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Systematic Review

Exploring the evolution of endocrowns: a bibliometric analysis (2010-2024)

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ABSTRACT

The aim of this bibliometric analysis is to evaluate the global research trends and patterns in publications related to endocrowns, a conservative restorative option for endodontically treated teeth. Endocrowns have gained significant attention due to their ability to preserve tooth structure while providing adequate retention and aesthetics. This study analyzed the scientific output from various databases, including Scopus, Web of Science, and PubMed, focusing on publication trends, geographic distribution, most cited articles, prolific authors, and key journals publishing on the topic. A systematic search was performed using specific keywords such as "endocrown," "endodontically treated teeth," and "ceramic restorations." The data was then processed using bibliometric software to visualize collaborations, citation networks, and emerging trends in the field. Results show a steady increase in publications over the last decade, with notable contributions from Europe and Asia. The top-cited articles primarily discuss clinical outcomes, material choices, and long-term success rates of endocrowns. This analysis highlights the growing interest in endocrowns as a restorative solution and provides insights into future research directions, including advances in materials science and long-term clinical performance. The findings of this study serve as a comprehensive guide for researchers, clinicians, and academicians in understanding the evolution and current state of research on endocrowns.

Keywords: Endocrown, Endodontically treated teeth, Ceramic restorations, Adhesive dentistry, Full-coverage restorations, Monolithic crowns

INTRODUCTION

The rehabilitation of endodontically treated teeth with significant coronal destruction presents a clinical challenge due to the diminished strength characteristics linked to the pulp and adjacent dentin tissues. Intraradicular posts may be necessary; however, their drawback is the further removal of sound tissue.[1]

The concept of endocrowns has garnered increasing attention in restorative dentistry over the past few decades. The complete glass ceramic crown restoration, proposed in 1999 by Bindl and Mörmann, serves as an alternative to the full post-and-core-supported crown; the "endocrown" is a singular ceramic structure. This crown would be affixed to the internal walls of the pulp chamber and the cavity margins to enhance micromechanical retention, while the application of adhesive cementation would further augment micro retention.[2]

The growing interest in endocrowns has led to an expanding body of research that investigates their clinical success, biomechanical properties, material performance, and long-term outcomes. However, no comprehensive overview has been conducted to map the global scientific output on endocrowns and identify the trends, key contributors, and the most impactful research. Bibliometric analysis, a statistical method for analyzing scientific literature, offers a systematic approach to exploring these dimensions. By examining publication

patterns, influential authors, collaborations, within the endocrown literature, this study aims to provide a deeper understanding of the evolution of research in this area.

In this bibliometric analysis, we explore publications from January 2010 to July 2024 to chart the landscape of endocrown research. The goal is to highlight trends in the literature, identify research gaps, and provide insight into future directions for both clinical practice and academic inquiry. Through this comprehensive analysis, we seek to contribute to the broader understanding of restorative dental practices, particularly in the context of endodontically treated teeth and minimally invasive dentistry.

METHODS

Bibliometric analysis of endocrown research (2010-2024)

This bibliometric analysis employed the R programming language and R Studio software was done in Government College of Dentistry, Indore to explore the research landscape concerning endocrown dentistry.

The study focused on articles indexed in the PubMed Core Collection from the year January 2010 to December 2024.

Inclusion criteria

Studies published between 01 January 2010, and 31 December 2024 and articles published in English were included.

Document types

Peer-reviewed journal articles, review articles, conference papers (if indexed in selected databases), systematic reviews and meta-analyses.

Topic relevance

Articles focusing on endocrowns, including their clinical application, design, materials, biomechanics, comparative studies, or longevity and studies mentioning endocrowns in the title, abstract, or keywords.

Databases

Articles indexed in databases like Scopus, Web of Science, PubMed, or Dimensions were included.

Exclusion criteria

Document type not specified, papers that have not been published, written in a language other than English and titles and abstracts containing irrelevant content were excluded.

Search strategy

The search strategy utilized PubMed as the primary database, encompassing literature up to December 2024. The algorithm applied for PubMed searches was as follows:

Combination of MeSH Terms

Endocrown AND (Dental Restoration OR Tooth Restoration) and Endocrown AND (Dental Implants OR Dental Prosthesis)

Broader search with keywords

Endocrown AND (dental OR tooth OR oral OR maxillofacial) AND (restoration OR rehabilitation OR treatment).

Narrower search with specific keywords

Endocrown AND (full-coverage crown OR composite resin crown OR ceramic crown) and Endocrown AND (Post and core).

Data extraction and analysis

The bibliometric analysis included extracting information such as title, author, institution, country, publication year, keywords, and citations. These details were imported into Microsoft Excel (MS Excel) 2000 (Redmond, Washington, USA). Citexs AI (Wuhan, China) was used for identifying related diseases. Visualization of countries, institutions, authors, journals, diseases, and keywords was carried out using R programming and R Studio software. In the visualization, the size of nodes and the thickness of lines connecting nodes in R Studio indicated the volume of publications and the strength of connections (Figure 1).

Data collection

Data extraction involved gathering information such as publication year, authors, affiliations, journals, citation counts, and keywords from the retrieved articles. This comprehensive data set formed the basis for subsequent analyses.

Data analysis

Publication trends involves the identification of publication trends over time helped in understanding the evolution of research interest in the field of endocrown dentistry. A descriptive analysis was conducted to examine trends in publications over different years and document types.

Author analysis includes the phase focused on identifying highly productive authors and mapping collaboration networks within the field. By analyzing author output and

patterns of co-authorship, we could highlight key contributors and the structure of their collaborative efforts.

Journal analysis, we assessed the impact and influence of journals publishing research on endocrowns. Evaluating metrics such as impact factor and citation count enabled us to gauge the significance of these journals within the academic community.

Keyword analysis involves the common keywords and themes across the literature were identified. By analyzing the frequency of keywords, networks of co-occurrence, and clusters of related themes, we could delineate the primary areas of focus and emerging topics within the research landscape.

Statistical analysis

Descriptive statistics, network analysis, and visualization techniques were employed to interpret and present the findings. These methods provided a clear and structured representation of the data, facilitating the identification of patterns and trends.

Visualization and interpretation

Bibliometric visualization methods such as co-authorship networks, keyword co-occurrence maps, and citation networks were used to illustrate connections and patterns within the data. The analysis of these findings was aligned with the specified research goals, allowing us to identify prominent trends, influential authors, emerging topics, and areas where research is lacking.

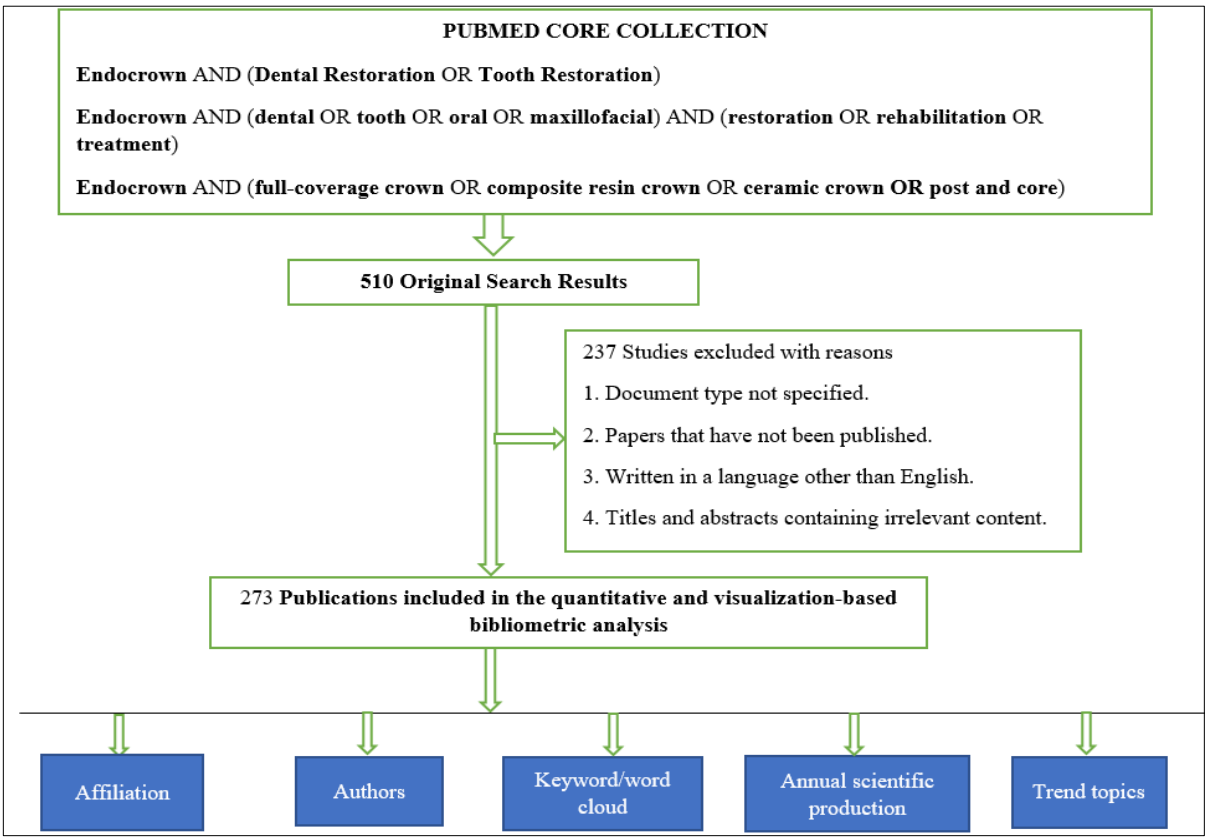

Figure 1: PubMed core collection.

RESULTS

Figure 2 and Table 1 shows the timespan (2014-2024). The data covers a decade, indicating a recent focus on the topic, which may suggest that it is a developing area of research.

Sources (journals and books)

A total of 89 documents have been identified, implying a reasonably substantial body of literature available for review or analysis.

Annual growth rate (35.59%)

This high growth rate indicates that the volume of research being published in this field is rapidly increasing, suggesting growing interest or relevance of the topic.

Document average age (3.03 years)

On average, the documents are just over three years old, which supports the idea that the research is current and reflects recent developments or trends in the field.

Average citations per document (0)

The fact that there are no citations per document might suggest that the research is relatively new or that the works are yet to be recognized or cited by other researchers. This could also indicate that the documents may not have gained traction in the academic community.

References (0)

Similar to the citation metric, having no references could imply that the documents may not be deeply interconnected with prior research, or they might be primary studies presenting new findings without extensive literature review. Overall, the data indicates a rapidly growing area of research with current publications, but it also suggests that the works might still be in the early stages of influencing the broader academic community.

Figure 2: Main information about data.

Figure 3 shows the data on annual scientific production from 2014 to 2024 shows a clear upward trend, indicating consistent growth in research output over the past decade.

2014-2016

The early years between 2014-2016 show relatively low productivity, with only 2 articles published in 2014, increasing to 6 in 2015 and 10 in 2016. This indicates a gradual rise in interest and focus on the topic.

2017-2019

The growth becomes more noticeable during 2017-2019, with the number of articles rising steadily from 13 in 2017 to a peak of 21 in 2018. Interestingly, there is a slight dip in 2019 with 18 articles, but the overall trend remains upward.

2020-2022

2020-2022, this period marks significant expansion, with 27 articles published in 2020, 41 in 2021, and 43 in 2022. The sharp increase from 2019 to 2021 suggests that the topic has gained substantial momentum and attention in the scientific community.

2023-2024

During 2023-2024 the highest productivity is observed in 2023 with 50 articles, showing the field's peak output. The projected 40 articles for 2024 suggest sustained activity, though with a slight decline compared to the previous year.

In summary, the annual scientific production has grown remarkably, with peak activity in recent years. Despite a small projected decrease in 2024, the overall trend points to increasing interest and contribution to this field over the decade.

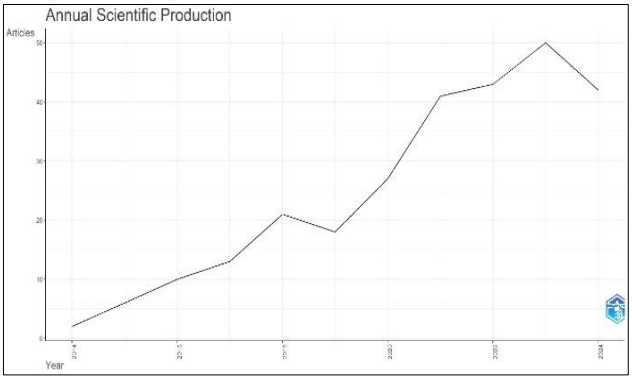

Figure 3: Annual scientific production.

Figure 4 represents the most relevant sources for a particular area of research, showcasing the number of documents published by each journal or source. The Journal of Prosthetic Dentistry is the most prolific source, with 18 documents. This highlights its importance and influence in the research domain.

BMC Oral Health follows with 14 documents, indicating that it is also a major contributor to the literature in this field. Journal of the Mechanical Behavior of Biomedical Materials with 13 documents. Cureus and Operative Dentistry, each contributing 11 documents.

Several journals contribute equally with 9 documents, including Dental Materials: Official Publication of the Academy of Dental Materials, Journal of Dentistry, Journal of Prosthodontics: Official Journal of the American College of Prosthodontists, Materials (Basel, Switzerland), and Journal of Esthetic and Restorative Dentistry has 8 documents, rounding out the key sources. Overall, this distribution of documents suggests that the field is heavily influenced by journals specializing in prosthetics, oral health, and material behavior in dentistry. The concentration of documents in these top sources points to a focused and specialized body of knowledge.

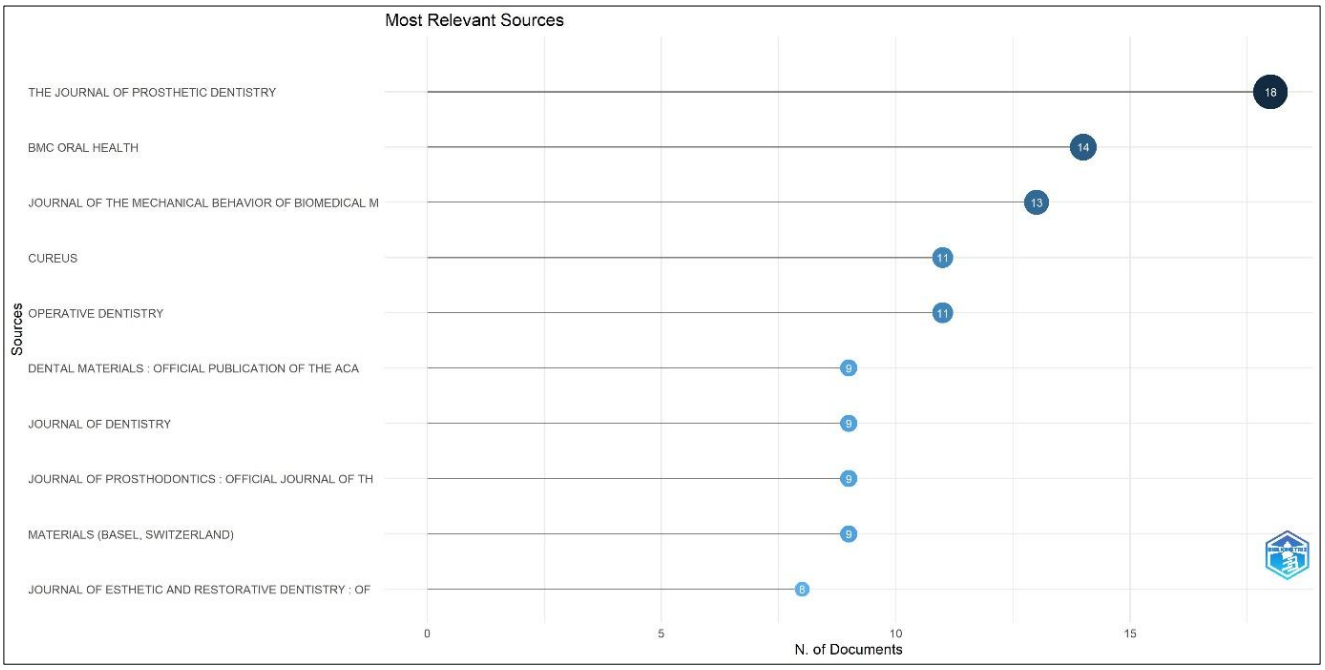

Figure 4: Most relevant sources.

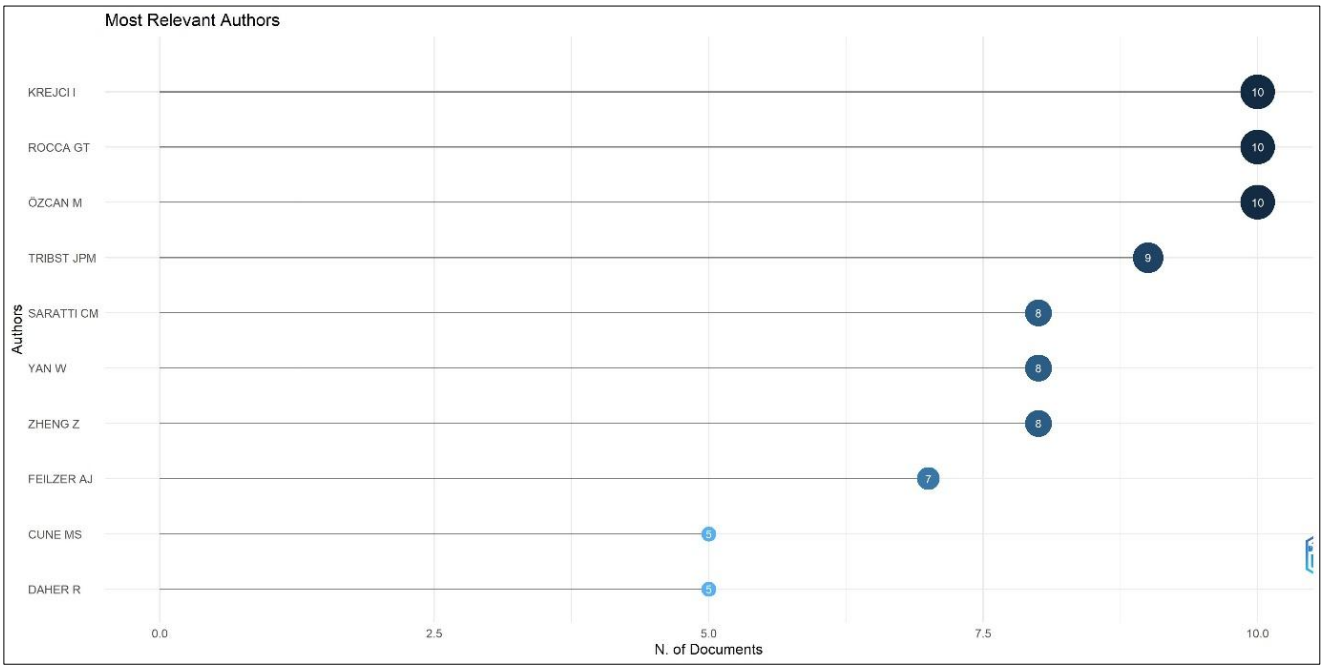

Figure 5: Most relevant authors.

Figure 5 shows most relevant authors based on the number of articles they have contributed. Krejci, Rocca, and Özcan have each authored 10 articles, making them the most prolific contributors. Their work likely plays a significant role in shaping the research landscape in this area, indicating their deep involvement and expertise in the field. Tribst follows closely with 9 articles, showing substantial contribution and positioning as a key author in the research community. Saratti, Yan, and Zheng have each authored 8 articles, marking them as important figures contributing consistently to the body of knowledge. Feilzer has contributed 7 articles, while Cune and Daher each have 5 articles, placing them among the significant, though slightly less frequent, contributors.

This data highlights the key authors whose research is most prominent and influential within this specific domain, with Krejci, Rocca, and Özcan standing out as leading figures.

Figure 6 highlights the most relevant academic affiliations based on the number of articles contributed to a particular field of research. Southern Medical University leads with

48 articles, indicating its prominent role in the research landscape. This suggests that the institution has a strong focus on this area of study and has made substantial contributions to advancing the field. University of Geneva follows closely with 44 articles, reflecting its significant involvement and expertise in the topic. Its high output places it among the top contributors. Sun Yat-Sen University with 40 articles and Tehran University of Medical Sciences with 37 articles are also key players in the field, contributing a large volume of research. São Paulo State University (UNESP) ranks fifth with 27 articles, marking it as a significant institution, particularly in the Brazilian academic landscape. Mansoura University (23 articles), Jazan University (22 articles), and King Khalid University (17 articles) from the Middle East show that research in this field is active across multiple regions, highlighting their role in contributing to global knowledge. The Federal University of Santa Maria (UFSM) and University of Ribeirão Preto (UNAERP), both from Brazil, have each contributed 16 articles, demonstrating Brazil's strong presence in this research domain.

In summary, institutions from China, Switzerland, Iran, Brazil, and the Middle East are leading the way in research output, with Southern Medical University and the University of Geneva standing out as the top contributors. This data shows a diverse and international collaboration in the research field.

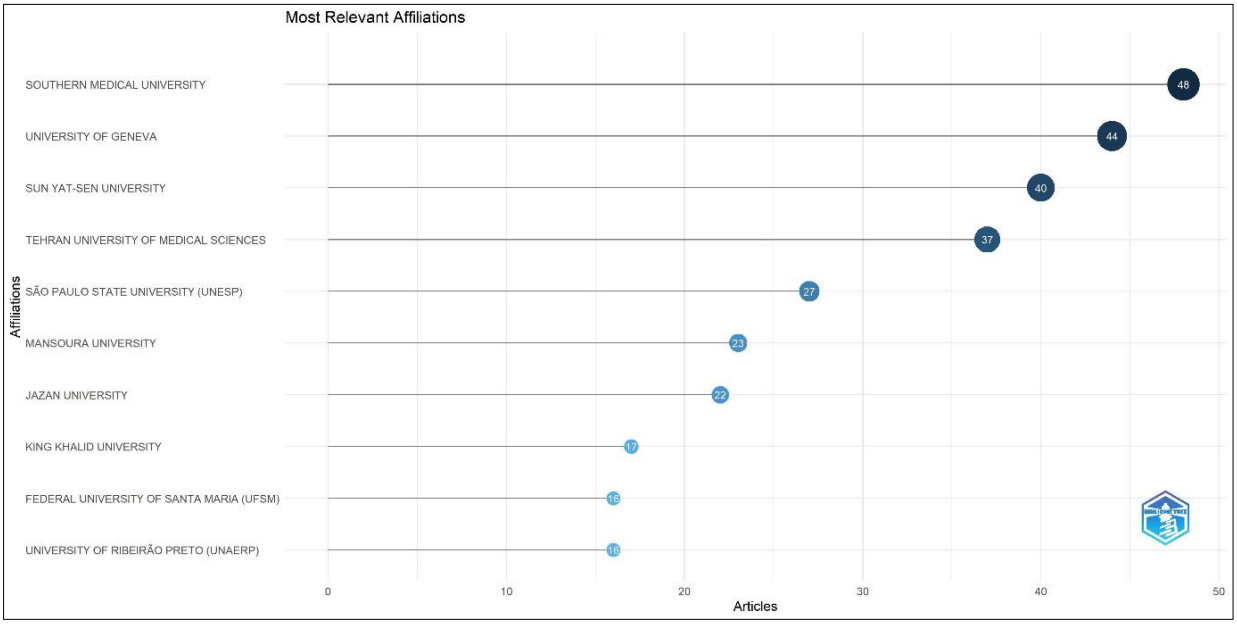

Figure 6: Most relevant affiliations.

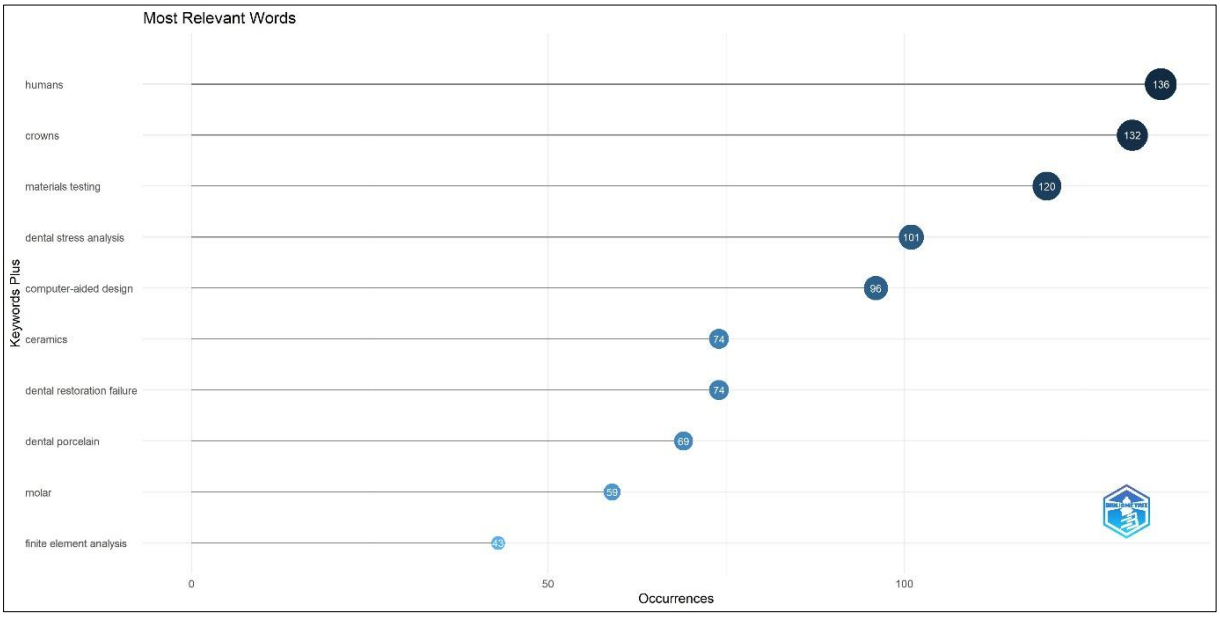

Figure 7: Most relevant words.

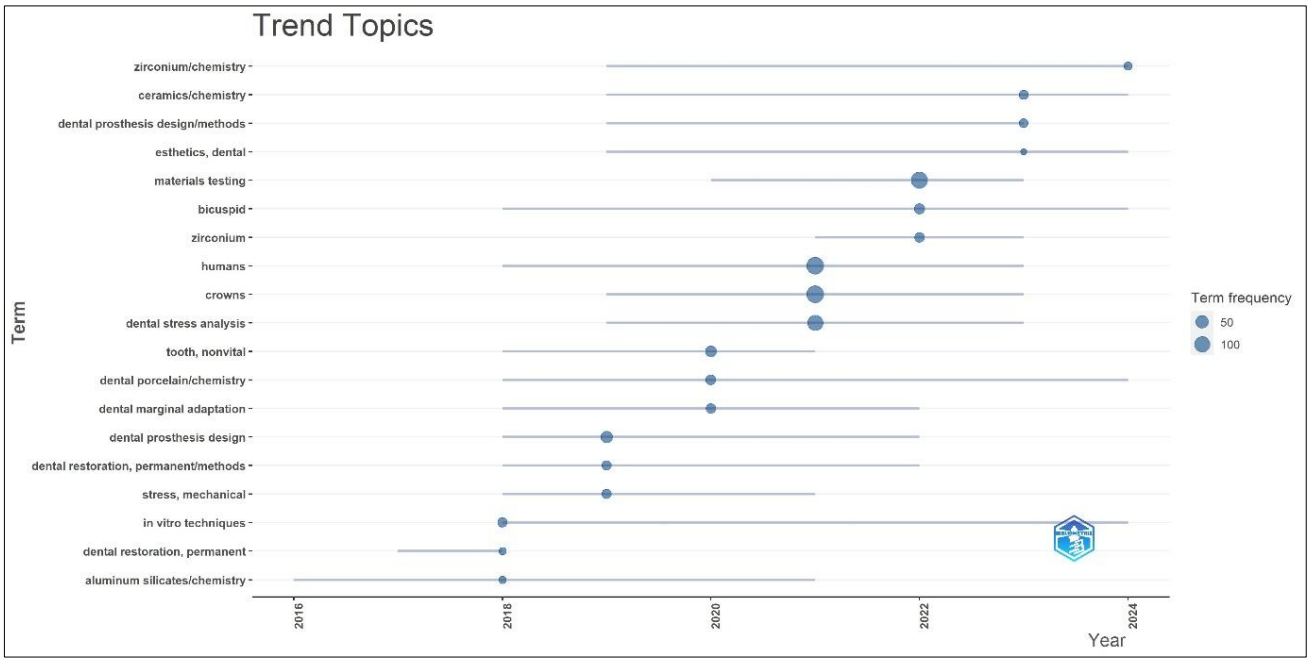

Figure 8: Trend topics.

Figure 7 highlights the most relevant words used in the research field, along with the frequency of their occurrence "Humans" is the most frequent term, with 136 occurrences. This indicates that a majority of the research involves human subjects or pertains directly to human-related dental conditions and treatments. "Crowns" follows closely with 132 occurrences, signifying that dental crowns are a central focus of the research in this field, likely involving the study of their materials, application, and performance. "Materials testing" appears 120 times, emphasizing the importance of evaluating dental materials' properties, durability, and suitability for various prosthetic and restorative purposes. "Dental stress analysis" and "Computer-aided design" are also prominent, with 101 and 96 occurrences, respectively. These keywords suggest a strong focus on the mechanical aspects of dental materials and restorations, as well as the use of advanced technologies like CAD for designing dental prosthetics. "Ceramics" and "Dental restoration failure" each occur 74 times, highlighting the significance of ceramics in dental restorations and the concern with understanding and preventing restoration failures. "Dental porcelain" and "Molar" are mentioned 69 and 59 times, indicating frequent study of porcelain as a material in restorative dentistry, especially concerning molar teeth. "Finite element analysis" (43 occurrences) suggests that computational techniques for stress and structural analysis are also integral to this research field.

In summary, the keywords reveal that the research heavily focuses on dental restorations, material testing, and advanced analytical techniques, with an emphasis on human subjects, crowns, and ceramic materials.

Figure 8 shows the trending topics in dental research, with terms plotted over time (from 2016 to 2024) and their term frequency visualized through bubble size.

Zirconium and ceramics

These terms have been popular topics since 2016, gaining more relevance by 2020 and continuing strong through 2024. Zirconium and ceramics are materials commonly used in dental restorations, and the focus on their chemistry shows the emphasis on material properties and advancements in dental prosthesis.

Dental prosthesis design and methods

This trend has remained consistent over the years, indicating ongoing research and development in prosthesis designs and the methods to enhance functionality and esthetics.

Esthetics, dental

The term "esthetics" appears frequently, which reflects a growing interest in improving the visual outcomes of dental treatments, possibly in combination with functional aspects such as crowns and implants.

Materials testing

This term has gained importance from 2020 onwards, highlighting the rise in research focusing on evaluating new materials' mechanical properties, durability, and performance in dental applications.

Crowns and dental stress analysis

Crowns and dental stress analysis have shown increasing relevance, especially after 2020. This suggests that research is concentrating on understanding how dental restorations, like crowns, handle mechanical stress, which is critical for long-term success.

Finite element analysis and computer-aided design (cad)

These terms also feature prominently from around 2018 and 2020, respectively, indicating the growing use of computational tools to simulate and design dental restorations, improving precision and durability.

Humans

This topic became highly relevant after 2020, indicating more research involving human subjects, possibly through clinical trials or studies evaluating the real-world application of dental materials and techniques.

Emerging focus (2022-2024)

New terms like aluminum silicates/chemistry and non-vital tooth suggest emerging research areas in dental materials (silicates) and clinical techniques for non-vital tooth restoration.

In summary, the trend indicates an increasing focus on material science, particularly in ceramics and zirconium, alongside advancements in dental prosthesis design and methods. There's a clear shift toward evaluating dental restoration performance through material testing and stress analysis, supported by computational tools like CAD and finite element analysis.

DISCUSSION

The findings from this bibliometric analysis provide valuable insights into the evolving landscape of endocrown research from January 2010 to July 2024. As restorative dentistry continues to adapt to technological advancements and changing clinical demands, endocrowns have emerged as a significant area of interest, particularly for endodontically treated teeth with substantial coronal loss.[3] The increase in research output, reflected in the annual growth rate of 35.59%, underscores the growing recognition of endocrowns as a viable treatment option, demonstrating a shift in both clinical practice and academic inquiry.[4]

The data reveals a notable upward trend in publication volume, particularly in the years 2020 to 2024, which correlates with an enhanced focus on minimally invasive dentistry and the development of advanced materials, such as lithium disilicate ceramics.[5] This growth may be attributed to an increasing body of evidence supporting the efficacy of endocrowns, leading to greater adoption in clinical settings. The identification of prominent institutions, such as Southern Medical University and the University of Geneva, highlights the collaborative nature of this research field, with contributions from diverse geographic regions. This international collaboration enriches the discourse around endocrown applications and fosters a multidisciplinary approach to research.[6]

Author analysis indicates that several researchers, including Krejci, Rocca, and Özcan, are at the forefront of this field, suggesting their work significantly shapes current understanding and practices related to endocrowns. Their high publication output reflects not only individual expertise but also potential collaborative networks that enhance the visibility and impact of their research. This emphasizes the importance of academic collaboration in driving forward the knowledge base in restorative dentistry.[7,8]

Keyword analysis reveals a strong focus on human subjects, crowns, and material testing, indicative of a research community dedicated to addressing clinical challenges associated with restorative practices.[9,10] The prominence of terms such as "dental restoration failure" and "materials testing" suggests that researchers are actively investigating the durability and performance of endocrowns, which is crucial for improving patient outcomes.[11,12] Furthermore, the integration of advanced technologies like computer-aided design (CAD) and finite element analysis signifies a trend towards incorporating innovative methodologies to optimize dental restorations.[13,14]

Despite the positive trends, the lack of citations per document and references may suggest that many studies are still in their infancy regarding academic impact.[15,16] This could indicate a need for further research to build upon existing findings and establish a more interconnected body of literature. As the field matures, it is essential for future studies to focus on long-term clinical outcomes, patient satisfaction, and cost-effectiveness of endocrown treatments to solidify their place in restorative dentistry

This bibliometric analysis provides a foundational understanding of the current state of endocrown research. It highlights significant trends, key contributors, and emerging topics while also identifying areas that require further exploration. As interest in minimally invasive restorative techniques continues to grow, ongoing research will be critical in advancing the field, informing clinical practices, and ultimately improving patient care in restorative dentistry.[17–19] Future investigations should aim to establish comprehensive guidelines and evidence-based practices for the effective use of endocrowns in diverse clinical scenarios.[20]

CONCLUSION

This bibliometric analysis of endocrown research from 2010 to 2024 highlights a dynamic and rapidly evolving field within restorative dentistry. The significant increase

in publication volume, particularly in recent years, underscores the growing recognition of endocrowns as an effective treatment modality for endodontically treated teeth with extensive coronal loss. Our findings reveal that key institutions and prominent authors are driving this research, contributing to a rich collaborative environment that fosters innovation and knowledge sharing.

The analysis of publication trends, author contributions, and keyword frequency provides valuable insights into the current focus areas and emerging themes within the literature. The emphasis on material testing, durability, and the application of advanced technologies indicates a concerted effort to enhance the clinical outcomes of endocrown treatments. However, the limited citation counts suggest that much of this research is still gaining traction in the academic community, highlighting an opportunity for future studies to build upon existing findings and establish a more robust evidence base.

As endocrown research continues to advance, it is crucial for future investigations to explore long-term clinical outcomes, patient satisfaction, and cost-effectiveness. By addressing these aspects, researchers can further solidify the role of endocrowns in restorative dentistry and contribute to the development of evidence-based guidelines that enhance patient care. Overall, this study serves as a foundational overview of the field, encouraging ongoing exploration and collaboration to drive innovation in restorative practices.

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