



Review article

Bibliometric analysis of pediatric dental sedation research from 1993 to 2022

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A B S T R A C T

Statement of problem: Bibliometric analysis methods were used to evaluate pediatric dental sedation research and to identify topical hotspots using quantitative and qualitative methodologies.

Purpose: To conduct bibliometric analysis on the retrieved data and to foresee the development of trends and hotspots in this research area.

Material and methods: We retrieved appropriate research articles from the Web of Science Core Collection on January 1, 2023. VOSviewer, Citespace and the Bibliometrics website were used to conduct bibliometric analysis on the retrieved data. GraphPad Prism 10.0 (GraphPad, San Diego, CA, USA) was used to conduct the statistical analysis.

Results: A total of 396 publications on pediatric sedation in dentistry, published between 1993 and 2022, were retrieved from online databases. The USA published most papers. Furthermore, the most frequent countries who cooperated were the USA and Canada. Six of the top ten publishing establishments were USA based. Papers on the research have appeared primarily in the journals of Dentistry and Anesthesiology. Keyword co-occurrence and co-citation cluster analysis revealed that the most common topics mainly were: dental anxiety; conscious sedation; dental caries; midazolam; propofol; hypoxemia.

Conclusions: During the three decades, the focus of pediatric sedation research has been on drugs, dental anxiety and procedural sedation. Keyword burst detection indicated that procedural sedation; adverse event; respiratory depression is an emerging research hotspot.

Dental anxiety is a prevalent issue among children and adolescents worldwide, affecting approximately 10 %–20 % among children and adolescents [1]. Fear and anxiety associated with the dentist and dental treatments are both significant factors contributing to patients' avoidance of dental care [2]. Both dental anxiety and fear evoke physical, cognitive, emotional and behavioral responses in individuals. This is a question often encountered in a dental surgery. Treating patients with such anxiety is stressful for the dentists, as it reduces mutual collaboration, requires more treatment time and resources and creates an unpleasant experience for both the patient and the dentist [3,4]. Therefore, it is crucial to approach dental treatment for pediatric patients in a reassuring and relaxed manner, employing appropriate interventions and management strategies to alleviate patient anxiety [5].

Using sedation techniques prior to dental treatment has been shown to help reduce pain and anxiety in children [6]. Due to the different characteristics of different dental sedation treatments, children of different ages have different sedative effects on various sedation programs. Therefore, it is necessary to formulate personalized sedation programs based on individual conditions to meet the specific treatment needs. Dental sedation for children involves a range of sedative drugs, with inhaled, oral and nasal drops being more commonly used than intravenous administration. Additionally, the level of sedation required for dental treatment in children is often deeper compared to adults. Overall, employing various sedation techniques can enhance the childrens cooperation and improve the overall satisfaction among patients and their families regarding dental care [7]. However, there is currently a lack of scientific studies

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on dental sedation in the Web of Science Core Collection (WOSCC) database, including analysis or predictions of research trends. Bibliometric analysis is a widely accepted method for evaluating the impact of published articles on a specific topic. By quantitatively and qualitatively analyzing published articles in various research areas, bibliometric analysis has been proven to accurately assess the contribution of a particular research topic, identify new research frontiers and highlight future new trends. In this study, we aim to provide a comprehensive overview of the literature on pediatric dental sedation from 1993 to 2022, and identify emerging trends and potential areas of focus from various aspects such as sedation drugs, sedation techniques, and adverse events.

1. Introduction MATERIAL and methods

To reduce bias caused by database updates, a literature search using the WOSCC database was carried out on January 1, 2023, with search strategies as follows: TS= (((dentistry) OR (dental) OR (dentist) OR (dentists)) AND ((“Conscious Sedation”) OR (Sedation, Moderate) OR (“Moderate Sedation”) OR (Sedation, Conscious) OR (“Deep Sedation”) OR (“Deep Sedations”) OR (Sedations, Deep) OR (Sedation, Deep) OR (sedation) OR (sedative) OR (sedated))) AND ((child) OR (children) OR (pediatric) OR (pediatric) OR (pediatrics))) Language = English, “Document”; to include only “Articles” and “Review” from 1993 to 2022. Filters were used to limit the extent of the search, Index = Science Citation Index Expanded (SCIExpanded), TimeSpan = 1993–2022.

After the initial interrogation of the databases, 2 researchers (JHZ and JZ) independently reviewed each retrieved article to determine their relevance. The aims of the research were to identify all relevant characteristics of the literature including the country of origin, establishments, journals, highly-cited articles, cluster networks of co-cited articles and the keywords with the greatest citation bursts. Burst detection was applied to keywords assigned to articles in the citation expanded collection, as well as noun phrases retrieved from articles. The structure/dynamics of dental sedation publications, from progressively synthetic networks generated from citations to articles which met various selection criteria, were rigorously analyzed. GraphPad Prism 10.0 (GraphPad, San Diego, CA, USA) was used to conduct the statistical analysis. The two-tailed Pearson correlation method was used to conduct correlation analysis. Statistical significance was set at $P < 0.05$.

2. RESULTS

A total of 396 publications on pediatric sedation in dentistry, published between 1993 and 2022, were retrieved from online databases.

3. Analysis of trend, countries and institutions

The database interrogation retrieved 396 relevant articles published between 1993 and 2022. Fig. 1 shows data about the numbers published each year and the contribution of each identified country. The general trend was an increase, with minor fluctuations in some years. It is noteworthy that the number of published articles per year could be readily classified into 4 periods of time: during the first period, 1993 to 2003, the number of the annual average publications was between 2 and 10; the second period from 2004 to 2007 generally accounted for an average of 10–20 articles per year; in the third period from 2008 to 2019 the number of articles was between 7 and 20; and in the fourth period from 2020 to 2022, the number of the annual average publications was significantly increased, to between 19 and 25.

Pediatric dental sedation literature was compiled from 318 institutions in 46 different countries between 1993 and 2022. Fig. 2 shows that manuscripts were mainly published in the USA ($n = 140$; 35.4 %), followed by England ($n = 54$; 13.6 %) and Israel ($n = 31$; 7.8 %). Fig. 2 presents the distribution of these countries and regions, and Fig. 3 shows the co-occurrence networks. The most high-

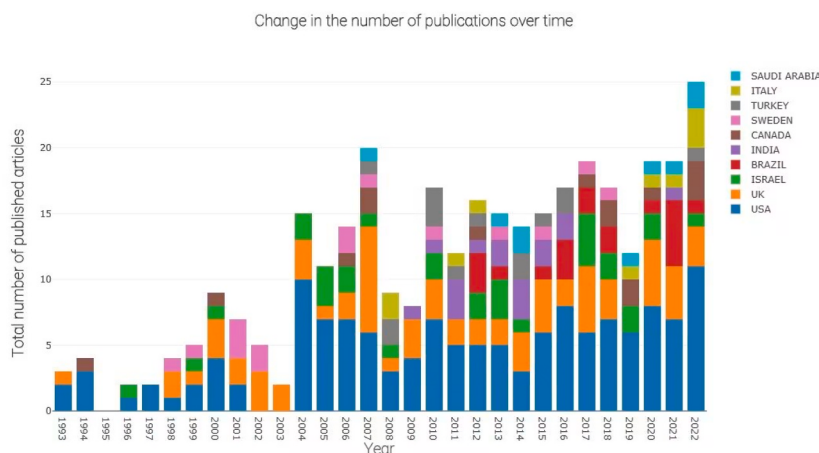


Fig. 1. The distribution of the publications on pediatric dental sedation from 1993 to 2022.

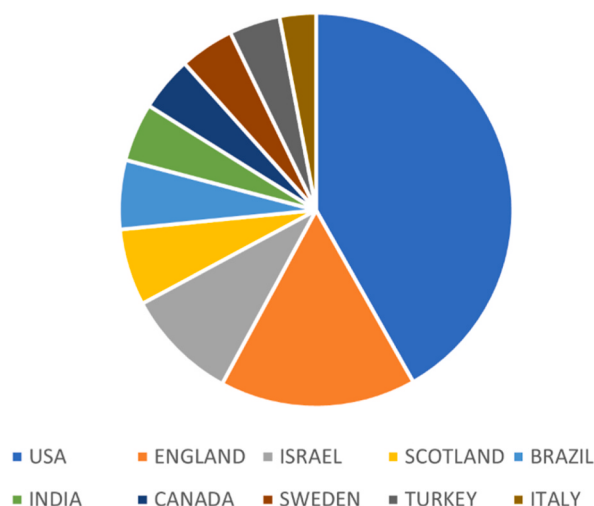


Fig. 2. Top 10 countries/regions with the most pediatric dental sedation-related articles published from 1993 to 2022.

volume research institution was based in the USA. Co-occurrence network analysis between research establishments revealed a low-density (density = 0.00118) map and a majority centrality index <0.05 (Fig. 3A), indicating that the research was dispersed among institutions and that the majority had relatively limited influence on their research fields. Cooperation network analysis showed that the most frequent cooperation was between the USA and Canada, and then between Brazil and the UK (Fig. 3B). Table 1 presents the distribution of these institutions, and Fig. 4 shows the co-occurrence networks.

4. Analysis of journals

Over the past three decades (1993–2022), 165 popular journals published articles on dental sedation. Table 2 lists 20 journals according to the number of published articles, together with their impact factors (IF) and Journal Citation Reports (JCR) quartiles. The top 5 were the “PEDIATRIC DENTISTRY”, “JOURNAL OF CLINICAL PEDIATRIC DENTISTRY”, “BRITISH DENTAL JOURNAL”, “INTERNATIONAL JOURNAL OF PAEDIATRIC DENTISTRY” and the “JOURNAL OF DENTISTRY FOR CHILDREN”, and they accounted for more than 50 % of the published material. The largest IF value was for “ANAESTHESIA” (10.7), followed by the BRITISH JOURNAL OF ANAESTHESIA” (9.8) and “PEDIATRICS” (8). The IF value of the above 4 journals exceeded 5 and were classified as Q1 according to the JCR2022 standard. In the past 30 years, the most articles on the topic of dental sedation research were mainly published in “PEDIATRIC DENTISTRY” and “JOURNAL OF CLINICAL PEDIATRIC DENTISTRY”. It is noteworthy that only 4 of the top 20 journals were dedicated solely to anesthesiology; they were “PEDIATRIC ANAESTHESIA”, “ANAESTHESIA”, “EUROPEAN JOURNAL OF ANESTHESIOLOGY”, and “BRITISH JOURNAL OF ANAESTHESIA”. Additionally, we examined the relationship between the average number of citations, year of publication, and impact factors of the 20 most cited journals. There was no connection between the average number of citations and the impact factor ($R^2 = 0.03525$, $P = 0.4279$). The mean number of citations and the year of publication did, however, significantly correlate with one another ($R^2 = 0.2946$, $P = 0.0134$) (Fig. 5A and B).

4.1. Analysis of authors and co-authors

Table 3 lists the 10 most prolific authors of the 921 included in the present study. Ram, D from Hadassah University Medical Central, Blumer, S from Newcastle University ranked first, both with 9 papers. We used Citespace software to visualize the citation information network of authors (Fig. 6A) and the authors co-cited (Fig. 6B). In first place was COTE, CJ with 72 citations. Among the centrality values of these authors, the centrality value of COTE, CJ (0.18) was >0.05 , indicating that important contributions had been made to pediatric sedation in dentistry and provided an important basis for further research.

4.2. Analysis of co-citation clusters

A co-citation network refers to one consisting of references that are co-cited in different groups of articles, while a conceptual cluster refers to the edges that arise when a cluster of articles is repeatedly cited. Co-citation and cluster network maps were constructed with Citespace (Figs. 7 and 8). “Pathfinder” and “Pruned Slice Network” options were chosen to preserve the most significant structures of the network. The visualization of co-cited documents revealed 830 nodes and 2397 links, with each node representing a cited article whose size was proportional to the maximum co-citation frequency of linked articles. Fig. 7 shows that the co-cited documents were assigned to 15 main cluster labels as follows: pharmacological patient-management; Portuguese parental acceptance; deep sedation; conscious sedation; silver diamine fluoride; dental anxiety; therapeutic procedure; pediatric dentistry; dental caries; dental extraction; composite restoration; pediatric population; midazolam; propofol and hypoxemia. Fig. 8 shows a timeline

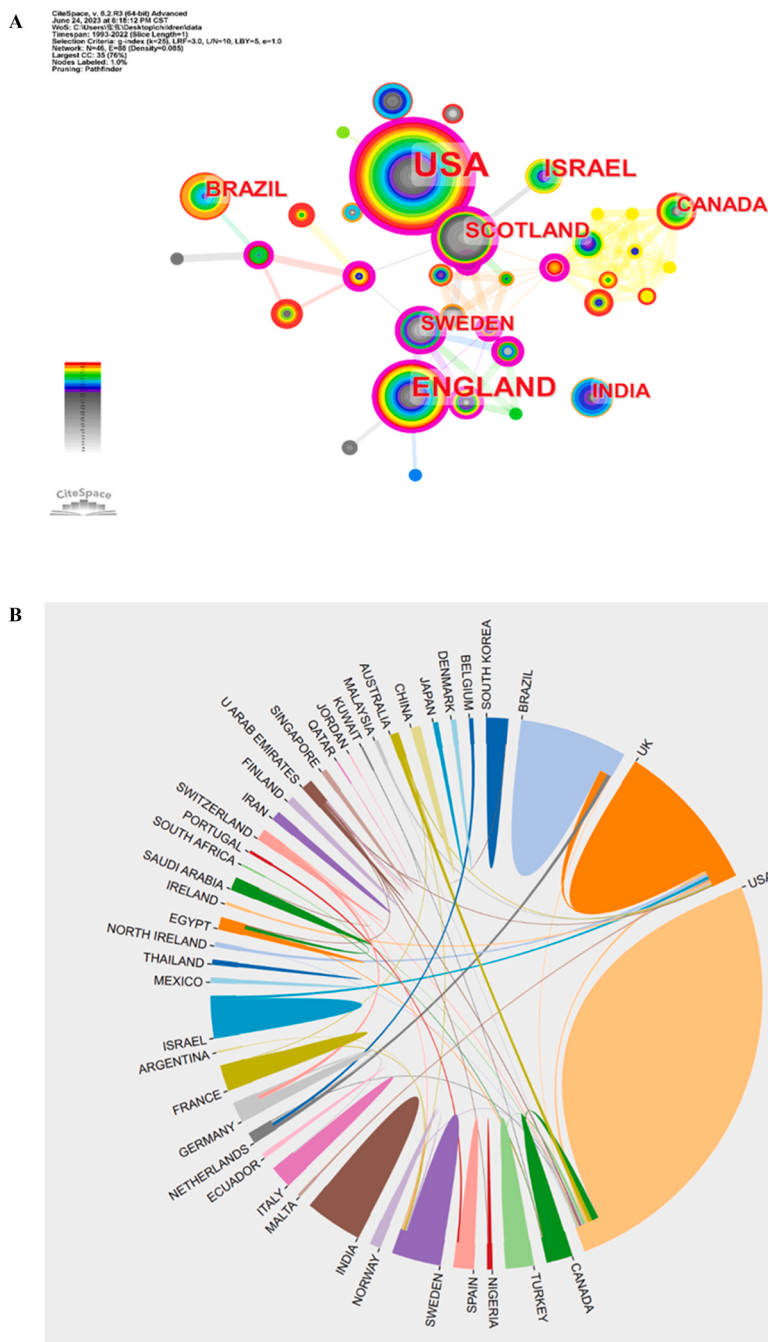


Fig. 3. (A) Published national network map of pediatric dental sedation research. (B) Collaboration efforts between different countries and regions on the topic of pediatric dental sedation from 1993 to 2022.

view of different co-citations. The results revealed that cluster zero, pharmacological patient-management, exhibited the greatest numbers of citation bursts, with the focus of research shifted to conscious sedation.

4.3. Analysis of keywords

Keyword co-occurrence analysis provides comprehensive evaluations of much researched topics in dental sedation, with author keywords and keywords plus assigned to each article. Through the analysis of the titles and abstract contents, VOSviewer found 150 keywords that occurred ≥ 12 times and the citation data were visualized by plotting a bubble chart. In the VOSviewer keyword co-

Table 1
The top 10 institutions in terms of number of publications on pediatric dental sedation research.

Rank	Institutions	Article counts	Total number of citations	Average number of citations	Total number of first authors	Total number of first author citations	Average number of first author citations
1	Univ Fed Goias	42	81	1.93	11	19	1.73
2	Univ Washington	20	115	5.75	4	18	4.5
3	Hebrew Univ Jerusalem	19	57	3	15	45	3
4	Univ N Carolina	18	33	1.83	4	7	1.75
5	Ohio State Univ	17	65	3.82	6	48	8
6	Kings Coll London	16	24	1.5	4	9	2.25
7	Tel Aviv Univ	14	13	0.93	10	12	1.2
8	Univ Texas Hlth Sci Ctr Houston	14	30	2.14	4	9	2.25
9	Univ Florida	13	28	2.15	8	25	3.13
10	Univ Illinois	13	21	1.62	5	12	2.4

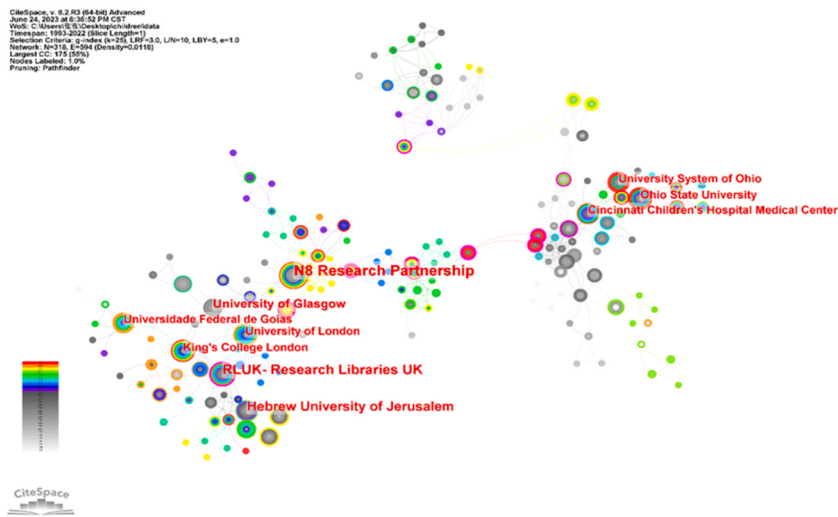


Fig. 4. Citespace network map of institutions involved in pediatric dental sedation research.

occurrence visualization map, the keywords are arranged into clusters. There were 4 main categories: sedation; conscious sedation; midazolam; and safety (Fig. 9A). In the overlay visualization the keywords are colored differently according to the publication year average (Fig. 9B). For example, “drug”, “anxious child” and “sevoflurane” mainly appeared before 2010, while keywords such as “oral midazolam” and “nitrous oxide oxygen” appeared later. Keywords such as “adverse event”, “respiratory depression”, and “procedural sedation” are colored yellow-green to indicate these topics have become popular research fields.

Burst detection reveals emerging concepts that increase suddenly with time. Through an analysis of 827 manuscripts from the WOSCC database, we identified various keyword bursts between 1993 and 2022. The timeline is illustrated as a year-by-year blue line, with time intervals in which a topical burst was detected marked as red segments, indicating the start, end years and the citation burst duration. The burst pattern of key words can identify new progress in endoscopic sedation and related research hotspots. Keywords with minimal research significance were excluded and the main focus was specifically on represented trends in dental sedation studies (Fig. 9C).

During the past 30 years, attitudes was first with regard to the greatest outbreak intensity (5.26), followed by sevoflurane (4.84) and procedural sedation (4.05). Beginning in 1994, diazepam and midazolam became the focus of research, followed by conscious sedation and extraction. In the ensuing years, some keyword explosions, such as sevoflurane and procedural sedation, continued for a while. Subsequently, moderate sedation and premedication became the main research focus. It is noteworthy that the outbreak of procedural sedation was strongest after 2020, indicating that it has become a new research hotspot for pediatric dental sedation.

5. Discussion

This study visualized the research literature in the field of pediatric dental sedation from 1993 to 2022. The number of articles published on this topic increased after 2004, reaching an average of over 19 per year by 2022. The results revealed that a limited number of papers were published in high-impact peer-reviewed journals, which exist official in indexed databases. The variation in the number of studies published by authors from different regions of the world was also evident. One of the most intriguing points in the

Table 2

The top 20 journals with the highest number of publications on pediatric dental sedation.

Rank	Journal title	Article counts	IF (2022)	Quartile in category – 2022	Total number of citations	Average number of citations
1	PEDIATRIC DENTISTRY	85	1.6	4	329	3.87
2	JOURNAL OF CLINICAL PEDIATRIC DENTISTRY	41	1.3	4	57	1.39
3	BRITISH DENTAL JOURNAL	37	2.6	3	87	2.35
4	INTERNATIONAL JOURNAL OF PAEDIATRIC DENTISTRY	26	3.8	1	64	2.46
5	JOURNAL OF DENTISTRY FOR CHILDREN	19	0.198	4	107	5.63
6	PEDIATRIC ANAESTHESIA	16	1.7	4	35	2.19
7	EUROPEAN JOURNAL OF PAEDIATRIC DENTISTRY	13	3.6	3	12	0.92
8	BMC ORAL HEALTH	10	2.9	2	10	1
9	ACTA ODONTOLOGICA SCANDINAVICA	8	2	3	26	3.25
10	JOURNAL OF DENTAL EDUCATION	7	2.3	3	4	0.57
11	CHILDREN-BASEL	7	2.4	2	0	0
12	JOURNAL OF ORAL AND MAXILLOFACIAL SURGERY	6	1.8	4	14	2.33
13	CLINICAL ORAL INVESTIGATIONS	6	3.4	2	6	1
14	PEDIATRICS	5	8	1	83	16.6
15	ANAESTHESIA	5	10.7	1	49	9.8
16	EUROPEAN JOURNAL OF ANESTHESIOLOGY	5	3.6	2	16	3.2
17	JOURNAL OF THE AMERICAN DENTAL ASSOCIATION	5	3.9	1	11	2.2
18	PEDIATRIC EMERGENCY CARE	5	1.4	3	7	1.4
19	SWEDISH DENTAL JOURNAL	4	0.818	4	18	4.5
20	BRITISH JOURNAL OF ANAESTHESIA	4	9.8	1	17	4.25

N/A, not applicable.

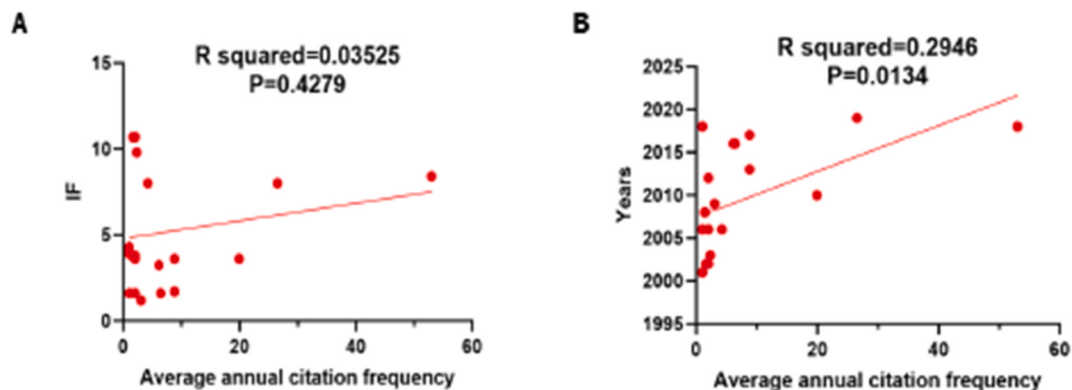


Fig. 5. The correlations of top 20 cited articles on pediatric dental sedation research were examined. (A) Based on the correlation analysis, there was not a significant relationship between the average annual number of citations and the impact factor ($R^2 = 0.03525$; $P = 0.4279$). (B) The average annual number of citations and the year of the analysis were related ($R^2 = 0.2946$; $P = 0.0134$).

articles analyzed was dental anxiety, which was a very prominent topic.

The clinical manifestations of dental anxiety are avoidance of dental treatment, increased heart rate and blood pressure, hyperhidrosis, dizziness and a refusal to cooperate with the dentist [1,8]. Intraoperative management through sedation techniques encourages a patient to respond to the dentist's verbal commands and cooperate with the treatment [9]. Benzodiazepines are the class of sedative drugs most commonly administered to relieve anxiety, in the published literature and including the present review [10]. Midazolam has been most commonly studied [11] and has been used to induce and maintain a safe and effective sedation state with little risk of cardiopulmonary complications [12]. In these studies, midazolam was compared to other sedatives and it was found that midazolam was the most effective in terms of its onset of action, depth of sedation and its anxiolysis actions [10,13,14]. In addition, in the VOSviewer keyword symbiosis visualization map, ketamine and dexmedetomidine were shown to have become more and more popular sedatives in recent years, and are likely to become research hotspots. Ketamine is an N-methyl-D-aspartate receptor antagonist. Compared with other drugs, ketamine has the advantage of its relatively stable and limited effects on the cardiovascular and respiratory systems. The recovery time was 30–120 min, which allows the patient to leave hospital within a short time after the dental procedure [14,15]. Dexmedetomidine is a highly selective α_2 -adrenoceptor agonist. Compared with traditional opioids, it has better efficacy and safety, and produces sedative, anxiolytic and analgesic effects after administration [14,16–18].

Table 3

The 10 authors with the highest number of publications on pediatric dental sedation.

Rank	Author	Article counts	Total number of citations	Average number of citations	First author counts	First author citations counts	Average first author citation counts	Corresponding author	Corresponding author citation counts	Co-cited author	Citation counts	Centrality
1	Ram, D	9	18	2.00	2	8	4.00	3	8	COTE CJ	72	0.18
2	Blumer, S	9	10	1.11	5	1	0.20	5	1	[ANONYMOUS]	63	0
3	Kupietzky, A	8	35	4.38	6	17	2.83	7	30	WILSON S	58	0.04
4	Girdler, NM	8	58	7.25	0	0	0.00	1	1	AMERICAN ACADEMYOF PEDIATRIC DENTISTRY	50	0.01
5	Shapira, J	7	37	5.29	2	28	14.00	1	14	HOUP T MI	43	0.12
6	Costa, PS	6	13	2.17	0	0	0.00	1	1	HOSEY MT	37	0.05
7	Cote, CJ	6	88	14.67	4	63	15.75	1	53	WILSON STEPHEN	36	0.05
8	Pandey, RK	6	23	3.83	2	6	3.00	0	0	HOUP T MILTON	35	0.1
9	Saksena, AK	6	23	3.83	0	0	0.00	0	0	NATHAN JE	33	0.01
10	Chandra, G	6	23	3.83	0	0	0.00	0	0	KLINGBERG G	32	0.03

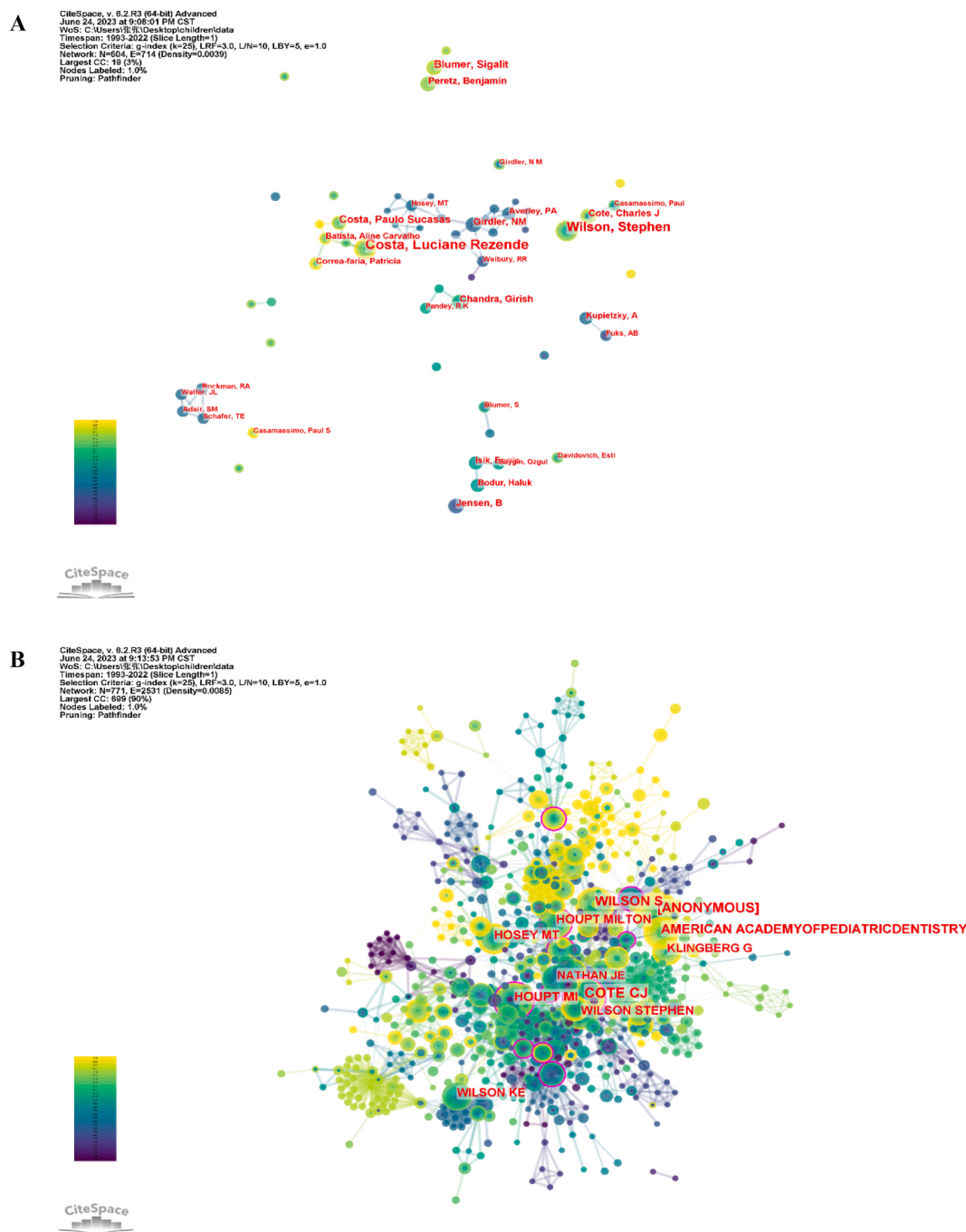


Fig. 6. (A) Clusters of authors. (B) Network map of authors who were co-cited.

Through the analysis of the included articles, according to keyword burst, nitrous oxide is an inhaled sedative given to children receiving short-term dental procedures in the outpatient setting, the most important factor for its use being rapid recovery [19]. However, inhaled sedatives may not provide sufficient anxiolysis. Intravenous sedation offers an alternative to inhaled sedation for children with dental anxiety [20]. Midazolam and propofol, the main drugs used for intravenous sedation in dental procedures, have been shown to provide an effective and successful management strategy for anxiety, producing only slight actions on the circulation at the doses administered [21]. In recent years, oral midazolam sedation for children has become an accepted practice in dentistry, especially for children with needle phobia [22]. A nasal route of administration was later tried and it was found to be easier to achieve compliance compared to oral sedation in children [23]. Since nasal administration is a simple and non-invasive technique, there are no injection-related infections. In addition, it is noteworthy that the use of nebulizers for intranasal administration has recently become

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 WoS: C:\Users\张引\Desktop\children\data
 Timespan: 1993-2022 (Slice Length=1)
 Selection Criteria: g-index (k=25), LRF=3.0, L/N=10, LB=5, e=1.0
 Network: N=469, E=1296 (Density=0.0118)
 Largest CC: 435 (92%)
 Nodes Labeled: 1.0%
 Pruning: Pathfinder
 Modularity Q=0.7567
 Weighted Mean Silhouette S=0.9045
 Harmonic Mean(Q, S)=0.824

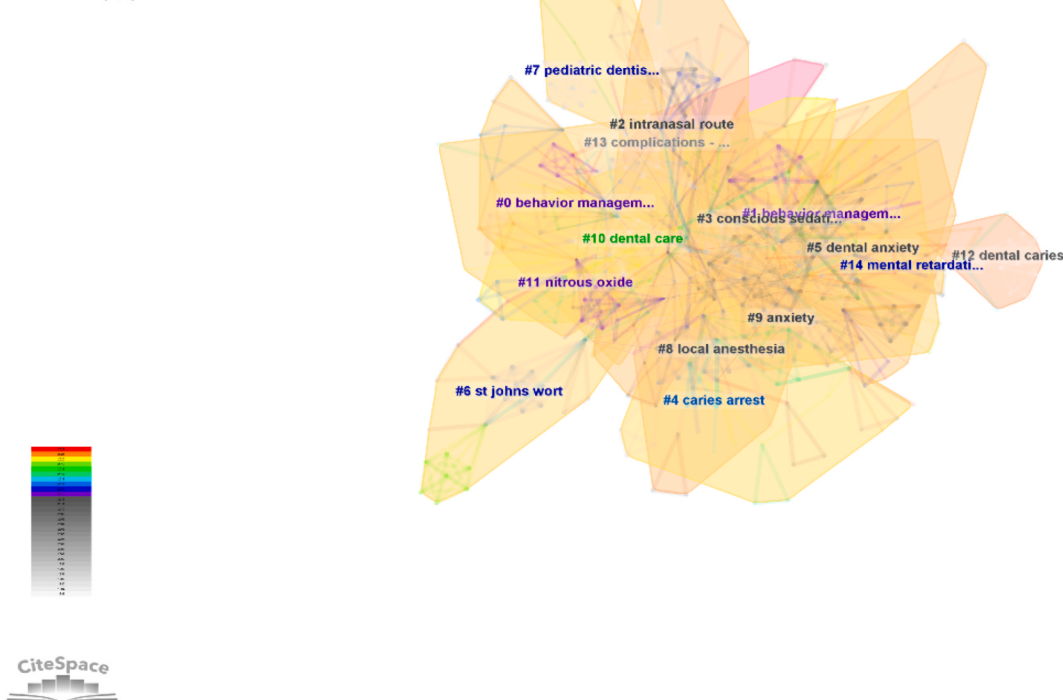


Fig. 7. Clustered network map of references that were co-cited about sedation in dentistry.

more popular [24,25].

Sedation techniques make it possible for children with dental anxiety to receive treatment that might not otherwise be readily available in a dental surgery outpatient clinic [26]. However, the safety and quality of sedation used are critical to providing high-quality dental care. In 2013, health security began to become a hotspot of concern. A meta-analysis that evaluated the incidence of emergency department adverse events (AEs) during procedural sedation in the pediatric population, including randomized controlled trials and observational studies over the past 10 years, found the following AEs: vomiting; agitation; hypoxia and apnea [27]. Another study conducted in 2019, analyzed the records of 8000 cases of procedural sedation in 39 countries and found that oxygen desaturation was the most common AE during procedural sedation, followed by airway obstruction and apnea [28]. Sedation-related dental surgery deaths were almost always due to respiratory failure [29]. For dental treatment given with sedation and for oral and maxillofacial surgery, the treatment site shares part of the upper airway. Therefore, in addition to the risk of upper airway obstruction due to the effects of anaesthesia on neuromuscular functions, mechanical factors, such as mouth opening and neck flexion, may increase the risk of upper airway obstruction [30]. In response to the aforementioned challenges, pertinent actions have been implemented to enhance the safety of children throughout the perioperative period. Before administering procedural sedation, physicians should assess a patient's health characteristics, medical history, vital signs and fasting status. It is important to plan ahead in order to reduce the risk of complications. On the one hand, dentists should develop a personalized sedation plan based on the child's treatment plan, risks, and the advantages of the drugs being used. When it comes to monitoring continuously the depth of sedation during surgery, the BIS score can accurately reflect the sedation level without deliberately stimulating the patient. The use of BIS reduces sedation-related complications, such as respiratory depression or cardiovascular complications. Additionally, BIS monitoring can assist in controlling the medication dosage, which can further expedite recovery after surgery [31]. By employing these methods, the oxygen supply and anaesthesia guidance for children during sedation can be safely ensured, minimizing the occurrence of serious AEs.

After 2019, it became evident that procedural sedation had become a new research focus. Procedural sedation is a therapeutic strategy that uses sedative or analgesic drugs to suppress the patients' level of consciousness. The expected depth of sedation should vary according to the specific needs of the patient and the procedure to be carried out [32,33]. Over the past few decades, the number of noninvasive and minimally invasive procedures conducted outside the operating room has grown exponentially. Many of these interventions or diagnostic procedures may require sedation, analgesia or both. In dental surgery practice outside the operating room, patients are often required to be moderately sedated and to receive analgesia before the procedure is carried out (termed conscious

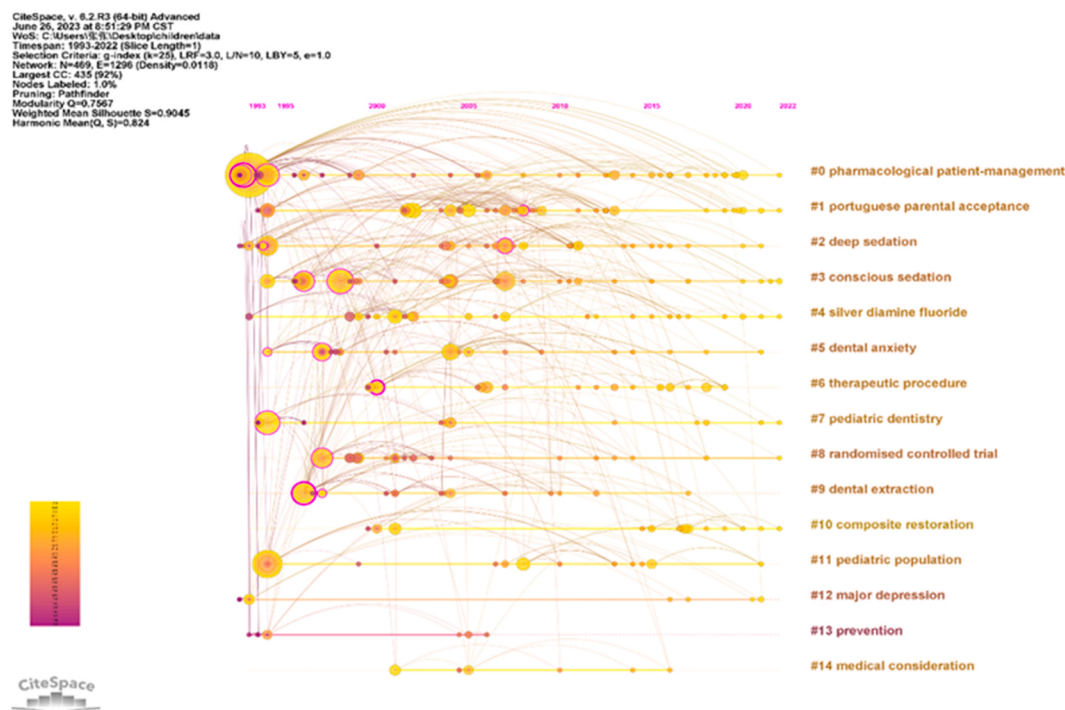


Fig. 8. Timeline of the cluster co-citations.

sedation by dentists) [34]. It is abundantly clear that procedural sedation can meet the sedation depth requirements needed for many types of dental procedure and that procedural sedation can be widely used in the dental practice.

Dental sedation offers numerous advantages for pediatric patients. It significantly reduces anxiety, enhances cooperation during dental procedures, and substantially minimizes discomfort. Additionally, it plays a crucial role in pain management, contributing to a more positive dental experience for children. This approach is not only beneficial for young children and those with special needs but is also advantageous for patients undergoing prolonged or extensive dental treatments. By using sedation, dentists can work more efficiently and effectively, ensuring a smoother and more comfortable experience for their young patients.

Compared to traditional literature reviews, analysis based on bibliometric tools provides a better understanding of research priorities and trends, and reveals data analysis results that are more comprehensive and objective. It should be pointed out, however, that bibliometric analysis has a number of limitations. For example, the current analysis only included articles published in the English language, so important articles written in other languages will have been unfairly excluded. In addition, due to the limitations of CiteSpace software, only indexed documents from the WOSCC database were analyzed. Although most articles on dental sedation are in the WOSCC database, PubMed and Scopus may better represent existing scholarship in this field. Therefore, future research should include non-English language articles, articles from other databases and more recent publications that may have been missed by citation indicators.

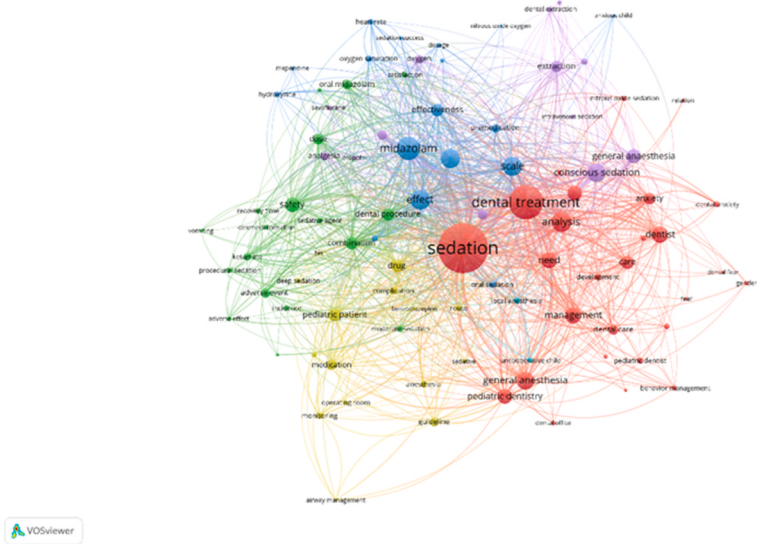
6. Conclusions

There has been significant growth in research on oral sedation in children over the past three decades. The United States, as the leading contributor, has had a substantial academic impact. Our study has identified that the current research on pediatric dental sedation primarily focuses on adverse events associated with sedation and their corresponding solutions. Furthermore, our analysis reveals that procedural sedation has emerged as a new research area of interest in this field. These findings offer valuable insights for clinicians and lay the foundation for future research directions.

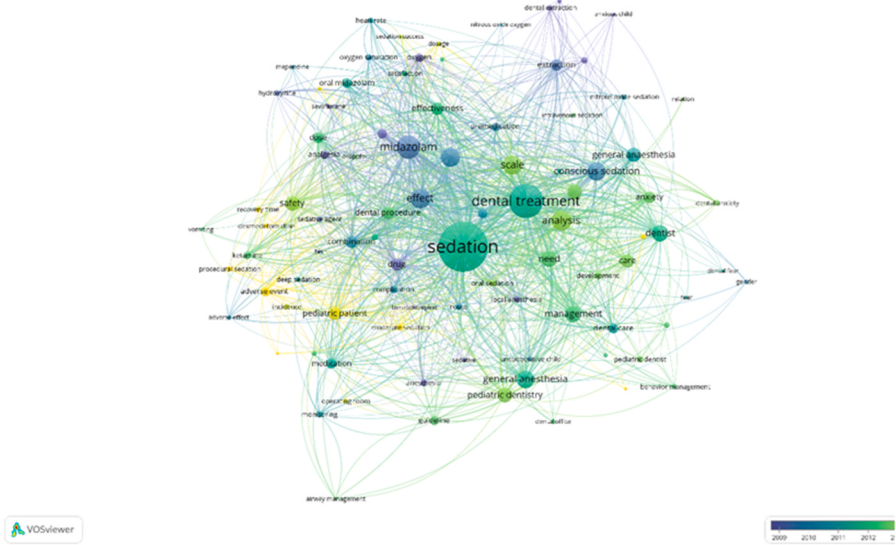
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B



C

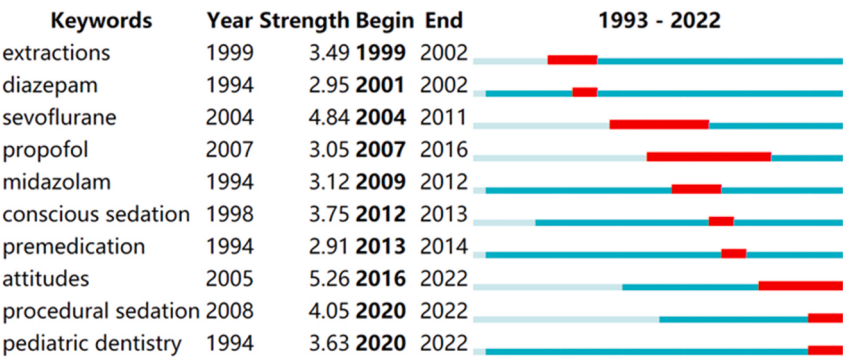


Fig. 9. Keywords analysis on pediatric dental sedation. (A) Network map of keyword clustering showing 150 keywords with minimum occurrences of 12 assigned to 4 main clusters. (B) They are colored according to the average publication year. (C) Keywords showing the greatest citation bursts from 1993 to 2022.

Data availability statement

There is no additional data available for this review article.

CRediT authorship contribution statement

Jinhong Zhang: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Data curation, Conceptualization. **Jie Zeng:** Visualization, Investigation, Data curation. **Pan Zhou:** Visualization, Software, Formal analysis. **Haixia Deng:** Visualization. **Cong Yu:** Writing – review & editing, Supervision, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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