active contributors (Figure 2(B)).

Geography distribution or country production analysis showed that researchers from Türkiye (formerly known as Turkey) and India were the major contributing countries in the field (Figure 3). The researchers from Türkiye and India collectively contributed 41.9% of the total publications (n = 39), with 25 articles from Türkiye and 14 from India as authors and co-authors in the articles included in this bibliometric study. It is worth noting that there was a limited number or no author from Southeast Asia, South America, Africa and the Pacific Ocean region in the analysed articles.

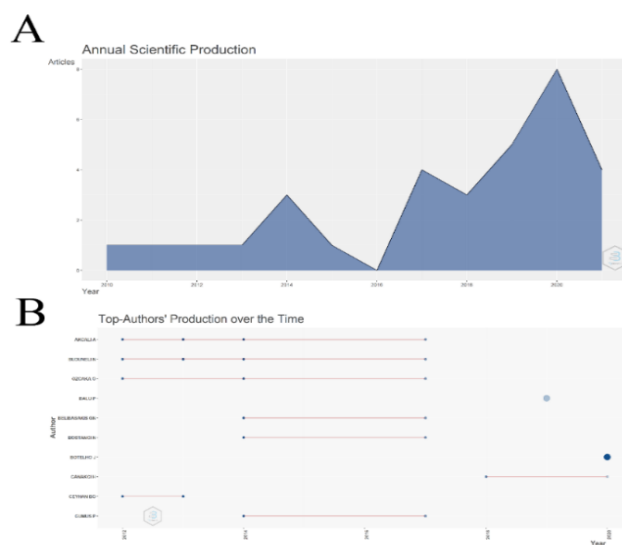


Figure 2 (A) Number of publications per year; (B) Publication trends over time for the top 10 authors showed the author publication frequency by year.

Country Scientific Production

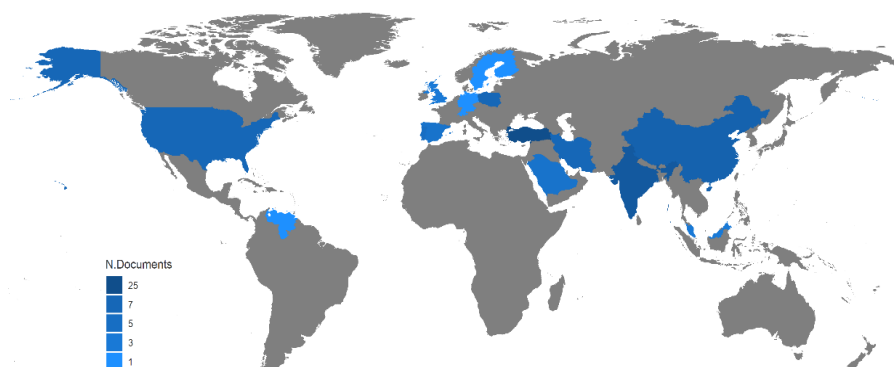


Figure 3 Geographic distribution of authors

Collaboration networks

Country collaboration networks revealed robust international partnerships, with Türkiye and the United States forming a central hub (Figure 4(A)). India, despite high productivity, showed limited direct collaboration with Türkiye, suggesting parallel research efforts. Author collaboration networks identified seven distinct clusters, with Akcali A and Buduneli N anchoring the largest group (Figure 4(B)). The presence of smaller, isolated clusters (e.g., Balu P's group in India) indicates emerging but disconnected research communities. These patterns suggest opportunities for enhanced global collaboration to pool expertise and address research gaps, particularly in underrepresented regions.

Citation analysis

Citation is an important metric to gauge the impact and relevance of literature; the top 10 most cited articles were summarised in Table 2. In the WoS database, a total of 262 citations were received by Ann Dent UM. 2026, 33: 1-10

all 32 articles, with an average number of 8.19 citations per paper. The average yearly citation per article was 1.04. Twenty-five articles (78.1%) received at least one citation, and 8 of them had more than 10 citations. The most cited article was a case-control study that evaluated the interrelationship between periodontal status and oxidant status in women with PCOS (n=33) [14]. The second (n=32) and third (n=30) most cited articles were two studies from the same authors that studied the interaction between different cytokines and gingival inflammation in PCOS patients [15, 16].

Author's keywords: Co-occurrence network

Analysis of 12 author keywords identified 3 clusters (Figure 5). Cluster 1, the largest, included terms like "PCOS," "periodontitis," and "periodontal disease," reflecting the core focus on their association. Cluster 2 comprised cytokine-related terms (e.g., "IL-6," "IL-17"), underscoring inflammation as a mechanistic focus. Cluster 3 included "C-reactive protein" representing broader inflammatory

Only one article (3.1%), an randomized controlled trial (RCT) study achieved LOE I–III, while 27 articles (84.4%) were classified as LOE IV–V (e.g., case-control or cross-sectional studies). Four articles (12.5%), including reviews and editorials, fell into LOE VI–VII. The scarcity of high-level evidence underscores a critical gap in rigorous study designs, limiting the ability to draw causal inferences or inform clinical guidelines.

The level of evidence (LOE) assessment revealed a predominance of lower-quality studies (Table 1).

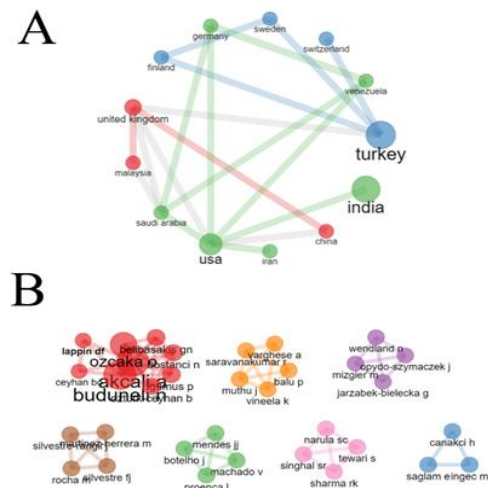


Figure 4 Collaboration Networks: (A) Countries; (B) Authors The graph reveals distinct networks of collaboration among countries and authors. Notably, Turkey and India appear to be part of separate interconnected networks, suggesting limited direct collaboration between the two countries in the field of periodontology and PCOS. Furthermore, author network analysis identifies seven distinct groups of researchers among the analysed articles (Figure 4 (B))



Figure 5 Co-occurrence network of the author's keywords

Authors	Year	Title	Total Citations	Citation per Year	Reference
Dursun et al	2011	Periodontal disease in polycystic ovary syndrome	33	2.20	[14]
Özçaka et al	2013	Is interleukin-17 involved in the interaction between polycystic ovary syndrome and gingival inflammation?	32	2.46	[15]
Özçaka et al	2012	Is There an Interaction Between Polycystic Ovary Syndrome and Gingival Inflammation?	30	2.14	[16]
Akcali et al	2014	Association between polycystic ovary syndrome, oral microbiota and systemic antibody responses	27	2.25	[27]
Porwal et al	2014	Periodontal status and high-sensitivity C-reactive protein levels in polycystic ovary syndrome with and without medical treatment	22	1.83	[13]
Rahiminejad et al	2015	Comparison of prevalence of periodontal disease in women with polycystic ovary syndrome and healthy controls	16	1.45	[28]
Kellesarian et al	2017	Association between periodontal disease and polycystic ovary syndrome: a systematic review	13	1.44	[3]
Deepti et al	2017	Effect of non-surgical periodontal therapy along with myo-inositol on high-sensitivity C-reactive protein and insulin resistance in women with polycystic ovary syndrome and chronic periodontitis: A randomized controlled trial	11	1.22	[9]
Saglam et al	2018	Evaluation of oxidative status in patients with chronic periodontitis and polycystic ovary syndrome: A cross-sectional study	9	1.13	[12]
Tanguturi & Nagarakanti	2018	Polycystic Ovary Syndrome and Periodontal disease: Underlying Links- A Review	9	1.13	[5]

DISCUSSION

Identifying current research trends and topics is a crucial first step to start any research project. Fortunately, the advancement and the availability of bibliometric tools allowed researchers to streamline this process and more efficiently examine the characteristics of articles derived from scientific databases. New emerging tools such as Biblioshiny and VOS Viewer's graphical display ability can clearly show the cooperative relationship between projects [17]. The bibliometric analysis of 32 articles published between 2010 and 2021 reveals a slowly evolving research landscape at the intersection of periodontitis and PCOS, characterized by a concentrated focus on inflammation and association studies, limited high-quality evidence, and uneven global contributions. This study provides a comprehensive map of publication trends, authorship, and research themes, offering insights into the field's development and barriers to advancing mechanistic understanding and clinical applications. The findings underscore the interdisciplinary nature of PCOS-periodontitis research, bridging periodontology, endocrinology, and immunology, yet highlight persistent gaps that impede broader impact.

The temporal analysis indicates a gradual increase in publications, from 2 articles in 2011 to a peak of 14 in 2020, followed by 6 in the first seven months of 2021 (Figure 2[A]). This trajectory suggests growing awareness of the PCOS-periodontitis link, likely driven by increased recognition of systemic inflammation's role in both conditions [3, 4]. However, the small total volume (32 articles over 11 years) and modest citation impact (average 1.04 citations per article per year) reflect a field in its infancy, progressing slowly compared to broader PCOS research, which has seen over 1,000 annual publications since 2015 [18]. The surge in 2020 may be attributed to heightened interest in inflammatory pathways during the COVID-19 pandemic, which spotlighted systemic health connections.

A critical assessment of the research reveals a narrow scope, with 45.5% of original studies focusing on the PCOS-periodontitis association and 27.2% on cytokine-mediated gingival inflammation, such as tumor necrosis factor alpha (TNF- α) [4], interleukin (IL) 6 (IL-6) [4, 19], IL-16 [20] and IL-17 [15]. While these studies provide valuable insights into inflammatory mechanisms, their repetitive focus limits innovation, as evidenced by the tight keyword clustering around "PCOS,"

"periodontitis," and "cytokines" (Figure 5). Underexplored areas, such as subgingival microbiota, hormonal pathways beyond androgens, or therapeutic interventions, represent missed opportunities to broaden the field's scope. For instance, only one RCT study examined the impact of non-surgical periodontal therapy on systemic inflammation in PCOS patients, highlighting a critical gap in interventional research [9]. The predominance of low-level evidence (84.4% LOE IV–V) further constrains the field's ability to establish causality or inform clinical guidelines, reflecting methodological challenges such as small sample sizes and cross-sectional designs.

The numbers of publications and citations are important literature metrics to examine the impact of journals and individual articles in the field. The rising number of publications in the present analysis without an obvious increase in citation number could be due to the reason that this topic is a highly specialized field that is still in its early stages of research. This limits the impact of individual articles, resulting in a low number of citations throughout the years. The country analysis also revealed a high number of publications in certain countries, such as India and Türkiye. This geographical diversity across different regions or countries could be attributed to varying prevalence rates of PCOS in those regions, where countries which experiencing a higher prevalence could tend to have greater research interest in studying the disease [21]. It is important to note that the global prevalence of PCOS varies depending on diagnostic criteria and study populations. According to a meta-analysis, the global prevalence of PCOS was estimated at 9.2% (95% CI: 6.8–12.5%) [22]. The World Health Organization (WHO) estimates that PCOS affects 6–13% of women of reproductive age globally [23]. Meanwhile, the pooled prevalence of PCOS in India was close to 10% using Rotterdam's criteria and Androgen Excess Society (AES) criteria, with 16% of Indian women between the ages of 20–29 suffering from PCOS [21]. This significant prevalence within India likely contributes to the heightened research activity observed among Indian researchers.

When examining the types of articles, it was evident that there is a limited number of original research articles and a lack of high LOE research articles in the field of PCOS (Table 1). Several potential factors could contribute to this issue, such as research question redundancy, where many studies in the field of PCOS address similar or overlapping research questions, leading to a limited number of novel contributions to the existing body of

knowledge. This repetition of research themes may reduce the overall diversity and impact of studies, thereby hindering the progression of new insights or innovative approaches in the field. Other factors include limited prior research, funding and resource constraints, challenges in recruiting participants, study design, sample size, and publication bias. To address these challenges, researchers should prioritize rigorous study design, conduct thorough literature reviews, collaborate with other researchers to pool resources, and consider alternative research approaches when needed [24].

One of the notable applications for bibliometric analysis is to help identify pivotal research questions. In this study, keyword co-occurrence network analysis was used to demonstrate the ability of a bibliometric tool in identifying research questions (Figure 5). The clusters with keywords such as “polycystic ovary syndrome”, “gingivitis”, “periodontitis”, “insulin-resistance” and “c-reactive protein” were revealed to be the biggest clusters. This co-occurrence network was in line with the important topics covered by the analysed articles, where the most popular research questions of the field mainly focused on the evaluation of the association between PCOS and periodontitis, as well as investigating the interaction of inflammatory molecules, especially various cytokines and C-reactive proteins. The results from the systematic review support the association between periodontal disease and PCOS, which is consistent with the established common pathophysiological mechanisms shared by both conditions [1].

In a bibliometric analysis conducted by Cai et al [18] which summarized the research status of PCOS and predicted the hot spots of PCOS in the future, the study revealed similar findings where the important keywords of PCOS research focused on “insulin resistance (IR)”, “obesity”, and “metformin” [18]. In concordance with the finding, previous studies have shown women with PCOS may have higher levels of white blood cell (WBC) count, C-reactive protein (CRP) and several cytokine concentrations, such as IL-6, IL-18, and TNF, were found to be elevated in these individuals [20, 25]. These cytokines can lead to chronic inflammation throughout the body, including in the gingiva, and this chronic inflammation can eventually cause damage to the gingiva and other structures that support the teeth, leading to periodontal disease.

Rudnicka et al [26] reported that Body Mass Index (BMI) and insulin resistance are the primary predictors of elevated CRP, there is also a link

between WBC count in PCOS and androgen concentration, suggesting that inflammation may be mediated not only by adiposity but also by increased androgen concentration [26]. Review has suggested that periodontal disease may exacerbate the hormonal imbalances associated with PCOS, leading to a worsening of PCOS symptoms. Evidence suggests that periodontal disease promotes persistent subclinical inflammation, which leads to insulin resistance and the development of type 2 diabetes, a common hallmark of PCOS [5].

This bibliometric analysis illuminates a field marked by slow but steady growth, driven by inflammation-focused studies and select regional contributions. The results presented in the present paper provide valuable insight into the research landscape and top contributors in the field of periodontology in PCOS. The limited number of original research articles published in the past decade underscores the need for more research to advance our knowledge and provide reliable evidence for clinical decision-making in dentistry. This analysis could catalyze enhancing networking, pinpointing knowledge gaps, and charting pathways for future investigation, especially in original research focusing on the mechanisms underlying disease development.

Moreover, these findings also highlight the dynamic nature of research and the potential for emerging investigators to make significant contributions in the future. Women affected by PCOS must acknowledge their vulnerability to periodontal disease and adopt diligent oral hygiene practices. Addressing this gap in the literature could help to improve the awareness of healthcare professionals regarding the association of PCOS and periodontal disease, hence it allows improving the current treatment planning for PCOS patients.

One of the limitations of this study is its narrow scope, as the literature search was restricted to studies investigating PCOS specifically in the context of periodontal diseases. As a result, broader studies on PCOS do not directly address periodontal outcomes. This focused approach, while enhancing the specificity of our analysis, it may limit the generalizability of the findings and overlook relevant insights from the wider PCOS research landscape. However, this narrow scope allowed for a more targeted analysis and enabled the inclusion of data from multiple databases, rather than relying solely on a single source, as is common in many bibliometric analyses. This strategy enhances the

specificity and methodological robustness of the review within the domain of periodontal research.

CONCLUSION

This bibliometric analysis reveals the global research landscape and key trends in the relationship between periodontitis and PCOS from 2010 to 2021, highlighting critical knowledge gaps for future investigation.

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DECLARATION OF INTEREST

Authors declare no conflict of interest.

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