

Satisfaction with dental treatment performed under nitrous oxide sedation: prospective questionnaire-based study



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Abstract

Aim Nitrous oxide sedation is an effective and safe pharmacological behaviour management technique that has been used in dentistry for many decades. The aim of this study was to assess the patients', accompanying adults' and dentists' satisfaction with dental treatment under nitrous oxide sedation.

Materials and methods This questionnaire-based study was conducted at the Department of Preventive and Pediatric Dentistry at the University of Greifswald in Germany. A questionnaire was distributed to eligible patients (n=51), accompanying adults and treating dentists. The opinions of accompanying adults and dentists were assessed by means of Visual Analogue Scale (VAS).

Results Fifty-one pre-cooperative and/or anxious children aged between 3-15 years (mean age 7.7 ± 2.8 years; 54.9% female) were treated in 54 nitrous oxide sessions. 47.1% were preschool-children (mean dmft: 6.1 ± 3.0). 92.6% of the participating children were highly satisfied with the nitrous oxide treatment as well as the majority of the accompanying adults as indicated by the mean score of (VAS; 0.6 ± 1.0). The cooperation of the patients was considerably improved by nitrous oxide sedation; 59.3% of the patients reached the maximum score 4 (Frankl Behaviour Rating Scale). In the 54 nitrous oxide sessions 97 teeth were treated (82.5% primary teeth) most commonly with extraction (60.8%).

Conclusion Most patients, accompanying adults, and dentists expressed high satisfaction with dental treatment under nitrous oxide, as it effectively enhanced the cooperation making the treatment in the majority of cases possible and more acceptable.

KEYWORDS paediatric dentistry, behaviour management, conscious sedation, nitrous oxide sedation, satisfaction.

children. Therefore, the use of pharmacological behaviour management techniques in these cases will be mandatory [AAPD, 2023]. Nitrous oxide (N₂O) conscious sedation is widely recognised as a safe and effective pharmacological behaviour management technique in paediatric dentistry. Studies have reported high success rates of 87.1%, 86.3%, and 92.7% respectively [Galeotti et al., 2016; Ferrazzano et al., 2020; Mourad et al., 2022a]. Furthermore, in recent decades parents have become apparently more accepting and aware of N₂O sedation. For illustration 44% of Indian parents considered sedations as an acceptable behaviour guidance to be used for their children during dental treatment [Acharya, 2017]. While N₂O sedation was considered as the third most acceptable technique by parents in Greece [Boka et al., 2014], parents in Germany rated the N₂O sedation as the most acceptable behaviour management technique for both normal and emergency dental treatments [Al Zoubi et al., 2019]. However, there were only few studies globally, and none for Germany, that evaluated the satisfaction of the child, their parents and dentists with the outcome of dental treatment under conscious sedation with nitrous oxide. Therefore, the aim of this study was to evaluate prospectively the patients', parents' and dentists' satisfaction with dental treatment under nitrous oxide sedation.

Materials and Methods

Study design and ethics

This questionnaire-based study was conducted in the Department of Preventive and Pediatric Dentistry at the University of Greifswald between June and September 2019. Patients' digital dental records were retrospectively analysed for patient characteristics and focusing on treatments performed under N₂O sedation. The study was approved by the Research Ethics Committee of the University of Greifswald, Germany (Protocol No. BB 068/19). Written consent was obtained

Introduction

Dental anxiety and fear are common in children. Recently described dental fear/anxiety (DFA) prevalence rates in children and adolescence were 13.7% (11.1% in Northern Europe, 21.9% in South-central Europe, 19.2% in Asia, and 20.2% in USA) [Cianetti et al., 2017]. Dental treatment of such children may impose a challenge for paediatric dentists. In addition, the use of basic behaviour management techniques (communications techniques) may be insufficient for some

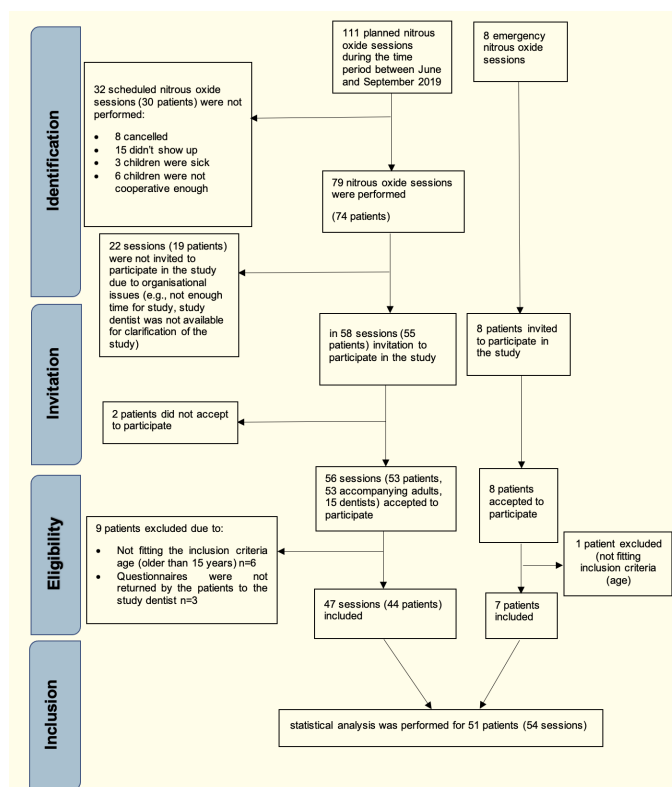


FIG.1 Flow-chart study assessing satisfaction with dental treatment performed under nitrous oxide sedation for children treated in the Department of Preventive and Pediatric Dentistry at the University of Greifswald between June and September 2019.

from both the children and their accompanying adults prior to distributing the questionnaires.

Participants

The study participants included children receiving dental treatment under N₂O sedation at the Department of Preventive and Pediatric Dentistry, University of Greifswald, their accompanying adults, and the treating dentists. In addition to the scheduled dental treatment sessions under N₂O within a three-month period, N₂O sessions for eligible emergency patients were also included (Fig. 1).

Inclusion criteria

- Patients aged between 3 to 15 years, with an ASA I or ASA II health condition.
- Patients requiring dental treatment (e.g., extraction, pulpotomy, crown or filling in the primary or permanent dentition) under conscious sedation with N₂O (planned and emergency treatment) in the time frame of June and September 2019.
- Patients/ accompanying adults accepted to participate in the study and gave written approval.

Exclusion criteria

- Children older than 15 years of age or younger than 3 years old.
- Children with medical diseases (ASA III, ASA IV health condition).
- Children/accompanying adults refusing to participate in the study.

Sample

The patient and the accompanying adult received a verbal and written explanation on the purpose of the study and were invited to participate. After informed consent was obtained, a set of three questionnaires was

completed following dental treatment under N₂O sedation by child/patient, accompanying adult, and dentist (operator). The questionnaires were filled out in a quiet place after the treatment, and ought to be returned directly.

Design of the questionnaires

The questionnaires were written in German language and designed to include visual analogue scale items to be less susceptible to bias from confounding factors [Voutilainen et al., 2016]. Both accompanying adults' and dentists' questionnaires used in this study were combined from questionnaires used before [Foley, 2005; Alkandari et al., 2016]. Child/patient questionnaire: the German version of the questionnaire used by [Cianetti et al., 2017] included two questions to simplify the answers for young children. The dentist's questionnaire included information on the operation (date, duration, planned dental treatment and its successful completion, use of local anaesthesia, maximum N₂O concentration, behaviour assessment according to Frankl Behaviour Rating Scale [Hosey and Blinkhorn, 1995], and consciousness level according to Brietkopf and Buttner classification [Wilson et al., 2002].

The used nitrous oxide sedation system

Titrateable N₂O system (Quantiflex MDM) was used to administer N₂O/O₂ mixture to the patients in all included N₂O sessions. The maximum N₂O concentration used was 50%. The pulse oximeter was used to monitor the pulse and blood oxygenation during the treatment in all of the 54 sessions of inhalative sedation.

Statistical analysis

Data was analysed using Office Excel and SPSS Statistics 17.0 for Windows. Frequency, percentage, standard deviation, mean and range were used to present descriptive statistics. T-test was used to assess the association of different characteristics with accompanying adults' or dentists' satisfactions. The threshold of P<0.05 was regarded as statistically significant.

Results

A total of 111 nitrous oxide appointments were planned for 104 patients at the Department of Preventive and Pediatric Dentistry at the University of Greifswald within 3 months. For statistical analysis 54 sets of questionnaires (patients, accompanying adults and dentists) have been used (Fig. 1).

Demographic distribution of the study sample

Demographic features of the patients

In total, 51 patients were included in the study. The majority (82.4%) were classified as ASA I (healthy), while 9 patients (17.7%) had a mild controlled systemic disease and were classified as ASA II. The patients' ages ranged from 3 to 15 years, with a mean age of 7.7 ± 2.8 years and exhibited a high caries experience, with a mean dmft score of 5.2 ± 3.5 (Tab. 1).

Demographic features of the accompanying adults

Most accompanying adults were females (74.5%) and primarily fell within the 30 to 40-year age range (45.1%; Tab. 2).

Primary outcomes

Child questionnaire

A total of 54 questionnaires were completed by 51 patients, as 3 patients received two N₂O sessions during the study period. In 35 sessions (64.8%), children rated the treatment under N₂O

Age group	N (%)	Male n (%)	Female n (%)	Mean age (years $\pm$ SD)	Mean dmft (SD)	Mean DMFT (SD)
3–6-year-olds	24 (47.1%)	11 (47.8%)	13 (46.4%)	5.2 years ($\pm$ 0.5)	6.1 ($\pm$ 3.0)	0.2 ($\pm$ 0.5)
7–11-year-olds	21 (41.2%)	9 (39.1%)	12 (42.9%)	8.6 years ($\pm$ 1.5)	5.4 ($\pm$ 3.1)	1.0 ($\pm$ 1.7)
12–15-year-olds	6 (11.8%)	3 (13%)	3 (10.7%)	13.5 years ($\pm$ 1.7)	-	4.8 ($\pm$ 2.6)
Sum	51 (100%)	23 (100%)	28 (100%)	7.7 years ($\pm$ 2.8)	5.2 ($\pm$ 3.5)	1.1 ($\pm$ 2.0)
Performed treatment	Fillings n (%)		SSC* n (%)	Pulpotomy + SSC* n (%)	Extractions n (%)	Sum n (%)
Primary teeth	2 (2.5%)		20 (25.0%)	5 (6.2%)	53 (66.3%)	80 (82.5%)
Permanent teeth	10 (58.8%)		1 (5.9%)	0 (0.0%)	6 (35.3%)	17 (17.5%)
Sum	12 (12.4%)		21 (21.6%)	5 (5.2%)	59 (60.8%)	97 (100%)

*SSC: Stainless steel crown

TABLE 1 Demographic features of the patients treated under N₂O sedation and performed dental treatments at the Department of Preventive and Pediatric Dentistry at the University of Greifswald between June and September 2019 (n=51).

sedation as 'great,' while in 15 sessions (27.8%), they rated it as 'very good.' Notably, no sessions were rated as bad. Additionally, 83.3% of patients indicated they would positively consider receiving dental treatment under N₂O again in the future.

Accompanying adult and dentist questionnaire

A total of 54 questionnaires were completed by the accompanying adults and the dentists, immediately following dental treatment under N₂O sedation.

Patients' behaviour and previous dental experience

The fear and anxiety levels of the patients, as reported by accompanying adults, ranged from 0 to 10, where 0 indicates extreme fear and 10 signifies no fear (mean score = 4.0 ± 3.2). The included patients were reported to visit the dentist frequently, with a mean score of 3.3 ± 2.4 (where 10 indicates no visits and 0 indicates very frequent visits). Accompanying adults also noted that many patients had no negative experiences at the dentist, reflected in a mean score of 5.5 ± 3.3 on a scale where 10 indicates no bad experiences and 0 indicates the worst experience (Tab. 3). According to the accompanying adults, sedation provided significant support to the children during the dental treatment, with a mean score of (0.8 ± 1.1). Additionally, the accompanying adults expressed high satisfaction with this treatment option, as indicated by a mean score of (0.6 ± 1.0 ; Tab. 3).

The influence of N₂O sedation on child's cooperation during dental treatment

The treating dentists were asked to evaluate the same three aspects as the accompanying adults (Tab. 4). For the first aspect, the dentists rated treatment success higher than the accompanying adults, with a statistically significant difference ($P = 0.011$). For the second aspect, the dentists rated the child's ability to cope without N₂O sedation lower than the accompanying adults, with a statistically significant difference ($P = 0.029$). For the third aspect, both groups observed a high improvement in cooperation, with no significant difference between their ratings ($P = 0.83$).

Secondary outcome

Child cooperation before and during the N₂O sedation session

The patients' cooperation was assessed using the Frankl Behaviour Rating Scale. In the visit before N₂O sedation, which involved primarily

simple treatments, 48.2% of patients were rated as cooperative (score 3). During the N₂O sessions, which involved more complex treatments, 59.3% of patients achieved the highest cooperation rating (score 4). Notably, none of the patients exhibited poor cooperation (score 1) during sedation (Fig. 3). Additionally, the treating dentists rated the cooperation of 46.3% of patients at least one grade higher during N₂O sessions compared to the pre-sedation visit. Overall, cooperation during N₂O sedation was significantly higher than in the previous visit, with mean values of 2.9 and 3.5, respectively ($P < 0.05$, t-test).

Drop-out analysis

A retrospective analysis of the digital dental records for patients who were not invited to participate in the study (19 patients, 22 sessions) showed no statistically significant differences compared to the study sample ($p > 0.05$). The primary reasons for dropout were the treating dentist forgetting to distribute the questionnaires, insufficient time to do so, or the unavailability of the study dentist to manage and obtain informed consent.

Discussion

The recent endorsement of N₂O sedation in dentistry by European and German associations has highlighted it as a significant research field with several areas to be explored [Hallonsten et al., 2003; Höhne et al., 2021]. This study stands out as it investigates the satisfaction of all involved (patients, parents, and dentists) regarding treatment under N₂O sedation. The majority of the study participants were preschool, and primary school children reflecting the age groups of children with high need for specialist treatment. The caries experience of the included patients (Tab. 1) was 5–6 times higher than the dmft/DMFT value reported in the most recent epidemiological national studies in Germany [IDZ, 2016; Team DAJ, 2017]. This indicates that the included patients belong to a very high caries risk group compared to the normal population. Besides the high caries level, fear and anxiety were shown among study patients. This correlation between anxiety and caries experience was also confirmed in the literature [Murthy et al., 2014].

Patients' questionnaire

Treatment with N₂O sedation was rated as "great and very good" by 92.6% of the study patients. This high satisfaction stands in line with the results of other studies: Foley stated in his study that 90% of patients found that sedation assisted them with local anaesthesia

Accompanying adult		N	Percentage
Gender	Female	38	74.5%
	Male	13	25.5%
Age	20-30 year-olds	7	13.7%
	30-40 year-olds	23	45.1%
	40-50 year-olds	17	33.3%
	>50 year-olds	4	7.8%
	Total	51	100%
Migration background	Yes	7	13.7%
	No	42	82.4%
	Didn't answer	2	3.9%
Education	No degree	2	3.9%
	Secondary school	19	37.3%
	High school	4	7.8%
	Apprenticeship	18	35.3%
	University	7	13.7%
	Didn't answer	1	2.0%

TABLE 2 The demographic features of the accompanying adults of the patients who received dental treatment under N₂O sedation at the Department of Preventive and Pediatric Dentistry at the University of Greifswald between June and September 2019 (n=51).

and dental treatment [Foley, 2005]. This is further confirmed by the results of Tieri et al. which showed that children experienced significantly less objective pain when treated under sedation which was regarded to the anxiolytic effect of N₂O [Tieri et al., 2023]. Additionally, 83% of the patients would request N₂O sedation again, which is similar to the findings of another German survey [Mathers et al., 2011] and an Italian study [Arcari and Ferro, 2008]. The remaining 16.7% who would not try N₂O sedation again were predominantly below the age of 6 years (88.9%). Hence their refusal could be explained by their young age which makes it difficult to differentiate between the repetition of N₂O sedation and the repetition of the whole complicated dental treatment that they received (local anaesthesia and extraction mostly).

Accompanying adults' and dentists' questionnaire

According to accompanying adults' views, most of the patients in the study sample were rated as not being able to cope with dental treatment without N₂O sedation (VAS score's mean 1). Also, the adults believed that the cooperation was highly improved by N₂O sedation (VAS score mean 1). This result is similar to another study in which 100% of parents believed their children were more comfortable during dental treatment under N₂O [Alkandari et al., 2016]. The accompanying adults rated the success of the treatment a little bit lower than the treating dentists (0.6 vs. 0.2, $p = 0.01$) and this difference was statistically significant. This could be due

Questions for the accompanying adults			
1 st Section: patients' behavior and dental experience	Mean ($\pm$ SD)	Min	Max
My child is afraid of the dentist.	4.0 ($\pm$ 3.2)	0	10
My child has been treated by a dentist before.	3.3 ($\pm$ 2.4)	1	10
My child has had a bad dental experience.	5.5 ($\pm$ 3.3)	0	10
2 nd Section: accompanying adults' opinion and satisfaction	Mean ($\pm$ SD)	Min	Max
N ₂ O sedation supported my child during the performed dental treatment.	0.8 ($\pm$ 1.1)	0.0	4.0
I am satisfied with this treatment option.	0.6 ($\pm$ 1.0)	0.0	5.0
I will recommend this treatment option to others.	0.5 ($\pm$ 0.9)	0.0	5.0

*VAS: visual analogue scale (0 strongly agree to 10 strongly disagree)

TABLE 3 VAS* ratings provided by accompanying adults of patients who received dental treatment under N₂O sedation at the Department of Preventive and Pediatric Dentistry at the University of Greifswald between June and September 2019 (n=54).

to the varying perspectives between dentists and accompanying adults regarding what constitutes a successful treatment; possibly the dentists are more focused on the achievement of dental treatment plan, whereas the accompanying adults are more concentrated on the comfort and cooperation of the child. Similar to previous studies the cooperation of the majority of patients in the study sample was significantly improved in comparison with their cooperation in the visit before N₂O sedation. Accordingly, the treatment was performed in comfortable environment for both the patient and the operator. A French study showed that about 56% of patients presented with score 0 or 1 in Venham scale (where 0= relaxed and smiling, 1= uneasy concerned) at initial contact with the dentist, this percentage rose to 92% after induction of N₂O sedation [Hennequin et al., 2012]. The prospective nature of the study and the use of precise rating (visual analogue scale) make the result of this study more reliable and less susceptible to bias from confounding factors [Voutilainen et al., 2016]. However,

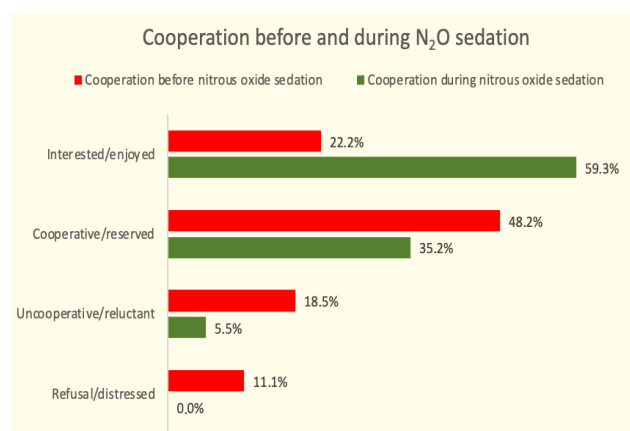


FIG. 3 Cooperation levels of patients during N₂O sedation session and in the visit before at the Department of Preventive and Pediatric Dentistry at the University of Greifswald (between June and September 2019) according to Frankl Behaviour Rating Scale (n=54)

Effect of N ₂ O Sedation on Child's Cooperation							
Statement	Accompanying adults' response			Treating dentist response			t-test (P-Value)
	Mean (±SD)	Min	Max	Mean (±SD)	Min	Max	
The sedation/treatment was successful during this visit.	0.6 (± 1)	0.0	6.0	0.2 (± 0.5)	0.0	2.0	0.01**
The child requires N ₂ O to manage dental treatment.	1 (± 1.3)	0.0	6.0	1.8 (± 2.2)	0.0	8.0	0.03**
The child's cooperation significantly improved with N ₂ O sedation.	1 (± 1.1)	0.0	5.0	0.9 (± 1.5)	0.0	6.0	0.83

*VAS: visual analogue scale (0 strongly agree to 10 strongly disagree)

** statistically significant

TABLE 4 VAS* ratings provided by accompanying adults as well as by the treating dentists regarding the effect of the treatment under N₂O sedation at the Department of Preventive and Pediatric Dentistry at the University of Greifswald between June and September 2019 (n=54).

as the patients' digital dental records were retrospectively analysed, documentation bias could not be avoided. Additionally, the medium-sized sample (n = 51, 54 sessions) and the short recruiting period (3 months) might limit the results of this study as selection bias cannot be fully avoided. Still, many variables stand in line with another large-scale retrospective study on N₂O sedation in the same department making the results highly plausible [Mourad et al., 2022b]. Despite dental general anesthesia being more expensive than N₂O sedation, N₂O sedation for dental treatment is still not covered by the national health insurance system in Germany. Therefore, the cost of sedation may play a role in caregivers' decisions when selecting this treatment.

Conclusion

Underage patients, their accompanying guardian and the treating dentist were generally highly satisfied with the dental treatment under nitrous oxide sedation. The cooperation of the patients was significantly improved by N₂O sedation, so that a variety of complex and potentially difficult dental treatments could be performed while avoiding the considerable risks and efforts of dental general anaesthesia.

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