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Nonpharmacological Management of Dental Anxiety in the General Population and Individuals With Learning Disabilities: A Bibliometric Analysis

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Abstract

Aims: Dental anxiety (DA) is reported among the general population, including individuals with learning disabilities (LDs). In many studies, nonpharmacological interventions have been applied to significantly improve DA among patients. This study aimed to examine publication trends and patterns in both populations to identify the current research trends and literature gaps.

Methods: A descriptive analysis of bibliographic data and network visualization were conducted using Microsoft Excel and VosViewer, focusing on literature published in the Scopus database between 1994 and 2023 and using "title" as the search field.

Results: For the study period, the following were identified: 1429 authors, 5858 total citations, and an h-index of 36. From a total of 2058 publications discovered, 363 publications were included in the study. Of these, only 11 articles addressed nonpharmacological management for people with LDs. In terms of the research country, the United Kingdom was the leading contributor, with 56 publications. Ad de Jongh was the most productive author, with 13 publications and 447 citations. The most highly cited paper was Lehrner et al. (2005), with 312 citations.

Conclusion: This study determined the number of publications related to nonpharmacological management of DA over three decades. The number of studies involving people with LDs was lower than that involving the general population, suggesting future research should occur in this area.

1 | Introduction

Dental anxiety (DA) is a complex, multifaceted, and widely experienced phenomenon, which is often linked to past negative dental experiences [1, 2]. It may manifest as negative psychological or physiological responses or behavioral issues, such as avoidance of dental visits or procedures. DA may result in poor dental health status and decreased oral-health-related quality of life [2].

DA has been reported to affect many patients, including those with learning disabilities (LDs). Among those with LDs, the

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prevalence of DA has been reported to range from 15.56% to 21% [3], which is comparable to the prevalence in the general population, which is about 15.3% among adults [4]. Despite the comparable prevalence, people with LDs may face further challenges in obtaining professional dental care, as they are detrimentally affected by other factors; collectively, LDs and other factors may contribute to a high risk of developing oral disease [3]—for example, people with LDs may experience difficulties in visiting a dentist caused by factors such as physical inaccessibility, affordability, and the availability of professionals or facilities that can accommodate patients with LDs [5–7]. It is therefore imperative that interventions to manage DA among those with LDs are pursued in research and practice as a means of improving accessibility to professional dental care for this population.

The body of literature addressing various nonpharmacological interventions aimed at reducing DA and enhancing comfort during dental procedures has steadily been increasing [8–14]. Nonpharmacological approaches consist of a wide range of techniques aimed at reducing DA without the use of medications and have attracted much research attention due to their diversity. Many nonpharmacological approaches, such as behavioral and cognitive interventions, have shown promise in assisting anxious individuals to feel more comfortable when obtaining needed dental care [8].

A reasonably adequate body of evidence-based work concerning several nonpharmacological anxiety management practices has been developed with a focus on the general population, but there is a lack of studies explicitly focusing on the population with LDs [8, 15]. Furthermore, knowledge of the publication trends of articles reporting the use of nonpharmacological management for DA among people with LD is limited [11]. This study thus aimed to examine articles, specifically those published within the past three decades, on nonpharmacological management of DA in individuals with LDs and to compare that body of literature with that more broadly focused on the general population. The study was based on the premise that a comprehensive bibliometric analysis of the existing literature on this topic could provide valuable insights into the current state of the research, identify knowledge gaps, and guide future research directions in this critical area [16–18].

2 | Materials and Methods

By using bibliometric analysis and network visualization, this study aimed to answer the following research questions:

- ***RQ1***. What are the publication trends in the field of nonpharmacological management of DA, and how have they changed over 30 years?
- ***RQ2***. Who are the most prolific authors in the field of nonpharmacological management of DA?
- ***RQ3***. What are the most common keywords in the literature on nonpharmacological management of DA?
- ***RQ4***. What are the most influential institutions in the field?
- ***RQ5***. What are the most highly cited documents in the field of nonpharmacological DA?
- ***RQ6***. How do publication trends and patterns differ between studies focusing on individuals with LDs and those more broadly focusing on the general population?

2.1 | Search Strategy

The search of the Scopus database electronic collection was done on November 1st, 2023 to identify papers on the management of DA. The search was conducted within the "TITLE" field by combining specific keywords. Keywords were selected using MeSH terms and Boolean operators. A thesaurus was also used to check for similar terminologies. After discussion among the researchers, the following keywords were chosen for the search: "phobia," "anxiety," "fear," "odontophobia," "aversion," and "dent*."

The search was limited articles published from 1993 to 2023. Additional filters were applied to restrict the search by excluding preprints and six subject areas including veterinary medicine, mathematics, physics and astronomy, chemical engineering, engineering, and agricultural and biological sciences (Figure 1).

2.2 | Data Collection and Analysis

A total of 2058 retrieved documents were considered and reviewed. Titles were screened in order to exclude duplicate or irrelevant articles, ensuring that only relevant documents were retained; a final count of 363 articles were saved under the label "Dental Anxiety" under the saved list tab on the Scopus website to facilitate further analysis. Screening was performed by two independent reviewers who arrived at a unanimous decision on the final list. When no further screening was required, the researchers analyzed the articles; recorded the publication trends, prolific authors, common keywords, institutions, and highly cited documents; and compared publication trends and patterns between studies focusing on individuals with LDs versus the general population.

Subsequently, bibliometric analysis was performed using Bibliomagika version 2.3 [19] and VOS Viewer version 1.6.20 [20] to construct and visualize bibliometric networks.

3 | Results

3.1 | Document Profiles

The majority of the academic documents (83.20%) were articles presenting original research and findings. Other documents, such as reviews, notes, and short surveys, comprised the remaining 16.80%, and these documents provide different perspectives and styles from the academic discourse (Table 1). Journals were the most significant source of academic publications, accounting for 97.80% of all articles. Books and conference proceedings accounted for a much smaller share, each representing only 0.83%. A small portion of documents (0.55%) required further clarification regarding source categorization (Table 2).

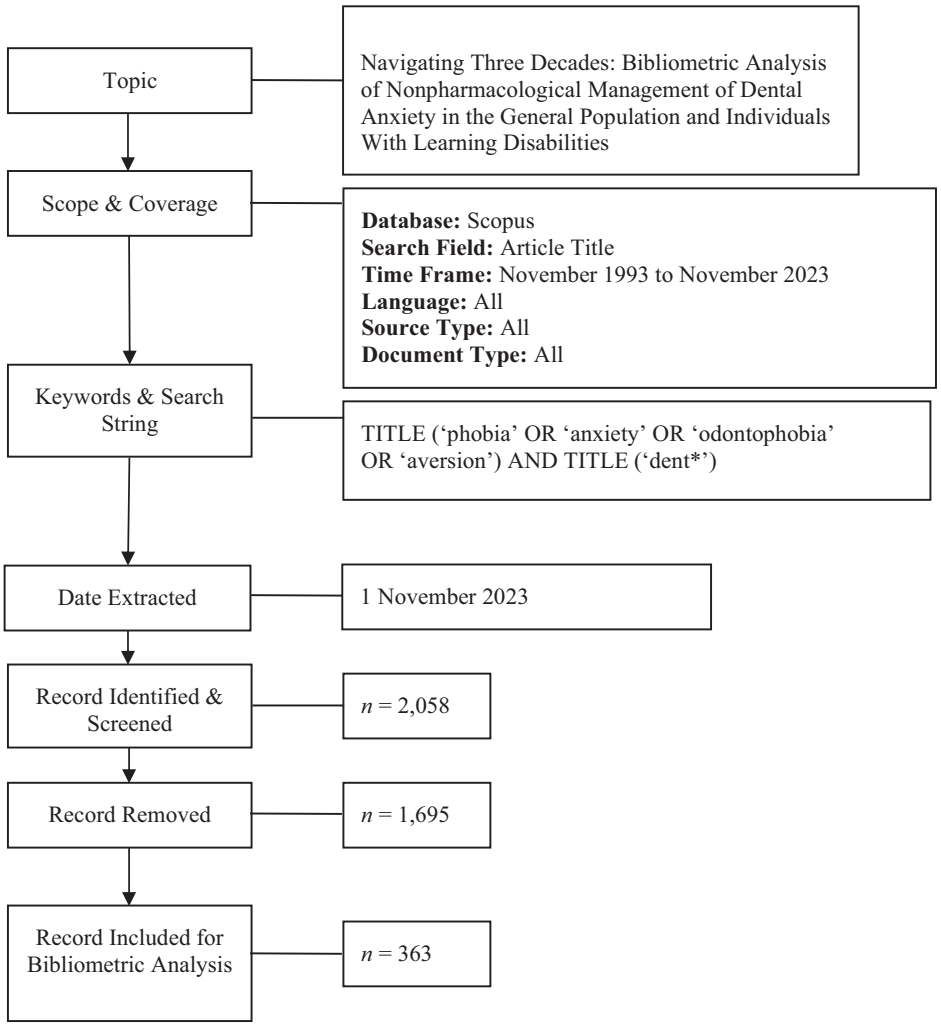


FIGURE 1 | Flow diagram of search strategy.

TABLE 1 | Document type.

Document type	Total publications	Percentage
Article	302	83.20%
Review	39	10.74%
Note	6	1.65%
Short survey	5	1.38%
Book	2	0.55%
Conference paper	2	0.55%
Erratum	2	0.55%
Retracted	2	0.55%
Book chapter	1	0.28%
Editorial	1	0.28%
Letter	1	0.28%
Total	363	100%

TABLE 2 | Source type.

Source type	Total publications	Percentage
Journal	355	97.80%
Book	3	0.83%
Conference proceeding	3	0.83%
Undefined	2	0.55%
Total	363	100%

Language plays a critical role in scholarly communication, and English was the predominant language, used in 93.39% of all documents. As the lingua franca of academia, English facilitates global discourse and knowledge exchange. Nevertheless, a notable portion (6.61%) of documents were presented in other languages, such as Dutch, German, and Chinese (Table 3).

The health sciences fields of dentistry and medicine accounted for 59.78% and 47.93% of all publications, respectively. However, the academic landscape is more expansive than these disciplines, and other areas, namely psychology, computer science, and arts and humanities, also were significantly represented, emphasising the interdisciplinary nature of academic research. Collaboration

TABLE 3 | Languages.

Language	Total publications	Percentage
English	339	93.39%
Dutch	5	1.38%
German	5	1.38%
Chinese	4	1.10%
Spanish	3	0.83%
Japanese	2	0.55%
French	1	0.28%
Hebrew	1	0.28%
Hungarian	1	0.28%
Italian	1	0.28%
Turkish	1	0.28%
Total	363	100%

TABLE 4 | Subject area.

Subject area	Total publications	Percentage
Dentistry	217	59.78%
Medicine	174	47.93%
Psychology	42	11.57%
Health professions	10	2.75%
Neuroscience	8	2.20%
Social sciences	8	2.20%
Biochemistry, genetics, and molecular biology	4	1.10%
Computer science	4	1.10%
Nursing	4	1.10%
Pharmacology, toxicology, and pharmaceutics	4	1.10%
Arts and humanities	3	0.83%
Multidisciplinary	2	0.55%
Business, management, and accounting	1	0.28%
Chemistry	1	0.28%
Immunology and microbiology	1	0.28%

among different knowledge domains is essential for addressing our complex societal challenges (Table 4).

3.2 | Publication and Citation Trends

As shown in Figure 2 and Table 5, the number of publications concerning the management of DA in the general population and among those with LDs from 1994 to 2023 underwent some significant changes. A substantial increase in total citations was evident in 1994–1995, despite a decline in the number of publications. The following year, the publication trend remained stable. However, the trend then started to decline and continued to do so until 2000, when the number of published documents exhibited a sharp rise, leading to a significant change in the number of total publications and citations. After 2000, the publication trends fluctuated and peaked again in 2013 with many publications. The trend then fluctuated again between 2013 and 2019 and gradually declined until 2023. These findings suggest a need for more research in DA management in both the general and LD populations.

TABLE 5 | Year of publication.

Year	TP	NCP	TC	C/P	C/CP	h	g
1994	7	6	36	5.14	6.00	3	6
1995	4	3	123	30.75	41.00	3	4
1996	4	4	123	30.75	30.75	4	4
1997	3	2	5	1.67	2.50	1	2
1998	3	3	51	17.00	17.00	3	3
1999	6	5	54	9.00	10.80	4	6
2000	8	8	488	61.00	61.00	6	8
2001	3	3	55	18.33	18.33	3	3
2002	7	6	298	42.57	49.67	5	7
2003	6	6	77	12.83	12.83	4	6
2004	4	3	209	52.25	69.67	3	4
2005	7	6	426	60.86	71.00	4	7
2006	10	8	138	13.80	17.25	7	10
2007	7	6	221	31.57	36.83	5	7
2008	5	5	205	41.00	41.00	4	5
2009	4	3	45	11.25	15.00	2	4
2010	7	6	181	25.86	30.17	4	7
2011	7	6	97	13.86	16.17	5	7
2012	6	6	182	30.33	30.33	6	6
2013	13	13	560	43.08	43.08	8	13
2014	18	17	345	19.17	20.29	10	18
2015	18	16	286	15.89	17.88	11	16
2016	23	20	410	17.83	20.50	9	20
2017	24	24	281	11.71	11.71	10	16
2018	19	16	227	11.95	14.19	9	15
2019	36	28	392	10.89	14.00	11	19
2020	23	19	160	6.96	8.42	7	12
2021	23	23	126	5.48	5.48	6	9
2022	24	15	43	1.79	2.87	4	5
2023	34	9	14	0.41	1.56	2	2
Total	363	295	5858	16.14	19.86		

Abbreviations: C/CP, average citations per cited publication; C/P, average citations per publication; g, g-index; h, h-index; NCP, number of cited publications; TC, total citations; TP, total number of publications.

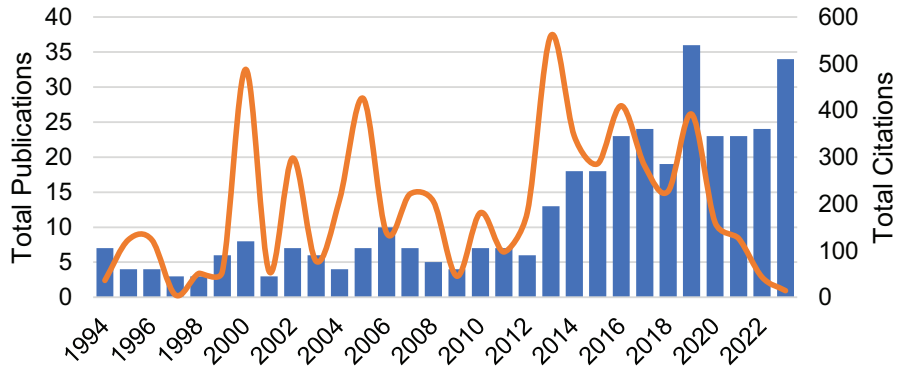


FIGURE 2 | Publication trend, 1994–2023.

TABLE 6 | Citation metrics.

Metrics	Data
Publication years	1994–2023
Total publications	363
Citable year	30
No. of contrib. authors	1429
No. of cited papers	295
Total citations	5858
Citations per paper	16.14
Citations per cited paper	19.86
Citations per author	4.10
Authors per paper	3.94
h-index	36
g-index	63

An examination of the literature published between 1994 and 2023 revealed 363 articles specifically focused on nonpharmacological interventions for DA. These articles have collectively garnered 5858 citations, averaging 16.14 citations per article. Authorship encompassed 1429 individuals working in 47 countries across six continents, reflecting a global research effort. The h-index for this body of work is 36, with an average of 4.10 citations per author (Table 6).

3.3 | Contributing Authors

Some highly productive authors were identified based on the number of articles published and the number of times their work has been cited. The top authors in terms of productivity were De Jongh, A. D., with 13 articles and 447 citations; Newton, J. T., with 13 articles and 316 citations; Marshman, Z., with 7 articles and 49 citations; Berggren, U., with 7 articles and 271 citations; Joehren, P., with 7 articles and 405 citations; and Sartory, G., with 6 articles and 95 citations. When considering both total citations and the h-index, the most cited authors were De Jongh from the Academic Centre for Dentistry, Amsterdam, with 447 citations, followed by Joehren from a private dental clinic in Germany, with 405 citations, and Newton from King's College of London, with 316 citations (Table 7).

3.4 | Country and Institution of Origin

Table 8 presents the top 20 countries based on the location of the first authors who contributed to the publications related to DA. Researchers from the United Kingdom had the highest h-index of 17 (59 articles, 55 citations), followed by those from the United States (51 articles, 43 citations) and India (44 articles, 35 citations). Among institutions, the most significant contributions were made by private dental practices from various countries (18 articles, 13 citations), King's College of London (14 articles, 14 citations), and the University of Amsterdam (9 articles, 9 citations; Table 9).

3.5 | Highly Cited Documents

The 20 most cited articles were published between 1995 and 2018. The paper with the highest citation count was Lehrner et al. (2005), which explored the ambient odors of essential oils and has been cited 312 times. Lehrner et al. had previously written about the same topic in 2000 but with a different target population, and that paper earned 259 citations. Although the 2000 study has a slightly lower citation count than the 2005 publication, it still has attracted considerable attention within the academic community, with a notable citation rate of 10.36 per year. After Lehrner's work, other highly cited papers were written by Armfield and Heaton in 2013, earning 246 citations; Appukuttan in 2016, with 221 citations; and Kritsidima et al. (2010) and Kvale et al. (2004), both with 136 citations. The remaining 14 articles by multiple authors have received from 63 to 120 citations, with the various studies ranging from randomized controlled trials to systematic reviews, as indicated in Table 10.

3.6 | Source Titles

The most active source titles based on total publications and total citations were the *European Archives of Paediatric Dentistry* (published by Springer Verlag), with 11 publications and 191 citations in total, and the *British Dental Journal*, with the same number of published documents and 193 citations. Although the *Community Dentistry and Oral Epidemiology* journal (published by Blackwell Munksgaard) featured only seven publications, they achieved the highest total citations of 390 over the study period. The *European Journal of Oral Sciences*, another Blackwell Munksgaard publication, featured nine publications and 312 citations (Table 11).

TABLE 7 | Most productive authors.

Author's name	Affiliation	Country	TP	NCP	TC	C/P	C/CP	h	g
De Jongh, A. D.	Academic Centre for Dentistry Amsterdam	Netherlands	13	12	447	34.38	37.25	10	13
Newton, Jonathon Tim	King's College London	United Kingdom	13	13	316	24.31	24.31	7	13
Marshman, Zoe	University of Sheffield	United Kingdom	7	7	49	7.00	7.00	3	7
Berggren, Ulf	University of Gothenburg	Sweden	7	7	271	38.71	38.71	5	7
Joehren, Peter	Dental Clinic Bochum	Germany	7	7	405	57.86	57.86	6	7
Sartory, Gudrun	University of Wuppertal	Germany	6	6	95	15.83	15.83	6	6
Nuvvula, Sivakumar	Narayana Dental College and Hospital	India	5	4	105	21.00	26.25	4	5
Milgrom, Peter	University of Washington	United Kingdom	5	5	191	38.20	38.20	4	5
Willumsen, Tiril	University of Oslo	Norway	5	5	111	22.20	22.20	5	5
Hakeberg, Magnus	University of Gothenburg	Sweden	5	5	172	34.40	34.40	4	5
Fauziah, Eva	University of Indonesia	Indonesia	4	3	4	1.00	1.33	1	2
Makkes, Peter C.	Centre for Special Dental Care	Netherlands	4	3	124	31.00	41.33	3	4
Gujjar, Kumar Raghav	Segi University	Malaysia	4	4	110	27.50	27.50	4	4
Rodd, Helen	University of Sheffield	United Kingdom	4	4	38	9.50	9.50	2	4
Carlsson, Sven G.	University of Gothenburg	Sweden	4	4	103	25.75	25.75	4	4

Abbreviations: C/P, average citations per publication; C/CP, average citations per cited publication; g, g-index; h, h-index; NCP, number of cited publications; TC, total citations; TP, total number of publications.

TABLE 8 | Top 20 countries: Publications.

Country	TP	NCP	TC	C/P	C/CP	h	g
United Kingdom	59	850	55	14.41	15.45	17	29
United States	51	1327	43	26.02	30.86	17	36
India	44	558	35	12.68	15.94	10	23
Netherlands	20	530	19	26.50	27.89	12	20
Germany	19	743	17	39.11	43.71	10	19
Brazil	19	141	14	7.42	10.07	6	11
China	17	96	14	5.65	6.86	4	9
Sweden	17	554	17	32.59	32.59	12	17
Iran	13	65	7	5.00	9.29	4	8
Turkey	13	130	9	10.00	14.44	6	11
Australia	13	458	13	35.23	35.23	9	13
Indonesia	11	48	10	4.36	4.80	4	6
Norway	11	323	10	29.36	32.30	8	11
Spain	10	123	8	12.30	15.38	5	10
Malaysia	8	179	7	22.38	25.57	6	8

(Continues)

TABLE 8 | (Continued)

Country	TP	NCP	TC	C/P	C/CP	h	g
Saudi Arabia	7	42	5	6.00	8.40	4	6
Austria	7	752	6	107.43	125.33	6	7
Israel	7	87	6	12.43	14.50	4	7
Italy	6	104	5	17.33	20.80	4	6
Switzerland	6	58	5	9.67	11.60	3	6

Abbreviations: C/CP, average citations per cited publication; C/P, average citations per publication; g, g-index; h, h-index; NCP, number of cited publications; TC, total citations; TP, total number of publications.

TABLE 9 | Most productive institutions with minimum of five publications.

Affiliation	Country	TP	NCP	TC	C/P	C/CP	h	g
Private dental practices	N/A	18	728	13	40.44	56.00	7	18
King's College of London	United Kingdom	14	339	14	24.21	24.21	8	14
University of Amsterdam	Netherlands	9	315	9	35.00	35.00	8	9
Academic Centre for Dentistry Amsterdam	Netherlands	9	278	8	30.89	34.75	6	9
University of Sheffield	United Kingdom	7	49	7	7.00	7.00	3	7
University of Washington	United States	7	470	7	67.14	67.14	6	7
University of Gothenburg	Sweden	7	286	7	40.86	40.86	6	7
Sheffield Hallam University	United Kingdom	6	47	6	7.83	7.83	3	6
University of Dundee	United Kingdom	6	160	6	26.67	26.67	5	6
University of Oslo	Norway	6	135	6	22.50	22.50	6	6
University of Manchester	United Kingdom	6	45	6	7.50	7.50	3	6
University of Wuppertal	Germany	6	95	6	15.83	15.83	6	6
D. Y. Patil Dental College and Hospital	India	5	25	4	5.00	6.25	3	5
Narayana Dental College and Hospital	India	5	76	4	15.20	19.00	3	5

Abbreviations: C/CP, average citations per cited publication; C/P, average citations per publication; g, g-index; h, h-index; NCP, number of cited publications; TC, total citations; TP, total number of publications.

3.7 | Coauthorship Network

For papers focusing on the general population, our construction of the coauthorship network for the study period yielded an initial figure of 1161 authors. However, only 981 meet the thresholds through fractional counting. To ensure the network map would reflect meaningful collaborations, we excluded articles where the coauthor count exceeded 25; this measure was taken to avoid marginal contributions. By applying criteria specifying that each author must have at least one published article and a minimum of one citation attributed to them, we mapped 106 authors visually (Figure 3). The graphical representation in the figure illustrates the cooperative links between authors, depicted by lines; further, 12 different colors designate various collaborative clusters. For studies concerning the population with LDs, however, our search resulted in a significantly more minor assembly of 34 authors. Adhering to the same established threshold, we determined that 23 authors met the criteria. Nevertheless, only five authors exhibited connectedness when we constructed the network map, as evidenced by the visual representation in Figure 4.

3.8 | Co-occurrence of all keywords

The co-occurrence of all keywords was explored to discern the thematic concentration and interconnections within the literature related to the general population (Figure 5). By utilizing fractional counting to equitably distribute the weight of keywords across multiple occurrences, we established a minimum threshold of two occurrences for a keyword to be included in our analysis. From the original pool of 1091 keywords, 340 met this threshold. These keywords were then visualized to depict the thematic landscape of the research area, with 333 keywords successfully mapped. The visualization revealed 13 distinct clusters, each representing a converging theme or topic within DA research. These clusters encapsulate the multifaceted

TABLE 10 | Most highly cited articles.

No.	Authors	Title	Citations	Citations per Year
1	Lehrner et al. (2005)	Ambient odors of orange and lavender reduce anxiety and improve mood in a dental office	312	15.60
2	Lehrner et al. (2000)	Ambient odor of orange in a dental office reduces anxiety and improves mood in female patients	259	10.36
3	Armfield and Heaton (2013)	Management of fear and anxiety in the dental clinic: A review	246	20.50
4	Appukuttan (2016)	Strategies to manage patients with dental anxiety and dental phobia: Literature review	221	24.56
5	Kritsidima et al. (2010)	The effects of lavender scent on dental patient anxiety levels: A cluster randomized-controlled trial	136	9.07
6	Kvale et al. (2004)	Dental fear in adults: A meta-analysis of behavioral interventions	136	6.48
7	Aitken et al. (2002)	The effect of music distraction on pain, anxiety and behavior in pediatric dental patients	120	5.22
8	Karst et al. (2007)	Auricular acupuncture for dental anxiety: A randomized controlled trial	116	6.44
9	Gordon et al. (2013)	A critical review of approaches to the treatment of dental anxiety in adults	107	8.92
10	De Jongh et al. (2005)	Clinical management of dental anxiety: What works for whom?	87	4.35
11	Lahmann et al. (2008)	Brief relaxation versus music distraction in the treatment of dental anxiety: A randomized controlled clinical trial	84	4.94
12	Wide Boman et al. (2013)	Psychological treatment of dental anxiety among adults: A systematic review	82	6.83
13	Dailey et al. (2002)	Reducing patients' state anxiety in general dental practice: A randomized controlled trial	80	3.48
14	Klinberg (2008)	Dental anxiety and behavior management problems in pediatric dentistry—A review of background factors and diagnostics	79	4.65
15	Wiederhold et al. (2014)	Clinical use of virtual reality distraction system to reduce anxiety and pain in dental procedures	78	7.09
16	Luscre and Center (1996)	Procedures for reducing dental fear in children with autism	76	2.62
17	Isong et al. (2014)	Addressing dental fear in children with autism spectrum disorders: A randomized controlled pilot study using electronic screen media	73	6.64
18	Sullivan et al. (2000)	The effect of virtual reality during dental treatment on child anxiety and behavior	73	2.92
19	De Jongh et al. (1995)	One-session cognitive treatment of dental phobia: Preparing dental phobics for treatment by restructuring negative cognitions	72	2.40
20	Bradt and Teague (2018)	Music interventions for dental anxiety	63	9.00

nature of the field, highlighting areas of concentrated study and potential relationships between various research topics. The network depicted a total link strength of 1707, which quantitatively indicates the overall connectivity and cohesion within the keyword network. With 7835 links mapped, the dense web of connections indicates a highly interrelated research field where topics do not exist in isolation but are part of an interdependent structure.

However, for the LD population, a much smaller set of keywords was identified, with all 65 keywords meeting the lower threshold of two occurrences. This reflects the more negligible body of literature available. Only 11 items were visually mapped, forming two clusters. The total link strength of 17.5 and 51 links indicate interconnectivity, but they also underscore the sparseness of research among patients with LDs compared to the general population (Figure 6).

TABLE 11 | Most active source titles.

Source title	TP	TC	Publisher
European Archives of Paediatric Dentistry	11	191	Springer Verlag
British Dental Journal	11	193	Springer Nature
Journal of Clinical Pediatric Dentistry	10	129	MRE Press
European Journal of Oral Sciences	9	312	Blackwell Munksgaard
European Journal of Paediatric Dentistry	9	92	Italian Society of Pediatric Dentistry
Journal of International Dental and Medical Research	9	31	Ektodermal Displazi Grubu
International Journal of Clinical Pediatric Dentistry	8	28	Jaypee Brothers Medical Publishers
International Journal of Paediatric Dentistry	8	109	John Wiley & Sons
BMC Oral Health	7	97	BioMed Central Ltd.
Acta Odontologica Scandinavica	7	115	MJS Publishing
Community Dentistry and Oral Epidemiology	7	390	Blackwell Munksgaard
Brazilian Research in Pediatric Dentistry and Integrated Clinic	7	23	Association of Support to Oral Health Research (APESB)
Dental Update	6	35	George Warman Publications (Pty.) Ltd.

Abbreviations: TC, total citations; TP, total number of publications.

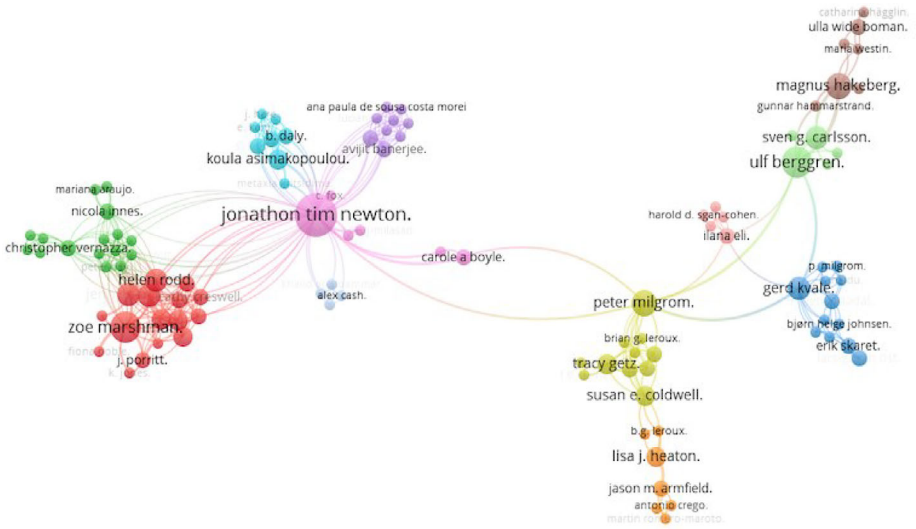


FIGURE 3 | Coauthorship network map of authors publishing on nonpharmacological management of DA in the general population, 1994–2023.

3.9 | Most Used Keywords

Overall, the analysis of the DA literature revealed a significant emphasis on the keywords "human" and "dental anxiety" for research focused on both the general and LD populations. The frequencies of these terms indicate their importance in this area of study, with "human" appearing 278 times and "dental anxiety" appearing 247 times in general population research. In the subset of the literature on individuals with LDs, "dental anxiety" occurred four times, and "human" occurred six times.

4 | Discussion

This study was a bibliometric analysis, which is a quantitative statistical method used to analyze published literature. It was first introduced by Alfred Lotka in 1926, who established Lotka's Law, provided the initial rules for bibliometrics, and exerted a lasting influence on the field. Bibliometrics involves the mathematical and statistical analysis of research works, providing an opportunity to analyze trends in the literature [21]. It has been widely used in various fields, such as medicine and dentistry, to assess the evolution of knowledge, identify leading research stakeholders, and analyze conceptual areas of knowledge development [22].

In this study, the Scopus database, which is among the largest curated databases of abstracts and citations, was used. Scopus provides comprehensive global and regional coverage of scientific journals, conference proceedings, and books, ensuring only the highest-quality data are indexed [23]. The database's ability to provide statistics on each article's metadata, including research areas, makes it a valuable resource for conducting comparative

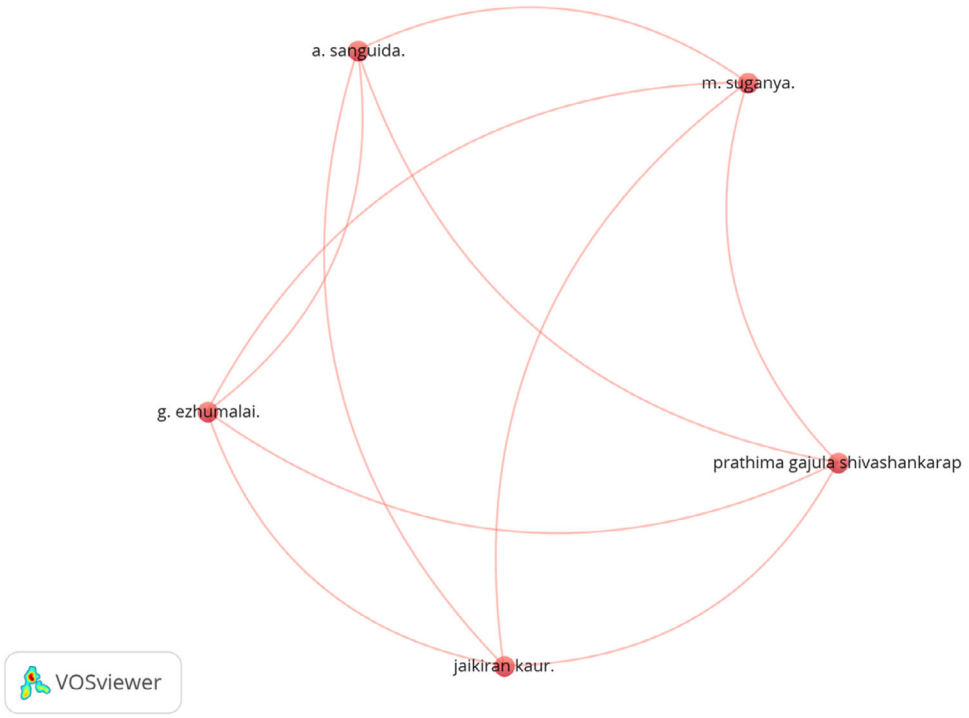


FIGURE 4 | Coauthorship network map of authors publishing on nonpharmacological management of DA in LD population, 1994–2023.

analysis and identifying research trends [24]. Moreover, Scopus has been noted to offer a wider choice of publications for bibliometric analysis compared to other databases, making it a suitable platform for comprehensive literature searches.

This study investigated the literature relating to the nonpharmacological management of DA, an approach that could potentially improve patients' well-being as well as dental access and care [8]. While pharmacological interventions like sedation are available, nonpharmacological approaches have attracted interest due to their potential for long-term anxiety reduction and improved coping mechanisms without the associated risks of medication [8]. Behavioral approaches are often overlooked as effective mechanisms for relieving patient apprehension, suggesting that sedation and general anesthesia may be unnecessary when psychological and behavioral approaches are practical [25]. Despite some advancements, research on the nonpharmacological management of DA in specific populations, such as individuals with LDs, remains limited [8, 26]. Further research is essential to develop tailored interventions that address the unique needs of specific populations and improve their dental experiences [27].

The present bibliometric analysis found 363 documents related to nonpharmacological management of DA from 1994 to 2023 by searching the Scopus database. Over the study period, an increase in publication was observed, with more than 10 publications per year being produced since 2013. This figure has fluctuated for the past 10 years, with the number of publications peaking in 2013 ($n = 38$). This finding indicates increasing interest in this study topic among researchers worldwide.

Notably, most of the studies were produced by authors from the United Kingdom. The high publication number from this country may be related to a well-established dental research infrastructure, historical research priorities, and funding allocations [28, 29].

When examining the subject areas covered, we observed a strong emphasis on health sciences, with dentistry (59.78%) and medicine (47.93%) dominating the field. This highlights the recognition of DA as a significant health concern with implications extending beyond oral health. The prominence of the researcher De Jongh, with 13 publications and a citation count of 447, underscores the active pursuit of knowledge within the field.

Further insights from the analysis revealed a robust, practical focus within the field. Private dental practices have contributed significantly to the literature (18 articles), indicating that managing DA is a crucial concern for practitioners and not just an academic pursuit. King's College London and the University of Amsterdam emerged as leading institutions, reflecting their active research programs in dentistry and related fields. The high citation counts for Lehrner et al.'s work on the ambient odors of essential oils (312 and 259 citations) point to a particular interest in nonpharmacological interventions like aromatherapy. The prominence of research on nonpharmacological approaches related to DA is evident in leading dental journals, including the *European Archives of Paediatric Dentistry* and the *British Dental Journal*.

Another major finding that demands careful attention is the significant gap between the extensive body of general research and the limited literature on people with LDs. Only 11 articles directly addressed nonpharmacological management for this specific group. The research on the general population is broad and diverse, but the research on the LD population is underdeveloped and requires further effort. The analysis of the coauthorship network in nonpharmacological management of

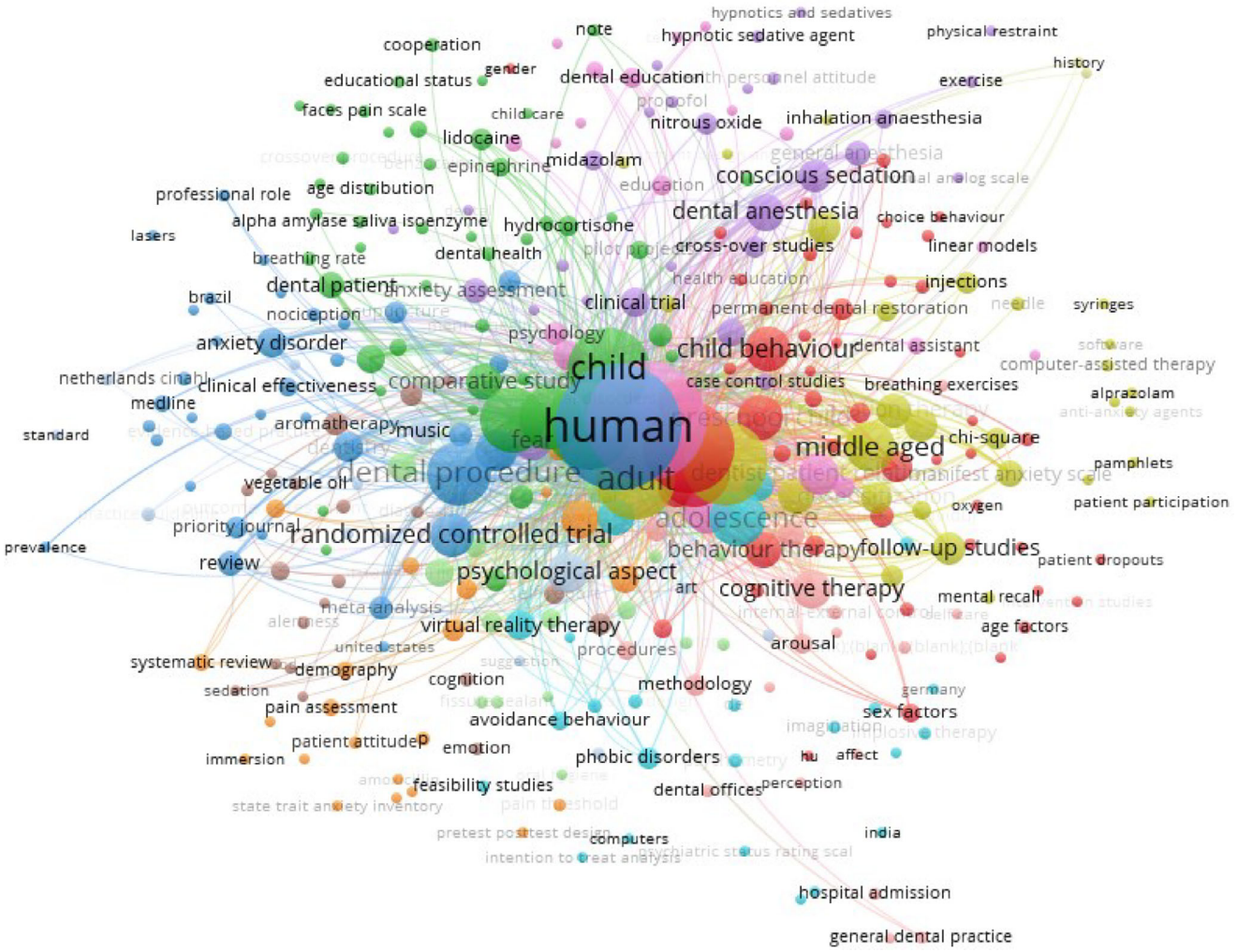


FIGURE 5 | Co-occurrence of all keywords used in publications on nonpharmacological management of DA in general population, 1994–2023.

DA revealed that research efforts have been more substantial in regard to the general population than for individuals with LDs.

In terms of authorship, research on DA involving people with LDs involved only 34 authors, and the resulting network depicted only five interconnected authors. This figure is low, especially compared to the 1162 authors who were involved with the overall set of DA-related publications, with 107 authors showing significant collaborations. This finding indicates significant differences in the quantity and density of collaborations for the two research population groups. Comparing these two networks revealed a disparity in research development and collaboration, with the network for research on individuals with LDs appearing significantly underdeveloped compared to the general population's network.

Moreover, the comparison of keyword co-occurrence yielded valuable insights into research trends and priorities. The research on the general population is characterized by a significant degree of thematic diversity and collaboration among researchers, indicating a well-established and interconnected field. In contrast, research on the LD population demonstrates a stronger and more focused structure, with fewer connections, highlighting critical areas in need of attention. This comparison underscores the urgent need for an expansion in LD-related research.

By building upon the foundation laid by this study, future research endeavors can be strengthened by incorporating the following key suggestions. First, conducting a systematic review and meta-analysis of existing studies would provide a more robust and comprehensive understanding of the effectiveness of various nonpharmacological interventions for DA. Second, fostering interdisciplinary collaborations involving experts from fields like psychology, behavioral science, and educational technology could lead to the development of more holistic and impactful interventions. Last, funding organizations must prioritize research addressing the identified gaps, particularly in regard to diverse populations and implementation challenges. Allocating resources to promote research equity and global knowledge translation would ensure that the benefits of effective interventions reach all those in need, ultimately contributing to a more equitable and healthier world.

This study is limited by the use of only one database, namely Scopus. Another limitation is the use of specific search terms and keywords, which may have limited the findings. Different keywords might have revealed other areas of literature. Finally, while author keywords helped to identify research clusters, incorporating additional science-mapping techniques like co-citation or bibliographic coupling analysis could uncover deeper

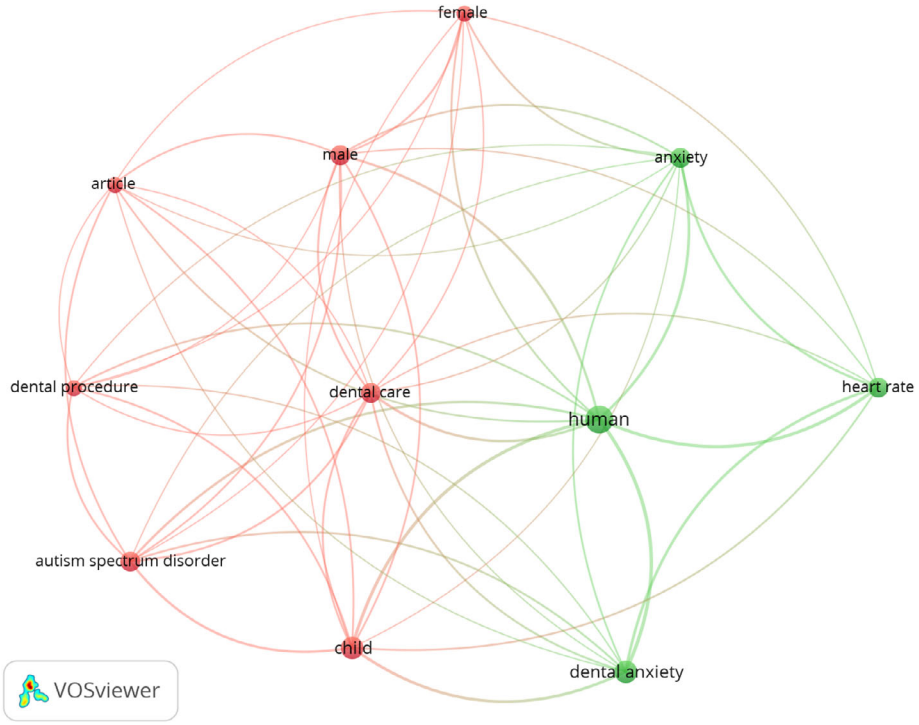


FIGURE 6 | Co-occurrence of all keywords used in publications on nonpharmacological management of DA in LD population, 1994–2023.

connections and research fronts. Despite these limitations, this study represents a valuable starting point for understanding the current research landscape on nonpharmacological interventions for DA. Future research could build a more complete picture by searching multiple databases, exploring alternative keywords, and using a broader range of science-mapping techniques.

This analysis may serve as a catalyst for a thorough reassessment of clinical practices and research strategies. Goals for the future should encompass bridging the gaps disclosed by this investigation both in practice and within the research community. Progress in DA management ought to resonate with and benefit society's most underserved members, particularly individuals with LDs. The dental healthcare sphere can assure more equitable care and enhance oral health outcomes for this population segment through such a dedicated and encompassing approach.

5 | Conclusion

This study found 2058 publications total, 363 publications related to DA, and 11 articles concerning patients with LD. For all publications, the study identified 1429 authors, 5858 total citations, and an h-index of 36. The leading country contributor was the United Kingdom (56 publications), the most productive author was De Jongh (13 publications and 447 citations), and the most highly cited paper was Lehrner et al. (2005; 312 citations).

Author Contributions

The manuscript has been read and approved by all the authors, the requirements for authorship for this document have been met, and each author believes that the manuscript represents honesty and integrity work.

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Conflicts of Interest

The authors declare no conflicts of interest.

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