



# OPEN Determinants of pediatric dental anxiety after comprehensive dental treatments under general anesthesia

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Providing dental treatment to young patients can pose challenges in certain circumstances, particularly when they experience anxiety about dental procedures. For this reason, general anesthesia (GA) is preferred as an alternative treatment for performing dental treatments on children. On the other hand, the use of general anesthesia could potentially increase the risk of developing dental anxiety complications. This study was aimed to explore determinants of pediatric dental anxiety after comprehensive dental treatments under general anesthesia (CDT-GA). In this prospective study, 80 healthy children aged 3 to 10 years who required CDT-GA were enrolled in 2023. Demographic information and treatment checklist (duration of GA, the number of fissure sealants, restorations, pulpectomies, pulpotomies, crowns, and extractions) were completed for each child. The standardized MCDAS-f (Modified Child Dental Anxiety Scale;- Faces Version) questionnaire was used to measure dental anxiety before GA, 7 days after GA, and 14 days after GA. Data were analyzed by SPSS 26 software, repeated measure analysis, and linear regression. The results of the study showed that dental anxiety significantly decreased 14 days after CDT-GA ( $P = 0.013$ ) compared to before CDT-GA ( $P < 0.001$ ). Additionally, anxiety before CDT-GA had a significant direct effect on anxiety levels on days 7 ( $P < 0.001$ ) and 14 ( $P < 0.001$ ). Other factors, such as the duration of GA, the number of treatments performed, age, and gender, did not have a significant effect on anxiety levels on days 7 and 14. Dental anxiety significantly decreases after CDT-GA, and this reduction is strongly influenced by the level of anxiety before CDT-GA. These findings highlight the importance of addressing preoperative anxiety to minimize postoperative anxiety and improve the overall dental experience for pediatric patients.

**Keywords** Dental treatment, General anesthesia, Psychological complications, Pediatric dentistry, Dental anxiety, Dental care

The widespread fear of dental procedures among children is considered a significant public health matter in several nations. Managing multiple treatments for children who refuse to cooperate is a major challenge. Therefore, comprehensive dental treatments under general anesthesia (CDT-GA) is often preferred as a viable treatment option for very young children, individuals with physical, mental, cognitive, or emotional disabilities, and those who face severe anxiety that necessitates significant rehabilitative care<sup>1,2</sup>.

In recent years, there has been an increase in public knowledge regarding CDT-GA, which has contributed to its widespread approval. CDT-GA provides numerous advantages, such as enhanced safety, increased efficiency, improved comfort, and superior quality in both restorative and preventive dental treatments<sup>3</sup>. The application of CDT-GA enables the completion of dental treatments in a single session, effectively minimizing discomfort for the patient, their parents, and the dental team<sup>2</sup>.

Many research efforts have concentrated on the non-psychological consequences of CDT-GA; nevertheless, some studies evaluated psychological complications that can develop after CDT-GA<sup>4,5</sup>. Findings from these researches highlight that the incidence of psychological complications is notably high among children who

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experience prolonged or multiple CDT-GA<sup>6–8</sup>. Zhang et al. reported that increased duration of CDT-GA is associated with a higher risk of postoperative pain, as well as heightened feelings of fatigue and lethargy. However, the analysis was restricted to short-term complications that manifested within a 72-hour duration<sup>9</sup>. According to the findings of Farsi et al., 24% of children showed signs of psychological changes, and there was a significant association between the duration of anesthesia and the psychological issues that manifested after the surgical procedure<sup>10</sup>. Ghafournia et al. found that the most critical psychological disturbances occurred two days after CDT-GA, which were connected to the level of attachment to parents and the tendency for excessive crying<sup>11</sup>. Recently, Farakh Gisour et al. found that the majority of physical complications tend to diminish notably within the first week, whereas psychological complications can continue to be present until the seventh day<sup>6</sup>. CDT-GA can lead to increased dental anxiety in children, which may result in a negative attitude towards dental care. The children involved in this research are inherently non-cooperative, a behavior that literature has identified as being influenced by their anxiety and fear associated with dental experiences. GA is known to provoke feelings of fear and anxiety, which can lead to significant long-term effects, including an increase in anxiety and fear during dental procedures throughout a person's lifetime. Dental anxiety and fear in young patients create significant barriers for the child, their guardians, and the dental care providers. As a result, these issues contribute to difficulties in managing care, increased avoidance of dental treatment, and adversely affects oral health outcomes<sup>12</sup>. Evaluating dental fear and anxiety is essential for addressing these issues, enabling accurate diagnosis and treatment, and ensuring a positive experience during dental appointments<sup>13</sup>. CDT-GA represents a significant emotional event in the dental experiences of children. This process often proves to be traumatic, especially due to the stress associated with anesthesia induction, the anxiety of separation, and the outcomes that arise from GA<sup>14</sup>.

Research investigating psychological issues and anxiety after CDT-GA is limited, with the majority of studies emphasizing short-term outcomes of less than one week<sup>3,15</sup>. Furthermore, a significant number of these research efforts address mental health challenges in a general manner, neglecting to analyze dental anxiety in detail<sup>3,16</sup>. This study aims to assess determinants of dental anxiety among children following CDT-GA.

## Materials and methods

### Study design and setting

The study population was children aged 5 to 10 years who were referred for CDT-GA to the largest referral hospital located in the central eighth zone of healthcare management in Iran, during the timeframe of June to December 2023. For the sample size estimation, G\*Power software was utilized to determine the required sample size for the study's statistical analysis. Specifically, an A priori analysis was conducted using F tests for ANOVA with repeated measures on within factors. The input parameters included an effect size ( $f$ ) of 0.25, an alpha error probability ( $\alpha$ ) of 0.05, and a desired power ( $1 - \beta$ ) of 0.8. The analysis considered two groups and three measurements, with a correlation among repeated measures set at 0.1 and a nonsphericity correction ( $\epsilon$ ) of 0.5. Based on these parameters, the total sample size required for the study was calculated to be 78 participants. We determined the sample size to be 80 participants.

Candidates eligible for the study needed to be aged of 5 to 10 years, have an American Society of Anesthesiologists (ASA) class 1 classification, exhibit non-compliance during dental procedures (children's behavior was evaluated by pediatric dentist using the Frankl Behavior Rating Scale<sup>17</sup>, children classified as "Definitely Negative" or "Negative" were considered uncooperative), no mental or physical health issues, lacked a history of allergies to GA, did not present any complicating medical conditions, were not using any medications, and provided informed consent to engage in the research.

Approval for the study's protocol was obtained from the Ethics Committee at Kerman University of Medical Sciences, identified by the code IR.KMU.REC.1402.132 and registration number 402,000,155. A final-year dental student, who has received training and is knowledgeable about the research protocol, communicated the objectives of the study to the parents. In line with the ethical principles defined by the World Medical Association in the Declaration of Helsinki (2002), the informed consent form was signed by either the parents or the legal guardians.

### Clinical procedure

An anesthetist arranged a preoperative consultation for anesthesia consideration to occur one or two days prior to the surgery for a child scheduled to receive GA. The children were instructed on proper oral hygiene, and a specific day was allocated for their treatment performed under GA. In the 4 to 6 h preceding GA, the children refrained from eating and drinking. To reduce their anxiety and fear levels, midazolam (Darupakhsh, Iran) was given nasally at a dose of 0.3 mg/kg, approximately 15 to 20 min ahead of the GA procedure. To induce GA, an intravenous combination of remifentanyl (Exir, Iran), propofol (Fresenius Kabi, Germany), and atropine (Caspian, Iran) was administered, with adjustments made in accordance with the weight of the patients. After successfully intubating the trachea with an appropriately sized tube through the nose and establishing mechanical ventilation that matched the required volume and rate for each child's weight, the maintenance of GA was ensured. Nitrous oxide, oxygen, and isoflurane (Piramal Critical Care, Schelden Circle, Bethlehem, PA, USA) gases were administered to every child, accompanied by a ventilation rate that was increased twofold. As muscle relaxants are not required during CDT-GA, the children's respiratory function were effectively restored. When the procedure was finalized, all gases were ceased apart from oxygen. As soon as the children were fully conscious and their cough and swallowing reflexes returned, the tracheal tube was removed. Once the respiration and recovery conditions were rechecked, the children were moved to the recovery unit. An anesthesiologist conducted all anesthetic interventions, ensuring that both the anesthetic agent and the technique employed were consistent across all study participants. The type of treatment and the duration of GA were carefully documented by the pediatric dentist's assistant. To ensure the completion of the questionnaires and checklists,

a student familiar with the study's protocol explained to the parents the significance of confidentiality, the need for follow-up appointments, and the requirement to return to the office one week and two weeks after CDT-GA. To stimulate greater parental involvement, the student participated in the process of completing checklists and questionnaires, providing answers to any questions their parents might have.

All dental treatments were carried out in a single session by a pedodontist using GA, in alignment with the Guidelines of the American Academy of Pediatric Dentistry<sup>18</sup>, including fissure sealants, restorative procedures, pulp treatments (pulpotomy and pulpectomy), stainless steel crowns (SSCs) of posterior teeth, and extraction of carious teeth (local anesthesia was used for the extraction procedure, and gel foam was inserted into the socket to effectively control any bleeding).

### Data collection

Data collection involved using a checklist and an anxiety questionnaire the day before general anesthesia, with follow-up assessments conducted on the seventh and fourteenth days post-procedure. The researcher conducted phone calls on both the seventh and fourteenth days to check that the questionnaires were completed. The checklist, prepared by the dental student, detailed the child's age and gender, the treatment modality, the number of teeth undergoing treatment, and the duration of GA.

### Anxiety questionnaire

The Modified Child Dental Anxiety Scale, specifically its Faces Version (MCDAS-f), served as the tool for measuring dental anxiety in children, a questionnaire developed by Howard and Freeman<sup>19</sup>. The MCDAS was revised to include a facial analogue scale in conjunction with its original numeric structure. This enhancement allows young and anxious children to exhibit improved cognitive functioning and to conduct a more accurate evaluation of their dental anxiety. The psychometric properties of the MCDAS-f have been validated, confirming its reliability as a measure of dental anxiety in children. This questionnaire is employed to measure state anxiety in children of different ages while they receive dental care. This self-assessment index consists of eight distinct questions, with each question providing five pictorial alternatives for responses. The range of scores on the MCDAS-f scale extends from 8 to 40. Due to its ease of use, the MCDAS-f scale is well-suited for young children<sup>19</sup>. This research involved participants aged between 5 and 10 years, utilizing the previously validated Persian adaptation of the MCDAS-f scale<sup>20</sup>.

### Data analysis

The IBM SPSS Statistics for Windows version 26.0 (IBM Corp, Armonk, NY, USA) was used for data analyses. Descriptive statistics were used to describe the data, including frequency and percentage, mean, and standard deviation. To analyze the data, repeated measure analysis and paired t-test were employed to compare the differences in scores between the seventh and fourteenth days. Linear regression analysis was then used to compare the effects of demographic variables, the number of treatments, duration of anesthesia, and pre-treatment anxiety on post-treatment anxiety on the seventh and fourteenth days. The significance level was set at 5%.

### Results

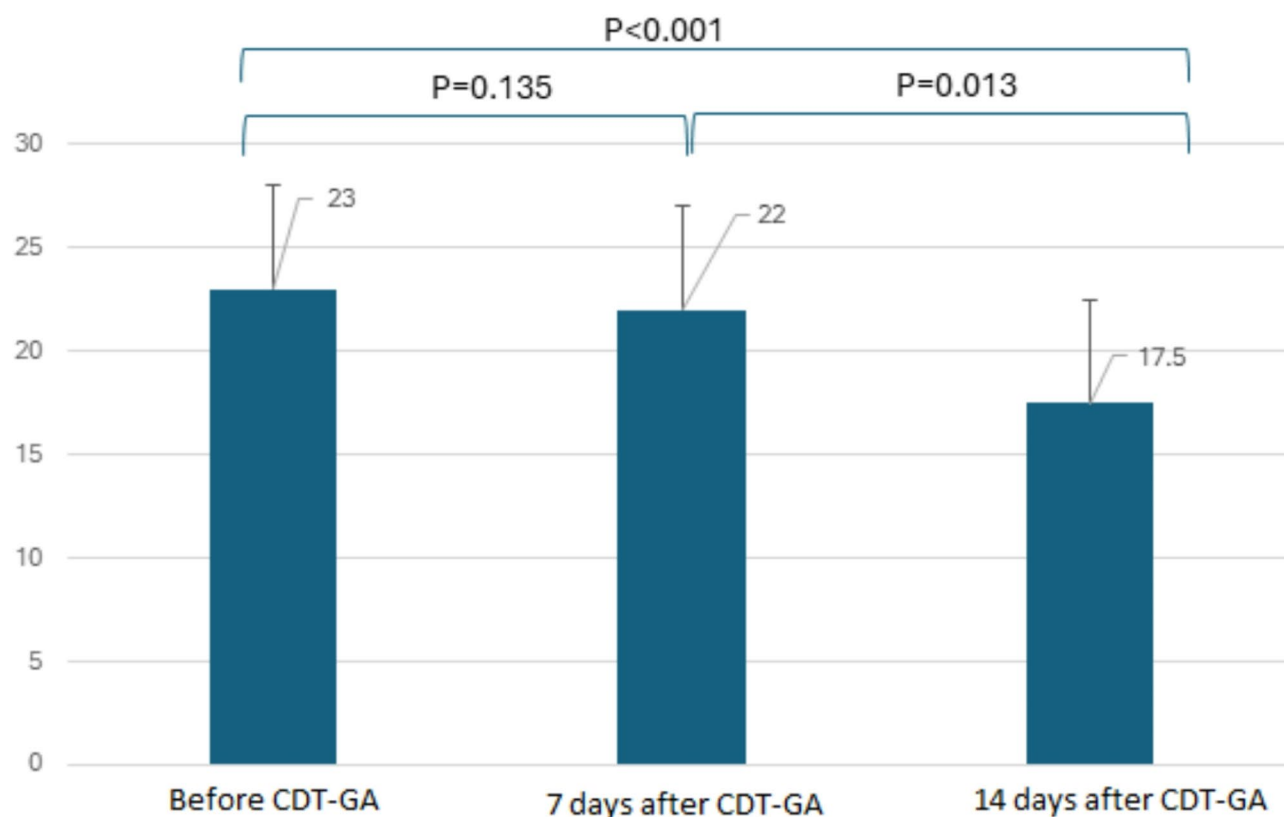
In this study, 87 children were enrolled, of which complete data was collected for 80 children and included in the analysis. In this study, out of 80 participants, 36 (45%) were female. The mean age of the participants was 62 months (SD = 22 months). The average number of treatments received during GA was 18.3 (SD = 5.9). The average anxiety scores were significantly different before CDT-GA, 7 days after GA, and 14 days after CDT-GA ( $P < 0.001$ ). The average anxiety score 7 days after CDT-GA was lower than before CDT-GA, but this difference was not significant. The mean anxiety score at 14 days after treatment was significantly lower than the preoperative score and 7 days after GA ( $P = 0.013$ ,  $P < 0.001$ ) (Fig. 1). Repeated measure analysis showed that the trends in anxiety before the operation, 7 days after the operation, and 14 days after the operation were not statistically significantly associated with sex ( $P = 0.054$ ), age ( $P = 0.191$ ), and the number of treatments performed during anesthesia ( $P = 0.874$ ) and duration of GA ( $P = 0.590$ ).

Analysis showed that preoperative anxiety was the key predictor of postoperative pediatric dental anxiety at 7 days (Beta = 0.72,  $P$ -value = 0.001) and 14 days (Beta = 0.70,  $P$ -value = 0.001) following GA. This results indicates a strong positive association between preoperative and postoperative anxiety. In contrast, variables such as sex, age, duration of GA, and the number of various dental treatments—including fissure sealants, restorations, pulpectomies, pulpomentomies, crowns, and extractions—showed no significant impact on postoperative anxiety levels (Table 1).

The responses to the MCDAS-f questionnaire questions revealed significant changes in anxiety levels at follow up periods. For question 1 (Going to the dentist) and question 2 (Teeth looked at), the anxiety scores were significantly lower 14 days after CDT-GA compared to 7 ( $P < 0.001$ ). Similarly, for questions 3 to 8, anxiety decreased significantly from preoperative to 14 days after CDT-GA ( $P < 0.001$ ), with the lowest score observed at 14 days (Table 2).

### Discussion

This study aimed to investigate the determinants of dental anxiety following CDT-GA in children. It also examined the factors influencing the severity and duration of complications following GA treatment. Our results indicated that children's dental anxiety decreases after GA, and their pre-anesthesia anxiety level is the only determinant of post-GA dental anxiety.



**Fig. 1.** The mean anxiety score measured by the MCDAS-f questionnaire in the days before the operation, 7 and 14 days after comprehensive dental treatment under general anesthesia (CDT-GA).

	7 days after CDT-GA		14 days after CDT-GA	
	Beta	P-value	Beta	P-value
Anxiety before GA	0.72 (0.52, 0.9)	0.001	0.7 (0.46, 0.9)	0.001
Sex (male vs. female)	0.06 (− 2.95, 3.15)	0.973	− 2.24 (− 5.74, 1.27)	0.207
Age	− 0.42 (− 1.32, 0.47)	0.322	− 0.58 (− 1.69, 0.41)	0.254
Duration of GA	− 0.01 (− 0.06, 0.04)	0.736	0 (− 0.06, 0.05)	0.939
Number of fissure sealants	0.11 (− 1.18, 0.94)	0.825	0.15 (− 1.2, 1.27)	0.801
Number of restorations	− 0.15 (− 0.62, 0.31)	0.534	− 0.05 (− 0.56, 0.48)	0.866
Number of pulpectomies	0.7 (− 0.05, 1.57)	0.073	0.22 (− 0.61, 0.94)	0.537
Number of pulpotomies	− 0.42 (− 1.28, 0.58)	0.332	0.05 (− 1.19, 1.29)	0.933
Number of crowns	− 0.4 (− 1.52, 0.42)	0.352	− 0.54 (− 1.55, 0.39)	0.208
Number of extractions	− 0.08 (− 0.65, 0.53)	0.777	− 0.29 (− 0.9, 0.29)	0.283

**Table 1.** The effect of preoperative anxiety, sex, age, duration of GA, and dental treatments on pediatric dental anxiety at 7 and 14 days after comprehensive dental treatment under general anesthesia (CDT-GA). GA General Anesthesia.

Our findings showed that the anxiety scores of children before CDT-GA and seven days after CDT-GA did not differ significantly, but there was a significant reduction in anxiety levels fourteen days post- CDT-GA. Additionally, a case-by-case analysis of the questionnaire responses revealed a significant decrease in anxiety expressed in various situations. This pattern suggests that while initial postoperative anxiety may be heightened, effective coping mechanisms or adaptations may occur as children adjust to their experiences. The observed trends underscore the importance of monitoring anxiety levels at multiple time points to better understand the dynamics of pediatric dental anxiety. Supporting our results, a study by Mathew et al. demonstrated a significant reduction in children's dental anxiety 14 days after CDT-GA<sup>21</sup>. Furthermore, Guney et al. showed that children's anxiety decreased significantly one month after CDT-GA<sup>22</sup>. Although all these results were based on standardized questionnaires completed by parents, the study by Yildirim et al. showed that one month after CDT-GA, both anxiety questionnaire scores and biochemical factors, such as cortisol, alpha-amylase, and chromogranin

	Before CDT-GA	7 days after CDT-GA	14 days after CDT-GA	P-value
Q1: How do you feel about going to the dentist generally?	2 (1, 3) <sup>a</sup>	3 (2, 5) <sup>b</sup>	2 (1, 3) <sup>a</sup>	<0.001
Q2: How do you feel about having your teeth looked at?	2 (1, 3) <sup>a</sup>	3 (2, 4) <sup>b</sup>	2 (1, 3) <sup>a</sup>	<0.001
Q3: How do you feel about having your teeth scraped and polished?	2.5 (2, 4) <sup>c</sup>	3 (2, 4) <sup>b</sup>	2 (2, 3) <sup>a</sup>	<0.001
Q4: How do you feel about having an injection in the gum?	4 (2, 5) <sup>b</sup>	4 (3, 5) <sup>b</sup>	3 (2, 5) <sup>a</sup>	<0.001
Q5: How do you feel about having a filling?	4 (3, 5) <sup>b</sup>	3.5 (2, 5) <sup>b</sup>	3 (2, 4) <sup>a</sup>	<0.001
Q6: How do you feel about having a tooth taken out?	4 (3, 5) <sup>b</sup>	4 (3, 5) <sup>b</sup>	3 (2, 5) <sup>a</sup>	<0.001
Q7: How do you feel about being put to sleep to have treatment?	3 (2, 4) <sup>b</sup>	3 (2, 5) <sup>b</sup>	2 (1, 4) <sup>a</sup>	<0.001
Q8: How do you feel about having a mixture of “gas and air” which will help you feel comfortable for treatment but cannot put you to sleep?	3 (2, 4) <sup>b</sup>	3 (2, 4) <sup>b</sup>	2 (2, 4) <sup>a</sup>	0.024
Total score	23 (16, 28) <sup>a</sup>	22 (16, 31) <sup>a</sup>	17.5 (14, 28) <sup>b</sup>	<0.001

**Table 2.** Distribution of responses participants MCDAS-f questions, before comprehensive dental treatment under general anesthesia (CDT-GA), 7 days after CDT-GA, and 14 days after CDT-GA.

A levels in saliva and serum, decreased<sup>16</sup>. According to Klaassen’s findings, children exhibited persistent anxiety following GA, which had marginally intensified, yet this change was not statistically significant<sup>23</sup>. The discrepancy in results between these studies and ours may be attributed to the timing of the assessments and the sample sizes. With advancements in awareness among parents and dentists regarding children’s dental anxiety, there has been a significant improvement in managing this fear. Additionally, the sample size in Klaassen’s study included only 25 children who underwent CDT-GA and were included in the statistical analysis<sup>23</sup>. A variety of dental problems, such as bruxism associated with stress and anxiety<sup>24</sup>, have been recognized, and our research suggests that the CDT-GA may have psychological effects related to these conditions. As a result, it is essential for pedodontists to emphasize the importance of managing anxiety in children and to actively seek to address psychological challenges faced by this population. Prioritizing early dental interventions within the healthcare framework can significantly reduce the necessity for CDT-GA in pediatric populations.

In our study, it was shown that pre-operative anxiety was the only significant factor influencing children’s anxiety levels at seven- and fourteen days after CDT-GA. Factors such as age, gender, duration of anesthesia, and the treatments performed did not have a significant impact on children’s anxiety after CDT-GA. Similarly, Guney et al. found that age did not significantly affect post-operative anxiety or changes in anxiety scores<sup>22</sup>. However, Guney’s study considered a limited age range, which may have contributed to the lack of significance regarding age as a factor. The duration of anesthesia and the number of treatments indicate the complexity and extent of the required treatments for children under CDT-GA. Based on our searches, no studies have yet examined other factors such as the duration of anesthesia and the number of treatments performed to pre-operative anxiety. The lack of significance of these two variables in the presence of pre-operative anxiety suggests that the causal pathway of the extent of decay, required treatments, and children’s pain operates through pre-operative dental anxiety affecting post-operative anxiety. Therefore, managing pre-operative anxiety in children undergoing GA is of particular importance. It is recommended to employ anxiety management strategies before GA to control dental anxiety. Since our study results indicated a significant reduction in children’s anxiety across all questionnaire items, particularly those related to examinations and treatments, reducing pre-operative anxiety will likely lead to a substantial decrease in post-GA anxiety, which will be beneficial for managing children’s dental issues in the future. This insight calls for a deeper investigation into other potential factors that may contribute to anxiety, such as children’s characteristics<sup>25</sup> or previous dental experiences<sup>26,27</sup>, which were not explored in this study.

The demographic analysis of the study participants revealed that out of 80 individuals, 45% were female, with a mean age of 62 months (SD=22 months). This demographic distribution is crucial for understanding the context of the findings, as it reflects the population under CDT-GA. It was shown that age and gender are determinants of the prevalence of dental anxiety<sup>28</sup>. The relatively balanced gender representation allows for a more comprehensive analysis of anxiety levels across sexes, although the slight predominance of females may suggest a need for further exploration into gender-specific responses to dental anxiety. Understanding the age range of participants also provides insight into the developmental stage of the children involved, which may influence their perceptions and reactions to dental treatments. Various studies demonstrate that there is no significant relationship between anxiety and age<sup>29–31</sup>. Moreover, the present study involved a limited age range, which could be the reason why the age variable did not yield significant results.

Various studies exploring dental anxiety in children have reported mixed results regarding gender differences<sup>32–34</sup>. Some research found no significant differences between boys and girls<sup>29,35–37</sup>, while other studies suggested that girls experience higher levels of anxiety<sup>32,38</sup>. Our study also found no significant differences between the two genders. This may be influenced by the characteristics of the population analyzed and the variety of tools used to evaluate anxiety.

While our study provides valuable insights into pediatric dental anxiety, it is essential to acknowledge its limitations. One limitation of the current study is that anxiety scores were recorded based on parental reports, which may vary due to differences in culture, socioeconomic status, and individuals’ perceptions of pain and other complications, potentially affecting the accuracy of comparisons. Additionally, this study was conducted on children visiting a private pediatric clinic, which may not be generalizable to all children. And also, longitudinal research would improve significantly with proper control of confounding factors and the



incorporation of continuous outcome measures, which would contribute to the establishment of more precise models for predicting the condition(39). It is recommended that the future studies consider a wider age range and evaluate the impact of different variables, including socio-economic status, cultural factors, and clinical settings through a multicenter approach with a larger sample size, which would enhance the generalizability of the results.

## Conclusion

In conclusion, this study highlights the significant role of preoperative anxiety as a predictor of postoperative anxiety in pediatric dental patients undergoing CDT-GA. The findings demonstrate a clear trend of anxiety levels fluctuating over time, with a notable decrease in anxiety scores by 14 days after CDT-GA. Despite the lack of significant associations between demographic factors and treatment variables with anxiety levels, the results underscore the importance of addressing preoperative anxiety to enhance the overall dental experience for children. By implementing targeted strategies to reduce anxiety before dental procedures, practitioners can potentially improve postoperative outcomes and foster a more positive attitude towards dental care in young patients.

## Data availability

The datasets and /or analysed during the current study available from the corresponding author on reasonable request.

Received: 21 December 2024; Accepted: 18 March 2025

Published online: 23 March 2025

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## Acknowledgements

We would like to express our gratitude to the authorities at the Kerman University of Medical Sciences for supporting this study.

## Author contributions

E.F. and F.J.M., Supervision, Conceptualization. A.N. and F. JM, Methodology, Data curation, Writing, Editing. F.J.M.: Visualization, Validation. M.B, E.F: Shape the research, Designed the figures and Tables. All authors reviewed the manuscript.

## Declarations

## Competing interests

The authors declare no competing interests.

## Additional information

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