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Zirconia in Dentistry: A 25-Year Bibliometric Analysis of Research Trends, Thematic Evolution, and Emerging Frontiers

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Highlights

- A bibliometric analysis of 6,156 WoS publications from 2000 to September 2025 maps global trends in dental zirconia research, showing sustained growth in publications and citations.
- The USA, Germany, Brazil and Switzerland, with core institutions such as the University of Zurich, University of São Paulo and University of Bern, anchor a densely connected international collaboration network with high citation impact.
- Co-citation and keyword analyses reveal a shift from early focus on framework strength and mechanical reliability toward bonding durability, esthetics, implant abutments and digitally driven precision.
- Frontier topics include monolithic and high-translucency zirconia, CAD/CAM accuracy and trueness, fully digital workflows and additive manufacturing for complex prosthetic and implant-supported restorations.

- Future priorities highlighted by this analysis are standardizing zirconia bonding and decontamination protocols, defining accuracy and quality benchmarks for digital and additive workflows, optimizing implant–abutment concepts and generating robust long-term clinical and real-world evidence.

ABSTRACT

Objectives

This bibliometric analysis aimed to map the global research landscape of zirconia in dentistry over the past 25 years, focusing on publication output, collaboration patterns, thematic evolution, and emerging research fronts.

Methods

Records published between 2000 and 2025 were retrieved from the Web of Science Core Collection using a zirconia-specific search strategy. After screening, 6,156 publications were included. Bibliometric analyses were conducted using VOSviewer, CiteSpace, and Bibliometrix to examine performance indicators, coauthorship and cocitation networks, keyword clustering, thematic evolution, and research frontiers. Journal metrics were obtained from the 2025 Journal Citation Reports. Correlation analyses between publication output and citation counts were performed using SPSS.

Results

Annual zirconia-related publications increased from fewer than 20 in 2000 to 494 by September 2025, reflecting sustained research activity over the observation period. The United States, Germany, Brazil, and Switzerland were the most productive contributors, while China, the Republic of Korea, and Turkey showed notable increases in output. The leading institutions included the University of Zurich, the University of São Paulo, and the University of Bern, with authors Kern, Sailer, and Özcan forming prominent collaboration networks. Cocitation and keyword analyses indicated thematic progression from structural reliability to bonding and interface research, esthetic-driven phase development, digital workflow accuracy, implant-supported zirconia components, and, more recently, additive manufacturing. Citation-burst detection highlighted emerging topics, including monolithic zirconia, translucency enhancement, computer-aided design and computer-aided manufacturing (CAD/CAM) precision, digital workflows, and three-dimensional (3D) printing.

Conclusion

Zirconia-related dental research has evolved from a focus on mechanical reliability to broader

themes encompassing bonding, esthetics, implant applications, and digital workflows, with emerging interest in additive manufacturing.

Clinical significance

By mapping research trends and thematic evolution, this bibliometric analysis provides insights into the shifting focus of zirconia research toward digitally integrated and clinically contextualized domains. These findings may support future research prioritization and methodological refinement in digital prosthodontics and dental materials.

Introduction

The increasing clinical demand for durable, esthetic, and metal-free dental restorations has driven the development and widespread adoption of advanced ceramic materials. Among these materials, zirconia has become one of the most intensively investigated ceramic materials in contemporary dentistry owing to its favorable mechanical properties,[1,2] chemical inertness,[3,4] and biocompatibility.[5,6] Since its introduction into dental applications, zirconia-based materials have been widely adopted in fixed prosthodontics,[7,8] implant-supported restorations,[9,10] and digitally fabricated dental prostheses.[11,12] Continuous advances in microstructural design,[13] phase stabilization,[14] surface modification,[15] and manufacturing technologies [12] have progressively expanded both the clinical indications and the scientific scope of zirconia research.

In recent years, zirconia-related dental research has experienced a marked increase in publication volume alongside a substantial diversification of research themes. Beyond classical topics such as mechanical reliability and aging behavior,[16] contemporary studies increasingly address esthetic optimization,[13] bonding strategies,[15] digital workflow accuracy,[17] manufacturing-induced variability,[12] and emerging additive manufacturing technologies.[18] This rapid expansion has resulted in a highly heterogeneous research landscape spanning materials science, digital dentistry, and clinical prosthodontics.

To synthesize this growing body of literature, numerous narrative and systematic reviews have been published,[13,[19], [20], [21]] focusing on specific aspects of zirconia research, including restoration types, material properties, bonding performance, and clinical outcomes. These reviews play a critical role in evidence-based clinical decision-making by addressing predefined and focused research questions. However, by design, such reviews are not intended to provide a comprehensive overview of research structures, thematic evolution, or interdisciplinary linkages across the entire zirconia research field.

Bibliometric analysis offers a complementary, macrolevel perspective by quantitatively mapping scientific activity, collaboration patterns, knowledge structures, and evolving research themes.[22,23] Although several bibliometric studies have previously examined selected aspects of zirconia-related dental research, these analyses have generally focused on specific clinical applications or

have relied predominantly on descriptive productivity indicators.[[24], [25], [26]] Consequently, an integrated bibliometric assessment capturing the overall evolution of zirconia research in dentistry remains limited in scope and structural integration, particularly with regard to the interaction between materials development, digital workflows, and advanced manufacturing technologies.

Against this background, a comprehensive bibliometric analysis is warranted to elucidate how zirconia research in dentistry has developed over time, how research priorities have shifted, and which thematic areas are emerging. For contextual reference, Supplementary Table S1 provides an overview of representative dental zirconia material categories discussed in the literature. Therefore, the present study conducts a bibliometric analysis of zirconia-related dental research published over the past 25 years. Using data retrieved from the Web of Science Core Collection and multiple bibliometric tools, this study aims to map global research output and collaboration patterns; identify influential contributors and journals; and reveal thematic evolution and emerging research frontiers, with an emphasis on materials development, digital workflows, and advanced manufacturing technologies.

Section snippets

Data collection and extraction

All records were retrieved from the Web of Science Core Collection (WoSCC). The WoSCC was selected because it provides standardized citation indexing, comprehensive bibliographic metadata, and wide coverage of high-impact journals in dentistry and materials science, which are essential for reliable bibliometric and citation network analyses. To target zirconia-related research in dentistry, the expanded topic query was applied as follows: WC = (“Dentistry oral surgery medicine”) AND …

Results

Figure 2A illustrates the annual and cumulative publication output of zirconia-related dental research from 2000 to 2025. The number of annual publications increased from fewer than 20 articles in 2000 to 494 articles by September 2025. Publication activity remained modest before 2008, followed by steady expansion throughout the 2010s and accelerated output after 2020. The

cumulative curve demonstrates a continuously rising trajectory over the study period, indicating sustained growth in …

Discussion

Bibliometric analysis is widely used to map patterns of scholarly activity, knowledge structure, and thematic development within a defined research corpus rather than to evaluate clinical effectiveness or compare therapeutic performance.[22,23] Accordingly, the findings of the present study should be interpreted as indicators of research attention, the collaboration structure, and evolving scientific priorities in zirconia-related dental research.

The temporal scope of the analysis was defined …

Conclusion

Zirconia research has progressed from high-strength frameworks to an integrated paradigm that balances esthetics, adhesion, digital precision, and implant-specific requirements. The field's collaborative structure reflects increasing cross-fertilization between clinical dentistry and materials science. Central challenges now include reconciling translucency with toughness, assuring interface durability in complex oral environments, and maintaining dimensional fidelity across digital and …

Author Contributions

Jingkun Zhang: Bibliometric analysis; Visualization; Writing-Original draft preparation;

Guangwei Chen: Bibliometric analysis; Visualization; Writing-Original draft preparation;

Wenshu Wu: Investigation

Xinchao Miao: Conceptualization, Supervision; Writing-Review and Editing.

Youcheng Luo: Conceptualization, Supervision; Writing-Review and Editing. …

CRediT authorship contribution statement

Jingkun Zhang: Writing – original draft, Visualization, Formal analysis. **Guangwei Chen:** Writing – original draft, Visualization, Formal analysis. **Wenshu Wu:** Investigation. **Xinchao Miao:** Writing – review & editing, Supervision. **Youcheng Luo:** Writing – review & editing, Supervision. …

Declaration of competing interest

The authors declare that they have no potential conflict of interest. …

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Special issue articles

References (50)

C. Piconi *et al.*
Zirconia as a ceramic biomaterial
Biomaterials (1999)

J.R. Kelly *et al.*
Stabilized zirconia as a structural ceramic: An overview
Dent. Mater. (2008)

I. Denry *et al.*
State of the art of zirconia for dental applications
Dent. Mater. (2008)

A.J. Raigrodski *et al.*
The efficacy of posterior three-unit zirconium-oxide–based ceramic fixed partial dental prostheses: A prospective clinical pilot study
J. Prosthet. Dent. (2006)

E.D. Rekow
Digital dentistry: The new state of the art - is it disruptive or destructive?
Dent. Mater. (2020)

T. Miyazaki *et al.*
Current status of zirconia restoration
J. Prosthodont. Res. (2013)

L. Hallmann *et al.*
Effect of dopants and sintering temperature on microstructure and low temperature degradation of dental Y-TZP-zirconia
J. Eur. Ceram. Soc. (2012)

S.-S. Kim *et al.*
Effect of digital scans on marginal and internal discrepancies of zirconia crowns
J. Prosthet. Dent. (2020)

P.F. Manicone *et al.*
An overview of zirconia ceramics: Basic properties and clinical applications
J. Dent. (2007)

R. Shahmiri *et al.*
Optical properties of zirconia ceramics for esthetic dental restorations: A systematic review
J. Prosthet. Dent. (2018)

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Cited by (0)

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