International Journal of Contemporary Pediatrics
Shikha S et al. Int J Contemp Pediatr. 2026 Dec;13(12):2428-2433
https://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: https://dx.doi.org/10.18203/2349-3291.ijcp20264306

Original Research Article

Comparative evaluation between art therapy and nitrous oxide: oxygen inhalation sedation in managing dental anxiety among children of ages 8-12 years

Smriti Shikha*, Chitritra Gupta Mukherjee, J. N. Shukla

Department of Pediatric and Preventive Dentistry, Buddha Institute of Dental Sciences and Hospital, Patna, Bihar, India

Received: 10 March 2026
Revised: 28 October 2026
Accepted: 03 November 2026

***Correspondence:**
Dr. Smriti Shikha,
E-mail: ssmriti@gmail.com

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ABSTRACT

Background: Dental anxiety in children often complicates treatment and impacts long-term oral health. While Nitrous oxide–oxygen (N_2O-O_2) inhalation sedation is effective, concerns about cost and accessibility have encouraged exploration of non-pharmacological alternatives such as art therapy (AT). The aim of the study is to compare the efficacy of art therapy and N_2O-O_2 sedation in reducing dental anxiety among children aged 8–12 years undergoing extractions under local anesthesia.
Methods: A randomized crossover clinical trial was conducted with 25 children (mean age: 9.84±1.57 years). Each child received both interventions in separate sessions: N_2O-O_2 sedation (10–40% titration) and 20 minutes of non-directive art therapy using mandala coloring. Anxiety was assessed using Venham's Anxiety Scale, Frankel's Behavior Rating Scale, and pulse rate at five treatment stages. Data were analyzed using paired and independent t-tests.
Results: Both interventions significantly reduced anxiety and improved behavior. Pulse rates declined post-treatment in both groups, with females showing higher values than males ($p<0.05$). N_2O-O_2 sedation showed slightly greater reduction during local anesthesia administration, but overall differences between the two interventions were statistically insignificant ($p>0.05$).
Conclusions: Art therapy and N_2O-O_2 are both effective for managing pediatric dental anxiety. Art therapy is a viable, low-cost, non-invasive alternative, particularly useful in resource-limited settings. Larger trials are recommended to validate long-term outcomes.

Keywords: Dental anxiety, Art therapy, Nitrous oxide, Children, Behavior management

INTRODUCTION

Dental anxiety is a prevalent concern in pediatric dentistry, often leading to behavioral management challenges, delayed treatment and compromised long-term oral health outcomes.[1,2] Although pharmacological approaches such as Nitrous oxide–oxygen (N_2O–O_2) sedation are widely used, concerns regarding potential side effects, cost and limited accessibility have prompted exploration of non-pharmacological alternatives such as art therapy.[3] Art therapy, grounded in expressive psychology, enables children to externalize and process their emotions, including anxiety and trauma, through creative activities such as drawing and coloring.[4,5]

Evidence supports its efficacy in reducing anxiety across various clinical populations; however, its specific application in managing dental anxiety remains under explored.[6] Given its low cost, safety and ease of implementation, art therapy represents a promising and accessible adjunct to conventional anxiety management

strategies in pediatric dentistry. To compare the efficacy of art therapy and N_2O-O_2 sedation in reducing dental anxiety among children aged 8-12 undergoing dental extractions under local anesthesia.

METHODS

This was a randomized crossover clinical trial. The study was conducted in Buddha Institute of Dental Sciences, Patna, Bihar, India in the year 2023-2024. involving 25 children (mean age: 9.84±1.57 years), each undergoing two treatment sessions requiring local anesthesia. Each child received N_2O-O_2 sedation for one session and art therapy for the other. The order was randomized to eliminate bias. Inclusion criteria included ASA I or II classification and Frankel behavior ratings of 2 or 3.

Assessment tools

Venham's anxiety scale (psychological measure); Frankel's behavior rating scale (behavioral measure); and pulse oximeter (physiological marker) intervention details.

N_2O-O_2 sedation

Titrated from 10% to 40% nitrous oxide concentration with continuous monitoring. The table used for recording the readings are mentioned in the appendix (Table 1).

Art therapy

Children engaged in 20 minutes of non-directive art using mandala books and coloring tools. The table used for recording the anxiety is mentioned in the appendix (Table 2).

Readings were taken at five stages: pre-treatment, during LA administration, during procedure, post-treatment and post-intervention. Figure 1 shows a patient undergoing art therapy pre-treatment and Figure 2 shows the procedure being carried out under nitrous oxide sedation. The study was approved from the ethical committee.

Statistical analysis

Paired and independent t-tests applied. Differences between art therapy and N_2O-O_2 groups were statistically insignificant ($p>0.05$).



Figure 1: Child undergoing art-therapy before extraction.



Figure 2: Procedure being carried out under nitous-oxide-oxygen sedation.

RESULTS

Both interventions led to significant reductions in anxiety and improvements in behaviour. Pulse rate: Females exhibited consistently higher pulse rates than males across both interventions ($p<0.05$), as stated in Table 1.

Pulse rates dropped significantly post-treatment in both groups. Behavior Rating Improvement from pre-treatment to post-treatment in both groups. No significant gender differences were appreciated in those 2 parameters.

Anxiety scale

N2O-O2 showed slightly better reduction during LA administration. Post-treatment scores approached similar baseline in both groups as stated in Table 3.

Table 1: Comparison of mean value of pulse rate between male and female at different stages of treatment in children managed with both nitrous oxide sedation and art.

		Male		Female		t value	P value
		Mean	Standard deviation	Mean	Standard deviation		
Nitrous oxide-oxygen group	Before treatment	92.14	14.39	108.45	13.57	-2.883	.008
	During LA administration	100.36	24.17	112.18	21.20	-1.280	.213

Continued.

		Male		Female		t value	P value
		Mean	Standard deviation	Mean	Standard deviation		
	During procedure	94.07	15.40	110.73	15.80	-2.654	.014
	Post treatment	87.64	12.38	98.82	16.78	-1.919	.068
Art therapy	Before treatment	98.43	10.52	110.64	16.10	-2.289	.032
	During LA administration	95.5	11.51	106.27	13.89	-2.122	.045
	During procedure	94.57	11.42	115.27	10.78	-4.609	.000
	Post treatment	85.50	25.75	99.27	11.82	-1.638	.115

Table 2: Distribution of study participants according to gender (n=25).

Gender	Number (N)	Percentage (%)
Male	14	56.0
Female	11	44.0
Total	25	100.0

Table 3: Comparison of physiological (pulse rate), behavioral (BPRS), and anxiety scores between Nitrous oxide–oxygen sedation and art therapy groups at different stages of dental treatment (before treatment, during local anesthesia administration, during the procedure, and post-treatment), showing mean values, standard deviations, mean differences, 95% confidence intervals, t-values, and p values.

Variables		Nitrous oxide		Art therapy		Mean Diff	95% CI for mean difference		t value	P value
		Mean	SD	Mean	SD		Lower	Upper		
Pulse Rate	Before treatment	99.32	16.04	103.80	14.36	-4.48	-13.13	4.17	-1.040	0.303
	During LA administration	105.56	23.23	100.24	13.49	5.32	-5.48	16.12	.990	0.327
	During procedure	101.40	17.43	103.68	15.13	-2.28	-11.56	7.00	-.494	0.624
	Post treatment	92.56	15.24	91.56	21.59	1.00	-9.62	11.62	.189	0.851
BRS	Before Treatment	2.76	.44	2.64	.49	0.12	-0.14	0.38	.915	0.365
	During LA administration	2.24	.52	2.08	.57	0.16	-0.15	0.47	1.033	0.307
	During procedure	2.28	.68	2.20	.71	0.08	-0.31	0.47	.408	0.685
	Post treatment	3.08	.76	3.12	.78	-0.04	-0.47	0.39	-.184	0.855
Anxiety	Before treatment	.80	.65	.68	.48	0.12	-0.20	0.44	.748	0.458
	During LA administration	1.52	.59	1.36	.70	0.16	-0.20	0.52	.876	0.385
	During procedure	1.12	.83	1.56	.87	-0.44	-0.92	0.04	-1.827	0.074
	Post treatment	.20	.65	.04	.20	0.16	-0.11	0.43	1.184	0.242

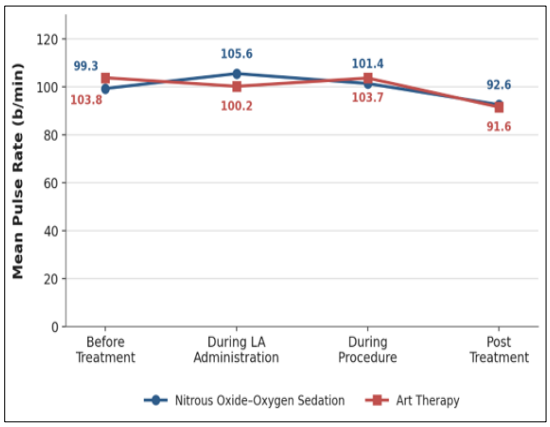


Figure 3: Graphical representation of mean pulse rate for art therapy and nitrous oxide oxygen sedation at different stages of treatment in children managed with both nitrous oxide sedation and art therapy.

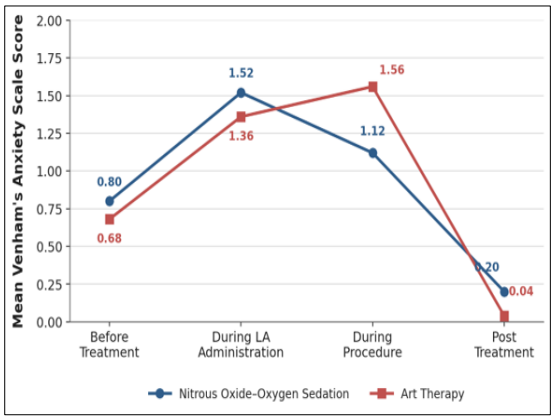


Figure 4: Graphical representation of mean Venham's anxiety scale scores at different stages of treatment in children.

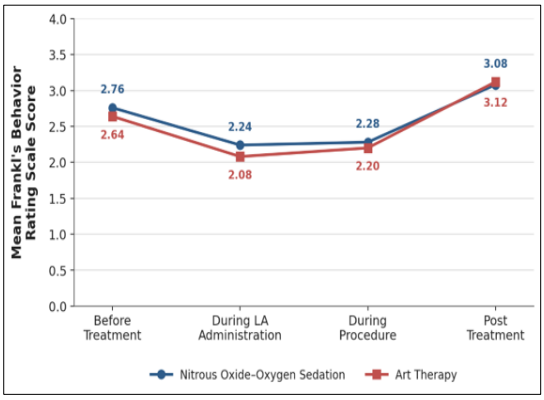


Figure 5: Graphical representation of mean Frankl's behavior rating scale (BRS) scores at different stages of treatment in children managed with both nitrous oxide sedation and art therapy.

Both interventions produced significant reductions in dental anxiety and improvements in behavior across all treatment stages, with no statistically significant difference between groups overall (Table 3, $p>0.05$).

Gender and pulse rate

Females had consistently higher pulse rates than males in both groups (Table 1, $p<0.05$), most notably before treatment, during the procedure, and during LA administration. However, gender did not significantly affect behavior rating or anxiety scores (Table 1). The sample was 56% male and 44% female (Table 2).

Pulse rate over time

Pulse rates declined from before- to post-treatment in both groups $N_2O–O_2$ from 99.32 to 92.56, and art therapy from 103.80 to 91.56 (Table 3) with no significant between-group differences at any stage (Table 3, $p>0.05$ throughout).

Anxiety and behavior scores

N_2O-O_2 showed a slightly greater reduction in anxiety scores during LA administration than art therapy (Table 3), with a similar pattern for behavior ratings (Table 3). Both groups converged to comparably low anxiety and favorable behavior scores by post-treatment, and none of the between-group differences reached significance (Table 3, all $p>0.05$).

DISCUSSION

Dental anxiety has been a long-standing problem among both children and adults. The purpose of this research was to identify an effective solution for managing dental anxiety in children to deliver quality treatment and foster a positive attitude towards dental care, thereby improving overall oral health. This study employed a randomized controlled trial with a crossover design to minimize inter-subject variability. Two groups were formed, and the same participants were subjected to both art therapy and Nitrous oxide-oxygen (N_2O-O_2) inhalation sedation to measure anxiety levels. Anxiety was assessed physiologically using a pulse oximeter and psychologically using Venham's anxiety scale and Frankl's behavior rating scale, both recorded by a trained independent observer.

The study revealed no significant difference in behavior rating and anxiety scores between genders (Table 1). However, Table 1 shows that pulse rate was significantly higher in females compared to males for both behavior management tools. In the Nitrous oxide group, mean pulse rate during and after the procedure was significantly lower. Behaviour rating scale scores differed significantly between "before treatment and during LA administration" and between "during procedure and post-treatment." Anxiety scores were significantly different across all time points, confirming the calming effect of nitrous oxide on dental anxiety.

Figures 3, 4 and 5 illustrate a decreasing anxiety pattern, except during local anesthesia administration. Anxiety levels decreased notably during the procedure in the Nitrous oxide group, consistent with the findings of Kebriaee et al.[8] who compared nitrous oxide with another non-pharmacological technique, cognitive behavioral therapy (CBT). Pereira-Santos et al reported similar outcomes in their study comparing nitrous oxide inhalation sedation and midazolam during molar extraction, concluding that inhalation sedation provided quicker recovery and better patient acceptance.[9]

Similarly, Gupta et al evaluated Nitrous oxide inhalation sedation during endodontic treatment and confirmed a significant reduction in both anxiety and pain levels, including during local anesthesia administration.[10] Emmanouil DE and Quock RM further stated that Nitrous oxide exhibits morphine-like properties, providing both anxiolytic and analgesic effects, explaining its efficacy in reducing dental anxiety.[11]

Yee R emphasized occupational safety concerns associated with chronic nitrous oxide exposure, including spontaneous abortion, bone marrow suppression and neurological disorders, though the incidence among dental students was not higher than in medical students.[12] In contrast, Bogari AF reviewed the safety index of inhalation anesthetics and highlighted the wide safety margin of nitrous oxide due to its dual anxiolytic and analgesic effects.[13] Mukundan D et al also found that nitrous oxide sedation significantly reduced anxiety in children during inferior alveolar nerve block procedures, with increased parental satisfaction findings consistent with the present study.[14]

In the art therapy group, mean pulse rate decreased between pre and post-intervention and between “during procedure and post-treatment.” Behaviour rating and anxiety scores significantly decreased at all time points except “during LA administration” and “during procedure.” Although emotions cannot be quantified precisely, improvements were evident through enhanced patient compliance, cooperation, and trust toward the clinician post-therapy.

Art therapy has been shown effective across various populations for alleviating anxiety and improving quality of life. Nooruzi et al demonstrated significant reductions in anxiety among preschoolers following ten sessions of art therapy.[15] Similarly, Sandmire et al found that art-making reduced both state and trait anxiety in undergraduate students prior to examinations, attributing this to the meditative “flow” state induced by repetitive creative activities.[16]

Abbing et al explored art therapy for anxiety in adults and found limited overall conclusions, but Abbing A and Barrs EW reported that women with moderate to severe anxiety benefited significantly, suggesting art therapy as a viable adjunct for managing anxiety and improving quality of life.[17,18] Shukla et al in a critical review stated that art therapy has been employed in diverse conditions such as cancer, autism, HIV, Alzheimer’s, COVID-19, dementia and Parkinson’s disease, demonstrating its broad therapeutic potential for mental health.[19] Mahat A et al conducted a quasi-experimental study among schoolchildren and concluded that art therapy significantly reduced anxiety levels.[20] Moula Z also found that art therapy improved quality of life, self-concept, and problem-solving skills in children aged 5-12 years, with sustained benefits at follow-up.[21]

A meta-analysis by Zhang including databases such as PubMed, Web of Science, Embase and Cochrane Library reported consistent evidence supporting art therapy’s positive impact on adolescent anxiety.[22] With increasing awareness of anxiety disorders, new non-pharmacological methods are being explored. Kong et al performed a network meta-analysis and identified music therapy, aromatherapy and gaming as effective interventions for dental anxiety, with music emerging as the most effective.[23]

In the present study, both nitrous oxide inhalation sedation and art therapy effectively reduced anxiety, behavior scores, and pulse rate, though differences were statistically insignificant. Graphs indicated improved post-treatment anxiety and behaviour, particularly in the nitrous oxide group. Due to limited research on art therapy for dental anxiety, this study draws comparisons with CBT-based interventions. Sardi et al concluded that art therapy and cognitive interventions yield comparable outcomes.[24] Willumsen et al similarly found both cognitive behavioral therapy and nitrous oxide sedation to be effective and interchangeable for short-term anxiety management, with non-specific therapeutic factors contributing significantly.[25]

Finally, Kebriaee et al reinforced these findings, concluding that nitrous oxide inhalation sedation remains a more effective technique for dental anxiety management.[8] However, Kebriaee et al argued that, given the cost, equipment needs, and supervision required for sedation, CBT may be preferable due to its wider applicability and safety profile.[8]

Limitations

The sample size was small due to short study period (i.e., 1 year). The study lacks diversity of population due to its limited Geographical reach. The time limitation of art therapy was 20 minutes, while a therapeutic session lasts for 25- 45 minutes.

CONCLUSION

Both AT and N_2O-O_2 are effective in reducing dental anxiety in children aged 8-12. Art Therapy is a viable, low-cost, non-pharmacologic alternative with no contraindications. Larger studies are needed to

definitively establish superiority or long-term outcomes. Increased awareness and acceptance of non-pharmacological tools like art Therapy could enhance pediatric dental care, especially in resource-limited settings.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Klingberg G, Broberg AG. Dental fear/anxiety and dental behaviour management problems in children and adolescents: a review of prevalence and concomitant psychological factors. Int J Paediatr Dent. 2007;17(6):391–406.
2. Cianetti S, Lombardo G, Lupatelli E, Pagano S, Abraha I, Montedori A, et al. Dental fear/anxiety among children and adolescents. A systematic review. Eur J Paediatr Dent. 2017;18(2):121–30.
3. Holroyd I. Conscious sedation in pediatric dentistry. A short review of the current UK guidelines and the technique of inhalational sedation with nitrous oxide. Paediatr Anaesth. 2008;18(1):13–7.
4. Malchiodi CA. The Art Therapy Sourcebook. 2nd ed. New York: McGraw-Hill; 2006.
5. Gazal G, Fareed WM, Zafar MS, Al-Samadani KH. Pain and anxiety management for pediatric dental procedures using various combinations of sedative drugs: a review. Saudi Pharm J. 2016;24(4):379-85.
6. Karkou V, Sanderson P. Arts Therapies: A Research-Based Map of the Field. Edinburgh: Churchill Livingstone; 2006.
7. Van der Vennet R, Serice S. Can coloring mandalas reduce anxiety? A replication study. Art Ther. 2012;29(2):87–92.
8. Kebriaee F, Sarraf Shirazi A, Fani K, Moharreri F, Soltanifar A, Khaksar Y, Mazhari F. Comparison of the effects of cognitive behavioural therapy and inhalation sedation on child dental anxiety. Eur Arch Paediatr Dent. 2015;16(2):173–9.
9. Pereira-Santos D, Azevedo ID, Costa LR. Comparison of oral midazolam and nitrous oxide sedation in dental anxiety management for children. Eur Arch Paediatr Dent. 2021;22(2):247–54.
10. Gupta PD, Kaur S, Hegde AM. Effect of nitrous oxide–oxygen inhalation sedation on anxiety and pain during endodontic treatment in children. J Clin Pediatr Dent. 2019;43(6):393–8.
11. Emmanouil DE, Quock RM. Advances in understanding the actions of nitrous oxide. Anesth Prog. 2007;54(1):9–18.
12. Yee R. Occupational exposure to nitrous oxide in dentistry: Risks and preventive measures. Br Dent J. 2010;209(7):331–6.
13. Bogari AF. Safety index and effectiveness of inhalation anesthetic agents with focus on nitrous oxide. Saudi J Anaesth. 2019;13(3):177–83.
14. Mukundan D, Gurunathan D. Effectiveness of nitrous oxide sedation on child's anxiety and parent perception during inferior alveolar nerve block: a randomized controlled trial. Cureus. 2023;15:e48646.
15. Nooruzi S, Dargahi S, Farajzadeh A. The effect of art therapy on anxiety and depression in preschool children. Iran J Psychiatry Behav Sci. 2020;14(2):e97987.
16. Sandmire DA, Gorham SR, Rankin NE, Grimm DR. The influence of art making on anxiety: a pilot study. Art Ther. 2012;29(2):68–73.
17. Abbing A, Ponstein A, van Hooren S, de Sonneville L, Swaab H, Baars E. The effectiveness of art therapy for anxiety in adults: a systematic review of randomised and non-randomised controlled trials. PLoS One. 2018;13(12):e0208716.
18. Abbing A, Baars EW, de Sonneville L, Ponstein AS, Swaab H. The effectiveness of art therapy for anxiety in adult women: a randomized controlled trial. Front Psychol. 2019;10:1203.
19. Shukla A, Choudhari SG, Gaidhane AM, Quazi Syed Z. Role of art therapy in the promotion of mental health: a critical review. Cureus. 2022;14(8):e28026.
20. Mahat A, Gurung M, Shrestha S. Effectiveness of art therapy on anxiety among school children. J Nepal Paediatr Soc. 2021;41(3):236–42.
21. Moula Z. A systematic review of the effectiveness of art therapy delivered in school-based settings to children aged 5–12 years. Int J Art Ther. 2020;25(2):88–99.
22. Zhang B, Wang J, Abdullah AB. The effects of art therapy interventions on anxiety in children and adolescents: a meta-analysis. Clinics (Sao Paulo). 2024;79:100404.
23. Kong X, Song N, Chen L, Li Y. Non-pharmacological interventions for reducing dental anxiety in pediatric dentistry: a network meta-analysis. BMC Oral Health. 2024;24(1):1151
24. Sardi O, De Oliveira L, Ferreira L. Comparison of art therapy and cognitive behavioral interventions in anxiety management. Int J Psychol Stud. 2019;11(2):58–67.
25. Willumsen T, Vassend O, Hoffart A. A comparison of cognitive therapy, applied relaxation, and nitrous oxide sedation in the treatment of dental fear. Acta Odontol Scand. 2001;59(5):290–6.

Cite this article as: Shikha S, Mukherjee CG, Shukla JN. Comparative evaluation between art therapy and nitrous oxide: oxygen inhalation sedation in managing dental anxiety among children of ages 8-12 years. Int J Contemp Pediatr 2026;13:2428-33.