



Relationship between subjective and objective measures of anticipatory anxiety prior to extraction procedures in 8- to 12-year-old children

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Background: This study assessed anticipatory dental anxiety levels among 8- to 12-year-old children based on subjective and physiological measures and their correlation. The variations in anxiety based on sex, age, temperament, and academic performance were evaluated.

Methods: An observational study was conducted in 60 children recruited from the waiting room over a 6-month period. The operator recorded subjective anxiety in the children using a novel visual facial anxiety scale. The operator also noted the demographic details and child's temperament using the nine dimensions of the Thomas and Chess criteria, and graded children as "easy," "slow to warm-up," and "difficult." The academic performance of the children was graded (parental ratings) on a five-point Likert scale. Physiological variables (heart rate [HR], oxygen saturation [SpO₂], and blood pressure [BP]) were recorded by another evaluator. The correlation between anxiety levels and physiological variables was also assessed. The effects of age, sex, temperament, and academic performance on anxiety were evaluated.

Results: The study included 60 children aged 8–12 years, including 36 boys and 24 girls. Seventy percent of children had mild to moderate levels of pre-extraction anxiety, while 30% of children demonstrated high anxiety. A significant positive correlation was noted between anxiety levels and HR ($r_s = 0.477$, $P < 0.001^*$) and systolic BP ($r_s = 0.294$, $P < 0.05$), while a significant but inverse correlation was observed with SpO₂ ($r_s = -0.40$, $P < 0.05$). Anxiety did not influence diastolic BP. Children with difficult temperament and poor academic performance had significantly higher anxiety.

Conclusion: A high percentage (70%) of children aged 8–12 years had mild to moderate anxiety prior to the extraction procedure. Increased HR, systolic BP, and reduced SpO₂ were significantly associated with high levels of anticipatory dental anxiety. Pre-extraction anxiety was significantly related to the temperament and scholastic performance.

Keywords: Blood Pressure; Dental Anxiety; Heart Rate; Oxygen Saturation; Temperament.



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INTRODUCTION

Dental anxiety is a complex psychological phenomenon composed of physical, mental, and social aspects

associated with visiting a dentist [1]. Patients with high levels of dental anxiety experience stress, and refuse or delay the required treatment, leading to progressive deterioration of oral health and the worsening of diseases. Dental anxiety also interferes with successful delivery of

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treatment by causing increased perceptions of pain, particularly during anesthesia, thereby delaying optimal recovery [2,3].

Anxiety in the dental setting is multifactorial in origin. Individual personality characteristics that play a role include neuroticism and self-consciousness, fear of the unknown, poor understanding, coping mechanisms, and the perception of body image [4-7]. Dental factors include exposure to frightening portrayals of dentists in the media; being in a vulnerable supine position on a dental chair; previous negative or traumatic visits, especially during childhood; and transference of dental fears from family members or peers [4-7]. The most common reason for fear or apprehension among children at the dentist's office is the fear of injections during dental anesthesia [8] and tooth extraction procedures [9].

Anxiety in dental clinics is generally recorded using both subjective and objective measures. Subjective measures of dental anxiety in children include scales such as the Corah's Dental Anxiety scale [10], Modified Dental Anxiety scale [11], Venham Picture scale [12], State-Trait Anxiety Inventory for Children [13], Visual Facial Anxiety Scale [14], and the novel Visual Facial Anxiety Scale (nVFAS) [15].

A rise in anxiety leads to the release catecholamines, leading to increased heart rate (HR) and blood pressure (BP) [16], and decreased galvanic skin resistance [17]. Other anxiety-related changes include increased sweat production, changes in the electrical conductivity of the skin, breathlessness, sighing, increased muscle tone, spasmodic movements, dry mouth, or constipation [18].

The correlation between subjective and objective measures was previously reported by Beck et al. [19], who observed a positive correlation between subjective dental anxiety and the HR. Rayen et al. [20] reported a positive association between negative behaviors and an increased HR and systolic BP (SBP) in children. A pilot study by Galamb et al. [21] noted a positive correlation between subjective anxiety and HR, BP, and sweating among 12-14-year-old children. To the best of our knowledge, the correlation between subjective anti-

cipatory anxiety levels in the waiting room and objective physiological variables (HR, oxygen saturation [SpO₂], and BP) among 8-12-year-old children has not been comprehensively evaluated.

Other predictors that may influence the levels of dental anxiety in children include age, sex, physical activity, and physical and psychological well-being [22]. Among psychometric traits, temperament describes an individual's inherent emotional capacity, which remains fairly stable over time and has a genetic influence on behavioral patterns [23,24]. Early temperamental characteristics may mold developmental pathways in children and influence behavioral patterns in later life [25, 26]. The temperament of a child may influence trait anxiety [27]. Gustafson et al. [28] reported that children with behavioral problems had worse social interactions than the reference group. Jain et al. [29] evaluated the role of temperament on dental anxiety and found that preschool children (3-5 years old) with higher dental anxiety had higher scores for emotionality and shyness. However, thus far, the relationship between temperament and anticipatory dental anxiety in the waiting room among 8-12-year-old children is not clearly understood.

The aim of the present study was to assess the levels of anticipatory dental anxiety among 8-12-year-old children using subjective and objective physiological measures (HR, SpO₂, and BP) in the waiting room and analyze any correlations between the same. The variations in anxiety, based on sex, age, temperament, and academic performance were also studied.

METHODS

1. Objectives and outcome measures

The primary objectives were to evaluate the level of subjective anticipatory anxiety in children and assess anxiety using physiological measures such as HR, SpO₂, and BP.

Variations in anxiety among children based on predictors such as age, sex, temperament, and academic

performance were assessed as the secondary study outcome. The correlation between the subjective and objective measures of anxiety among children was also evaluated.

2. Ethical considerations

The Institutional Ethical Review Board of the University College of Medical Sciences and Guru Teg Bahadur Hospital, Delhi, India approved this study. (IRB approval number IEC-HR-2018-36-133). Written informed consent and pediatric assent were obtained from parents and children, respectively, to ensure voluntary participation. The purpose and nature of the study were explained, and the confidentiality of the study records was maintained.

3. Participant characteristics

Willing participants meeting the inclusion criteria after initial screening in the exodontia waiting room were recruited. Healthy children (ASA-I) aged 8–12 years requiring primary tooth extraction as their first dental procedure due to advanced dental caries were included in the study [30]. Children with anxiety \geq mild on the nVFAS [15] were recruited.

Children with medical, psychological, or psychiatric illnesses were excluded. Other exclusion criteria included known allergy to local anesthetics or its constituents, extra-oral swelling associated with the tooth, and traumatic dental injuries. Children with a history of dental extractions were excluded to minimize bias due to past dental experiences [31].

4. Sample size estimation

A power analysis was performed to calculate the number of participants to be included in the study. The G*Power version 3.1.9.7 was used to calculate the sample size required for chi-square tests for an effect size of 0.45, with a power of 80%, and level of significance of 5% indicated a required sample of 59 participants for the study [32].

5. Study design

The evaluator was duly trained in mental state examination and recording psychiatric history by a trained, qualified psychiatrist. The caregivers and children were introduced to the scales and tools of the study prior to the assessments. The evaluator recorded subjective anxiety using the self-reported nVFAS [15]. The psychometric evaluation of the temperament of the child by the parent was graded using the Thomas and Chess classification as “easy,” “slow-to-warm-up,” and “difficult” [33]. Academic performance was graded according to parental perception on a five-point Likert scale as very poor, 1; poor, 2; average, 3; good, 4; excellent, 5. HR, SpO₂, and BP were measured by another evaluator who was blinded to the subjective anxiety scores to minimize bias. The assessments were made in the following sequence: case history, age, sex, academic performance, temperament, subjective anxiety record, and physiological measurements. The subjective and objective measurements were recorded in continuity within an average time of 5–10 min [20]. Behavior management techniques were used after completing all anxiety records. Gentle communication was used throughout, to put all children at ease. We recorded pre-extraction anticipatory anxiety among children selected randomly on each Thursday (day designated for exodontia) over a 6-month period between November 1, 2018 and May 1, 2019 until the required sample size was obtained. The study was conducted at the Department of Pedodontics and Preventive Dentistry at the University College of Medical Sciences, Delhi, India, in accordance with the STROBE guidelines (Fig. 1) [34].

6. Outcome measures used

1) Subjective measurement using Visual Facial Anxiety Scale

The novel nVFAS introduced by Cao et al. [15] in 2017 consists of six faces representing an increasing level of anxiety from none (neutral facial expression) to the

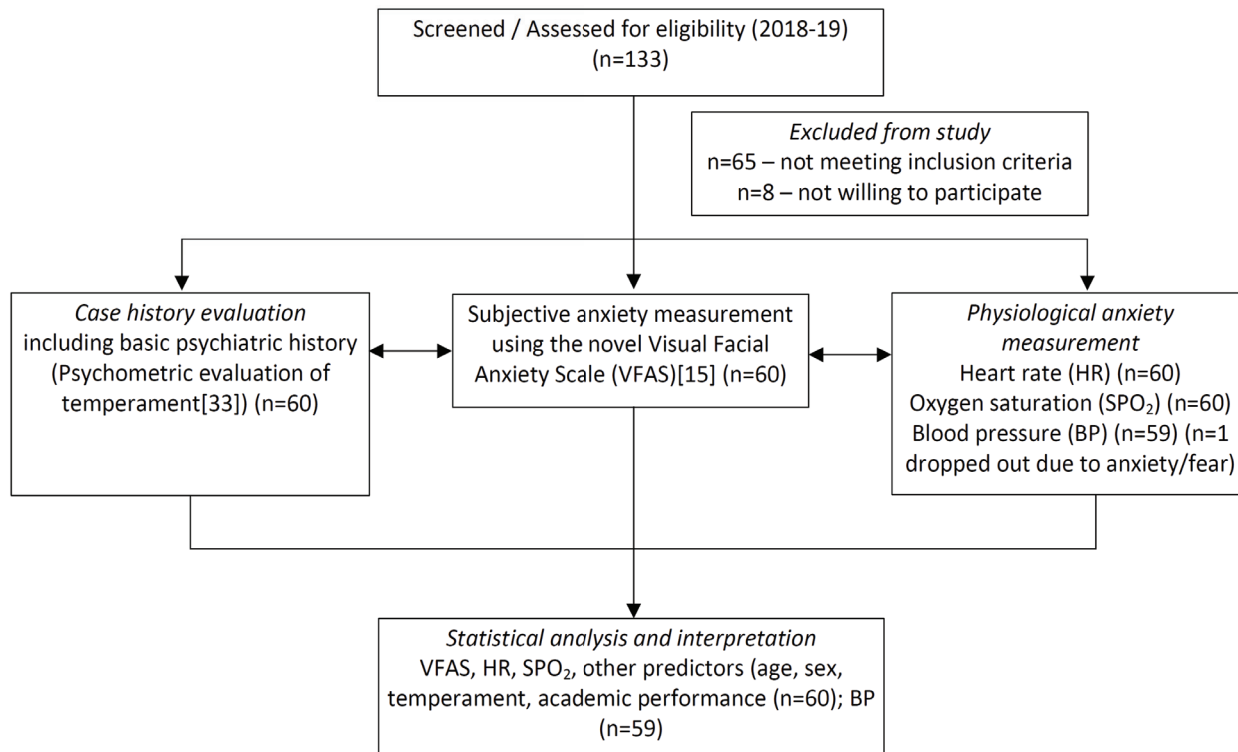


Fig. 1. Flowchart showing participant enrollment as per STROBE guidelines [34].

highest (expressing extreme fear). It is a valid tool for assessing acute state anxiety before elective surgical procedures, and can be easily administered in routine clinical practice. We selected the nVFAS to assess subjective anxiety levels among children, as it has not been studied as a tool for assessment of dental anxiety in children [15].

2) Objective assessment of anxiety levels

To objectively measure the anticipatory anxiety levels in children, HR and SpO₂ were measured for each child using a pulse oximeter (Pulse Oximeter, PO-15, Delhi, India). Pre-extraction BP was measured using an automated BP monitor (MX3; Omron, Tokyo, Japan).

3) Psychometric evaluation of children's temperament

The Thomas, Chess, and Birch theory is believed to be one of the generator theories that lays the foundation for the modern understanding of children's temperament and environmental perspectives. The Thomas and Chess

classification employs nine temperament dimensions (rhythmicity of body function, activity levels, approach to/withdrawal from new stimuli, adaptability, sensory threshold, quality of mood, intensity of mood, distractibility, and persistence/attention span) that combine to form three superordinate categories: "easy," "slow-to-warm-up or shy," and "difficult/active/feisty." Subsequent research focused on refining the dimensions to minimize redundancy; however, the Thomas and Chess classification serves as the gold standard. In the present study, the Thomas and Chess classification was employed for the psychometric grading of temperament based on parental descriptions of the child's temperament as assessed during the psychiatric history evaluation. Children were graded as follows [33]:

Easy children: Have regular body rhythms (e.g., for eating, sleeping, and toileting), balanced activity levels, a positive approach towards or withdrawal from new stimuli, and low-to-moderate moods.

Slow-to-warm-up children: Have low activity levels, a negative approach towards or withdrawal from new

Table 1. Demographic description of the study participants including age, sex, academic performance, and psychometric temperament evaluation of 8- to 12-year-old children

Variable	Description	N = 60	Percentage (%)
Age	8–10 years (middle childhood)	39	65.0
	11–12 years (pre-adolescent)	21	35.0
Sex	Male	36	60.0
	Female	24	40.0
Academic performance	Very Poor	6	10.0
	Poor	10	16.7
	Average	21	35.0
	Good	18	30.0
	Excellent	5	8.3
Temperament [33]	Easy	34	56.7
	Slow to warm-up	17	28.3
	Difficult	9	15.0

stimuli, low intensity of moods, and descriptive expression.

Difficult children: Have irregular bodily rhythms, high activity levels, a negative approach or withdrawal to new stimuli, highly descriptive expression, and increased mood swings.

7. Statistical analysis

Statistical analysis was performed using IBM SPSS software (version 20.0; IBM Corp. Released 2011., Armonk, NY, IBM Corp.). Quantitative data are summarized using means and standard deviations (SD) and categorical data are summarized using frequencies and proportions. Furthermore, Spearman's bivariate correlation coefficient was used to compare the subjective and objective measures of anxiety. Pearson's chi-square test was used to analyze the significance of the association of subjective anxiety levels with age, sex, temperament, and academic performance in children. A P-value of < 0.05 was considered statistically significant.

RESULTS

The study included 60 children (36 boys and 24 girls) aged 8–12 years (8–10 years, $n = 39$; 11–12 years, $n = 21$). Of these, 57 children were enrolled in school (Class 2–4, 19 children; Class 4–6, 20 children; Class 7–8, 18 children). Academic performance, as graded using a

five-point Likert scale, revealed that the majority of the children had average (21 children) or good (18 children) academic performance. According to the Thomas and Chess classification, 34, 17, and nine children had “easy” temperament, were “slow-to-warm-up” or “shy”, and were “difficult”, respectively. Table 1 shows the demographic characteristics of the study participants.

Table 2 presents the anxiety in the waiting room using subjective measures nVFAS and physiological measures (HR, SpO₂, and BP). With regards to the nVFAS scores for anticipatory anxiety, 25% (15/60), 30% (18/60), and 8.3% (5/60) children had mild, mild-moderate, and the highest anxiety, respectively. Thirteen percent of children had a moderate-to-high anxiety score. Mild-to-moderate anxiety levels were observed in 70% of children. High levels of dental anxiety (moderate-to-high and the highest level) were observed in 30% of children. The physiological evaluation revealed a mean HR of 118.45 ± 12.96 beats per minute and mean SpO₂ of 98.15 ± 1.79 %. The mean SBP was 125.02 ± 9.38 mmHg while the mean diastolic BP (DBP) was 79.91 ± 5.72 mmHg.

Table 3 depicts the results of the bivariate Spearman's correlation test, which was used to identify correlations between the subjective and objective measures. A positive correlation was noted for HR ($P < 0.001^*$, $r_s = 0.477$) and SBP ($P < 0.05^*$, $r_s = 0.294$), indicating that HR and SBP increased with increasing nVFAS anxiety scores in children. An inverse correlation was observed between nVFAS scores and SpO₂ levels ($P < 0.05^*$, $r_s = -0.40$),

Table 2. Pre-extraction anxiety levels among 8- to 12-year-old children assessed using the nVFAS scores and physiological parameters including HR, SpO₂, and BP

Variable	nVFAS category	N
Novel Visual Facial Anxiety Scale [15]	Mild	15
	Mild-moderate	18
	Moderate	9
	Moderate-high	13
	Highest	5

Variable	Range	Mean ± Std
HR	98.00–155.00	118.45 ± 12.96
SpO ₂	90.00–100.00	98.15 ± 1.79
SBP	104.00–144.00	125.02 ± 9.38
DBP	68.00–89.00	79.71 ± 5.72

Abbreviations: nVFAS, novel Visual Facial Anxiety Scale; HR, Heart rate; SpO₂, oxygen saturation; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 3. Bivariate correlation between subjective anxiety levels (nVFAS) and HR, SpO₂, and BP among 8- to 12-year-old children

Variables compared	Spearman’s correlation coefficient (rs)	Strength of correlation	Significance (P value)
nVFAS vs. HR	0.477	Moderate positive	Highly Significant (0.001)
nVFAS vs. SpO ₂	−0.40	Moderate negative	Significant (0.002)
nVFAS vs. SBP	0.294	Weak positive	Significant (0.023)
nVFAS vs. DBP	0.177	*	Non-Significant (0.17)

Test used: Spearman’s correlation coefficient.

Abbreviations: nVFAS, novel Visual Facial Anxiety Scale; HR, heartrate; SpO₂, oxygen saturation; SBP, systolic blood pressure; DBP, diastolic blood pressure.

which implies a reduction in SpO₂ with increasing nVFAS scores in children. No statistically significant correlation was observed between nVFAS anxiety scores and DBP ($P > 0.05$, $r_s = 0.177$).

Pearson’s chi-square test (Table 4) found no significant variation in anxiety with age or sex, but a highly significant correlation was noted between academic performance and levels of anxiety ($P < 0.001^*$). Children with “poor” or “very poor” academic performance had higher levels of dental anxiety than children with “good” or “excellent” academic performance. Children with a “difficult” temperament reported significantly higher levels of anxiety than children with an “easy” temperament ($P < 0.001^*$).

DISCUSSION

The present study aimed to assess anticipatory anxiety in an exodontia clinic waiting room using both subjective

and physiological parameters among 8- 12-year-old children and ascertain the relationship between the two parameters. We found that 70% of children had mild-moderate levels of dental anxiety, and 30% of children had notably high anxiety levels (moderate to high) in the waiting room. No age- or sex-related variation in pre-extraction anxiety levels was observed among the children (Tables 1 and 4). It is expected that school-aged children will develop better coping mechanisms, cognitive ability, and self-control, and thus may demonstrate reduced dental anxiety [35,36]. However, contrary to this belief, previous studies have demonstrated a high prevalence of anxiety in school-going children [37-39].

Subjective anxiety levels, as ascertained using nVFAS, were compared with physiological parameters (HR, SpO₂, and BP) to identify correlations (Tables 2 and 3). The current study found a positive correlation between HR and SBP and subjective dental anxiety, indicating that increased subjective anxiety levels are associated with

Table 4. Association between age, sex, temperament, and academic performance in 8- to 12-year-old children with subjective anxiety scores as assessed using the novel Visual Facial Anxiety Scale (nVFAS)

Variable	Measures/ Gradations	nVFAS anxiety scores					Chi square	P value
		Mild	Mild-moderate	Moderate	Moderate-high	Highest		
Age	8–10	9	12	6	8	4	0.76	0.94
	> 10 years	6	6	3	5	1		
Sex	Male	8	11	4	11	2	5.31	0.25
	Female	7	7	5	2	3		
Academic performance	Very Poor	0	2	0	3	1	41.7	< 0.001*
	Poor	0	2	1	3	4		
	Average	4	4	6	7	0		
	Good	8	8	2	0	0		
	Excellent	3	2	0	0	0		
Temperament [33]	Easy	14	14	3	3	0	50.43	< 0.001*
	Slow to warm-up	1	4	5	7	0		
	Difficult	0	0	1	3	5		

Test used: Pearson's chi-square test.

Abbreviations: nVFAS, novel Visual Facial Anxiety Scale.

high HR and SBP among children. Anxiety causes a stress response that alters hemodynamics due to the release of catecholamines [16,18]. Balasubramanian et al. [40] reported increased HR and BP in adults undergoing exodontia. Fernandez-Aguilar et al. [41] reported a positive correlation between preoperative anxiety and DBP and HR among Caucasian adults.

Among children, similar findings were observed by Rayen et al. [20], who found significant increases in HR and SBP in addition to poor behavior before dental extraction procedures. In the present study, no significant change in DBP was noted. Similarly, a pilot study conducted by Galamb et al. [21] noted a positive relationship between anxiety and HR, BP, and sweat scores among children aged 12–14 years, and found sweating to be the most reliable indicator of anxiety, and significantly correlated with dental anxiety scores. In contrast, Beck et al. [19] reported an increase in HR but no changes in BP in response to anticipatory dental anxiety in children, which may be attributed to compensatory reductions in stroke volume and/or peripheral resistance.

Anxiety may lead to changes in the respiratory system, such as sighing or breathlessness [18]. In the present study, an inverse correlation was found between SpO₂ and

subjective anxiety levels, implying that SpO₂ reduces with increased anxiety (Tables 2 and 3). Likewise, Ize-Iyamu et al. [42] reported a drop in SpO₂ levels for extraction and pulpotomy procedures among children. However, Rayen et al. [20] found that the SpO₂ remained unaltered. Few studies have provided conclusive evidence on the overall association of SpO₂ with dental anxiety in children; therefore, future research should focus on the same.

The present study also assessed the role of temperament in influencing dental anxiety levels in children aged 8–12 years. We found that children with a “difficult,” “active,” or “feisty” temperament as per the Thomas and Chess classification [33] had significantly higher anxiety levels (Table 4). A study by Klingberg et al. [43] revealed higher grades of dental fear among children expressing shyness or negative emotionality using the Emotionality, Activity, and Sociability survey in 5–7- and 10–12-year-old children. Jain et al. [29] evaluated the association between temperament and dental anxiety among pre-school children and found that children with higher dental anxiety had increased negative behaviors. Emotionality and shyness had a weakly positive association with higher anxiety among preschool children. In corroboration with the present findings, Krikken et al. [38] found higher dental anxiety among aggressive or emotionally reactive 4–12-year-old

children in a pilot study. A literature search revealed no studies that report a definite correlation between simplified temperament types according to the Thomas and Chess classification [33] and dental anxiety among 8–12-year-old children; thus, the present findings are valuable.

We found significantly higher dental anxiety among children with “poor” and “very poor” academic performance. In the field of school psychology, Owens et al. [44] found higher levels of generalized anxiety and depression were associated with poor academic performance in 12–13-year-old adolescents from two schools in the United Kingdom. The authors postulated that increased test-specific worry impairs working memory and executive function processes in children. To the best of our knowledge, no studies have shown a correlation between academic performance in school- aged children and levels of dental anxiety among 8–12-year-old children. Further well-planned trials will enable a better understanding of this association (Table 4).

The strengths of the current study include the use of a multidisciplinary approach wherein a single operator was trained to reliably use subjective anxiety measures. Further, the use of a novel subjective anxiety measure, the nVFAS, in combination with physiological and psychometric measures enhanced the understanding of their dynamic relationship. In addition, the association of dental anxiety with children’s academic performance and temperament in 8–12-year-old children revealed interesting findings that can form the basis for future research. The recruitment of children from a hospital contributes to a hospital-representative sample, which may be a potential limitation of the present study. This study lacks a prospective understanding of post-extraction anxiety behaviors. Future studies should focus on studying the role of various psychometric parameters, such as memory, self-confidence, emotional intelligence, and study habits, in relation to dental anxiety.

The present study revealed that mild to moderate levels of anticipatory dental anxiety are prevalent among the majority (70%) of 8–12-year-old children in the waiting room. The ultimate utility of these findings is to plan

behavior management strategies tailored to the varying requirements of the children, beginning in the clinical waiting area. With increasing pre-extraction anxiety, as was seen among 30% of children, more intense behavior management tools may be warranted.

In conclusion, mild-to-moderate and moderate-to-highest levels of anticipatory anxiety were seen in 70% and 30% of 8–12-year-old children, respectively, in the exodontia waiting room. Anxiety levels did not significantly vary with age or sex. Dental anxiety showed a significantly positive correlation with HR and SBP. SpO₂ was significantly inversely correlated with anticipatory anxiety. DBP did not vary significantly with measured anxiety. Further, children with difficult, active, or feisty temperament had higher pre-extraction anxiety. Moreover, poor academic performance was associated with higher anticipatory anxiety among children.

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Rishi Tyagi: Conceptualization, Data curation, Edit, Methodology, Project administration, Resources, Supervision, Writing - review & editing

Amit Khatri: Conceptualization, Formal analysis, Edit, Supervision, Writing - review & editing

Shruti Srivastava: Conceptualization, Investigation, Edit, Methodology, Project administration, Supervision, Visualization, Writing - review & editing

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