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SYSTEMATIC REVIEW

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Application of cognitive behavioral therapy and behavioral modification therapy in pediatric dental anxiety: a systematic review

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Abstract

Background: Pediatric dental anxiety (DA) is a common problem which impacts children's cooperation during dental procedures and hampers long-term oral health outcomes. Effective DA management is crucial for the positive dental experiences and regular dental care visits among children. Most randomized controlled trials (RCTs) suggest that psychotherapy, particularly the cognitive behavioral therapy (CBT) and behavioral modification therapy (BMT), is conducive in alleviating DA. This systematic review aims to evaluate CBT and BMT in managing pediatric DA via the comprehensive assessment of RCTs. **Methods**: Multiple electronic databases including Cochrane Oral Health Group's Trials Register, Web of Science, PubMed, and EMBASE via Ovid were systematically searched from January 2000 to October 2023. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed for the search. Eligible studies were the RCTs assessing CBT or BMT interventions for pediatric DA. The outcomes included validated measures of anxiety and physiological parameters. Two reviewers independently examined the study selection, data extraction, and risk of bias assessment. The discrepancies were resolved with consensus. **Results**: Fourteen RCTs met the inclusion criteria with 11 focusing on BMT and 3 on CBT interventions. Most studies showed favorable impact of psychotherapy in reducing DA, however, there were methodological limitations such as lack of blinding and small sample sizes. The outcome measures included validated scales for DA assessment and parameters like heart rate and blood pressure. **Conclusions**: CBT and BMT may alleviate pediatric dental anxiety, however existing studies demand cautious interpretations because of methodological limitations. Future studies should prioritize high-quality RCTs with larger number of samples and effective methodologies to enhance interventions' efficacy in pediatric dental care. **The PROSPERO Registration**: The systematic review protocol was registered in PROSPERO (ID: CRD 42024524307).

Keywords

Cognitive behavioral therapy; Behavior therapy; Dental anxiety; Systematic review; Randomized controlled trial

1. Introduction

The positive cooperation of children is critical to achieve desired outcomes in pediatric dentistry [1]. However, the invasive nature of dental treatments coupled with children's limited language skills, comprehension, and self-control lead to resistance and non-cooperation during these procedures [2, 3]. Dental anxiety (DA) in clinical settings is common among children. It is characterized by strong aversion to certain aspects of dental treatment [4, 5]. This results in psychological fear, anxiety, and tension, which lead to decreased tolerance, increased sensitivity, and resistance to the treatment [6]. DA affects the diagnosis and treatment in pediatric dental care. It poses challenges for dental practitioners. It is a major barrier for children in seeking and continuing dental care [1]. Additionally, early experiences of DA may lead to continued fear into the adulthood [7, 8].

Literature indicates that DA affects 23.9% to 74.3% children [9–11]. It is a daily challenge for pediatric dentists to effectively confront DF. The medical and dental healthcare system demands the evaluation of treatment modalities for various diseases. The best treatment should routinely be used based on efficacy, cost, and patient-related outcomes [12]. Furthermore, it is crucial to cease the usage of ineffective treatments [13]. The gold standard for evaluating healthcare technologies involves systematic reviews with stringent protocols such as

examining literature regarding treatments and methodologies [14]. Randomized Controlled Trials (RCTs) provide conductive evidence of the effectiveness of various intervention [15]. DA is treated to either diminish it or support regular dental treatment in short and long run [16]. Behavioral interventions in dental settings use the principles of cognition, social learning, and learning theories [17]. Behavioral Modification Therapy (BMT) and Cognitive Behavioral Therapy (CBT) are the trusted psychotherapeutic approaches for treating anxieties related to specific situations [18–20].

BMT and CBT efficacies can be attributed to their principles based on psychological theories [21, 22]. CBT identifies and modifies maladaptive thoughts and behaviors associated with anxiety. It helps patients in changing their fear and stress towards dental treatment [23]. Patients are given better understanding of the root cause for anxiety, and teach positive coping mechanisms for its alleviation [24]. BMT uses reinforcement and conditioning to gradually change patients' behavior patterns via motivation and rewards [25]. This progressive behavior adjustment assists patients in overcoming dental treatment fear and establishing positive associations and experiences [26]. These two treatment methods are appropriate for pediatric DA because they target the anxiety and teach effective ways to alter behavioral responses through positive reinforcement.

This study aims to investigate the efficacy of behavioral interventions for DA in children. BMT and CBT are described in the articles as types of behavioral interventions for assessing DA treatment. The usefulness of BMT and CBT is thus evaluated.

2. Material and methods

This systematic review was registered in PROSPERO (ID: CRD 42024524307). The framed research question was "What is the effect of CBT and BMT on DA?". The 2020 version of Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were adhered in conducting and reporting of this systematic review (**Supplementary Table 1**). A rigorous approach using Consolidated Standards of Reporting Trials (CONSORT) checklist guidelines was employed [24]. This research was based on experimental clinical trials. Patient selection and the internal and external validities of trials were verified through stringent standards.

2.1 Inclusion criteria

Inclusion criteria were based on the Patient, Intervention, Comparison, Outcome (PICO) approach [27]. The criteria included: recorded presence of severe DA in study population as assessed by valid psychometric scales or by meeting the DA criteria [18]; interventions were based on BMT/CBT where BMT included methods like tell-play-do (TPD), biofeedback therapy, virtual reality (VR), audiovisual distraction (AD), and relaxation training (RT), while CBT employed traditional CBT and self-help CBT; the control condition, specifically placebo/no treatment or the conventional tell-show-do (TSD) method; outcome variables included the degree of DA (measured by valid scales), heart rate (HR), pulse, blood pressure, *etc.*; and the study design using RCTs. The valid self-report scales used for assessing DA in this study were comprised of the Facial Image Scale (FIS), Venham Picture Test (VPT), Children & Fear Survey Schedule Dental Subscale (CFSS-DS), Modified Child DA Scale (MCDAS), and Behavioral Avoidance Test (BAT).

Exclusion criteria ensured the selection of most relevant studies pertaining to research question. Studies not adhering to the following criteria were excluded: devoid of focus on pediatric DA as the primary outcome; lack of CBT or BMT interventions; lack of RCT design; non-English publications; duplicate articles or overlapping data from same study; and studies with inadequate reporting of outcomes or method details. Studies involving population of severe cognitive impairment or other comorbidities that could confound results' interpretation were excluded. The exclusion criteria were implemented during initial screening of titles and abstracts, and at the full-text assessment stage to ensure the selection of relevant studies.

2.2 Literature search and screening

Search strategy: The search encompassed electronic databases including the Cochrane Oral Health Group's Trials Register, Web of Science, PubMed, and EMBASE via Ovid from January 2000 to October 2023. Only English publications were considered for the study A pre-established search strategy was employed in the search procedures: ("DA" OR "Dental Anxieties" OR "Dental Fear" OR "Dental Fears" OR "Odontophobias" OR "Odontophobia" OR "Dental Phobias" OR "Dental Phobia" OR "Dental Phobic" OR "Dental Phobics") AND ("Behavior Therapy" OR "Behaviour Therapy" OR "Behavior Therapies" OR "Behaviour Therapies" OR "Behavior Treatment" OR "Behavior Treatments" OR "Behavioral Therapy" OR "Behavioral Therapies" OR "Behavioural Therapy" OR "Behavioural Therapies" OR "Behavioral Treatment" OR "Behavioral Treatments" OR "Cognitive Behavioral Therapy" OR "Cognitive Behavioral Therapies" OR "Conditioning Therapy" OR "Conditioning Therapies" OR "Cognitive Behavior Treatment" OR "Cognitive Behavior Treatments" OR "Behavior Modification" OR "Behavior Modifications" OR "Cognitive Behavior Therapy" OR "Cognitive Behavior Therapies" OR "Cognitive Behavioral Treatment" OR "Cognitive Behavioral Treatments" OR "Cognitive Psychotherapy" OR "Cognitive Therapy" OR "Cognition Therapy" OR "Psychologic Desensitization" OR "Psychological Desensitization" OR "Mindfulness" OR "Implosive Therapy" OR "Flooding Therapy" OR "Exposure Therapy" OR "Meditation") AND ("Kids" OR "Kid" OR "Children" OR "Child" OR "Teenager" OR "Teenagers" OR "Adolescent" OR "Adolescents"). A comprehensive search strategy used for each database had been provided in **Supplementary material** (**Supplementary material 2**). Data collection process for this systematic review adhered to the PRISMA 2020 guidelines. Two review authors independently screened articles based on titles and abstracts. Subsequently, full-text screening of selected articles was conducted. Two independent reviewers collected data from selected articles using standardized data extraction form. Consensus on study inclusion, data extraction, and bias assess-

ment was reached through discussion. The study authors were contacted for clarification or missing information. The data collection process did not use automation tools.

2.3 Quality rating of individual studies

The scrutinized literature underwent thorough evaluation for academic rigor using RCT checklist [28]. This approach was aligned with the methods adopted by health technology assessment (HTA) centers worldwide, and also consistent with the CONSORT checklist guidelines [29]. The assessment considered both external and internal validities, as well as the study precision [28]. The queries covered aspects such as the study population criteria (inclusion and exclusion pre-randomization), intervention allocation (methodology and execution of randomization), randomization outcomes (comparison of groups on significant variables), blinding protocols (involving patients, treatment providers, and evaluators), dropout details (numbers and reasons), adherence to treatment protocols, evaluation of primary and secondary outcomes and potential complications (predefined and thoroughly reported), and results' accuracy and thoroughness (comprehensive reporting and analysis of statistical power). Responses to these queries had three quality levels (low, moderate and high) as per the standards of CONSORT checklist guidelines.

Minimum of two reviewers individually assessed the included articles and the evidence for specific outcomes. All authors had consensus on overall assessments. The disagreements were mutually resolved. Rigorous methods were employed to address discrepancies in study selection and data extraction. Independent discussions aiming to reach consensus on specific issues were made upon disagreements Third reviewer facilitated consensus through negotiations if discussions failed to resolve disputes. Decisions made through discussion and negotiation minimized the biases and errors.

2.4 Data presentation

Tabular and visual displays were used to present results of individual studies and syntheses, which facilitated comparison and interpretation. Results utilized narrative approach by considering therapeutic effects of CBT and BMT in pediatric DA. Meta-analysis was not conducted because of the heterogeneity in study designs and outcome measures.

3. Results

After removing duplicates, a total of 1528 articles were identified with 1398 abstracts excluded. Remaining 130 articles were evaluated wherein 116 got excluded. Fourteen articles were thus included in current analysis. The literature search process and screening is depicted in Fig. 1.

3.1 Study characteristics

Fourteen RCTs publications were scrutinized through systematic literature review [30–43] by following the inclusion criteria. Eight studies were conducted in India [30–34, 38, 39], two in China [42, 43], two in Iran [37, 41], one in UK [35], one in Sweden [36], and one in Saudi Arabia [40].

All fourteen publications assessed therapeutic effects on DA through valid indicators (Table 1). Nine assessed the therapeutic effects on DA with heart or pulse rate [30–34, 38–40, 43], six using VPT [32, 34, 37, 39–41], five using CFSS-DS [31, 36, 37, 42, 43]. two using FIS [30, 41], and two using Modified Child DA Scale (MCDAS) [33, 35]. Table 1 lists the general and methodological characteristics of included studies (more details in **Supplementary material 3**).

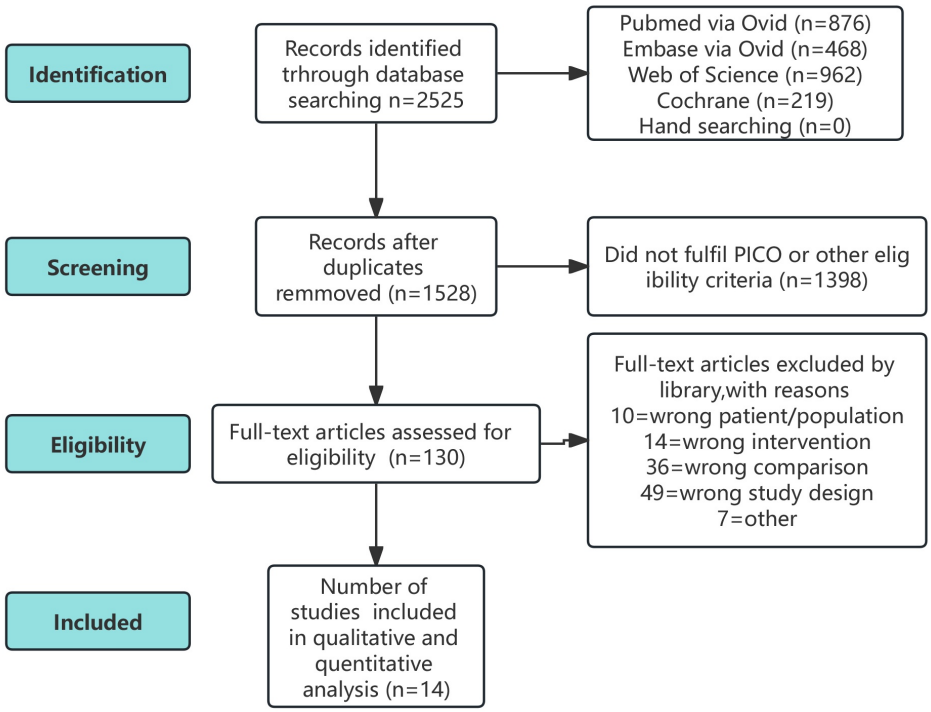

FIGURE 1. Study flow diagram for the selection and screening of the literature.

TABLE 1. Summary of included studies.

Study	Year	Country	Intervention	BMT or CBT	Number of patients		Withdrawals and dropouts		Age	
					Intervention	Control	Intervention	Control	Intervention	Control
1	2019	India	Bubble breath exercise	BMT	33	33	Unclear	Unclear	Unclear	Unclear, $p = 0.06$
2	2016	India	The video output of the dental operating microscope (DOM)	BMT	45	45	Unclear	Unclear	Unclear	Unclear
3	2015	India	Audio and audiovisual distraction	BMT	10	10	Unclear	Unclear	Unclear	Unclear
4	2015	India	Audiovisual distraction with 3D video glasses	BMT	30	30	0	0	8.23 ± 1.10	8.67 ± 1.60
5	2014	India	Biofeedback therapy	BMT	20	20	Unclear	Unclear	Unclear	Unclear
6	2009	UK	Treatment modelling intervention	BMT	36	37	9	11	7.99	7.62, $p = 0.34$
7	2016	Sweden	Cognitive behavioral therapy (CBT)	CBT	13	17	2	1	10.00 ± 3.00	10.00 ± 3.00
8	2015	Iran	Cognitive behavioral therapy (CBT)	CBT	15	15	0	0	4.92 ± 0.95	5.15 ± 0.86
9	2023	India	“Tiny dentist” game	BMT	78	78	0	0	5.50 ± 1.10	5.80 ± 4.60, $p = 0.57$
10	2023	India	Monaural beats; binaural auditory beats	CBT	15, 15	15	Unclear	Unclear	8.80 ± 2.10, 9.50 ± 2.10	8.60 ± 2.60, $p = 0.17$
11	2023	Saudi Arabia	Virtual reality distraction	BMT	18	18	Unclear	Unclear	9.10 ± 2.60	10.10 ± 2.80, $p = 0.25$
12	2023	Iran	Audio-visual storytelling; “tell-show-do” (TSD) technique	BMT	15, 15	15	Unclear	Unclear	7.80; 7.46	7.60
13	2022	China	A digital intervention using virtual reality helmets	BMT	43	43	2	1	6.30 ± 3.50, $p = 0.06$	
14	2020	China	Experiential learning	BMT	473	515	67	74	Unclear	Unclear

BMT: behavioral modification therapy.

3.2 Evaluation of "rating of quality"

The studies were categorized as low, moderate, and high quality for summarizing the overall assessment of BMT/CBT effectiveness in treating pediatric DA. The classification was based on the following perspectives: study population criteria, intervention allocation, randomization outcomes, blinding protocols, dropout details, adherence to treatment protocols, evaluation of primary and secondary outcomes, potential complications, and the results' accuracy and thoroughness. The information regarding dropout details [35, 36, 39–41] and blinding [30, 32, 40, 41] was often missing or incomplete, the quality of this domain was thus low (Figs. 2,3). Measures of secondary outcomes were missing in some studies [35, 38, 42], the quality in this domain was also low. The study by Bagher *et al*. [40] was of high-quality regarding randomization results as it compared the demographic characteristics and dental history of participants at the baseline (Figs. 2,3).

3.3 Synthesis of results

Most of included studies demonstrated that appropriate CBT or BMT is conducive for alleviating DA. However, Howard *et al*. [35] found that a method of BMT, *i.e.*, the passivity to activity through live symbolic, was ineffective in reducing pediatric DA.

4. Discussion

Addressing dental anxiety in children has always been focused, which indicate its significance in pediatric dentistry.

The traditional sedatives and anti-anxiety medications have been clinically efficient, however their administration in pediatric patients requires dosage control. Excessive doses may cause adverse reactions and severe consequences [44–46].

Literature provides alternative methods for managing non-cooperative patients during dental procedures. They include techniques like distractions (audio, audiovisual, virtual reality, instruments' camouflaging, biofeedback, dental operating microscope, toys), hypnosis, computerized anesthesia, *etc*. [47–50].

Psychological therapies can also assist patients in coping dental surgery, overcoming anxiety and fear, and independently confront future dental treatments [51]. Pharmacological sedation provides temporary relief and treatment. Psychological therapies should thus be considered as the primary method for long-term control and alleviation of DA [52, 53]. Common psychological therapy interventions have two categories: BMT, which includes TPD method, biofeedback therapy, virtual reality, audiovisual distractions, and relaxation training; and CBT, comprising traditional CBT and self-help CBT [20, 54, 55].

The primary finding of this systematic review suggests that CBT/BMT interventions can be effective in treating DA. They reduce DA and increase the chances to accept dental procedures. However, the quality of evidence is low or very low as per the rigorous assessment criteria of CONSORT system. The research design of each publication included herein contribute to these results. Despite only incorporating RCTs, serious procedural violations are identified pertaining to the evaluation principles acknowledged for such study designs. Issues encountered in these studies include lack of blinding, limited sample sizes, and insufficient information on randomization procedures. Violating these RCTs characteristics lead to lower

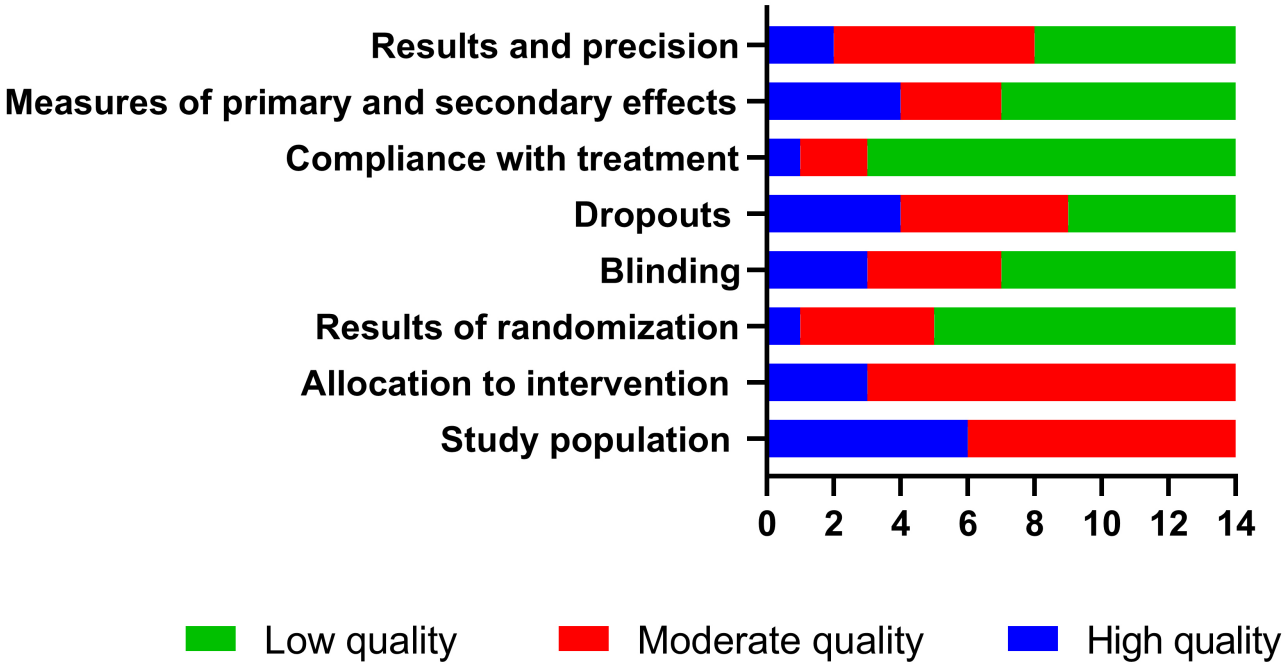

FIGURE 2. Quality assessment graph: review authors' judgments about each quality assessment domain presented as number across all included studies.

FIGURE 3. Quality assessment summary: review authors' judgments about each quality assessment domain for each included study. Green: high quality; Yellow: moderate quality; Red: low quality.

study quality even to moderate level.

No systematic review to the best of our knowledge has been published to explore BMT/CBT effects on DA according to strict CONSORT criteria. Fourteen articles are identified by following the standardized exclusion procedure [30–43]. All included studies report acceptable patient populations, specifically the pediatric DA population. Control groups consist of either no treatment or patients receiving traditional TSD methods. This is crucial for comparing the outcomes and efficacies of various interventions. Comparing these studies also points out an issue. Despite authors consider CBT or BMT series programs as the core treatments, there are differences in specific behavioral treatment protocols. Furthermore, most studies included herein are from Asian countries which may reduce the generalizability to other populations.

Patients in this study are children where most show improvement in DA during treatment. The long-term efficacy of psychological therapies is not mentioned in any study. Treatment experiences during childhood may influence the DA prevalence in adulthood. Further research is required to investigate whether CBT/BMT can reduce DA in adulthood. Treatment methods evaluated in this study target severe DA populations. Prioritizing this subset of population seems reasonable [56, 57]. However, it is vital to alleviate DA in ones with anxiety and also in regularly receiving dental treatments without severe anxiety reactions [58]. This will minimize the negative impact on dental health behaviors including the avoidance of dental care [59].

Well-designed studies are lacking as the knowledge gaps have been identified in this systematic review. Investigations are required for clinically relevant outcomes (life quality, oral health-related life quality, dental care acceptance, and dental health status), treatment complications, and long-term follow-up.

Future research must focus on long-term follow-up studies to assess the lasting efficacies of CBT and BMT in managing

pediatric DA. These studies can track patients over several months to years, and evaluate changes in anxiety levels, oral health behaviors, dental visit patterns, and overall life quality. Furthermore, works required to explore effectiveness of interventions in populations including culturally diverse communities and children of varying backgrounds or special healthcare needs. This will assist in tailoring the interventions according to specific needs of multiple groups. Researchers should prioritize methodological rigor and transparency to improve study quality by implementing robust blinding and adhering to standardized reporting guidelines like CONSORT. Systematic documentation of dropout rates and the underlying reasons is essential for the accurate results' interpretation. Investigating long-term effects of CBT and BMT interventions towards adulthood can provide insights into preventing and managing DA across the lifespan. Longitudinal studies tracking patients from childhood to adulthood can identify the factors contributing to anxiety persistence or remission, and guide about the conducive intervention strategies.

5. Conclusion

CBT and BMT have emerged as the promising interventions for addressing pediatric dental anxiety. Based on this systematic review, clinicians should incorporate CBT and BMT into treatment plans to help children overcome DA. However, it is important to consider the limitations of study findings and to update relevant knowledge for optimal care services. Despite evidence suggest their efficacy in reducing anxiety levels and facilitating acceptance of dental procedures among children, the overall evidence quality remains limited because of the constraints in study design and execution. Nonetheless, this systematic review highlights the potential benefits of psychological therapies in managing pediatric DA. Future research should prioritize study quality via robust methodologies including long-term follow-up assessments and evaluation of clinically relevant outcomes. Such investigations will further elaborate the role and effectiveness of CBT and BMT in pediatric DA management. The findings will further inform about clinical practice and thus improve patient outcomes.

ABBREVIATIONS

DA, dental anxiety; RCTs, randomized controlled trials; CBT, cognitive behavioral therapy; BMT, behavioral modification therapy; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; CONSORT, Consolidated Standards of Reporting Trials; PICO, patient, intervention, comparison, outcome; TPD, tell-play-do; VR, virtual reality; AD, audiovisual distraction; RT, relaxation training; TSD, tell-show-do; HR, heart rate; FIS, Facial Image Scale; VPT, Venham Picture Test; CFSS-DS, Children & Fear Survey Schedule Dental Subscale; MCDAS, Modified Child DA Scale; BAT, Behavioral Avoidance Test; HTA, health technology assessment.

AVAILABILITY OF DATA AND MATERIALS

The data are contained within this article. More details could be found in the **Supplementary material**.

AUTHOR CONTRIBUTIONS

CXZ and WYW—designed the research study. CXZ, DHZ and WYW—performed the research; wrote the manuscript together. WYW—provided help and advice on data screening, figure drawing and article structure. CXZ—analyzed the data. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Not applicable.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.jocpd.com/files/article/1917110886106841088/attachment/Supplementary%20material.zip.

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