Knowledge, Training, and Confidence in Nitrous Oxide Inhalation Sedation Among Dental Professionals: A Cross-Sectional Pilot Questionnaire Survey

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ABSTRACT:

Aims: To assess the knowledge, training background, and confidence levels regarding nitrous oxide inhalation sedation (NOIS) among dental professionals attending a continuing education workshop.

Methods: A cross-sectional, interview-based questionnaire study was conducted at a one-day workshop on NOIS attending a workshop. Ten dental professionals participated (response rate: 100%). The questionnaire captured demographic information, training history, current practice, and confidence across 17 Likert-scale items spanning preoperative, intraoperative, postoperative, and general confidence domains. Data were analyzed using descriptive statistics, Mann-Whitney U tests, and Spearman's rank correlation coefficients.

Results: All participants (100%) expressed willingness to use NOIS, yet only 40% (n=4) had received formal training. The mean overall confidence score was 3.46 ± 0.94 (out of 5.00). Participants with formal training demonstrated significantly higher confidence scores (4.01 ± 0.44) compared to those without training (3.05 ± 1.04; $p = 0.038$). A strong positive correlation was observed between formal training and overall confidence ($\rho = 0.698$, $p < 0.05$). No significant differences were found based on gender ($p = 0.524$) or BLS certification status ($p = 0.619$).

Conclusions: Formal training in nitrous oxide sedation is significantly associated with higher confidence levels among dental professionals. The substantial gap between willingness to use NOIS and receipt of formal training highlights the urgent need for structured educational interventions in Indian dental education and continuing professional development.

Keywords: nitrous oxide inhalation sedation, NOIS, dental professionals, BLS, PALS.

Introduction

Dental anxiety affects approximately 20-30% of children and represents a significant barrier to optimal oral healthcare delivery.[1,2] The management of uncooperative and anxious pediatric patients remains a considerable challenge for dental practitioners worldwide.[3] Nitrous oxide/oxygen inhalation sedation (NOIS), commonly known as "laughing gas," has been recognized as one of the safest and most effective pharmacological behavior management techniques in pediatric dentistry.[4,5] With over 150 years of clinical use, nitrous oxide has a unique pharmacological profile characterized by rapid onset, minimal metabolic transformation, and complete elimination via the respiratory system within minutes.[6,7] The success rate of NOIS exceeds 90%, making it an invaluable tool in modern pediatric dental practice.[8]

Despite its established safety and efficacy, the use of NOIS varies considerably across countries and healthcare settings.[9,10] In India, research has revealed significant gaps in knowledge, training, and practice related to inhalation sedation. A study conducted in Mangalore found that only 32 out of 72 participating dentists were trained in inhalation sedation, with even fewer (14) using it regularly.[11] Bhardwaj and colleagues reported that 59.72% of dentists wanted to gain information and undergo training in inhalation sedation. In comparison, 70.83% believed that such training should be an integral part of the undergraduate dental curriculum.[12] Multiple barriers impede the widespread adoption of NOIS. Lack of formal training represents the most significant obstacle, with many dental professionals reporting insufficient exposure during undergraduate training.[13,14] Financial constraints, including the costs of delivery systems and monitoring equipment, present additional barriers.[15,16] A study by Rajab and AlNahhas in Jordan identified lack of availability in clinics and hospitals (66.7%) and high cost (31.3%) as principal reasons for not using nitrous oxide sedation.[17]

The importance of structured training cannot be overstated. International guidelines from the American Academy of Pediatric Dentistry emphasize that practitioners who use N_2O inhalation sedation must have appropriate training, skills, and facilities to manage any reasonably foreseeable emergency.[18] A postgraduate training course implemented across French dental faculties demonstrated that trainee practitioners provided effective and safe inhalation sedation, with success rates comparable to experts (89.6% vs. 93.2%).[19] Given the substantial gap between recognized need and limited implementation, this study aimed to assess dental professionals' knowledge, training, and confidence regarding NOIS after attending a one-day workshop. The specific objectives were to: (1) evaluate current use and willingness to utilize NOIS; (2) determine formal training status; (3) measure confidence across multiple domains of sedation administration; and (4) identify factors associated with confidence in NOIS administration.

Methodology

Study Design and Setting

This cross-sectional, interview-based questionnaire study was conducted during a one-day continuing education workshop on nitrous oxide inhalation sedation held in Duchenne Smiles, Hyderabad, Telangana, India. The workshop was designed to provide dental professionals with theoretical knowledge and practical exposure to NOIS in pediatric dental practice.

Study Population

The study population comprised all dental professionals attending the workshop. Inclusion criteria were: (1) dental professionals (dentists, postgraduate students, or dental faculty members); (2) currently practicing or training in dentistry; (3) willing to participate; and (4) able to understand and respond to questionnaire items. All 10 workshop attendees participated, representing a 100% response rate.

Questionnaire Development

The questionnaire was developed through literature review and expert consultation with two pediatric dentists, one anesthesiologist, and one

dental educator. Content validity was assessed using the Content Validity Index (CVI), with items scoring ≥0.80 retained (overall CVI: 0.89). Face validity was established through pilot testing on five dental professionals not participating in the main study. Internal consistency demonstrated good reliability (Cronbach's α = 0.87).

Questionnaire Structure

Section A: collected demographic information (gender, age).

Section B: assessed training and experience: current NOIS use, willingness to use, attendance at courses/lectures/hands-on workshops, knowledge of regulatory approval, preferred training frequency, and BLS/PALS certification status.

Section C comprised 17 Likert-scale items across four subdomains: preoperative assessment and management (2 items), intraoperative management (4 items), postoperative management (3 items), and general confidence (2 items). Responses were rated on a 5-point scale: Strongly Disagree (1) to Strongly Agree (5).

Data Collection

Structured interviews were conducted by trained research assistants not involved in workshop instruction. Interviews lasted 15 minutes and were conducted in private settings at the workshop venue. All responses were recorded on paper forms and double-entered into an electronic database.

Statistical Analysis

Analyses were performed using SPSS version 26.0. Categorical variables were summarised as frequencies and percentages; continuous variables as mean ± standard deviation (SD). The Mann-Whitney U test was used for two-group comparisons, and Spearman's rank correlation coefficient for correlations. Statistical significance was set at $p < 0.05$. Overall confidence scores were calculated as the mean of all 17 Likert items. Confidence levels were categorized as Low (1.00-2.33), Moderate (2.34-3.67), or High (3.68-5.00).

Ethical Considerations

The Institutional Review Board approved the study. Written informed consent was obtained from all participants. All responses were anonymized, and data were stored securely.

Results

Table 1: Demographic and professional characteristics of participants

Characteristic	Category	n (%)
Gender	Male	4 (40.0)
	Female	6 (60.0)
Current NOIS Use	Yes	4 (40.0)
	No	6 (60.0)
Willing to Use NOIS	Yes	10 (100.0)
	No	0 (0.0)
Formal Training Received	Yes	4 (40.0)
	No	6 (60.0)
BLS Certification	Yes	7 (70.0)
	No	3 (30.0)
PALS Certification	Yes	0 (0.0)

	No	10 (100.0)
Preferred Training Frequency	Once/year	6 (60.0)
	Twice/year	2 (20.0)
	Once/2 years	2 (20.0)

Ten dental professionals participated (Table 1). The sample comprised 60% female (n=6) and 40% male (n=4). All participants expressed willingness to use NOIS; however, only 40% (n=4) had received formal training. 70% (n=7) held BLS certification, and none held PALS certification. Regarding preferred training frequency, 60% (n=6) favored annual courses, 20% (n=2) biannual courses, and 20% (n=2) biennial courses.

Table 2: Overall confidence scores by demographic and training characteristics

Variable	Group	n	Mean Score ± SD	Min	Max	P-Value*
Overall	All Participants	10	3.46 ± 0.94	2.00	5.00	-
Gender	Male	4	3.16 ± 0.82	2.41	4.35	0.524
	Female	6	3.66 ± 0.99	2.00	5.00	
Formal Training	Yes	4	4.01 ± 0.44	3.76	4.35	0.038
	No	6	3.05 ± 1.04	2.00	4.50	
BLS Certification	Yes	7	3.54 ± 0.90	2.00	5.00	0.619
	No	3	3.13 ± 1.26	2.41	4.12	
Current NOIS Use	Yes	4	3.41 ± 0.41	3.00	4.06	0.524
	No	6	3.50 ± 1.05	2.00	5.00	

*Mann-Whitney U test; significant values in bold ($p < 0.05$)

The mean overall confidence score across all participants was 3.46 ± 0.94 (out of 5.00). Total scores ranged from 34 (mean: 2.00) to 85 (mean: 5.00), with a maximum of 85 (Table 2).

Table 3: Subdomain Scores Comparing Trained and Untrained Participants

Subdomain	Items	Trained (n=4)	Untrained (n=6)	P-Value*
Preoperative Assessment	1-2	4.13 ± 0.85	2.92 ± 1.24	0.038
Intraoperative Management	3-6	3.88 ± 0.85	2.83 ± 1.17	0.048
Postoperative Management	7-9	4.00 ± 0.85	2.89 ± 1.16	0.048
General Confidence	10-11	4.00 ± 0.71	3.08 ± 1.24	0.048

*Mann-Whitney U test; significant values in bold

Trained participants demonstrated consistently higher confidence across all subdomains (Table 3).

Statistically significant differences were observed in preoperative assessment (Items 1-2; $p = 0.038$), intraoperative management (Items 3-6; $p = 0.048$), postoperative management (Items 7-9; $p = 0.048$), and general confidence (Item 10; $p = 0.038$). Perceived need for NOIS services (Item 11) showed no significant difference between groups ($p = 0.603$).

Table 4: Correlation Matrix Between Key Variables and Overall Confidence Score

Variable	Correlation Coefficient (ϱ)	P-Value
Formal Training	0.698	0.032
Attended Lecture	0.452	0.124
Hands-on Workshop	0.452	0.124
BLS Certification	0.158	0.613
Current NOIS Use	-0.084	0.789
Gender (Female=1)	0.203	0.512
Training Frequency	0.584	0.067

Spearman's rank correlation coefficient

Classification of Confidence Levels

Based on mean scores, 50% (n=5) demonstrated high confidence, 40% (n=4) moderate confidence, and 10% (n=1) low confidence. All participants in the high-confidence category (n=4) had received formal training, except one experienced clinician without formal training.

Discussion

This study provides valuable insights into the knowledge, training, and confidence regarding nitrous oxide inhalation sedation among dental professionals in India. The key finding that formal training is strongly associated with higher confidence levels ($p = 0.038$) underscores the critical importance of structured educational interventions in this field. Despite all participants expressing willingness to use NOIS, only 40% had received formal training. This disparity mirrors findings from other Indian studies. Bhardwaj and colleagues reported that 59.72% of dentists in Mangalore wanted training in inhalation sedation, while 70.83% believed it should be part of the undergraduate curriculum.[11,12] Similarly, Nidhi and colleagues found that 88% of dental practitioners in Tamil Nadu were willing to learn and practice inhalation sedation.[13] The substantial gap between willingness and training highlights systemic issues in dental education and continuing professional development.

International comparisons reveal similar patterns. In Jordan, Rajab and AlNahhas reported that only 37.7% of pediatric dentists used N_2O sedation, with lack of availability (66.7%) and high cost (31.3%) identified as the principal barriers.[17] In Brazil, Daher and colleagues found that while 77% of licensed dentists used relative analgesia, this was largely determined by practice frequency and prior training.[17] The strong correlation between formal training and confidence ($\varrho = 0.698$, $p < 0.05$) is consistent with existing literature. Collado and colleagues evaluated a postgraduate training course in conscious sedation. They found that trainee practitioners provided effective and safe inhalation sedation, with no significant difference in success rates between trainees and experts (89.6% vs. 93.2%).[17] This suggests that structured training programs can effectively prepare practitioners to administer sedation safely. Our subdomain analysis revealed that trained participants scored significantly higher across preoperative, intraoperative, postoperative, and general confidence domains. The most pronounced differences were in patient selection (Item 1; $p = 0.048$) and determination of appropriate sedation levels (Item 2; $p = 0.038$), suggesting that training enhances clinical judgment in areas essential for safe practice. This aligns with international guidelines emphasizing that practitioners must possess appropriate training and skills and have access to proper facilities, personnel, and equipment to manage any reasonably foreseeable emergency.[18] The finding that 60% of participants preferred annual training courses indicates strong demand for

continuing education. This is consistent with the wider Indian context, where 88% of practitioners in a larger study were willing to learn and practice inhalation sedation.[12,13] The success of postgraduate training courses in other countries, such as the French collaborative program that enabled practitioners to observe, assist, and then perform conscious sedation under supervision,[19] provides a model that could be adapted to the Indian context. The limited formal training observed in our cohort reflects broader challenges in Indian dental education. Studies have identified multiple barriers: lack of knowledge and awareness (51.3%), expensive equipment, increased treatment costs, potential complications, and lack of training.[13,21] The Dental Council of India has incorporated behavior management and sedation into the undergraduate curriculum;[22] however, implementation remains inconsistent across institutions, and many graduates feel ill-prepared to use sedation in clinical practice.[23,24] Several limitations should be acknowledged. The sample size (n=10) limits generalisability, and, as a single-center study, the findings may not represent practices across India. Participants were workshop attendees, potentially introducing selection bias toward those already interested in sedation. The cross-sectional design cannot establish causality, and self-reported confidence may not correlate with actual clinical competence. Despite these limitations, our findings have important implications. The strong association between training and confidence suggests that structured educational programs should be prioritized to increase NOIS utilization. Given the widespread willingness to pursue further training, there is substantial foundation for developing comprehensive continuing education programs. Furthermore, the finding that 70% of participants held BLS certification while none held PALS certification suggests a need for more comprehensive emergency preparedness training. The clinical significance of expanding NOIS availability is substantial. Nitrous oxide has the highest safety margin of any anxiolysis or sedation modality in dentistry,[23] and its success rate exceeds 90%.[8] By enhancing practitioners' confidence and training, we can improve access to care for anxious and uncooperative patients, reduce the burden of untreated dental disease, and help establish positive dental attitudes in the pediatric population.

Conclusions

This study demonstrates that formal training in nitrous oxide inhalation sedation is significantly associated with higher confidence levels among dental professionals in India. The substantial gap between willingness to use NOIS and receipt of formal training highlights the urgent need for structured educational interventions in Indian dental education and continuing professional development. The strong correlation between training and confidence, coupled with universal recognition of clinical need, provides a compelling rationale for developing comprehensive training programs. By enhancing the knowledge, skills, and confidence of dental professionals in NOIS administration, we can improve the quality of care for anxious and uncooperative patients and contribute to better oral health outcomes in the pediatric population.

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Conflict of Interest

All the authors declared no conflicts of interest.

Data availability

Data will be available from the corresponding author upon request.

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