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Effects of dental treatment under general anesthesia on the oral health quality of life and dental fear of preschool children: a systematic review and meta-analysis

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Abstract

Objectives In this review, we aimed to determine the effects of dental treatment under general anesthesia on the oral health-related quality of life and dental fear of preschool children.

Materials and methods A comprehensive electronic search of PubMed, Embase, Scopus, and the Cochrane Library was conducted up to July 20, 2023 (updated on April 10, 2024). A manual search and evaluation of the gray literature were also performed. Clinical trials utilizing a before-and-after design to evaluate the effects of dental treatment under general anesthesia (DGA) on oral health-related quality of life (OHRQoL) and dental fear in preschool-aged children were included in this research. To assess study quality, tools specifically designed for "before-after studies without control groups" were employed to determine potential biases. Two independent investigators conducted separate evaluations of the studies' quality assessment processes. A meta-analysis was conducted via the random effects model.

Results In the final analysis, 13 studies employing a pre-post design were included. The meta-analysis revealed a statistically significant difference in Early Childhood Oral Health Impact Scale (ECOHIS) scores between the pre-evaluation group ($n=1365$) and the post-evaluation group ($n=1344$) (mean difference [MD] = 9.61, 95% CI: 6.28–12.93; $P<0.00001$). However, there was no significant difference in the mean Children's Fear Survey Schedule-Dental Subscale (CFSS-DS) score between the pre-evaluation group ($n=536$) and the post-evaluation group ($n=531$) (MD = 5.53, 95% CI: -16.48–27.54; $P=0.62$).

Conclusions This study confirmed that children who received dental treatment with general anesthesia experienced improvements in their oral health-related quality of life. However, there is insufficient evidence to support the claim that dental treatment with general anesthesia can effectively alleviate dental fear in children.

Clinical relevance Dental treatment with general anesthesia significantly improved the OHRQoL of children. However, methods to improve dental fear in children during this procedure remain to be explored.

Keywords Dental caries, Dental treatment, General anesthesia, Children, Dental fear

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Introduction

Early childhood caries (ECC) is defined as the presence of one or more decayed (either noncavitated or cavitated lesions), missing teeth (due to caries), or filled tooth surfaces in any primary tooth of a child under the age of six years [1]. ECC is a highly prevalent oral disease that affects preschool children, resulting in significant dental damage, such as tooth decay and tooth loss [2]. In China, the prevalence rates of dental caries among children aged 3, 4, and 5 years according to the 4th National Oral Health Survey are 50.8%, 63.6%, and 71.9%, respectively [3, 4]. Severe early childhood caries (S-ECC) is characterized by any sign of smooth-surface caries in a child younger than three years of age [1]. Additionally, from ages three through five, children with a decayed, missing, or filled score of ≥4 (at age 3), ≥ 5 (at age 4), or ≥6 (at age 5) can also be diagnosed with S-ECC [1, 5]. ECC and S-ECC have been shown to have detrimental effects on growth and development in children [6]. This is primarily due to pain, disrupted sleep patterns, and behavioral alterations resulting from dental issues. It is imperative to provide comprehensive dental treatment for children diagnosed with ECC or S-ECC [6].

Dental fear poses a significant challenge in the clinical management and medical prognosis of dental treatment for children. The prevalence rates of dental fear among children and adolescents range from 13.3 to 29.3% [7]. Children suffering from dental fear frequently display strong negative emotions associated with dental procedures and utilize different strategies to avoid or delay treatment. This behavior can lead to delayed dental treatment, compromised treatment outcomes, and strained relationships between dental professionals and parents [8]. Comprehensive dental treatment with general anesthesia (DGA) is deemed necessary when the following conditions are present: a child is diagnosed with ECC or S-ECC, a high level of dental fear or anxiety, and failure of behavioral management techniques [9–11].

Several studies have reported the effects of DGA on increased growth and improved oral health-related quality of life (OHRQoL), which is a multidimensional construct that includes the evaluation of oral health and the impacts of oral symptoms on functional and emotional well-being [12–15]. Park et al. also confirmed the positive impact of DGA on OHRQoL in children, as evidenced by their meta-review [16]. Nevertheless, since diverse questionnaires have been employed to assess the impact of DGA on children's OHRQoL, considerable methodological heterogeneity was exhibited among these studies [17–20]. Additionally, DGA is not the end of the oral health management of children; we should consider not only the impact of DGA on oral health-related quality of life but also its effects on subsequent oral health management in children, such as dental fear and subsequent behavior management. To control heterogeneity among studies and provide a comprehensive analysis of the effects of DGA on children, this study aimed to assess the impact of DGA on children's OHRQoL via the Early Childhood Oral Health Impact Scale (ECOHIS) [21–24]. Additionally, the Children's Fear Survey Schedule-Dental Subscale (CFSS-DS) was used to investigate the effect of DGA on children's dental fear, which may provide a theoretical foundation for managing oral health after DGA [25–29].

Method

Protocol and registration

This review has been registered in the International Prospective Register of Systematic Reviews (PROSPERO, CRD [CRD42022358313]) and is available for consultation at https://www.crd.york.ac.uk/prospero/display_record.php? ID = CRD42022358313. The systematic review and meta-analysis were conducted following the guidelines provided by the Cochrane Handbook for Systematic Reviews of Interventions and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Selection criteria

The eligibility criteria of this review followed the universal "Patient, Intervention, Control, Outcome" (PICO) criteria: In preschool children, does dental treatment under general anesthesia affect the levels of children's oral health-related quality of life and dental fear compared with pre-treatment levels?

- Population = preschool children.
- Intervention = dental treatment under general anesthesia.
- Compared with = pre-treatment levels of children's oral health-related quality of life and dental fear.
- Outcome of interest = levels of children's oral health-related quality of life and dental fear.

Inclusion criteria

The included articles met the following criteria:

- Patients included in the studies were between the ages of 0 and 6 years.
- Patients included in the studies were diagnosed with ECC or S-ECC.
- Patients included in the studies underwent comprehensive treatment with general anesthesia.
- Studies were conducted to assess pre- and postoperative outcomes via the ECOHIS and the CFSS-DS.
- The articles were original studies with a design similar to that of before-after clinical trials.

Exclusion criteria

- The number of patients included in the studies was less than 10.
- Patients included in the studies were undergoing orthodontic treatment.
- Patients included in the studies were diagnosed with one or more systemic diseases.

Information sources and search strategy

The electronic search of four databases, namely, PubMed, Embase, Scopus, and the Cochrane Library, was conducted between July 2023 and August 2024 (updated on August 10, 2024). The search strategies employed in this study were derived from the information presented in Table 1. The current systematic literature search was further supplemented with data from searches of gray literature and additional studies that the authors identified via a citation search. In the search process, the language, status, and publication data of the articles were not limited. Following the study search, the titles and abstracts of the potential studies were also independently assessed by these two investigators (Huang and Wang). Studies in the form of reviews, case reports, editorials, conference summaries, and correspondences were excluded from consideration. The independent reviewers were

Table 1 Keywords and algorithms used in the search strategy

Electronic databases	Keywords and algorithms
PubMed: 218	#1(("Anesthesia, General"[Mesh]) OR (Anesthesias, General[Title/Abstract])) AND ((("Dental Care"[Mesh]) OR (Dental Care[Title/Abstract])) OR (dental treatment[Title/Abstract]))
	#2 (children[Title/Abstract]) OR (("Child"[Mesh]) OR (Child[Title/Abstract]))
	#3 ((((((("Quality of Life"[Mesh]) OR (Quality of Life[Title/Abstract])) OR (Life Quality[Title/Abstract])) OR (OHRQOL[Title/Abstract])) OR (oral health related quality of life)) OR (OHRQoL[Title/Abstract])) OR ((((((((((("Dental Anxiety"[Mesh]) OR (Dental Anxieties[Title/Abstract])) OR (Anxiety, Dental[Title/Abstract])) OR (Dental Phobia[Title/Abstract])) OR (Fear, Dental[Title/Abstract])) OR (Dentophobia[Title/Abstract])) OR (Dentophobias[Title/Abstract])) OR (Odontophobia[Title/Abstract])) OR (Dental Fear[Title/Abstract])) OR (Dental Fears[Title/Abstract])) OR (Dental Phobias[Title/Abstract]))
	1# AND 2# AND 3#
Embase: 255	#1('dental procedure'/exp OR 'dental procedure' OR 'dental treatment':ti, ab, kw) AND ('general anesthesia'/exp OR 'general anesthesia' OR 'anesthesias, general':ti, ab, kw OR 'general anesthesias':ti, ab, kw)
	#2 'child'/exp OR child OR children: ti, ab, kw
	3# 'dental anxiety'/exp OR 'dental anxiety' OR 'dental anxieties':ti, ab, kw OR 'anxiety, dental':ti, ab, kw OR 'dental phobia':ti, ab, kw OR 'fear, dental':ti, ab, kw OR dentophobia: ti, ab, kw OR dentophobias: ti, ab, kw OR odontophobia: ti, ab, kw OR 'quality of life'/exp OR 'quality of life' OR 'life quality':ti, ab, kw OR 'health-related quality of life':ti, ab, kw OR ohrqol: ti, ab, kw
	1# AND 2# AND 3#
Scopus: 454	#1 (TITLE-ABS-KEY (anesthesia, AND general)) AND ((TITLE-ABS-KEY (dental AND care) OR TITLE-ABS-KEY (dental AND treatment)))
	#2 (TITLE-ABS-KEY (child) OR TITLE-ABS-KEY (children))
	#3 ((TITLE-ABS-KEY (dental AND anxiety) OR TITLE-ABS-KEY (dental AND phobia) OR TITLE-ABS-KEY (fear, AND dental) OR TITLE-ABS-KEY (dentophobia) OR TITLE-ABS-KEY (odontophobia))) OR ((TITLE-ABS-KEY (quality AND of AND life) OR TITLE-ABS-KEY (life AND quality) OR TITLE-ABS-KEY (ohrqol)))
	1# AND 2# AND 3#
Cochrane Library: 127	#1 MeSH descriptor: [Anesthesia, General] explode all trees
	#2 (Anesthesia, General): ti, ab, kw in Trials (Word variations have been searched)
	#3 #1 OR #2
	#4 MeSH descriptor: [Dental Care] explode all trees
	#5 (dental care): ti, ab, kw OR (dental treatment): ti, ab, kw in Trials (Word variations have been searched)
	#6 #4 OR #5
	#7 #3 AND #6
	#8 MeSH descriptor: [Child] explode all trees
	#9 (child): ti, ab, kw in Trials (Word variations have been searched)
	#10 #8 OR #9
	#11 MeSH descriptor: [Dental Anxiety] explode all trees
	#12 (Dental Anxiety): ti, ab, kw OR (Dental Phobia): ti, ab, kw OR (Fear, Dental): ti, ab, kw in Trials (Word variations have been searched)
	#13 MeSH descriptor: [Quality of Life] explode all trees
	#14 (Quality of Life): ti, ab, kw OR (Life Quality): ti, ab, kw OR (OHRQOL): ti, ab, kw OR (oral health-related quality of life): ti, ab, kw in Trials (Word variations have been searched)
	#15 #11 OR #12 OR #13 OR #14
	#16#7 AND #10 AND #15

calibrated according to the inclusion and exclusion criteria using a sample comprising 20% of the retrieved studies. The agreement between the reviewers was good, with a kappa statistic (K) of 0.78. Disagreements were resolved by the third author (Li).

Data extraction and summary measures

Two reviewers (Huang and Wang) independently extracted data via a tested data extraction form. The results of the ECOHIS and CFSS-DS were used as the outcome data. The ECOHIS, consisting of 13 items, was designed to evaluate how parents perceive the impact of their preschool children's oral health on the quality of life for both the child and the family, and it has been translated and validated in different languages [21–24]. The CFSS-DS, developed by Cuthbert and Melamed, is a psychometrically robust scale widely used to quantify dental anxiety in children. This instrument has been employed internationally and is available in various translated versions [30, 31]. The means and standard deviations (SDs) of the scores of these two questionnaires were collected from the included articles. Additional information, such as the first author, publication year, country, age of patients, and details of oral health, was collected.

Risk of Bias assessment

Two independent reviewers (Huang and Wang) assessed the risk of bias, with a K of 0.98. The study quality assessment tools developed by the National Heart, Lung, and Blood Institute of the National Institutes of Health (NIH) were used to evaluate the quality of the included studies. These tools are specifically designed for assessing the quality of "before-after studies with no control group" [32].

Certainty of evidence

Two independent reviewers assessed the certainty of evidence (Huang and Wang) with a K of 0.87. The Grading of Recommendation Assessment, Development and Evaluation (GRADE) system was employed in this process [33, 34].

Statistical analysis

Review Manager 5.3 software was used to conduct the meta-analysis. The scores obtained from the ECOHIS and CFSS-DS are presented as the mean difference (MD) along with the 95% confidence interval (CI). The I^2 test was used to assess statistical heterogeneity. Random effects models were employed for the meta-analyses because significant heterogeneity was detected ($I^2 > 50\%$).

Results

Search results and study characteristics

Thirteen studies with a prepost design were included in this systematic review, and the results of the search are depicted in Fig. 1 [13, 19, 20, 35–44]. Three studies contributed to this meta-analysis multiple times, as both the ECOHIS and the CFSS-DS were used within the same publication.

Two outcomes were obtained: the ECOHIS score and the CFSS-DS score. The characteristics of the studies included in this analysis are presented in Table 2. All of the studies utilized a pre-post design and were nonrandomized studies. All the samples utilized in these studies consisted of patients younger than 6 years. In all the studies conducted, the recruitment of children for the DAG intervention was based on the diagnosis of ECC or S-ECC. Additionally, these children presented high levels of dental fear and/or behavioral management issues during previous dental treatments. Among the 13 studies analyzed, 9 studies provided data on the mean decayed, missing, filled teeth (DMFT) scores of patients, whereas 11 studies reported the implementation of DGA [13, 19, 20, 35–40]. However, studies providing specific information regarding the type of dental treatment are lacking.

Risk of Bias

Table 3 displays the results of the methodological quality assessment following the Quality Assessment Tool for Before-After (Pre-Post) studies with no control group from the NIH. The results were matched, and disagreements were resolved by consensus. Nine studies were classified as "fair", and 4 were classified as "poor".

Certainty of evidence

The certainty of evidence was assessed via the GRADE framework and was found to be very low (details in Table 4). Serious concerns were identified within the risk of bias and inconsistency domains.

Changes in ECOHIS

The studies that reported ECOHIS scores before and after DGA are presented in Table 2. The patients included in these studies were children younger than 6 years. The timeframe for completing follow-up questionnaires ranged from 1 to 4 weeks after the DGA. All of the studies demonstrated a statistically significant reduction in the ECOHIS score. According to the forest plot shown in Fig. 2, the analysis revealed a statistically significant difference in the mean ECOHIS score between the preevaluation group ($n = 1365$) and the postevaluation group ($n = 1344$) (MD = 9.61, 95% CI: 6.28–12.93; $P < 0.00001$). A significant level of heterogeneity ($I^2 = 98\%$) was observed among the studies.

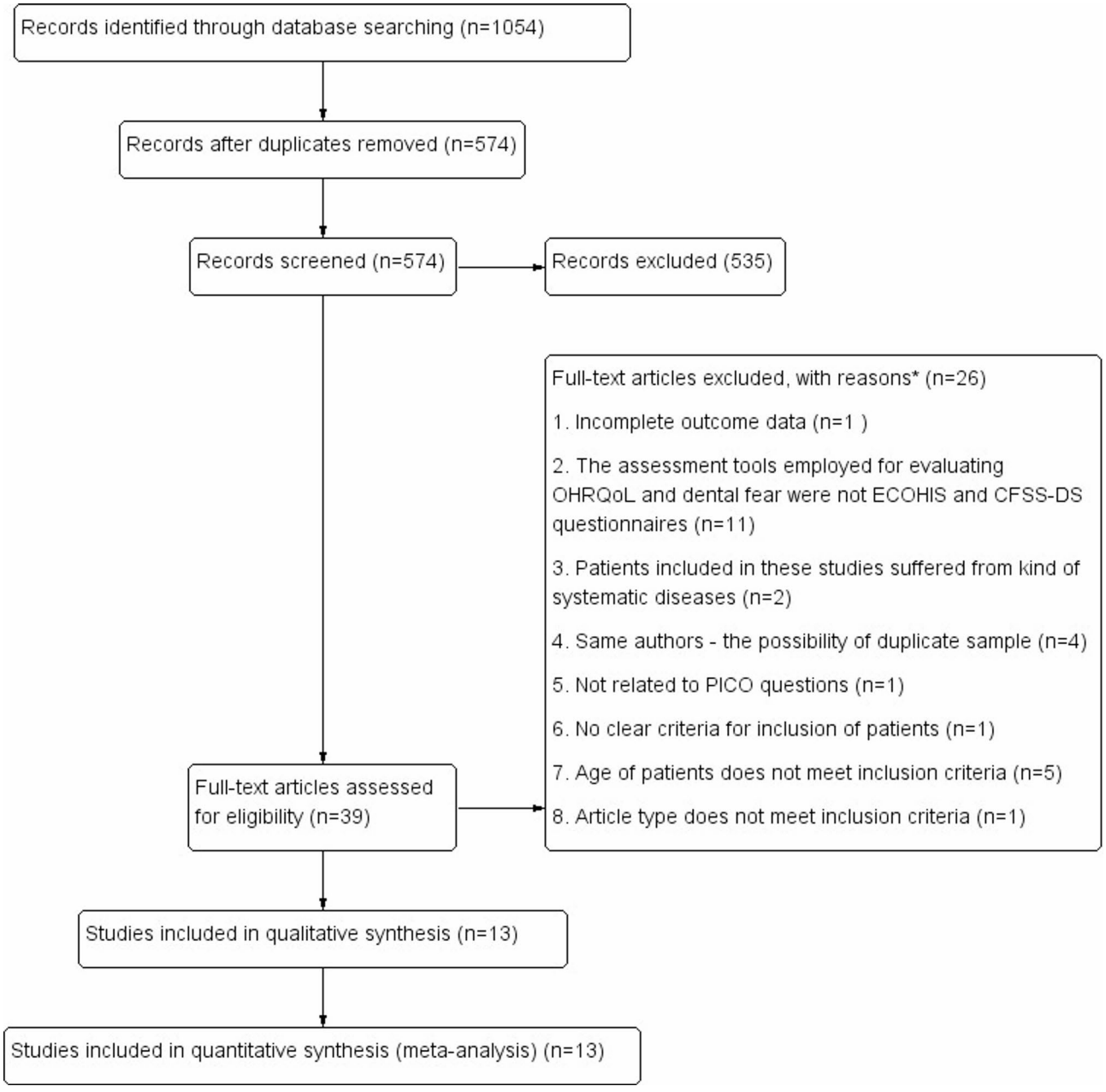

Fig. 1 PRISMA flow diagram for the study search

Changes in the CFSS-DS

The studies that documented the CFSS-DS scores prior to and following the DGA are presented in Table 2. Of the nine studies that were included, three provided CFSS-DS scores both before and after evaluation. Mathew et al. reported a significant reduction in dental fear following DGA [37]. However, contrasting findings were observed in the other two separate studies, which demonstrated no significant improvement in the degree of dental fear.

According to the forest plot shown in Fig. 3, the analysis revealed that there was no significant difference in the mean CFSS-DS score between the preevaluation group ($n = 536$) and the postevaluation group ($n = 531$) (MD = 5.53, 95% CI: -16.48–27.54; $P = 0.62$). A significant level of heterogeneity ($I^2 = 100\%$) was observed among the studies.

Discussion

This meta-analysis revealed a significant association between DGA and improved OHRQoL. However, there is insufficient evidence to support a decrease in dental fear following DGA.

The findings of this study support the notion that DGA has a positive effect on the scores of the ECOHIS

Table 2 Characteristics of the included studies

Author/s; year	Country	Mean age (years)	DMFT score mean (± SD)	Dental treatment
WONG et al. 2016 [40]	Australia	4.02 ± 0.97	8.27 ± 4.13	restorative treatment and/or appropriate extraction
Guney et al. 2019 [36]	Turkey	3–5	NR	restorative treatment and/or appropriate extraction
Boukhobza et al. 2021 [13]	Austria	3.6 ± 1.1	12.4 ± 6.1	restorative treatment and/or appropriate extraction
YAWARY et al. 2015 [35]	Austria	4.08 ± 1.01	9.79 ± 3.17	restorative treatment and/or appropriate extraction
Mathew et al. 2023 [37]	India	4.21 ± 1.37	9.33 ± 4.79	restorative treatment and/or appropriate extraction
Li et al. 2017 [38]	China	5.4	NR	NR
Klaassen et al. 2009 [20]	The Netherlands	4.08 ± 1.09	NR	NR
Cantekin et al. 2014 [51]	Turkey	5.03 ± 1.4	6.87 ± 6	restorative treatment and/or appropriate extraction
Jiang et al. 2019 [39]	China	3.49 ± 0.87	9.44 ± 4.33	restorative treatment and/or appropriate extraction
Alwadani et al. 2023	Saudi Arabia	5.04 ± 1.08	NR	restorative treatment and/or appropriate extraction
Bagis et al. 2023	Turkey	4–6	12.48 ± 2.62	restorative treatment and/or appropriate extraction
Faheem et al. 2023	Germany	3.80 ± 1.11	9.74 ± 3.41	restorative treatment and/or appropriate extraction
Öztürk et al. 2024	Turkey	4.5 ± 1.2	11.1 ± 3.1	restorative treatment and/or appropriate extraction

Extend

Author/s; year	N1	ECOHIS M1 (± SD)	N1′	CFSS-DS M1′ (± SD)	Follow-up (weeks)	N2	ECOHIS M2 ± SD	N2′	CFSS-DS M2′ (± SD)
WONG et al. 2016 [26]	126	29.01 ± 9.8	NR	NR	2	126	19.70 ± 7.3	NR	NR
Guney et al. 2019 [22]	28	15.1 ± 6.7	NR	NR	4	28	6.14 ± 4.8	NR	NR
Boukhobza et al. 2021 [8]	80	14.60 ± 7.71	NR	NR	4	80	9.89 ± 6.34	NR	NR
YAWARY et al. 2015 [21]	39	27.85 ± 9.55	NR	NR	2	39	19.26 ± 8.18	NR	NR
Mathew et al. 2023 [23]	200	21.6 ± 9.5	200	46.6 ± 7.1	2	200	11.2 ± 4.2	200	23.8 ± 5.6
Li et al. 2017 [24]	62	13.1 ± 17.2	NR	NR	4	62	1.9 ± 3.2	NR	NR
Klaassen et al. 2009 [20]	27	12.89 ± 6.39	25	36.4 ± 13.37	4	22	7.38 ± 6.97	20	37.76 ± 11.6
Cantekin et al. 2014 [19]	311	20.6 ± 8.1	311	32.7 ± 9.3	1–3	311	11.5 ± 4.2	311	37.8 ± 11.2
Jiang et al. 2019 [25]	180	10.61 ± 6.71	NR	NR	4	180	2.51 ± 4.01	NR	NR
Alwadani et al. 2023 [44]	37	6.11 ± 1.3	NR	NR	4	37	4.96 ± 0.99	NR	NR
Bagis et al. 2023 [43]	31	25 ± 8	NR	NR	4	31	7.8 ± 3.7	NR	NR
Faheem et al. 2023 [42]	88	16.72 ± 7.07	NR	NR	4	88	0.9(±3.08)	NR	NR
Öztürk et al. 2024 [41]	150	18.1 ± 8.5	NR	NR	4	134	3.1 ± 3.9	NR	NR

*M1 = pre-treatment mean score of ECOHIS; M1′=pre-treatment mean score of CFSS-D; M2 = post-treatment mean score of ECOHIS; M2′= post-treatment mean score of CFSS-D; SD = standard deviation; NR = not reported; DMFT score = the score of decayed, missing, and filled teeth; ECOHIS = early childhood oral health impact scale; CFSS-DS = Child Fear Survey Schedule-Dental Subscale

questionnaire, which has been demonstrated to be a valid and reliable tool for evaluating the influence of oral health on the quality of life of preschool children [45–48]. The findings of the ECOHIS in this review were consistent with the results reported by Park et al. Since their study focused on children and teenagers of all ages, our study enriched the evidence framework of DGA by first offering evidence that DGA improved the OHRQoL of preschool children aged 0–6 years. Given the significant heterogeneity observed in the analysis, we conducted

Table 3 Results of risk of bias assessmen

Questions for assessment	WONG et al. [40]	Guney et al. [36]	Boukhobza et al. [13]	YAWARY et al. [35]	Mathew et al. [37]	Li et al. [38]	Klaassen et al. [20]	Cantekin et al. [19]	Jiang et al. [39]	Alwadani et al. [44]	Bagis et al. [43]	Faheem et al. [42]	Öztürk et al. [41]
Was the study question or objective clearly stated?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Were eligibility/selection criteria for the study population prespecified and clearly described?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Were the participants in the study representative of those who would be eligible for the test/service/intervention in the general or clinical population of interest?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Were all eligible participants that met the prespecified entry criteria enrolled?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Was the sample size sufficiently large to provide confidence in the findings?	NR	No	NR	No	NR	NR	NR	NR	NR	No	NR	No	NR
Was the test/service/intervention clearly described and delivered consistently across the study population?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Were the outcome measures prespecified, clearly defined, valid, reliable, and assessed consistently across all study participants?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Were the people assessing the outcomes blinded to the participants' exposures/interventions?	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in the analysis?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post changes?	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Were outcome measures of interest taken multiple times before the intervention and multiple times after the intervention (i.e., did they use an interrupted time-series design)?	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
If the intervention was conducted at a group level (e.g., a whole hospital, a community, etc.) did the statistical analysis take into account the use of individual-level data to determine effects at the group level?	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

*NA = not applicable; NR = not reported

Table 4 Results of quality assessment across studies

Quality assessment							No of patients		Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Pre	Post		
Oral Health Related Quality of Life (Better indicated by lower values)										
13	observational studies	serious[1]	serious[2]	no serious indirectness	no serious imprecision	none	1365	1344	ÅOOO VERY LOW	CRITICAL
Dental Fear (Better indicated by lower values)										
3	observational studies	Serious[3]	Serious[2]	no serious indirectness	no serious imprecision	none	536	531	ÅOOO VERY LOW	CRITICAL

*1 = High risk of bias in 2 study, moderate risk of bias in 7 studies;

2 = Significant heterogeneity between studies;

3 = Moderate risk of bias in 3 studies

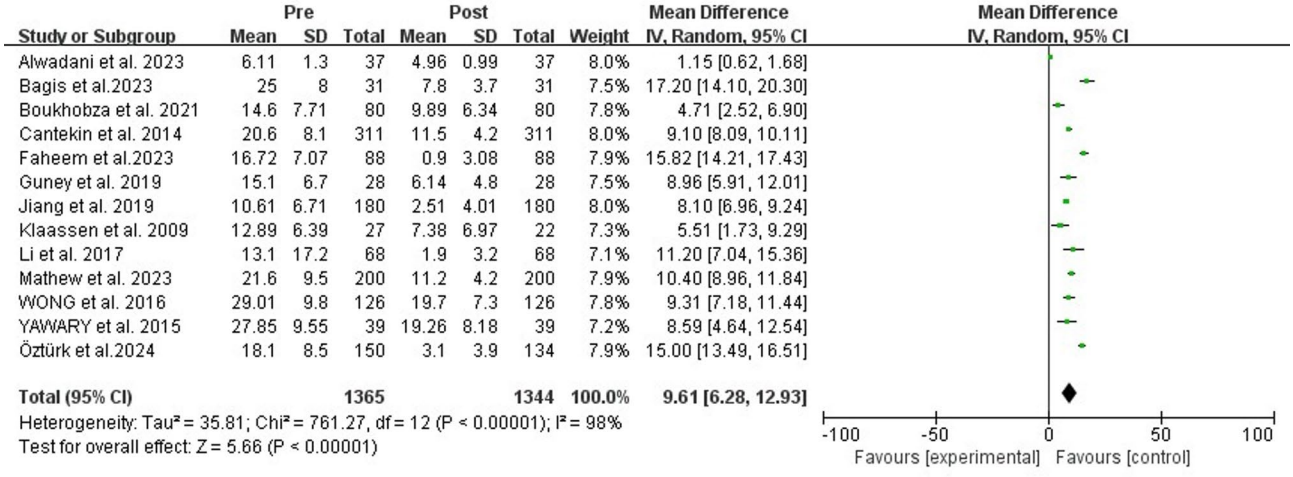

Fig. 2 Forest plot of the distance of OHRQoL

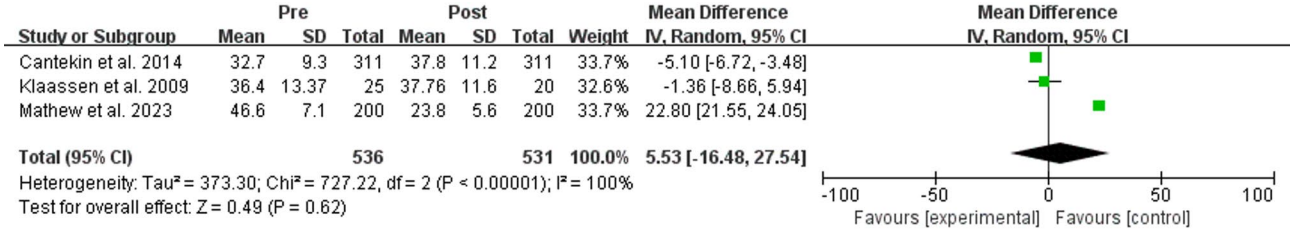

Fig. 3 Forest plot of the distance of dental fear

additional subgroup and sensitivity analyses to identify potential sources of this heterogeneity but were unable to determine the specific causes. However, the heterogeneity observed in the subgroups may be attributed to the following two factors. The participants exhibited varying interpretations of the ECOHIS questionnaire, making it unattainable to recruit samples that possess identical comprehension of the option criteria within the ECOHIS questionnaire on a global scale. Another potential factor could be attributed to the varying conditions of children within the DGA, as well as the lack of explicit information regarding comprehensive dental treatment. The children received various types of dental treatment during DGA on the basis of their individual oral conditions. Therefore, it is unrealistic to anticipate that children would report identical postoperative perceptions following DGA, which may influence their postevaluation of OHRQoL.

Another finding of the systematic review was the initial evaluation of the impact of DGA on children's dental treatment-related fear. The DF-CFSS was used to assess the level of dental fear in children, as examined by the

three studies included in this review. The DF-CFSS has been translated into various versions and has demonstrated strong criterion validity [30, 49, 50]. The findings of this review indicate a lack of sufficient evidence to support the reduction of dental fear following DGA. Significant heterogeneity was observed among the three studies that were included in the analysis ($P < 0.001$, $I^2 = 100\%$).

Several factors may contribute to the large heterogeneity in the changes in children's dental fear following DGA. First, dental fear is a multifaceted issue that may be influenced by various psychosocial factors, such as interpersonal factors, familial factors, and external dental factors [29]. The influence of various factors, such as the age and temperament of children, anxiety levels, socioeconomic status of the family, and previous dental experience, on the outcomes of the CFSS-DS has been reported [29]. Although the ages of the children were readily obtained by the investigators who conducted these three studies, a majority of the potential factors that could impact children's dental fear were ignored. As a result, establishing the consistency of these potential factors at baseline across studies was challenging, which may have led to significant heterogeneity when comparing the variation in dental fear across studies with limited information.

Another potential factor could be the postoperative discomfort experienced following DGA. Postoperative discomfort, such as emergence agitation (EA), throat irritation, nausea, and vomiting associated with GA, as well as bleeding and difficulties in chewing due to dental treatment, has been reported to contribute to an unpleasant experience following DGA [51]. For example, a notable occurrence of emergence agitation (EA) and its significant association with both dental extraction and the duration of anesthesia has been reported by Jiang et al. and Chao et al. [39, 52]. Since the children who subjected to complex or prolonged dental procedures tend to experience a higher rate of EA, they may report a greater level of dental fear than those who have undergone only straightforward treatments of brief duration. Despite the lack of specific information regarding dental treatment in the majority of existing studies, it is widely acknowledged that each child receives individualized dental treatment on the basis of their own conditions across various studies. The lack of consistency in treatment plans may result in significant heterogeneity in the evaluation of changes in dental fear across various studies.

Third, the time interval of postoperative collection of the CFSS-DS varied across the 3 included studies, which may have contributed to significant heterogeneity and led to insignificant results. Although several studies have reported dynamic changes in OHRQoL following DGA, few studies have examined long-term alterations in dental fear following DGA [19, 20, 53]. Owing to the varying findings of studies investigating long-term changes in dental fear after dental general anesthesia (DGA), it is essential to conduct more high-quality longitudinal research to gain a clearer understanding of how DGA impacts dental fear. In addition, we concur with the research conducted by Klaassen et al., which emphasized that dental general anesthesia (DGA) alone may not be sufficient to alleviate children's dental fears, and highlighted the importance of post-DGA guidance and behavioral therapy [20].

In the GRADE assessment, we found that inconsistencies among studies, as shown by the high I^2 value, were the greatest reason for the downgrading. Greater consistency is needed with regard to the detailed data of oral examination at baseline and therapeutic schedule, so that systematic review authors can rely on the data with controlled inconsistency and heterogeneity.

The main strength of this review is that it not only focuses on changes in children's quality of life after DGA but also explores the potential effects of DGA on subsequent oral health management in children. We suggest that DGA should not be considered the final step in comprehensive dental treatment. In contrast, DGA should be regarded as a comprehensive treatment option with significant potential. Instead of a singular procedure, comprehensive DGA should consist of a series of integrated approaches for managing oral health. This includes implementing efficient methods to help children relax before DGA, providing comprehensive dental treatment during surgery, and ensuring proper postoperative care and follow-up. Hypnosis, sedation (nitrous oxide and midazolam), audiovisual distraction, video modeling, and audiovisual glasses have been documented as techniques employed in dental clinics as alternatives to DGA [54, 55]. Regrettably, these methods were consistently disregarded during the implementation of DGA.

However, there are several limitations. The 13 studies included in the review expanded the application of the CFSS-DS [25–29]. Although various studies have demonstrated robust reliability and validity of the CFSS-DS across an extended age range, this broader application could impact outcomes related to children's dental fear. Second, this study was limited by the lack of specific details regarding dental treatment and potential factors influencing dental fear in the included articles. Consequently, it is imperative to conduct more comprehensive studies that not only examine clinical outcomes but also explore the treatment process and management of dental fear.

In conclusion, this study demonstrated that children who underwent DGA experienced an improvement in OHRQoL. Insufficient evidence supports the claim that DGA can effectively alleviate dental fear in children. While the use of DGA is often practical for pediatric dentists and families, the potential complications associated

with DGA should not be overlooked. Cantekin et al. report a 59% incidence of postoperative issues, including emergence agitation (EA), throat irritation, nausea, vomiting related to general anesthesia, and bleeding following tooth extraction [56]. Consequently, DGA should not be the primary option for children's dental treatment. Parents and caregivers are encouraged to seek early dental care to prevent the progression of oral conditions and the need for complex dental procedures, which can heighten children's fear and anxiety regarding dental visits. Pediatric dentists should prioritize minimally invasive interventions when treating children. DGA should be considered only when basic management techniques are ineffective, and the decision to use DGA must be made with caution. During DGA, it is crucial to implement standardized, systematic protocols to ensure the effective restoration of masticatory function, aesthetics, and speech improvement, thereby enhancing the OHRQoL for these uncooperative children.

Conclusion

Children who received dental treatment with general anesthesia reported improved OHRQoL. However, the effect of DGA on subsequent oral health-related behaviors in children was almost ignored in the present study. There is insufficient evidence showing the relationship between DGA and the alteration of dental fear. Clinical trials focusing on the alteration of dental fear are needed to demonstrate the potential influence of DGA on dental fear and further oral health-related behaviors in children. Instead of resorting to DGA, prioritizing early dental care and adhering to standard treatment protocols is crucial for preventing (S-ECC and avoiding complex treatment interventions. When DGA becomes the final option for children who cannot undergo conventional procedures, it is essential to implement standardized and systematic DGA protocols. This approach aids in restoring children's dental health and provides a chance to rebuild confidence for children to receive subsequent dental care during their childhoods and lives.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

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Author contributions
TH designed the methodology, conducted investigations, curated data, wrote the original draft, revised and edited the manuscript, and supervised the research. JCL contributed to critical manuscript revision and conducted extensive literature. CRL established the methodology, executed investigations, and managed data curation. ZHW formulated the methodology, carried out investigations, and organized data curation. All authors reviewed the manuscript.

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Declarations

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Not applicable.

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