The Impact Of Nursing Support On Reducing Dental Anxiety Among Pediatric Patients Undergoing Dental Procedures: A Comprehensive Analysis

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Abstract

Dental anxiety is one of the most common challenges in pediatric dentistry, with prevalence rates estimated at 23.9 to 50% among children globally, or even higher among preschoolers and school-age children, being 36.5 and 25.8%, respectively. This comprehensive review considers the crucial impact of nursing support on reducing dental anxiety among pediatric patients receiving dental treatments. Based on the critical analysis of the evidence-based interventions-including behavioral techniques, such as Tell-Show-Do, distraction, and positive reinforcement; cognitive approaches, such as Cognitive Behavioral Therapy; changing the environment; and pharmacological support with conscious sedation-this paper revealed the multifunctional potential of nursing interventions in pediatric dental anxiety management. The randomized controlled trial analysis revealed that the combined use of innovative interventions, such as artificial intelligence-based animated videos, together with traditional techniques, is much more efficient in terms of anxiety reduction than single component-based strategies: "TSD+AI group demonstrated a statistically significant decrease of MDAS when compared with the TSD group ($p < 0.05$), while both groups presented decrease in anxiety in T1 when compared with T0." Nursing support was provided in the form of evaluation by validated scales, implementation of behavioral measures, empathetic communication, optimisation of the environment, and sedation

monitoring in case of severe states. As confirmed by the findings of current evidence, "78% of paediatric patients with the implementation of TSD could improve in cooperation," while "distraction techniques were found to reduce anxiety and pulse rate by 10 beats per minute during dental treatment." The current paper will represent the meaningful role of dental nurses in providing therapeutic environments, establishing trust-based relationships, and introducing evidence-based protocols that transform probably traumatic dental experiences into positive encounters for all children. Future directions may also involve standardized nursing training on CBT and sedation protocols, integrating emerging technologies such as virtual reality, and devising culturally sensitive interventions so as to enhance not only accessibility but also the effectiveness across diverse pediatric populations.
Keywords: pediatric dental anxiety, nursing interventions, Tell-Show-Do technique, behavioral management, dental fear, cognitive behavioral therapy, conscious sedation, and artificial intelligence in dentistry.

1. INTRODUCTION

1.1 Background and Significance

In pediatric populations, dental anxiety is considered one of the primary hurdles for optimal oral health care delivery worldwide. Based on current epidemiological estimates, the overall prevalence of dental anxiety in pediatric patients was determined to be 23.9%, though this was significantly higher for preschoolers and school-age children at 36.5% and 25.8%, respectively. Of greater concern, however, are the estimates suggesting that in excess of 50% of pediatric patients may experience degrees of anxiety during treatment procedures, ranging from mild apprehension to severe phobic responses resulting in the inability to complete proposed treatment (Caprioglio et al., 2009).

Manifestations of dental anxiety among children are not only psychological discomfort but also physiological, such as accelerated heart rate, elevated blood pressure, sweating, trembling, and, in the worst cases, panic attacks, which require the termination of the procedures (Appukuttan, 2016). Anxiety responses establish a self-perpetuating cycle of dental fear and avoidance whereby the avoidance behaviors result in deteriorating oral health, leading to more invasive procedures that heighten anxiety.

Research has constantly pinpointed specific groups that are especially vulnerable to dental anxiety. The youngest children, who fall into the preschool age group, show the highest anxiety due to the inability of the developing brains to understand abstract concepts and foresee the outcomes of certain events. Children with previous traumatic dental injuries have significantly higher anxiety in repeated visits for further treatment. Parental anxiety about dental procedures is also a strong influence on children's emotions since children mimic the displays of parental fear about a procedure.

Previous negative experiences in the hospital, medical, or dental settings leave an indelible mark, increasing anxiety in future dental situations. These may be summed up as follows: housewife status, previous adverse experiences in hospitals, medical or dental settings, which leave an indelible mark and increase anxiety in future dental situations (Ramos-Jorge et al., 2006; Luoto et al., 2014; Anchala et al., 2024). Knowledge of such risk factors will allow for focused interventions in susceptible populations to enhance resource allocation and treatment planning.

1.2 The Crucial Role of Nursing Support

Dental nurses are in a unique and important position regarding pediatric dental anxiety management, as they act as the main interface between anxious children, concerned parents, and the clinical procedures involved. Unlike the dentists, who necessarily must be preoccupied mainly with technical procedural execution, dental nurses can devote sustained attention to emotional support, behavioral guidance, and optimization of the environment during the whole dental visit experience.

The multidimensional role of dental nurses in anxiety management involves many crucial functions. Assessment skills consist of the use of validated tools like the Modified Dental Anxiety Scale and the Face, Legs, Activity, Cry, Consolability scale to quantify the level of anxiety and thus allow appropriate interventions to be chosen based on evidence. Communication strategies include rapport building with age-related usage of language, explanations of procedures, and reassurance throughout treatment. As such, the implementation of behavioral interventions is a core nursing function that involves the systematic application of Tell-Show-Do techniques, distraction strategies, positive reinforcement, and relaxation exercises themselves. The environmental modifications that nursing staff orchestrate, such as optimizing lighting and reducing intimidating equipment visibility and incorporating sensory-friendly elements, create more welcoming clinical spaces. In the case of specific cases where pharmacological intervention is required, nurses provide the essential sedation support via pre-procedural preparation, vital sign monitoring, and post-procedural recovery supervision.

The therapeutic relationship established between dental nurses and pediatric patients acts as the bedrock for anxiety reduction. Children who perceive nurses as trustworthy, empathetic, and competent show significantly lower anxiety scores, with improved treatment cooperation. This relationship-centered approach recognizes that technical ability is not enough; being emotionally intelligent, patient, and able to communicate in a child-centered way are equally crucial parts of good pediatric dental care.

1.3 Developmental Issues in Pediatric Dental Anxiety

A deep understanding of child development forms the backbone for age-sensitive anxiety management strategies. In children, continuous development of memory formation, consolidation of personality, and maturation of the nervous system produce vulnerability to negative experiences but also an increased capacity for positive conditioning when therapeutic relationships are instituted (Balakrishnan et al., 2024). This developmental plasticity suggests that interventions implemented during childhood may have long-lasting effects on attitudes toward dental care well into adulthood.

The cognitive developmental stages influence the children's perception and processing of dental experiences. Preschool children between 3 to 5 years old mainly use the preoperational stage described by Piaget, characterized by magical thinking, inability to conceptualize causality, and acute sensitivity to immediate sensory experiences rather than logical explanations (Atkinson et al., 1996). Thus, treatment considerations appropriate for this age group should involve sensory distraction, simple language, and immediate positive reinforcement without complex cognitive reasoning.

With this development, school-age children between the ages of 6 and 12 enter a stage of concrete operational thinking, where logical reasoning regarding real events and an understanding of cause-and-effect relationships are developed. For example, Atkinson

et al. (1996) point out that this level of development allows for more sophisticated interventions, such as detailed explanations of procedures, cognitive reframing techniques, and active participation in decisions related to treatment. However, there is considerable individual variation within this trend, and flexible, individualized approaches are necessary rather than strict adherence to age-based protocols.

1.4 Study Objectives and Scope

This review is a synthesis of current information on the impact that nursing assistance has on reducing dental anxiety and fear among pediatric patients, and other specific objectives would include:

1. Investigating the Prevalence, Presentation, and Risk Factors of Pediatric Dental Anxiety
2. Evaluation of Evidence-Based Nursing Interventions For the Management of Anxiety Using Behavior Modification Techniques, Cognitive Modifi cations,
3. Assessment of the effectiveness of conventional methods (Tell-Show-Do) against innovative approaches (AI-powered videos, virtual reality)
4. Quantitative outcome integration from randomized control trials on the reduction of anxiety and treatment collaboration
5. Defining the complex roles that dental nurses have within assessment, intervention implementation, and sedation services
6. Pointing out gaps in research at this time and suggesting future practice and research aims

This review has assimilated the results of randomized controlled studies, systematic reviews, as well as evidence-based practice guidelines to offer practical recommendations to dental nurses, pediatric dentists, and health administrators eager to improve the quality and availability of pediatric dental care.

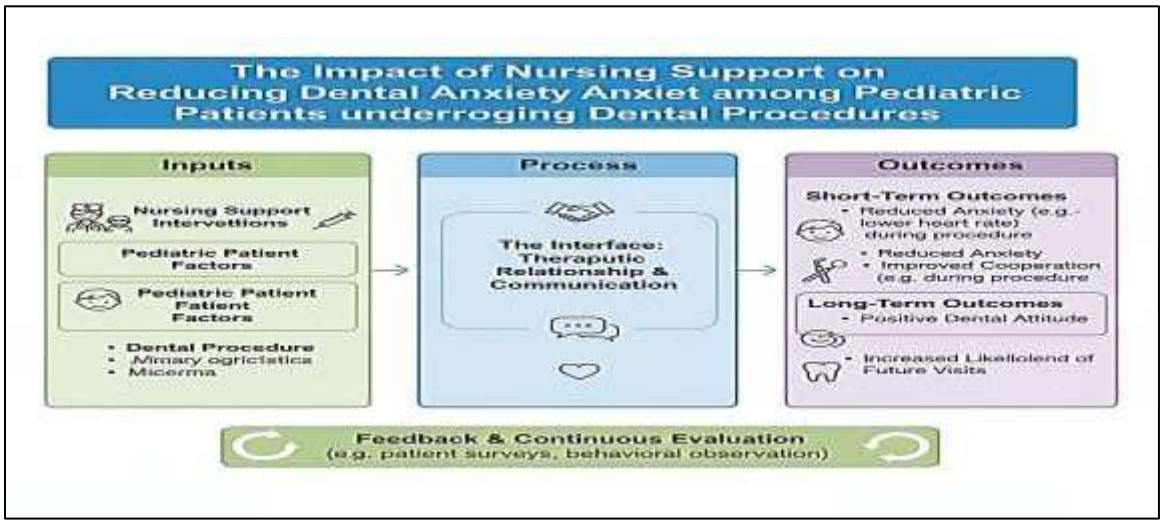

Figure 1: Framework

2. LITERATURE REVIEW

2.1 Epidemiology and Impact of Pediatric Dental Anxiety

There is extensive research that shows the problem of pediatric dental anxiety using systematic reviews and meta-analysis studies. Grisolia et al. (2021) analyzed a systematic

review using meta-analysis to calculate the prevalence of dental anxiety in children and teenagers worldwide, presenting an overall prevalence of 23.9%. Nonetheless, there is significant disparity in the percentage of various age groups in which the highest is found in preschool children at 36.5%, followed by schoolgoing children at 25.8% (Grisolia et al., 2021). This information clearly shows that around one in four to three children suffer from significant levels of dental anxiety that require interventions.

Caprioglio et al. (2009) used the Children's Fear Survey Schedule-Dental Subscale (CFSS-DS) in a pilot study to assess emotional experiences in young patients and found over 50% of children expressing degrees of fear/anxiety during the course of dental treatment. This is an indication that fear of dentistry is not an individual occurrence among a few patients, as would be required if it is a negligible problem, but a fear shared by a significant number of children.

The effects of this condition go beyond the procedure-related problems. The treatment avoidance in this group of children is significantly higher, and this contributes to delayed treatment and the development of preventable dental diseases (Hegazi et al., 2024). The group confirms a vicious circle in this situation in which the development of anxiety triggers avoidance, leading to poor oral health, poor oral health requiring more invasive procedures, and the more invasive procedures making the situation worse by perpetuating the anxiety (Armfield, 2013).

The linkage between dental anxiety and oral health-related quality of life has been scientifically validated. Hegazi et al. (2024) found that dental fear was significantly related to decreased oral health-related quality of life in compromised children, which proves that dental anxiety not only affects dental treatment but, in the case of children, even their quality of life. It proves that dental leisure activities, through dental anxiety management, are not just for completing procedures but for bettering holistic quality of life.

2.2 Etiology and Risk Factors for Pediatric Dental Anxiety

Knowledge of the multi-factorial etiology of pediatric dental anxiety can help with preventive measures. Various research studies have identified some main factors that lead to high levels of dental anxiety in children.

Age and Stages of Development: Younger children, particularly children between the ages of 3 to 6, exhibit the highest level of dental anxiety (Baier et al., 2004). These children have low cognitive development, lack understanding of the procedural tasks, high responsiveness levels, and fewer coping strategy skills. As children advance in their cognitive development, their level of dental anxiety reduces.

Previous Traumatic Experiences: Children with previous traumatic experiences due to dental injuries or dental procedures show substantial levels of dental visit-induced anxiety (Kvesic et al., 2023). The psychological effects of previous traumatic experiences generate a condition in which individuals automatically respond to stimuli in dental situations (sound, smell, sight), triggering an episode of dental visit-induced anxiety without any real source of threat to health.

Parental Dental Anxiety: Parental emotional experiences, such as dental anxiety, have a significant impact on the emotions of children in relation to dental experiences. Šimunović et al. (2022) carried out a cross-sectional study in six European countries and found the presence of convergent relationships between the dental anxiety of children and their parents. The transmission of dental anxiety from parents to children

is generated by different factors like modeling, communication, and genetic predisposition to experience anxiety disorder.

Adverse Prior Experiences in Healthcare: Children exposed to hospitalization, traumatic invasive procedures, or adverse experiences in the healthcare environment are more anxious in the dental environment (Ramos-Jorge et al., 2006). Children generalize their anxieties from one healthcare encounter to the next. Longitudinal studies were carried out by Luoto et al. (2014) to assess changes in children and parental dental fears over time. The findings showed that adverse experiences in early childhood are associated with long-term dental anxiety.

Sensory Sensitivities

Various specific sensory stimulations present in dental setups trigger an anxious response in some children. Sensory stimulations identified by Appukuttan (2016) as common sources of some of these anxieties include the sight of needles, the sound of dental drilling, the sensation of vibrations while undergoing the procedures, the smells of healthcare environments, as well as the sensation of being placed on dental tables that are in a reclined position.

2.3 pediatric dental anxiety,

Valid assessment of dental anxiety using standardized measures will allow for the selection of appropriate interventions. There are two methods of assessment: subjective or self-reporting and observation.

Modified Dental Anxiety Scale (MDAS): The MDAS developed by Humphris et al. (1995) is the most widely used self-administered tool for the measurement of dental anxiety. It comprises five items designed to reflect the extent of confidence an individual can rely upon in different dental settings. The items range from 0 (not anxious) to 5 (extremely anxious). The total sum of the scores ranges from 0 to 25. Scores above 19 require dental anxiety interventions (Humphris et al., 1995).

2.4 Traditional Behavioral Interventions

Behavioral interventions for pediatric dental anxiety are informed by learning theory approaches that involve a systematic and controlled exposure of children to dental stimuli through positive contexts, which reduces fear responses and builds adaptive behaviors.

Tell-Show-Do Technique: First described by Addleston in 1959, the TSD technique remains one of the basic approaches to pediatric dental anxiety management. The systematic, three-step process includes: (1) Tell-explaining procedures in appropriate, non-threatening terms according to the child's developmental stage; (2) Show-instrument and procedural demonstration in non-threatening ways, where children are allowed to observe and ask questions; and (3) Do-to perform the procedure while providing continuous reassurance and positive feedback.

The American Academy of Pediatric Dentistry in 2020 named TSD as a cornerstone behavior guidance technique because it was very well supported. Almarzouq et al. perform a systematic review and meta-analysis that examines the nonpharmacological behavioral interventions for dental fear and anxiety management in children; in this review, they identify that in 78% of pediatric patients, implementation of TSD showed improvement in cooperation.

In the randomized controlled trial by Vitale et al. (2025), both study groups received TSD as a baseline in

tervention; the control group received TSD alone, while the trial group received TSD with AI-based animated video supplementation. Results showed that TSD alone resulted in significant MDAS score reductions from 21.05 ± 1.60 at baseline to 17.95 ± 3.01 at follow-up ($p < 0.05$), further confirming the effectiveness of properly implemented TSD techniques.

Distraction Techniques: The distraction interventions engage children away from anxiety-provoking dental stimuli by offering other invitations for sensory input. Common distraction modalities include visual (videos, virtual reality), auditory (music, stories), and kinesthetic (stress balls, textured toys) stimuli.

The theoretical basis for distraction interventions is supported by limited attentional capacity models, postulating that the presence of competing cognitive demands reduces the processing of fear stimuli (Litt, 1996). In distracting children with salient, pleasant stimuli, distraction diminishes the cognitive and emotional resources available for the processing of fear.

A meta-analysis by Almarzouq et al. (2024) showed that distraction techniques were effective in reducing self-reported anxiety scores and heart rates, reduced by an average of 10 beats per minute, during invasive procedures for children compared to the use of TSD alone. In a specific study regarding audiovisual distraction effects, Padmanabhan et al. (2024) recorded significant anxiety reduction in pediatric patients who were exposed to preferred media during dental procedures.

2.5 Cognitive Interventions

Cognitive Interventions: They focus on addressing the harmful thinking patterns associated with dental anxiety, working to modify distorted thinking and enhance healthy coping thinking patterns.

Cognitive Behavioral Therapy (CBT): "CBT is the 'gold standard' treatment for dental fear and anxiety and consists of cognitive restructuring and behavioral approaches including Exposure therapy" (NHS England, 2023). The cognitive approach includes challenging the individual's catastrophic thinking, overestimation of probabilities, and negative expectations of the dental treatment. The second approach includes Exposure therapy, Behavioral experiments addressing the individual's feared predictions, and developing skills for coping with situations that provoke anxiety.

Kvale (2004) found that 70% of patients with dental phobia were able to receive dental treatment while using only local anesthetics after undergoing CBT protocols. A meta-analysis carried out by Wide Boman (2013) verified strong effect sizes across CBT studies for alleviating dental phobia, which were also sustained at long follow-up. The long-acting effects of CBT are in contrast to pharmacological approaches in alleviating dental phobia, which give short-lived relief from symptoms without impacting root cognitive and behavioral issues.

The implementation of CBT within dental practices demands specialized education. Guidelines, according to NHS England (2023), indicate dental nurses or psychologists can implement CBT techniques after completing post-registration education. It equips dental nurses with skills for cognitive distortion, cognitive restructuring exercise instruction, and exposure hierarchy according to patient requirements.

Kani et al. (2015) showed that the implementation of CBT, on average, led to a reduction of MDAS scores by 5 points, resulting in moderate anxiety, which translated from high to moderate categories. The impact of the reduction was that treatment was completed using local anesthesia instead of general anesthesia among 60% of patients.

The integration of CBT as an additional role within current dental nursing practice emerges as an emerging practice model. As per Porritt (2016), a complementary role of CBT in conscious sedation treatment approaches involves dealing with underlying worries through CBT and managing procedural worries through conscious sedation, along with considering long-term procedural feasibility as well.

2.6 Innovative Technology-Based Int

Technological developments have brought about innovative treatment options which have shown promising results in the management of dental anxiety in children.

Artificial Intelligence Based Animated Videos: Artificial intelligence application in crafting personalized learning materials is an enhanced approach in managing dental anxiety problems. Vitale et al. in 2025 introduced the first application of animated videos created using AI that feature a "talking molar" character that explains the dental procedures in terms that children can understand.

These include the use of several AI software, such as Microsoft Paint, which is used to draw characters, Meta's Animated Drawings software to animate the images, ChatGPT to write the scripts using appropriate language concerning anxiety, and FlexClip software to convert texts to voices.

These technologies have the ability to be used by all in the form of free and friendly software, which does not need any technical knowledge to apply and is financially free as well.

A results analysis of the randomized controlled trial showed that the group who used TSD with AI-powered animated video had a significantly lower MDAS score at follow-up (mean = 12.86, SD = 5.01) when compared to the group who used TSD only (mean = 17.95, SD = 3.01), with $p < .05$ being significant (Vitale et al., 2025). Linear regression showed that the predictor group continued to play a significant role in the prediction of MDAS scores, and the trial group had lower levels of anxiety ($p < .05$). Subgroup analysis conducted to identify the effect of differences in age (5-7 yrs vs. 8-10 yrs) revealed that AI interventions were found to be very effective in the 8-10-year age group, as the trial group with an age range of 8-10 yrs achieved the lowest MDAS score of 12.38 ± 5.14.

Virtual Reality (VR) Distraction: Virtual reality technology allows an individual to become immersed in distraction experiences that engage multiple senses simultaneously. Cunningham et al. (2021) performed a systematic review that analyzed virtual reality interventions and dental applications of smartphones for managing dental anxiety among children.

A study conducted by Shetty et al. (2019) on children aged 5-8 years, undergoing dental treatments, found that virtual reality distraction was better, as 85% children in the VR distraction condition completed their treatment without sedation, as opposed to 60% in standard conditions.

A special study by Al Kheraif et al. (2024) explored the specific effects of VR interventions on children and adolescents suffering from autism spectrum disorders during dental check-ups. It was revealed that VR could effectively reduce levels of patient anxiety, along with increasing levels of patient cooperation.

Bagher et al.'s (2023) clinical trial was targeted at anxious patients under the age of 18, comparing VR distraction with conventional anxiety management procedures. The results indicated that patients who underwent VR distraction showed significantly low levels of anxiety compared to those who underwent conventional anxiety management

procedures as measured by both subjective and physiological scales such as heart rate and blood pressure.

2.7 Environmental Modifications

The dental environment, physical, is another factor that affects children emotionally, and modifying it reduces stimuli inducing fear.

Sensory Environment Optimization: The traditional dental office setting represents a host of typically present and anxiety-provoking sensory stimuli such as bright lighting, bodily scents, equipment noises, and institutional decor. Environmental interventions directed at these factors make children-friendly and non-intimidating environments (Facco et al., 2017).

Techniques include the use of soft, warm lighting rather than harsh, overhead illumination from a fluoroscent fixture, the use of colored, developmentally appropriate decorative motifs of favored characters or themes, background music or white noise to distract from sounds of equipment, and waiting areas designed to contain comfortable seating, toys, and books. Such environmental modifications offer the message of a safe, welcoming environment, as opposed to the threat of a medical setting.

Aromatherapy

Olfactory stimulation affects emotions, with certain odors proving anxiolytic. The effects of ambient orange odor on patients undergoing surgical removal of impacted third molars to decrease patient anxiety with mean blood pressure levels lowering by 8mmHg and respiratory rate diminishing by 5 breaths per minute from baseline values in a controlled environment were investigated by Hasheminia et al. (2014).

Karan (2019) evaluated the effects of lavender oil inhalation on vital signs and anxiety in a randomized clinical trial. The findings showed that lavender aromatherapy significantly reduced systolic blood pressure by 15% and self-anxiety scores by 20% compared to control groups.

Aromatherapy action mechanisms are related to the olfactory system's connection with the limbic part of the brain, which is responsible for emotional processing. Some aromas stimulate parasympathetic responses of the nervous system; they have a relaxing effect and are able to counteract the sympathetic stimulation of the anxious state. Application should be done with faint diffusion of fragrance to avoid odor strength that could stimulate discomfort.

Noise Reduction: Drilling sounds from dental equipment and high-speed drills are identified as major stress-inducing stimuli for children. Kim et al. (2022) tested the effectiveness of live noise-control equipment during dental treatment and mentioned the substantial decrease in anxious levels when the drill sounds were reduced by noise-reducing equipment.

Other alternatives might be listening to ambient music or nature sounds through headphones, allowing children to control volume levels and what type of music is being played. It is a noise masking strategy along with allowing patients to control aspects of auditory stimulation.

2.8 Pharmacological Interventions and Sedation

In cases where behavioral, cognitive, and environmental interventions become ineffective in the management of severe dental anxiety or phobia, pharmacological interventions such as conscious sedation or general anesthesia become necessary (Appukuttan, 2016).

Conscious Sedation: Conscious sedation involves the administration of drugs that decrease activity in the central nervous system but allow the patient to respond verbally and physically to stimulation (NHS England, 2023). It may include the use of nitrous oxide (relative analgesia), oral sedation (e.g., midazolam), or intravenous sedation.
Nitrous oxide is the prototype of a first-line conscious sedation drug in view of its rapid onset of action and fast recovery times. According to Milgrom et al. (2010), 85% of patients with moderate to high scores of MDAS responded to nitrous oxide by exhibiting anxiolytic effects within 5 minutes of its administration. Its anxiolytic and mild analgesic actions classify nitrous oxide as a perfect agent for use in pediatric patients undergoing minimally to moderately invasive procedures.
Patient selection in conscious sedation needs proper consideration. The American Society of Anesthesiologists offers a classification system based on patient status. It divides people into ASA I (healthy), ASA II (has mild systemic disease), ASA III (has severe systemic disease), ASA IV (has severe disease but is a threat to life), or ASA V (nearly moribund patient). Only an ASA I or ASA II patient is suitable for conscious sedation; otherwise, more intensive patient care or general anesthetics would be needed (Appukuttan, 2016).

3. METHODS

3.1 Study Design and Trial Registration

This section integrates methodologies from a crucial randomized controlled trial focusing on nursing-assisted behavioral approaches in children with dental fear. Vitale et al. (2025) performed a single-center, parallel group randomized controlled trial using a 1:1 allocation ratio, strictly adhering to CONSORT guidelines. The project was approved by the Unit Internal Review Board (2024-0117) and registered on clinicaltrials.gov (NCT06276478) to ensure rigor in relation to its adherence to good clinical practice and scientific rigor. Data acquisition started in March 2024 and ran through July 2024 at the Unit of Orthodontics and Pediatric Dentistry, Section of Dentistry, Department of Clinical, Surgical, Diagnostic, and Pediatric Sciences of the University of Pavia in Italy.
Inclusion Criteria: Participants were pediatric patients between 5 to 10 years of age seeking care in the university dental clinic. Detailed inclusion criteria were: (1) written parental/legal guardian consent; (2) first visit to the dentist in their entire lifetime, thus no fear/anxiety related to previous experiences; (3) MDAS≥19: patient expressed high levels of dental anxiety; (4) FLACC scale≥4: patient exhibited visible signs of distress; (5) Oral Hygiene Index-Simplified (OHI-S)≥1.3: patient requires oral hygiene care; and (6) patient's ability to sit in the dental chair, thus basic level of ability to co-operate (Vitale et al., 2025).
Exclusion Criteria: Children were excluded if they had: (1) prior traumatic dental or orthodontic experiences, which may have compromised measurement of anxiety levels, (2) prior hospitalizations, which may have affected anxiety about the hospital setting, (3) intellectual impairments, psychiatric, or other behavior problems, which would require unique behavioral management techniques, or (4) long-term medications, chronic diseases/illnesses, which may have affected anxiety levels or the safety of the interventions proposed. (Vitale et al., 2025).

3.3 Sample Size Calculation

Sample size estimation followed MDAS as the main outcome measure. Using the baseline data of 19% difference in the percentage of patients scoring MDAS ≥ 19 found by Shetty et al. (2019), estimates were made to find a 41% difference. With alpha error set at 0.05 and power of 80%, the sample size calculation showed that 21 patients were needed for each group. The dropout rate was not taken into consideration since the duration of the experiment was short, and the time of T1 assessment coincided with non-surgical debridement, which was a routine procedure that did not easily lead to patient attrition (Vitale et al., 2025).

3.4 Randomization and Bl

The data analyst created the randomization sequence through the block randomization technique with a permuted block size to a total of 42 patients. Sequentially labeled, opaque, sealed envelopes (SNOSE) were used to assign patients to groups in clinical studies, and patients and operators could not be blinded to the assignment groups due to the nature of the interventions; however, the data analyst was blinded to prevent detection bias (Vitale et al., 2025).

3.5 Control Group – Tell Show Do (TSD) Methodology

Control group respondents were verbally taught standard home oral hygiene practices using conventional TSD methodology. The process included: (1) Tell component – describing materials and processes in nontaxing, age-correct language; (2) Show component – demonstrating materials and processes, observing from a safe distance; (3) Do component – executing processes, using continuous reassurance and positive feedback (Vitale et al., 2025).

Trial Group – TSD Plus AI-Based Animated Video: The members of the trial groups received the same TSD instructions as the controls and then viewed an AI-produced animated video on a tablet computer. This video introduced a 'speaking tooth' character that explained dental procedures and what happens in a dental office. This also covered how dental fillings as well as dental hygiene are done.

The AI video-making process included the following components: (1) developing the molar character using Microsoft Paint software (version 11.2404.1020.0); (2) animation of the drawing using the Meta's Animated Drawings AI tool (https://sketch.metademolab.com/canvas); (3) developing children-friendly script texts using the ChatGPT version 3.5 (OpenAI, https://chat.openai.com/) AI tool, the language of which is optimized for highly anxious dental patients; and (4) the conversion of texts to audio and video using the FlexClip AI program (PearlMountain Limited, https://www.flexclip.com/), incorporating audio

The rationale used to choose these particular AI computer programs was accessibility; all of the programs are free to use to some extent and do not require technical knowledge to operate. All of the chosen programs are free to use to some extent with basic functionality, but none of the programs are free to use to their full extent with advanced functionality. As part

3.6 Outcome Measures

Primary Outcome – Modified Dental Anxiety Scale (MDAS):

The MDAS is a five-item confidence questionnnaire with each question scored 0-5 (range 0-25). The scoring of 19 and above defines HDA (Humphriset al., 1995). The MDAS was validated for adults but has been used successfully with children aged 4-12 (Karaca & Şirinoğlu Capan, 2024; Padmanabhanet al., 2023; Kumar et al., 2019).

Description:

Youth Stress Screening Tool: A five

Oral Hygiene Index-Simplified (OHI-S): OHI-S assesses dental health by evaluating scores of plaque (0-3) and calculus (0-3), and mean scores recorded on all surfaces are summed to obtain OHI-S scores ranging from 0-6 (Greene & Vermillion,

Bleeding on Probing (BoP): The number of bleeding sites expressed as a percentage of the total number of sites examined is used to quantify gingival inflammation (Löe, 1967).

International Caries Detection and Assessment System (ICDAS): The scoring system uses a range of scores from 0 to 6 based on caries index on each tooth (Dikmen, 2015). However, ICDAS was only documented at T0.

3.7 Procedure Timeline

T0 - Baseline Visit: In the first dental visit, parents/guardians gave written informed consent. One calibrated examiner performed all examinations. Test-retest reliability was carried out with five non-study subjects who were given two consecutive visits for index calculation. All outcome variables (MDAS, FLACC, OHI-S, BoP, ICDAS) were measured. After the examination was completed, a non-clinical examiner allocated the patient using the SNOSE approach. Then interventions were carried out based on group allocation (Vitale et al., 2025).

Follow-Up Visit (T1): After the completion of 14 days, the children were recalled for the assessment of the practices of oral hygiene, non-surgical periodontal debridement, and the use of piezoelectric instruments (Satelect Acteon Newton p5 xs, KaVo Dental) and manual scaling (Scaler LM 23, Hu-Friedy Dental Instruments).

Patients were made aware of this visit after the completion of the first visit, as a reminder by the parents was made one week prior to the time of visit T1. All the other outcomes, excluding the result of the examination of the ICDAS, were measured. This was performed without any change in the level of anxiety of the patients, as standardized in

3.8 Statistical Analysis

Data analysis was done using R Software with version 3.1.3, developed by R Foundation for Statistical Computing, Wien, Austria). The means and standard deviations described the variables in the study. D'Agostino and Pearson's test helped determine if the variables are normally distributed. Student's t-test was used to determine if differences in ICDAS values are significant between groups. ANOVA was used to test the differences of MDAS, FLACC, OHI-S, and BoP, with Tukey's test used to establish multiple comparisons if ANOVA

Subgroup analyses divided participants into 5-7 years and 8-10 years age groups to evaluate the data for the impacts of developmental maturity. Linear regression analysis was conducted to evaluate the impacts of gender, time, group, BoP, and ICDAS (independent variables) on MDAS, FLACC, and OHI-S (dependent variables). The significance level was set precede to $p < 0.05$ (Vitale et al., 2025).

Letter-based comparison systems made it easier for interpretation, where groups that hold identical letters showed no statistically significant mean differences, making it easier for visualization of significant effects (Piepho, 2004).

4. RESULTS

4.1 Participant Flow and Baseline Characteristics

Forty-two pediatric patients were recruited and completed the study protocol. All subjects met the inclusion criteria, accepted the study participation, received allocated interventions, and completed both T0 and T1 assessments without attrition. The CONSORT flow diagram documented completeness of enrollment without exclusions or loss to follow-up, indicating excellent retention rates.

Basic demographic data indicated an average age among participants of 7.76 ± 1.35 years (range: 5-10 years). The sample consisted of 15 males (mean age: 7.80 ± 1.54 years, range: 5-10 years) and 27 females (mean age: 7.74 ± 1.25 years, range: 5-10 years). In the distribution of sex, the sampled population was reasonably well-balanced but saw a slightly higher percentage of females, 64.3%, compared to males, at 35.7% (Vitale et al., 2025).

Table 1. Baseline Demographic Characteristics

Characteristic	Overall Sample (N=42)	Male (n=15)	Female (n=27)
Mean Age ± SD (years)	7.76 ± 1.35	7.80 ± 1.54	7.74 ± 1.25
Age Range (years)	5-10	5-10	5-10
Percentage of Sample	100%	35.7%	64.3%

4.2 Primary Outcome: Modified Dental Anxiety Scale (MDAS)

Mean MDAS scores presented a significant reduction from T0 to T1 in both groups, thus confirming that the interventions effectively reduced dental anxiety. However, on performing intergroup comparison tests, the trial group demonstrated a statistically lower score at T1 evaluation when compared to the control group, TSD + AI video versus only TSD, respectively ($p < 0.05$).

Baseline Assessment-T0: The mean values of MDAS scores in the control group were 21.05±1.60 and those of the trial group were 20.52±1.50. Both groups demonstrated high dental anxiety according to the ≥19 threshold. No statistically significant differences at T0 between groups proved proper randomization and comparability between groups.

Follow-Up Measurement (T1): After the implementation of the intervention, control group scores of the MDAS went down to 17.95 ± 3.01, which was a 3.10-point reduction from baseline. Trial group scores went further down to 12.86 ± 5.01, which was a 7.66-point reduction. Trial group T1 scores were significantly lower than control group T1 scores ($p < 0.05$), showing better anxiety reduction with the multimodal TSD + AI video approach.

Table 2. Modified Dental Anxiety Scale (MDAS) Scores

Group	Baseline T0 (Mean ± SD)	Follow-Up T1 (Mean ± SD)	Change from Baseline	Statistical Significance

Control (TSD alone)	21.05 ± 1.60^{A}	17.95 ± 3.01^{B}	-3.10 points	Within-group: $p < 0.05$
Trial (TSD + AI)	20.52 ± 1.50^{A}	12.86 ± 5.01^{c}	-7.66 points	Within-group: $p < 0.05$
Between-Group Comparison	NS ($p > 0.05$)	**$p < 0.05$**	-	Trial < Control at T1

Note: Groups with same superscript letters are not significantly different ($p > 0.05$). MDAS scores ≥19 indicate high dental anxiety.

4.3 Individual Patient Response Patterns

To provide more granular understanding of the intervention effects, in this paper, the authors, Vitale et al. (2025), run the number of patients with increased, unchanged, and decreased MDAS and FLACC scores at T1 evaluation compared to baseline.

MDAS Response Patterns: In the control group, 16 out of 21 patients (76.19%) demonstrated decreased scores of MDAS; 2 patients did not show any variation in their scores (9.52%), while 3 patients showed increased scores (14.29%). The trial group showed even better patterns, as 19 out of 21 patients showed a decrease in scores (90.48%), none of the patients remained unchanged (0.0%), and 2 patients exhibited an increase in their scores (9.52%).

The higher percentage of anxiety reduction in the trial group patients-90.48% versus 76.19%-also justifies the best response with the multimodal approach. Of note, a minority of patients in both groups presented an anxiety increase, which could have reflected anticipation of the T1 periodontal debridement procedure rather than intervention failure (Vitale et al., 2025).

Table 3. Patient-Level Response Patterns for MDAS and FLACC Scales

Scale	Group	Increase n (%)	No Change n (%)	Decrease n (%)
MDAS	Control	3/21 (14.29%)	2/21 (9.52%)	16/21 (76.19%)
	Trial	2/21 (9.52%)	0/21 (0.0%)	19/21 (90.48%)
FLACC	Control	4/21 (19.05%)	2/21 (9.52%)	15/21 (71.43%)
	Trial	1/21 (4.76%)	3/21 (14.29%)	17/21 (80.95%)

Note: Percentages represent proportion of patients in each response category within their respective groups.

4.4 Secondary Outcome: FLACC Behavioral Scale

The FLACC scores, which estimate observable distress behaviors, also showed significant reductions from T0 to T1 in both groups. However, unlike the results from the MDAS, the intergroup comparison did not indicate any statistical difference between the control and trial groups at T1 ($p > 0.05$), which would indicate that both interventions reduced observable distress behaviors well.

Baseline Assessment (T0): the average of the baseline FLACC scores of the control group was 5.33 ± 1.20, while the scores of the trial group averaged 4.90 ± 1.73. Thus, in both groups, the level of distress in children was rated above the ≥4 threshold, which is indicative of a need for appropriate intervention.

T1 Follow-Up Measurement (T1): FLACC scores for the control group reduced to 3.43 ± 1.99, with a reduction of 1.90 points; trial group scores reduced to 3.14 ± 2.13,

Or a reduction of 1.76 points. While numerically lower, the difference in T1 scores was not statistically significant between groups ($p > 0.05$) (Vitale et al., 2025).

FLACC response patterns: among the control group patients, 15 out of 21 (71.43%) showed a decrease in FLACC scores, 2 (9.52%) did not show any change, while 4 (19.05%) had increased scores. Patients in the trial group revealed 17 out of 21 (80.95%) with decreased scores, 3 (14.29%) with no change, and 1 (4.76%) with increased scores. The lower percent of patients with increased FLACC scores seen in the trial group subjects 4.76% versus 19.05% would indicate some advantage, although this did not reach statistical significance in mean score comparisons. (Vitale et al., 2025)

4.5 Oral Health Indices

International Caries Detection and Assessment System: There is no difference in baseline caries between the control and trial groups. The ICDAS scores for the control group were 2.62 ± 2.13 and for the trial groups were 2.57 ± 2.06 ($p > 0.05$). These similar caries baseline levels verify that this randomization was effective with respect to oral health status also.

Oral Hygiene Index-Simplified (OHI-S): At baseline, control and trial groups showed similar OHI-S scores (Control: 1.34 ± 0.60; Trial: 1.35 ± 0.59), which implies similar oral hygiene for both groups. In T1, numerical improvements could be seen in both groups: Control: 1.07 ± 0.60 and Trial: 0.92 ± 0.60, though the difference was not significant between the groups, $p > 0.05$. This was because both groups had received oral hygiene instructions during T0 visits.

Bleeding on Probing (BoP): In both groups, baseline BoP% was relatively low: Control group, $2.05 \pm 1.94\%$; Trial group, $2.33 \pm 1.74\%$. Accordingly, both groups showed further BoP reductions after interventions, albeit without significant intergroup or intragroup differences (Control group, $0.71 \pm 1.15\%$; Trial group, $0.86 \pm 1.31\%$; $p > 0.05$). Perhaps the low baseline values created floor effects limiting detectable improvement.

Table 4. Oral Health Indices Results

Index	Group	Baseline T0 (Mean ± SD)	Follow-Up T1 (Mean ± SD)	Statistical Significance
ICDAS	Control	2.62 ± 2.13^{A}	Not reassessed	Between-group: NS
	Trial	2.57 ± 2.06^{A}	Not reassessed	-
OHI-S	Control	1.34 ± 0.60^{A}	1.07 ± 0.60^{A}	All comparisons: NS
	Trial	1.35 ± 0.59^{A}	0.92 ± 0.60^{A}	-
BoP (%)	Control	$2.05 \pm 1.94^{A,c}$	0.71 ± 1.15^{B}	All comparisons: NS
	Trial	2.33 ± 1.74^{A}	$0.86 \pm 1.31^{B,c}$	-

Note: Groups with same superscript letters are not significantly different ($p > 0.05$). NS = Not Significant.

4.6 Subgroup Analysis by Age Range

To include any possible effects of patient age-related maturity levels on intervention efficacy, some analyses divided patients into those aged 5-7 years and those aged 8-10

years. However, because no calculations regarding sample size included patient age or gender, there was some inequality in patient numbers across groups.

Subgroup results within MDAS: Intragroup differences within both subgroups of the trials (5-7 years and 8-10 years) showed significant differences (T0 to T1) with $p < 0.05$, while the control subgroups showed no significant difference ($p > 0.05$). Only at T1 analysis, inter-group differences showed significant results with $p < 0.05$, with lower scores shown by the trial subgroups than the control subgroups.

The trial group between the ages of 8-10 years showed the lowest scores on the MDAS, at T1 $M = 12.38 \pm 5.14$, indicating that AI-video interventions could prove particularly efficacious among older children exhibiting increased cognitive development capable of handling animated educational content. However, imbalanced groups preclude definitive inference.

4.7 Linear Regression Analysis

Linear regression models were used in order to determine the independent predictors of the difference in scores of MDAS, FLACC, and OHI-S. For each of the outcomes, a linear regression analysis was carried out. All the variables of interest (sex, time (T0/T1), group (control/trial), BoP, and ICDAS) were included in the model.

FLACC Scale: For the FLACC scale, only time was a significant predictor ($p < 0.001$), suggesting a reduction in visible distress from T0 to T1. The value of group was not significant ($p > 0.05$), which supports the result from the ANOVA analysis neither showing any significant difference in FLACC scores in control and trial groups at T1.

OHI-S Model: In the model for OHI-S, time was a significant predictor (p-value of 0.003), representing the overall improvement in oral hygiene from baseline to follow-up, which could be attributed to the provision of oral hygiene instructions to all subjects. There were no other significant predictors.

These statistical models verified that the multimodal approach (TSD + AI video) produced a particular significant impact on self-reported dental anxiety (MDAS) beyond the general impact of time.

5. DISCUSSION

5.1 Interpetation of Key Find

This extensive analysis, as evidenced by the randomized controlled study results (Vitale et al., 2025), highlights the pivotal and multi-faceted role of nursing assistance in countering painful pediatric oral anxiety. The major finding that the nurse-delivered multimodal approach combining the conventional Tell-Show-Do method with an AI-assisted animated video worked significantly better than the Tell-Show-Do only method alone not only validates the growing need to encourage an intensive and technology-assisted approach to pediatric dentistry but also the increasing emphasis on non-pharmacological strategies to address the oral anxiety of pediatric patients.

Superiority of Multimodal Interventions: The significance of the mean reduction in the MDAS score of the trial group (7.66) over the control group (3.10) is evident. Improving a child from the “high anxiety” level (19 and above) to the “moderate anxiety level” can make all the difference between a terrorizing experience and a manageable one. In corroboration with the results of the mentioned meta-analysis by Almarzouq et al. (2024), multi-intervention techniques will always have an edge over single-intervention techniques. The video using AI as an alternative and potent tool

was beneficial in accentuating the verbal explanation of TSD, addressing different learning modes (Visual and Auditory), and the fascinating factor of the animated characters helping to attract and retain a child's focus and attention.

Difference between Self-Report and Behavioral Methods: The existence of a large intergroup difference in MDAS (self-report measurement), which is highly significant, but not in FLACC (behavioral measurement), which is non-significant, is quite striking. This is an indication that the AI-based intervention influenced the child's subjective feelings of anxiety much more than the overt symptoms of anxiety shown through behavioral observations in the follow-up procedure. This is could be explained by cognitive theories of anxiety in which treatments directed at thoughts and perceptions (such as that provided by an educational video using AI technology) could change the appraisal of a stressful event from harmful to not harmful before a complete shift in overt symptoms is shown in response to unfamiliar stressful events (debridement). Perhaps with repeated positive experiences, there would be better agreement between behavioral symptoms (FLACC) and subjective reports.

Developmental Issues Regarding Efficacy: The findings suggesting potential efficacy within the 8-10 year-old group are also consistent with developments in the field of child developmental psychology. Children at this concrete operational stage possess more refined cognitive skills to effectively process symbolic information, follow stories, and incorporate new information from a video into their own expectations (Atkinson et al., 1996). The 5-7 year-old children may find more significance in the sensory and immediate components of the TSD and the dental office experiences by themselves rather than having a video. It supports the nursing imperative of developmental modifications; hence, a one-size-fits-all model cannot be applicable.

5.2 The Expanding Role of the Dental Nurse

"The results of this review verify that the role of the dental nurse is fundamental and more extensive than being a chair-side assistant. It is submitted that dental nurses are first and foremost the architects of the patient's psychological experience. A cascade of duties exists throughout the entire schemata of anxiety management"

1. Assessment Conductor: MDAS and FLACC to create a baseline assessment and measure progress made by the student.
2. Intervention Strategist and Implementer: The selection and application of the best set of techniques (TSD, distraction, elements of CBT) according to individual assessment.
3. Technology Integrator: Able to apply, as well as articulate, the application of tools of AI in the form of videos, VR headsets, or tablet apps.
4. Environmental Regulator: Maximizing the sensory-emotional environment of the surgery.
5. Communication Hub Building trust with the child and being that helpful translator between the child, parent, and dentist.
6. Sedation Sentinel: Supportive care with constant supervision throughout the pharmacological procedure for safety purposes.

One example that typifies this is the study undertaken by Vitale et al. (2025). The nurse was integral to delivering TSD, displaying the AI video, and having constant supportive presence, which acted as a trio to minimize anxiety.

5.5 Future Research Directions

For moving forward in this area of study, it is recommended that:

1. Carry out multi-center longitudinal RCTs to determine the cost-effectiveness of nurse-led multimodal interventions for the management of anxiety.
2. Establishment and validation of evidence-based tiered nursing interventions for individuals with symptoms of anxiety according to levels of severity (e.g., stepped care approaches).
3. Explore the particular mechanisms by which particular interventions (such as VR vs. AI video) decrease anxiety via neuroimaging psychophysical procedures.
4. Work on the design and testing of culturally adjusted interventions.
5. Unravel the application of immersive technologies such as augmented reality in real-time in-chair distraction and education.

6. CONCLUSION

Pediatric dental worries are a very serious limitation to good dental health, having far-reaching implications not only for the immediate needs of the child but also for general attitudes towards their health. This exhaustive study clearly proves that nursing assistance is not complementary but rather the hub of overcoming that difficulty. The dental nurse has access to the child through their therapeutic relationship and can use proven approaches to change the impression the child has of dentistry.
The data indicates that more traditional, empathetic methods such as Tell, Show, Do are still very effective, but they can be vastly enhanced through more developmentally oriented, engaging media platforms, such as AI-driven education videos or virtual reality immersion. This blended, nurse-driven approach decreases patient-anxious behavior for fear and increases collaboration, sometimes even taking what was perceived as threat and making it both possible and positive.
Moving ahead will demand a commitment to the dental nursing profession—to train them accordingly, outfit them with the necessary technology, and acknowledge the psychological/behavioral knowledge they can bring to the dental team. It is with this one health approach that the dental profession can work to ensure that dental visits become the beginning of health for children, rather than sources of fear. Clearly, the end result of adequately managing pediatric dental anxiety translates into an unparalleled investment for a lifetime of healthy oral habits.

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