



# Risk factors associated with early childhood caries: A bibliometric analysis

[Factores de riesgo asociados a la caries de la primera infancia: Un análisis bibliométrico]

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## Abstract

**Context:** Early childhood caries (ECC) is a significant oral health problem affecting children worldwide. Its consequences can range from pain and infection to impact on children's quality of life. Research on risk factors associated with ECC is evolving but shows gaps and inconsistencies.

**Aims:** To examine research trends on risk factors associated with early childhood caries in the Scopus and Web of Science databases.

**Methods:** A methodology based on the PRISMA 2020 declaration was used, focusing on a systematic bibliometric review.

**Results:** The results showed a significant increase in scientific interest in ECC, especially in 2021 and 2022, with a 98.87% increase in publications. Countries such as India and the United States were leading the research, and current thematic trends lean towards oral hygiene practices and survival analysis.

**Conclusions:** The evolution of the field suggests a focus on emerging areas and adaptability to the changing needs of affected populations.

**Keywords:** early childhood caries; oral health; oral hygiene practices; prevention; PRISMA 2020.

## Resumen

**Contexto:** La caries de la primera infancia (CPI) es un importante problema de salud bucodental que afecta a niños de todo el mundo. Sus consecuencias pueden ir desde el dolor y la infección hasta el impacto en la calidad de vida de los niños. La investigación sobre los factores de riesgo asociados con la CPI está evolucionando, pero muestra lagunas e inconsistencias.

**Objetivos:** Examinar las tendencias de la investigación sobre los factores de riesgo asociados a la caries de la primera infancia en las bases de datos Scopus y Web of Science.

**Métodos:** Se utilizó una metodología basada en la declaración PRISMA 2020, centrada en una revisión bibliométrica sistemática.

**Resultados:** Los resultados mostraron un aumento significativo del interés científico por la CPI, especialmente en 2021 y 2022, con un incremento del 98,87% de las publicaciones. Países como India y Estados Unidos lideraban la investigación, y las tendencias temáticas actuales se inclinan hacia las prácticas de higiene oral y el análisis de supervivencia.

**Conclusiones:** La evolución del campo sugiere un enfoque en áreas emergentes y adaptabilidad a las necesidades cambiantes de las poblaciones afectadas.

**Palabras Clave:** caries de la primera infancia; salud bucodental; prácticas de higiene bucodental; prevención; PRISMA 2020.

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## INTRODUCTION

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Early childhood caries (ECC) is an oral health problem that affects preschool children and is characterized by the presence of caries in primary teeth. This dental condition has a significant impact on children's quality of life and can lead to long-term health problems if not properly managed. Understanding the risk factors associated with dental caries is essential to developing effective prevention and treatment strategies. Scientific research has extensively investigated the relationship between various risk factors and congenital cardiovascular disease (CHD) in young children.

Aspects related to the perinatal period and metabolic factors that may influence the occurrence of CHD have been studied (Boustedt et al., 2020). On the other hand, a study focused on exploring biopsychosocial factors that could be associated with CHD in preschool children in Indonesia is being conducted (Achmad et al., 2019). In addition, the association between the diet of 18-month and 3-year-old Japanese children and their oral health behaviors will be investigated (Tashiro et al., 2021). In contrast, a retrospective cohort analysis of 3-year-old Chinese children focused on investigating the potential association between cesarean delivery at birth and the risk of CHD (Ge et al., 2023).

They conducted a comprehensive review to examine the association between breastfeeding and CHD in childhood. These studies offer a broad perspective on the risk factors associated with CHD in different populations and settings, enriching the understanding of this important dental health issue in children (Panchanadikar et al., 2022). This bibliometric work analyzes these and other related studies to identify trends and advances in research on caries and its risk factors.

ECC is a major oral health challenge affecting children worldwide. Its importance stems from both short- and long-term consequences, including pain, infection, tooth loss and impact on children's quality of life. To effectively address this problem and develop appropriate preventive strategies, it is essential to understand the risk factors associated with ECC. A bibliometric analysis of different scientific sources provides a more complete and detailed view of the research on this topic.

A recent study analyzed the relationship between the diet of Japanese children aged 18 months to 3 years and their oral health habits. This study emphasizes the importance of elements such as diet and oral care routines in preventing early childhood caries at an early age (Tashiro et al., 2021). In contrast, research

conducted in Shandong, China, supplies important data on risk elements at different stages of life, which may be useful in designing oral health education approaches adapted to different stages of child development (Zhang et al., 2020). Similarly, a study in Vietnam emphasized the diversity of risk factors in diverse cultural and economic settings (Nguyen et al., 2018). This emphasizes the importance of using approaches adapted to specific cultural contexts to address ECC. Finally, prospective studies have focused on the association between sugar consumption and the occurrence of ECC, emphasizing the relevance of diet in the prevention of this oral disease in young children (Boustedt et al., 2022).

Studies investigating the risk elements associated with early childhood caries continue to evolve, but there are still notable gaps in our knowledge. These deficiencies are reflected in the lack of a solid consensus and the differences in results between studies, which underscores the importance of conducting a comprehensive bibliometric analysis to summarize and evaluate the available information. For example, a comprehensive systematic review was conducted on the association between breastfeeding and early childhood caries, but multiple approaches and divergent results were identified in this area of research (Panchanadikar et al., 2022). In addition, they conducted a systematic review in the South African context to examine risk factors, emphasizing the breadth of items assessed and the importance of a comprehensive synthesis (Kimmie-Dhansay et al., 2022).

In addition, the frequency and elements of risk were investigated in the Middle East region, although it is important to note that geographical differences and differences in research methods may affect the results (Kotha, 2022). Despite the growing interest in understanding the risk factors associated with ECC, the existing literature lacks consensus and consistency in findings. Various studies have identified discrepancies in results, as well as significant gaps in our understanding of this important oral health problem. These disparities emphasize the urgent need for a comprehensive literature review that can synthesize and unify current knowledge on the subject. This review aims to consolidate existing scientific advances and provides a comprehensive understanding of key risk factors for early childhood caries. Additionally, it identifies the main gaps and areas of uncertainty, which inform the establishment of a robust research agenda to address the most pressing needs in the field.

The current understanding of risk factors associated with early childhood caries is constantly evolving and expanding. Although progress has been made in

identifying and understanding various risk factors, significant gaps and areas of uncertainty remain. Research has shown that diet, oral hygiene, socioeconomic status, and biological factors can influence the onset and progression of cavities in young children. However, researching this oral condition and its interaction with environmental and genetic factors remains challenging for health professionals due to its complexity.

These examples illustrate the lack of consistency in the scientific literature and illustrate the importance of conducting a bibliometric analysis to identify patterns, areas of missing information, and discrepancies in the study of risk factors related to early childhood caries. Therefore, the objective was to examine research trends on risk factors associated with early childhood caries in the Scopus and Web of Science databases to establish a research agenda for future research. To this end, the following questions were asked.

- What are the years in which there has been the most interest in the topic of risk factors associated with early childhood caries?

- What is the growth of the number of scientific articles on the study of risk factors associated with early childhood caries?

- What are the main research references on the topic of risk factors associated with ECC?

- What is the thematic evolution derived from scientific production on risk factors associated with ECC?

- What are the growing and emerging keywords in the field of research on risk factors associated with ECC?

To address this issue, a literature review study is crucial, particularly through bibliometric analysis. This method gives a panoramic and quantitative view of the current state of research on risk factors associated with early childhood caries. Bibliometric analysis can identify publication patterns, temporal trends, most influential authors, and emerging themes, given the breadth and diversity of studies. Furthermore, this approach enables a systematic evaluation of the methodological quality of the studies included, as well as the identification of areas with strong consensus and those requiring further investigation. Therefore, a bibliometric analysis provides a solid foundation for formulating public health policies, planning preventive interventions, and guiding future research in this critical field of children's health.

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## MATERIAL AND METHODS

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In the current research study, exploratory research was carried out using secondary research sources, following the parameters and guidelines established in the PRISMA 2020 statement (Page et al., 2021). The methodology used in this bibliometric review was based on the strict application of the PRISMA principles, which included the systematic search and selection of relevant studies, data extraction, and thorough analysis of the existing scientific literature on risk factors associated with early childhood dental caries. This methodological approach allowed a detailed synthesis of the available evidence with the aim of identifying trends, key areas of research, and possible gaps in knowledge in this important area of children's oral health.

### Eligibility criteria

In the bibliometric study on risk factors for early childhood caries, strict inclusion criteria were applied. First, the titles and keywords of the records were considered as key data. Specifically, the combination of terms such as "early childhood caries" and their equivalents along with "risk factor" was sought. This exhaustive search strategy allowed us to identify documents that accurately and pertinently addressed the topic of interest.

Three different phases were followed in the exclusion of records. In the first phase, all records with incorrect or insufficient indexing were excluded to guarantee the quality of the database. In the second phase, documents for which the full text was not accessible were excluded. However, this exclusion only applied to systematic literature reviews, since bibliometrics focused on the analysis of bibliographic data and not on the exhaustive review of the entire content. Finally, the third stage of exclusion eliminated records with incomplete indexing, conference proceedings, and texts that were not considered relevant to the research objectives. These phases of exclusion were applied systematically to ensure the quality and relevance of the data analyzed in bibliometrics.

### Information sources

In order to carry out this bibliometric study on the risk factors related to early childhood caries, it was decided to select the Scopus and Web of Science databases, given their prominent position as the main sources of scientific and academic information at that time. These databases offered extensive coverage of scientific journals, conferences, books, and other types of academic literature, making them essential resources for conducting complete and exhaustive bibliometric research. The choice was based on a com-

parative analysis of scientific journal coverage previously conducted by (Page et al., 2021), which demonstrated the relevance and breadth of these two databases compared to other sources of academic information. In this way, Scopus and Web of Science offered a solid and representative set of data to perform the bibliometric analysis required in that research.

### Search strategy

In order to carry out the search in the two selected databases, Scopus and Web of Science, two personalized search equations were developed, precisely adapted to the previously established inclusion criteria and to the search characteristics of each platform. These equations were carefully constructed, considering key terms related to "early childhood caries" and its synonyms, as well as "risk factors". Additionally, they were adapted to the specific search characteristics of each database, including the use of Boolean operators, truncation, and filters to ensure relevant and exhaustive results. This detailed approach to the construction of customized search equations was essential to obtain a representative and appropriate dataset for subsequent bibliometric analysis in that scientific research.

For the Scopus database: (((TITLE ("early childhood caries" OR "pediatric dental caries" OR "childhood dental caries" OR "children's dental caries" OR "juvenile dental caries") AND TITLE ("risk factor\*" OR "causative factor\*" OR "risk determinants" OR "contributing elements")) OR (AUTHKEY ("early childhood dental caries" OR "childhood dental caries" OR "childhood dental caries" OR "childhood dental caries" OR "juvenile dental caries") AND AUTHKEY ("risk factor\*" OR "causative factor\*" OR "risk determinants" OR "contributing factors")))).

For the Web of Science database: (((TI=("early childhood dental caries" OR "childhood dental caries" OR "childhood dental caries" OR "childhood dental caries" OR "juvenile dental caries")) AND TI=("risk factor\*" OR "causative factor\*" OR "risk determinants" OR "contributing factors")) OR (AK=("early childhood dental caries" OR "childhood dental caries" OR "childhood dental caries" OR "childhood dental caries" OR "adolescent dental caries") AND AK=("risk factor\*" OR "causative factor\*" OR "risk determinants" OR "contributing elements")))).

### Data management

Microsoft Excel® was used to manage and analyze the data collected from the Scopus and Web of Science databases in the bibliometric study on risk factors for early childhood caries. This application allowed the systematic extraction and storage of rele-

vant bibliographic information, as well as the subsequent manipulation and organization of data for analysis purposes. Additionally, the VOSviewer® software (Eck and Waltman, 2010) was used in conjunction with Microsoft Excel® to visualize and generate representative graphs of the different bibliometric indicators. VOSviewer® played a critical role in the creation of bibliometric maps, which facilitated the identification of patterns and trends in the scientific literature and contributed to a deeper and clearer understanding of research in the field. This rigorous methodological approach was applied to ensure the accuracy and quality of the bibliometric analysis performed in that scientific study.

### Selection process

According to the PRISMA 2020 declaration guidelines, it was crucial to mention whether an internal automated classification system was used to facilitate the selection process and assess internal or external validation to reduce the risk of omitting relevant studies or making incorrect classifications (Page et al., 2021). In the study, it was decided to use automation tools in Microsoft Excel® as the internal tool. All researchers involved in the research project developed this approach collaboratively. Each researcher independently applied this tool during the selection process, following the predefined inclusion and exclusion criteria. The implementation of this automated method in Excel® aimed to reduce the risk of omitting relevant studies or making incorrect classifications by allowing the results of all team members to converge. This ensured a more comprehensive and accurate review of the available scientific literature on risk factors for early childhood caries.

### Data collection process

Consistent with the recommendations, it was important to detail the procedures used to obtain data from the reports, including the number of reviewers involved in collecting information for each report, whether they worked independently, any procedures used to obtain or verify data directly from the study investigators, and, if applicable, information on the automation tools used in this process (Page et al., 2021). In the study, Microsoft Excel® was used as an automated tool to collect data from reports obtained from the two selected databases, Scopus and Web of Science. Each of the study authors acted as an independent reviewer regarding data validation, and a collaborative data confirmation process was carried out. This validation and confirmation process was conducted exhaustively until a complete consensus was reached on the collected results, ensuring the accuracy and reliability of the data used in the bibli-

ometric analysis of risk factors for early childhood caries.

### Data items

In the bibliometric study on risk factors related to early childhood caries, exhaustive searches were performed in the Scopus and Web of Science databases to obtain results from all articles relevant to the research objectives. This meant attempting to collect information from all articles relevant to the risk factors associated with early childhood caries, following specific search equations designed for each database. However, it is important to emphasize that in those cases where incomplete or unclear information was found in the articles, they were excluded under the category of "not relevant texts". This decision was made to ensure that the knowledge base used in the bibliometric analysis remained consistent with the objectives and scope of the research, thus guaranteeing the quality and relevance of the data collected.

### Study risk of bias assessment

In the context of the bibliometric review of risk factors associated with early childhood caries, potential bias in the included studies was assessed using a collaborative approach. Since all study authors were involved in the data collection process, it was decided to assess the risk of bias in a common and consistent manner. The same automated Microsoft Excel® tool that had been used for data collection was utilized for this assessment. This allowed each author to independently assess and analyze each study based on the pre-established inclusion and exclusion criteria, thereby ensuring the quality and integrity of the results obtained. The risk of bias was assessed in a rigorous and transparent manner, which supported the reliability of the data used in the bibliometric analysis of that scientific research.

### Effect measures

This bibliometric review of risk factors for early childhood caries did not utilize traditional measures of effect, such as risk ratios or mean differences. These measures are primarily employed in primary research to assess specific outcomes in clinical or experimental studies. Instead, this study, based on secondary research sources, examined bibliometric indicators such as the number of publications, the number of citations, and the temporal trend in the use of keywords related to early childhood caries. These indicators were collected and processed using Microsoft Excel®. Additionally, the VOSviewer® tool was employed to visualize and analyze the thematic association between key terms and keywords present in the scientific literature, facilitating the detection of patterns

and trends in research on this topic. This bibliometric approach offers a global and descriptive vision of the evolution and relevance of risk factors associated with early childhood caries in the scientific community over time.

### Synthesis methods

In this bibliometric review of risk factors associated with early childhood caries, specific procedures were employed to determine the eligibility of studies for synthesis. These procedures included the collection of data on document characteristics, such as the number of publications, the number of citations, and the pattern of use of relevant keywords over time. Additionally, bibliometric measurements related to quantity, quality, and structure were conducted in the study on quality measures of scientific publications (Durieux and Gevenois, 2010). These indicators were applied in an automated manner using Microsoft Excel® to those documents that successfully passed the three levels of exclusion previously defined in the research. This rigorous methodological approach allowed for a complete and objective evaluation of the quantity, quality, and structure of the scientific literature related to risk factors for early childhood caries, thus providing a solid basis for bibliometric analysis in this scientific research.

### Reporting bias assessment

It was crucial to consider the risk of bias that might have arisen due to the lack of results included in the analysis, which could have originated from notification biases. In this research, there was a possibility that certain synonyms identified in thesauri, such as the Institute of Electrical and Electronics Engineers (IEEE) were favored, which was reflected in the inclusion criteria, search strategy, and data collection. Similarly, the exclusion of documents with incomplete indexing, conference proceedings, and non-relevant texts could have resulted in the omission of valuable information for the development of knowledge related to the topic. It was, therefore, important to be aware of these potential biases and to take measures to reduce their influence on the integrity of the results and the representativeness of bibliometric research.

### Certainty assessment

The assessment of certainty in the body of evidence was addressed in a general rather than individualized manner, as would be done in primary studies. The assessment of certainty was made by considering the independent application of inclusion and exclusion criteria, the definition of bibliometric indicators, and the identification of possible methodo-

logical biases in the study design. It also recognized the importance of mentioning the limitations of the research during the discussion phase. This contributed to a critical assessment of the certainty of the results and offered a more complete understanding of the quality and robustness of the body of evidence generated by the bibliometric approach.

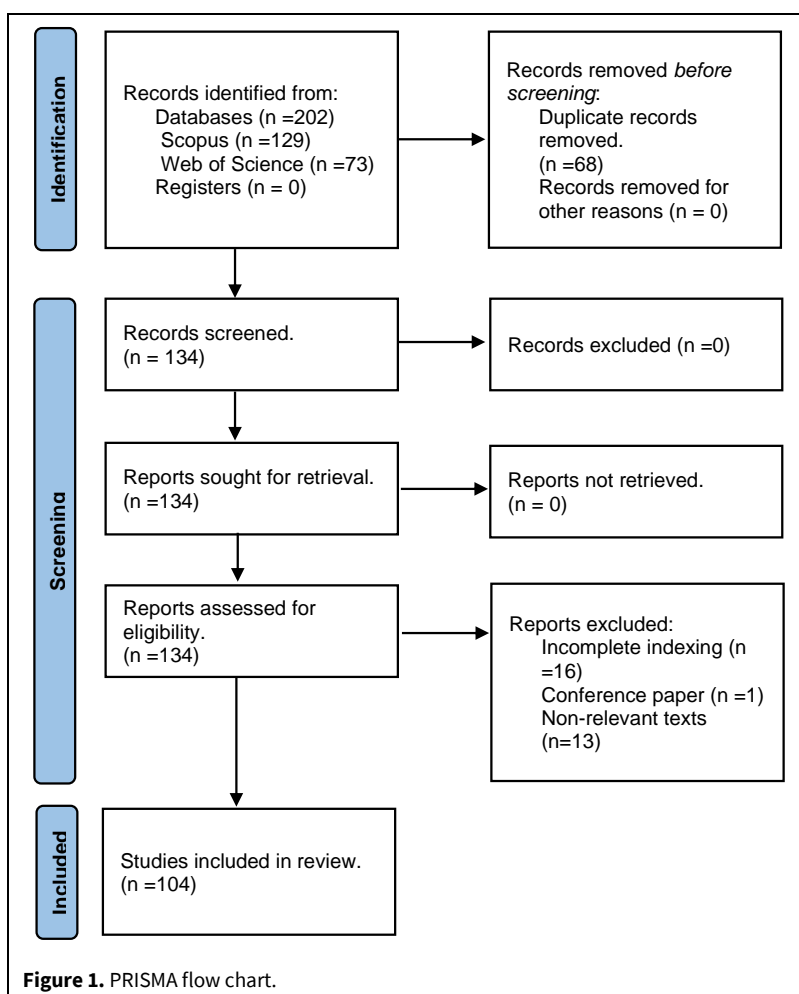
Fig. 1 illustrates what has been explained previously, showing the initial identification phase with the results obtained from each database, followed by the evaluation phase with the defined exclusion criteria. Finally, the number of results or final articles analyzed in this bibliometric article is presented.

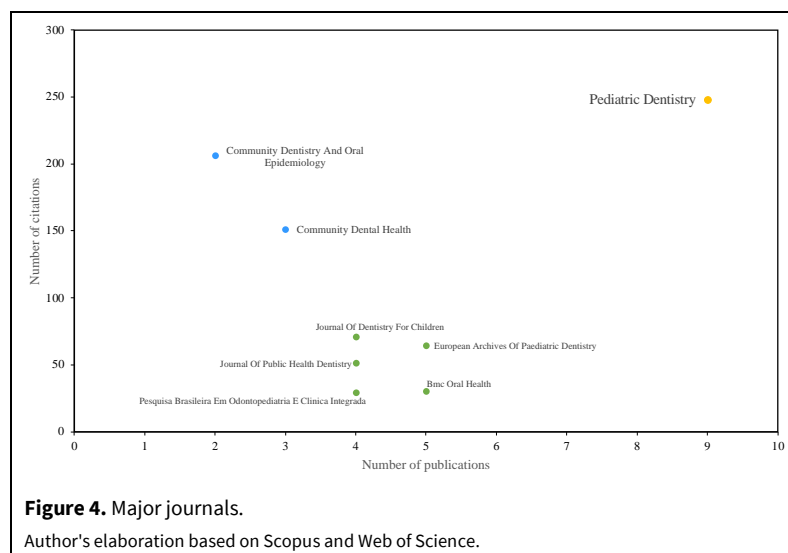
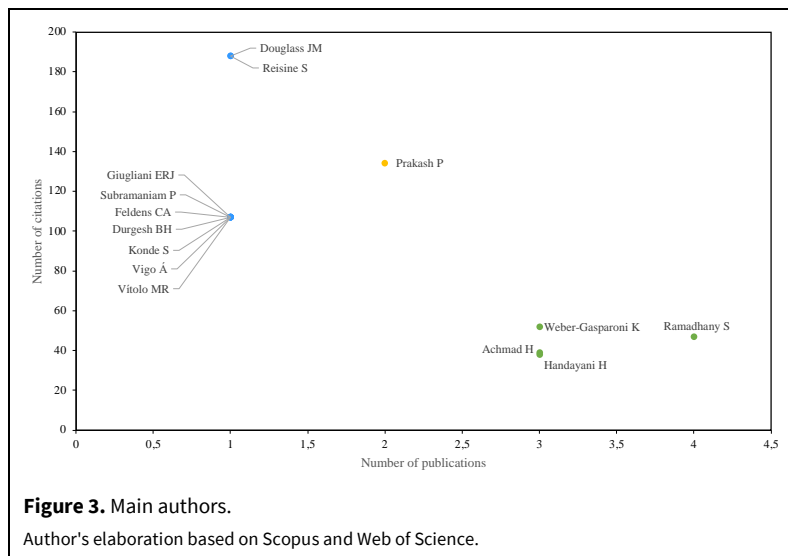
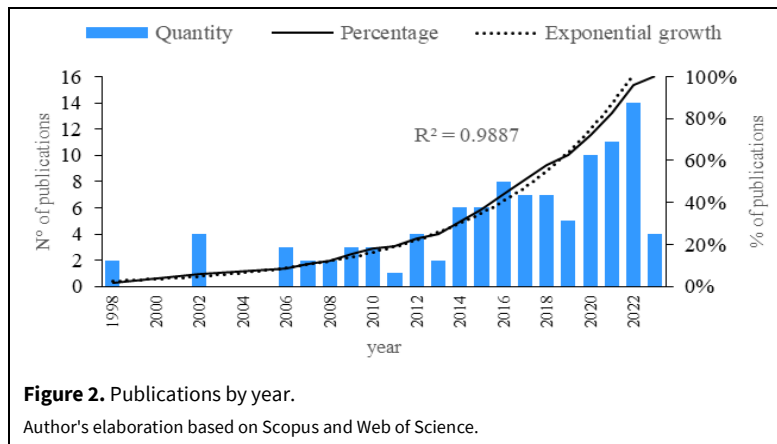
## RESULTS

The present bibliometric study in Fig. 2 demonstrated an exponential growth of approximately 98.87% in the production of articles related to the risk factors associated with early childhood caries. This significant increase in the number of publications

concerning this topic was primarily observed in the years 2020, 2021, and 2022, indicating a greater interest and growing concern within the scientific community to address and understand these risk factors.

As depicted in Fig. 3, the bibliometric study revealed the existence of three different groups of authors in the field of risk factors associated with early childhood caries. The first group included authors such as Prakash P, whose high productivity and research impact emphasized their significant contribution to the body of knowledge in this field. The second group comprised authors such as Douglas and Raisine, and Giuliani and Subramania, who, despite their low scientific productivity, were distinguished by the impact and relevance of their research, reflecting a significant influence on the scientific community. Finally, the third group, mainly composed of authors such as Ramadhany S, was characterized by high productivity in terms of the number of publications, although not necessarily by a high number of citations.





Among the scientific journals that stood out in the field of risk factors associated with early childhood caries, the bibliometric analysis conducted here revealed the presence of three different groups, as shown in Fig. 4. The first group was comprised of high-impact journals with high productivity, among which pediatric dentistry stood out, making a signifi-

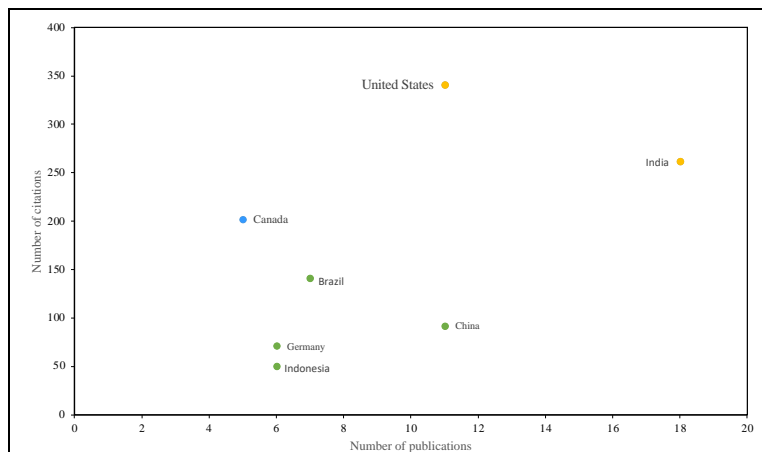
cant contribution both in terms of the number of publications and its influence on the scientific community. The second group included journals such as Community Dentistry and Oral Epidemiology and Community Dental Health, which stood out for their impact and relevance in the scientific literature despite their low productivity in terms of the number of

articles published. Finally, the third group, represented mainly by the journal *European Archives of Pediatric Dentistry*, was characterized by high productivity in terms of the number of publications but not necessarily by a high number of citations.

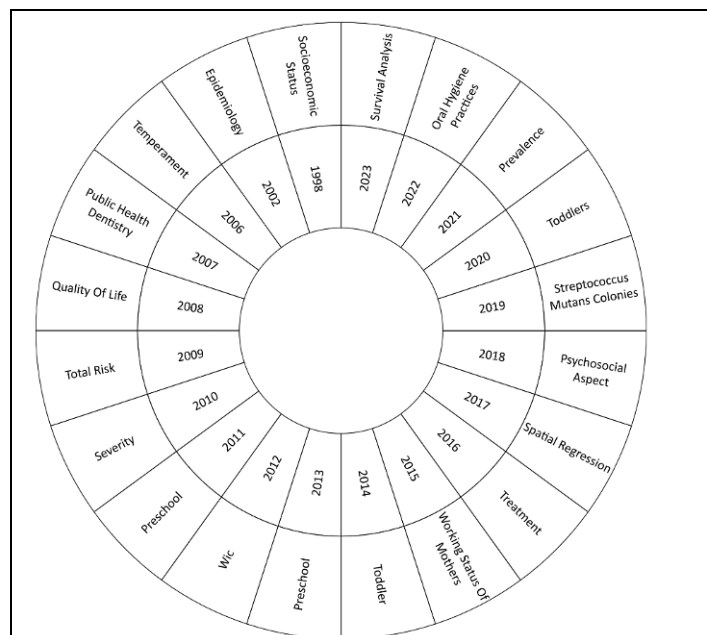
In terms of scientific production by country, Fig. 5 identified three different groups in the field of risk factors associated with early childhood caries. The first group included countries with high productivity and influence, notably the United States and India; they had made significant contributions both in terms of the number of publications and their impact on the scientific community. The second group comprised countries such as Canada, which had a low number of published articles but stood out for their impact and relevance in the scientific literature. Finally, the third

group was characterized by high productivity in terms of the number of publications, but not necessarily in terms of the number of citations, with China and Brazil being the main representatives.

As shown in Fig. 6, the present bibliometric research examined the thematic evolution of the literature regarding the risk factors associated with early childhood caries, spanning from the year 1998 until the year 2023. At the starting point of the analysis in 1998, key concepts such as socioeconomic status emerged, marking the beginning of research in this field. Conversely, in more recent years, topics such as survival analysis, oral hygiene practices, prevalence, and toddlers have emerged, reflecting current research trends in this area.



**Figure 5.** Main countries. Own elaboration based on Scopus and Web of Science.



**Figure 6.** Thematic development. Own elaboration based on Scopus and Web of Science.





were positioned in Quadrant 1, indicating their consolidation and growth as concepts. This graphical representation provided a complete view of the evolution and position of keywords in the scientific literature related to early childhood caries.

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## DISCUSSION

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The discussion section of this bibliometric study plays a crucial role in the detailed analysis of the results obtained in the bibliometric research. Here, a comprehensive analysis of the data is presented, highlighting the trends found in terms of authors, journals, countries, and keywords. The practical implications of these findings for clinical practice and research on early childhood caries risk factors have also been discussed. The main gaps in the scientific literature were identified, the limitations of the studies were discussed, and the keywords, according to their purpose, were classified. Finally, a research agenda was developed to help define priority areas and potential directions for future studies in this field and to advance knowledge about early childhood caries and its prevention. In this way, it will continue to promote research on the subject and propose strategies for improvement.

### General interpretation of results

Early childhood caries has become a public health problem due to its high prevalence and its impact on the quality of life of children. This disease has been shown to be associated with a number of risk factors, including diet, oral hygiene, fluoride exposure, and the presence of cariogenic bacteria. These factors interact with each other, making early childhood caries a complex and multifactorial disease.

During the years 2022, 2021, and 2020, an increase in the amount of research related to early childhood caries was observed (Boustedt et al., 2022), and a prospective study to investigate the relationship between free sugar intake and the occurrence of caries in young children was conducted. Findings suggest the importance of limiting sugar intake in this vulnerable population (Boustedt et al., 2022). Other research was also conducted in Tunisia, where the risk factors associated with early childhood caries and their prevalence were evaluated; the results are useful for understanding the caries situation in the region (Chouchene et al., 2022).

In 2021, Tashiro et al. (2021) conducted a study of Japanese children aged 18 months to three years to examine how infant feeding influences oral health and dental caries behaviors. This study discussed practices in the Japanese context that may lead to tooth decay in young children. In addition, Bencze et

al. (2021) conducted an ecological study in the European Union to assess the prevalence of dental caries in children under five years of age and its associated risk factors. Their research offers a more comprehensive view of early caries in Europe.

In 2020, prospective research was conducted on perinatal and metabolic factors related to early childhood caries (Boustedt et al., 2020). Their findings illustrate the importance of understanding risk factors that begin during pregnancy. On the other hand, Ganesh et al. (2020) conducted a university-based study to identify risk factors for caries in young children. Their research provides insightful data on this topic in a specific institutional setting.

Author Prakash P. has distinguished himself by his remarkable productivity and impact in the field of early childhood caries research. Their research entitled "Prevalence of early childhood caries and associated risk factors in preschool children of urban Bangalore, India: A cross-sectional study" shed light on the prevalence of early childhood caries in preschool children in an urban Indian setting, while identifying important risk factors (Prakash et al., 2012). This study improved our knowledge of the epidemiology of dental caries in a specific population.

Reisine and Douglas formed another group of esteemed authors in this field. Their study, "Psychosocial and behavioral problems in early childhood caries," addressed the psychosocial and behavioral problems associated with early childhood caries (Reisine and Douglass, 1998). In addition to illustrating the importance of addressing psychological and behavioral issues as well as biological factors in the prevention and treatment of dental caries, this study was essential to understanding how psychosocial factors can affect children's oral health.

They also recognized the research that author Subramaniam has conducted on early childhood caries. Her study, "Prevalence of early childhood caries and associated risk factors in preschool children in urban Bangalore, India: A cross-sectional study," provided insightful information on the incidence of caries in this population and highlighted specific risk factors (Prakash et al., 2012). The development of successful prevention and treatment strategies depends on this type of research.

Scientific journals are essential for the dissemination of information and the advancement of research in many areas, including oral health and dental caries in young children. *Pediatric Dentistry* has been an exceptional journal in this regard in terms of productivity and impact. Although no specific citations were provided in this reference, it is clear that *Pediatric Dentistry* is one of the leading journals in pediatric

dentistry and has made a significant contribution to the knowledge and advocacy of children's oral health. Important studies on the prevention and treatment of pediatric dental caries are likely to have been published in this journal, providing scientists and dental health professionals with important insights.

In contrast, community dentistry and oral epidemiology have been important sources of information on oral health epidemiology and, as mentioned above, have published relevant studies in the area of early childhood caries. The subsequent study focused on the psychosocial and behavioral concerns associated with caries in young children, demonstrating the value of this journal in elucidating factors other than biological that affect children's oral health (Reisine and Douglass, 1998). The study on the sociodemographic determinants of spatial disparities in early caries further demonstrates the value of this journal for epidemiological research in the field of dentistry (Meyer et al., 2017).

The study on the prevalence and risk factors associated with dental caries in Mongolian children provides further evidence that Community Dental Health has contributed to our understanding of early childhood caries (Jigjid et al., 2009). This journal has offered a platform for community oral health research and has published important findings that may be useful for caries prevention and treatment in specific settings.

In terms of scientific research on early childhood caries, the United States and India have excelled and made important contributions to the body of knowledge in this area. In the United States, research has focused on psychosocial and behavioral issues related to dental caries in young children, leading to a better understanding of factors other than biological that influence children's oral health (Reisine and Douglass, 1998). The study also examined caries risk assessment among children in daycare centers in the Mississippi Delta region, providing critical details on prevalence and risk factors in a specific American context (Southward et al., 2008).

On the other hand, India has been a pioneer in the study of early childhood caries, and research has significantly advanced our understanding of the prevalence and risk factors among preschool children in Bangalore, India (Prakash et al., 2012). Research has also provided pertinent details on the associated risks and importance of early dental care, shedding light on the prevalence of dental caries in preschool children in India (Olatosi et al., 2015).

In terms of the impact of early childhood caries research, Canada has been at the forefront thanks to studies focusing on the prevalence and risk factors for

caries in First Nations children in Manitoba (Schroth et al., 2013). This study has improved our knowledge of the prevalence of caries in specific communities and has helped to identify key areas for intervention to support children's oral health.

Early research on early childhood caries relied heavily on the idea of "socioeconomic status", which gave researchers a clear understanding of how social and economic factors can affect children's oral health. The Psychosocial and Behavioral Problems in Early Childhood Caries study examined the psychosocial and behavioral problems associated with dental caries in young children and served as a critical springboard for understanding the importance of considering factors other than biological ones in children's oral health (Reisine and Douglass, 1998). This initial strategy helped to contextualize and highlight the complex relationship between the social environment and dental health during a child's formative years and laid the foundation for subsequent studies that have contributed to our understanding of the topic.

The terms "survival analysis," "oral hygiene practices," "prevalence," and "young children" have become more relevant in recent research on early childhood caries and have greatly aided understanding of the topic. To shed light on the risk factors for caries in this crucial age group, an institutional study focusing on "young children" was conducted (Ganesh et al., 2020). Focusing on young children from the outset is essential to address caries in its early stages and develop effective prevention strategies.

They studied the "prevalence" of dental caries among preschool children in Riyadh in 2021, which helped researchers understand the extent of the problem in this population (AlMarshad et al., 2021). This is important for identifying problem areas and developing sound oral health policies. To learn more about the importance of oral hygiene practices in caries prevention, researchers in Jaipur studied the "oral hygiene practices" of urban and rural children (Yadav et al., 2022). Finally, they conducted a "survival analysis" study of children who had large cavities filled under general anesthesia. This study offers more information about the duration and effects of treatment in this population (He et al., 2023). These emerging concepts reflect progress in early childhood caries research and allow for a deeper understanding of risk factors, preventive practices, and prevalence, especially in critical age groups such as young children.

The main keyword co-occurrence network of this bibliometrics shows thematic affinity in terms of groups. With keywords such as "preschool children", "oral health", "ECC" (Early Childhood Caries), "quality of life" and "child care center", the purple group

stands out. The importance of understanding how caregiving and quality of life factors may affect dental caries in this population is highlighted, for example, by the study that examined the oral health of young children in child care centers in the Mississippi Delta (Southward et al., 2008).

Keywords such as "prevalence," "oral hygiene," and "preschool child" are in the second largest group, illustrated in yellow. This suggests a thematic affinity regarding caries prevalence in preschool children and hygiene practices. The study emphasized the importance of this group in current early childhood caries research by examining the prevalence of early caries and associated risk factors in preschoolers in Bangalore, India (Prakash et al., 2012). These thematic groups give a more complete picture of the risk factors associated with early childhood caries and reflect the diversity of approaches and concerns within the field of study.

Preschool and diet are in quadrant 4 of the Cartesian plane, where they are used less frequently than in the past in the scientific literature on early childhood caries. This concept, in the case of "preschool," referred primarily to the population of preschool-aged children and their propensity to suffer from dental caries. By providing useful information on the prevalence of dental caries among preschool children in Bangalore, India, the study sparked initial interest in understanding and treating dental caries at this critical stage of childhood development (Prakash et al., 2012). However, "diet" highlighted the importance of diet in children's oral health by focusing on the relationship between diet and early childhood caries. Subsequent studies examined a number of risk factors associated with early childhood caries, including diet, and emphasized the historical importance of this topic in childhood caries research (Kakanur et al., 2017). Although these ideas may not have been as prevalent in more recent literature, their influence on our understanding of risk factors for early childhood caries remains important for advancing our knowledge in this area.

The terms "oral hygiene practices" and "survival analysis" are included in quadrant 2 of the Cartesian plane, which represents new ideas in the study of early childhood caries. Oral hygiene routines and techniques, such as brushing and flossing, are called "oral hygiene practices" because they are essential to the prevention of tooth decay. The study focused on the importance of instilling good oral hygiene practices in children from an early age by examining the relationship between early childhood caries and oral hygiene practices in urban and rural children (Yadav et al., 2022).

On the other hand, "survival analysis" has become an important tool to determine how long it will take for an event, in this case, the occurrence of childhood dental caries, to occur. To determine the prevalence and risk factors of un-planned retreatment after general anesthesia for dental work in children with severe early caries, survival analysis was used in the study (Li et al., 2023). This method provides a deeper understanding of the dynamics of the disease and helps to identify more effective preventive and therapeutic measures. With a focus on promoting oral hygiene and using state-of-the-art analytical tools to improve child care, these emerging concepts represent a promising direction for research and clinical practice in the area of early childhood caries.

Basic terms such as "breastfeeding", "prevalence", "pediatric dentistry" and "ECC". They are included in quadrant 1 of the Cartesian plane, which represents evolving and well-established concepts in the study of early childhood caries. Because it has been shown to have a significant impact on the prevention of early caries, the concept of "breastfeeding" is critical to understanding children's oral health. Research has examined the causes of childhood caries in Saudi Arabia and emphasized the value of breastfeeding in this setting (Ali et al., 2021).

The word "prevalence" is crucial because it allows us to measure the severity of the caries problem among children. To inform prevention strategies, studies such as the one conducted in Bangalore, India, have assessed the prevalence of early caries and its risk factors (Prakash et al., 2012). One of the most important areas of oral health care for children is pediatric dentistry. Research in this field, such as the study that addresses issues related to dental treatment in children with special health needs, illustrates the importance of pediatric dentistry in the treatment of early caries (Schulz-Weidner et al., 2022).

Last but not least, "ECC" (Early Childhood Caries) is a key term in the literature on early childhood caries. Studies such as the one investigating the risk factors for caries in young children are contributing to the knowledge of this disease in a critical age group (Ganesh et al., 2020). To effectively address this dental health issue in children, future research and clinical practice will continue to build on these evolving and solidifying concepts that currently form the basis of knowledge about early childhood caries.

#### **Classification of early childhood caries risk factor keywords by function**

The most important emerging and expanding keywords related to risk factors for early childhood caries have been comprehensively categorized

**Table 1.** Classification of keywords according to their function.

Keyword	Associated Tools	Applications	Characteristics
Oral Hygiene Practices	Dental floss, Toothbrush, Fluoride	Oral hygiene promotion	Promotes oral care habits
Survival Analysis	Kaplan-Meier, Cox regression	Survival analysis	Evaluate time to cavities
Oral Epidemiological Investigation	Surveys, Data analysis	Oral epidemiological research	Collect data on caries in the population
Parents	Questionnaires, Interviews	Parent involvement	Evaluation of parental influence on caries
Education	Health literacy, Workshops	Oral hygiene education	Improve knowledge about oral care
Breastfeeding	Duration, Exclusivity	Breastfeeding	Evaluates the impact of breastfeeding on caries
Prevalence	Surveys, Epidemiological data	Prevalence estimation	Determines the prevalence of caries in the population
Pediatric Dentistry	Sealants, Behavior management	Pediatric dentistry	Provides specific treatments for children
Early childhood caries	Caries Risk Assessment, diagnosis	Caries risk assessment	Provides specific treatments for children

Author's elaboration based on Scopus and Web of Science.

according to their function in Table 1 of this study. This classification was created with the intention of providing the reader with an in-depth understanding of the characteristics and potential uses of each keyword in the context of the academic study of early childhood caries.

Keywords have been grouped into several categories based on their usage. These categories include words such as "prevalence" and "epidemiology," which are important to understanding the scope of the topic because they relate to the epidemiology and prevalence of early caries. Other keywords emphasize the value of successful public health and clinical care initiatives by highlighting aspects of prevention and control, such as "preventive measures" and "intervention". In addition, terms associated with specific risk factors, such as "socioeconomic status" and "diet", have been identified to allow for investigation of the underlying causes of early caries. The inclusion of terms related to specific populations, such as "toddlers" and "preschoolers," underscores the importance of adapting research and treatment methods for different age groups.

This table provides a structured categorization of keywords in the context of early childhood caries risk factors, along with relevant tools, primary applications, and characteristics of each. This could help improve the way oral health researchers and professionals' approach and study this important topic in child health.

## Implications

Decision-making on oral health and child health policies will be significantly influenced by the conduct of biblio-metrics on risk factors related to early childhood caries. A shift in the research focus of this field is indicated by the thematic evolution from the study of socioeconomic status to more modern ideas such as survival analysis, oral hygiene habits, prevalence, and young children. This shows that researchers are placing more emphasis on knowing the precise and profound factors that can affect dental caries in young children, which in turn can help inform more effective prevention and treatment methods.

The discovery of the main thematic group, composed of the keyword's preschool children, oral health, ECC, quality of life, and child care center, reveals the conceptual affinities around the quality of life and dental care of children. By highlighting the importance of addressing these related issues comprehensively, this information may be useful to health professionals and policy planners. Analysis of the frequency and validity of keywords gives important information about the direction of research. The fact that terms such as "preschool" and "diet" are declining in popularity suggests that they may no longer be relevant to current research. However, the appearance of terms such as oral hygiene practices, survival analysis, oral epidemiologic research, parents, and education indicates that these aspects are becoming more important in the scientific literature. In addition, the increased use of terms such as breastfeeding, prevalence, pediatric dentistry, and ECC suggests a greater

emphasis on these issues, which may have implications for future policy.

For this reason, the present research is useful, as it is necessary to continue research on the multiple risk factors involved in the development of early childhood caries in the child population and its evolution over time.

### Limitations

A detailed overview of the research in this area is offered by the current bibliometrics on risk factors related to early childhood caries, conducted using the PRISMA 2020 methodology and databases such as Scopus and Web of Science. However, it is important to point out some limitations of this type of bibliometric analysis. First, the ability of databases to find relevant publications based on the search terms and strategies used depends largely on the accuracy and completeness of the results. Research published in other sources or in other languages that also advances our knowledge in the field may have been overlooked because the scope of this bibliometric analysis is limited to the selected databases.

The choice of keywords and the definition of thematic groups, which can be arbitrary and change according to the standards of the researcher, are two other limitations to be taken into account. Furthermore, bibliometrics does not consider subsequent research that may have been carried out, since it is based on data available up to the cut-off date. Finally, although they used VOSviewer to visualize the keyword co-occurrence network, configuration and filtering options can affect how the tool interprets thematic affinity and clustering. These limitations illustrate the need for future research in this area to have a broader focus and consider a variety of information sources to gain a complete understanding of the evolution and trends in early childhood caries risk factor research.

### Research gaps

The major research gaps in the area of risk factors associated with early childhood caries are summarized in Table 2 of this bibliometric. To improve our understanding of this important public health issue, future studies will need to fill these gaps, which represent areas where the current scientific literature indicates gaps or unmet research needs.

Research on early childhood caries has revealed several significant gaps that require attention to give a more complete and holistic understanding of the problem. One of the most important gaps identified relates to thematic gaps. Although various individual risk factors have been identified, we still need to understand how they interact with each other. Multifac-

torial interaction is essential to address the problem as a whole. In addition, although preventive interventions have been proposed, more robust evidence is needed on their long-term effectiveness in specific populations.

From a geographic perspective, significant geographic gaps were identified. Underserved communities have striking disparities in dental care for children, highlighting the need for targeted strategies to improve access to dental care in such areas. This gap reinforces the need to address dental health disparities for children in different regions.

In the interdisciplinary field, there is a perceived lack of integration between health and social data. Collaboration between health professionals and social scientists can give valuable input and a deeper understanding of how socioeconomic and health factors interact and influence the prevalence of early childhood caries. Finally, in relation to temporal gaps, the urgency of conducting more longitudinal studies that follow children as they grow is highlighted. This will allow us to understand how risk factors evolve and change over time and how trends in the prevalence of early caries have changed over the years.

### Research agenda

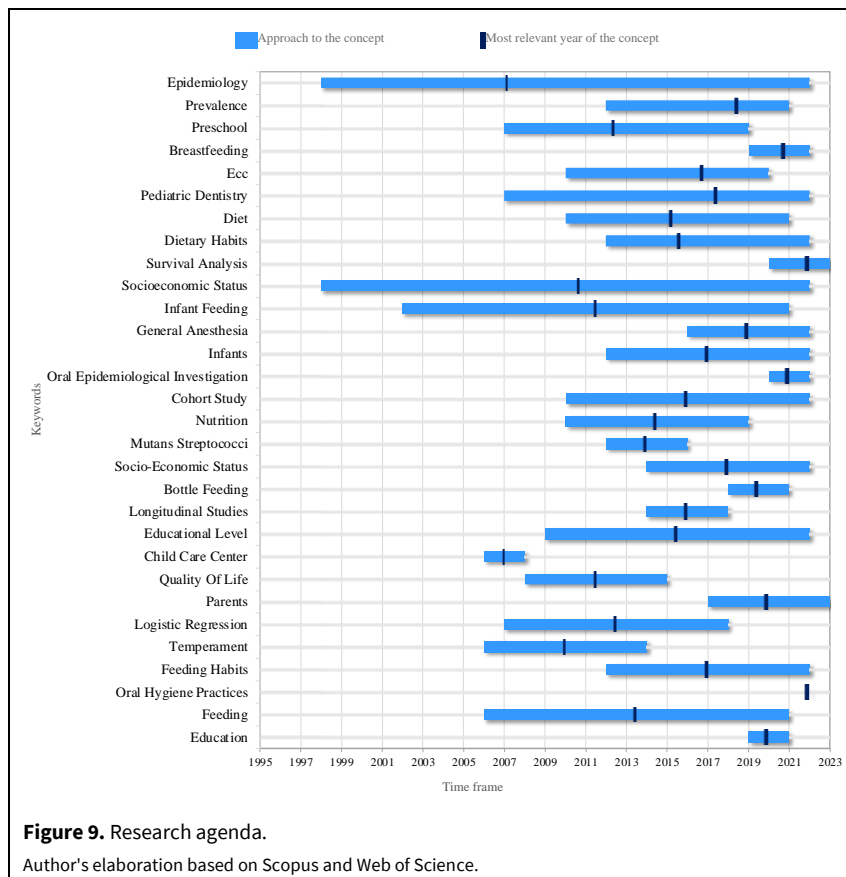
Dental caries in early childhood is largely preventable thanks to parents, as it is a chronic disease that can be prevented through lifestyle changes. Currently, research has focused on understanding how parenting practices and parental influence affect children's oral health. Future research could focus on how parental behaviors related to their children's oral hygiene, parental knowledge about dental caries, and parental access to dental care services affect early caries prevention, as this disease is dynamic and based on lifestyle behaviors. In addition, further research could suggest effective interventions and strategies to educate and counsel parents in the promotion and prevention of their children's oral health, which could help reduce the incidence of this disease.

Survival analysis is a powerful statistical tool that has been used in studies of early childhood caries to analyze the time to occurrence of events such as first caries. Its importance lies in providing a more accurate understanding of the dynamics of childhood dental caries and how risk factors may influence its occurrence and how they interact with each other as the child grows. Future studies could use survival analysis to identify specific risk factors that increase children's chances of developing dental caries over time. It can also be used to evaluate how well preventive measures work to delay or stop the development of early tooth decay over time (Fig. 9).

**Table 2.** Research gaps.

Category	Investigation gap	Justification	Questions for future investigators
<b>1) Thematic gaps</b>	Multifactor interaction	Despite the identification of individual risk factors, there is a lack of understanding of how they interact.	How do the risk factors for early caries interact?
	Evaluate effective interventions	More evidence is needed on the long-term effectiveness of preventive interventions in specific populations.	What interventions are effective in preventing early caries?
<b>2) Geographic gaps</b>	Underserved communities	Geographic disparities in children's dental care need to be addressed.	How can access to dental care in underserved areas be improved?
<b>3) Interdisciplinary gaps</b>	Integration of health and social data	Collaboration between health professionals and social scientists can provide a more complete understanding.	How do health and social risk factors relate to early caries?
<b>4) Temporal gaps</b>	Longitudinal studies	More studies are needed that follow children over time.	How do risk factors change as children grow?
	Temporal trends	It is important to understand trends in the prevalence of early caries over time.	How have early caries and its risk factors evolved over time?

Author's compilation based on Scopus and Web of Science.



One of the most important factors in preventing early childhood cavities is good oral hygiene habits.

The importance of this idea lies in how children's dental health can be affected by brushing, flossing,

and other oral hygiene practices. Future studies could examine the effectiveness of different methods to promote good oral hygiene in young children, as well as the usability and acceptability of oral hygiene tools and products designed for this population. It would also be beneficial to investigate how oral hygiene practices can be successfully integrated into the daily care routines of children and families.

Epidemiology is essential to understanding early childhood caries because it provides information on prevalence, distribution, and associated risk factors. Although this idea is well established, further research into the epidemiology of dental caries in specific populations, such as vulnerable communities, can help to identify patterns and trends that can be used to develop more effective preventive measures. In addition, epidemiological research could investigate how new variables, such as parental influence and oral hygiene habits, interact with social and economic determinants to influence early caries in different childhood populations.

Risk factors for early childhood caries continue to be significantly influenced by socioeconomic status. Despite its historical importance, current research can examine how economic disparities affect community access to preventive dental care and levels of childhood nutrition. Future studies could also investigate effective strategies to reduce socioeconomic disparities in the prevalence of early caries and improve access to oral health care for children from families with limited resources in rural areas without health care systems.

To further prevent early childhood caries, childhood nutrition is essential, as this disease is sugar-dependent, meaning that its development is based on high sugar consumption. Future research can examine how feeding practices and nutrition counseling, such as bottle use and the introduction of solid foods, affect children's oral health. To develop healthy dietary strategies to prevent early caries in different contexts and communities, an interdisciplinary approach is required that combines pediatric dentistry and child nutrition, and that these go hand in hand in the support and counseling of the child patient and his or her environment. close, as is the family.

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## CONCLUSION

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Recent bibliometrics on risk factors associated with early childhood caries have shed light on the evolution and growth of interest in this field of knowledge. It is noteworthy that, in terms of temporality, the peak of scientific interest was most pronounced in the years 2021 and 2022. This growing curiosity is sup-

ported by an exponential increase, exactly 98.87%, in the publication of scientific articles on the subject.

On the other hand, the influence and contribution of different authors and sources are clearly visible in the corpus of related literature. Thought leaders such as Prashanth Prakash, Joanna M. Douglass, and Susan Reisine have set the tone for research, with journals such as *Pediatric Dentistry and Community Dentistry* and *Oral Epidemiology* serving as prominent platforms for the dissemination of their findings. Geographically, the predominant role of countries such as India and the United States at the forefront of this research is noteworthy.

Furthermore, the evolution of the topics addressed in these studies reveals an interesting transition. While the initial research was firmly focused on socioeconomic status, the current trend shows an inclination towards areas such as oral hygiene practices and survival analysis. This thematic shift demonstrates not only the adaptability of the field of study, but also its responsiveness to the changing needs and realities of affected populations.

Finally, emerging thematic clusters and keyword analysis indicate the future direction of the field. Consolidated themes such as preschool children, oral health, and ECC, as well as emerging concepts such as breastfeeding and prevalence, illustrate the need to delve deeper into these areas. On the other hand, the emergence of new terms and approaches, such as oral hygiene practices and survival analysis, suggests that the field is ready to embrace new methodologies and perspectives, reinforcing the idea that research on early childhood caries remains a growing and highly relevant topic.

It is evident that research trends demonstrate a dynamic and responsive progression to changing demands in the field of early childhood caries. This evolution is not only reflected in the exponential increase in scientific production but also in the diversification of the topics addressed and methodological approaches used. The shift from focusing solely on socioeconomic status to including factors such as oral hygiene practices and survival analysis demonstrates the adaptability and responsiveness of research to the evolving needs of affected populations. This flexibility showcases the maturity and breadth of the field of study, as well as its willingness to explore new avenues of research that promote a more comprehensive and effective understanding of the risk factors associated with early childhood caries.

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## CONFLICT OF INTEREST

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The authors declare no conflicts of interest.



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Contribution	Pinella-Vega M	Romero-Gamboa J	Gallego-Ramírez JE	Millones-Gómez PA	Valencia-Arias A
Concepts or ideas	x		x		x
Design		x	x		
Definition of intellectual content	x	x			
Literature search	x				
Experimental studies			x	x	
Data acquisition					x
Data analysis		x			x
Statistical analysis			x		x
Manuscript preparation	x	x		x	
Manuscript editing			x	x	x
Manuscript review	x	x	x	x	x

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