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Willingness of Parents to Pay for Nitrous Oxide and Oxygen Inhalation Sedation During Dental Treatment for Children in Saudi Arabia

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Abstract

This study aimed to evaluate parental willingness to pay (WTP) for nitrous oxide and oxygen inhalation sedation (NOIS) as a behavior management technique during pediatric dental treatment. A total of 293 parents (aged 20–65 years) having children aged 3–14 years were enrolled in this study. All eligible parents completed an online questionnaire comprising two sections. The first section collected informed consent, demographic data, and previous dental history, while the second section included an educational video on NOIS followed by bidding process questions to elicit WTP. All the collected data on WTP was compared across different groups using Mann-Whitney U and Kruskal-Wallis tests. Nearly, 27.60% of parents were willing to pay the average cost of 600 SAR for NOIS for their children, while the majority, 72.40%, found it to be expensive. Father's education (p = 0.014) and monthly income (p = 0.004) were significantly associated with parents' WTP for NOIS for their children during dental treatment. In contrast, no significant difference in child gender (p = 0.825) or child age (p = 0.064) and mothers' education (p = 0.211) was observed with regard to the WTP. The results showed that most parents found the mean cost for NOIS of 600 SAR for their children during dental treatment to be expensive. Monthly income and the father's education level were the only factors that affected the parents' WTP for NOIS.

Keywords: *Behavior Management, Nitrous Oxide, Sedation, Willingness to Pay.*

Introduction

Dental anxiety is widespread among children and adolescents, with 5%–20% suffering from it [1]. This can lead to dental anxiety and fears in adulthood, which have long-lasting effects on health later in life [2]. Behavior management is commonly recognized as a key factor in delivering effective dental care for children [3]. A range of non-pharmacological and pharmacological management techniques has been employed to manage child behavior during dental treatment. Nitrous oxide and oxygen inhalation sedation (NOIS) as pharmacological behavioral management techniques have been used in clinical practice for over 150 years to manage anxiety in pediatric dental patients [4]. The NOIS acts as both an analgesic and an anxiolytic agent [5, 6]. It can also raise the patient's pain threshold, thus enhancing the action of any local anesthetic agent used [7].

The field of dental economics has seen a surge of interest, with researchers endeavoring to ascertain the cost-effectiveness of various treatments [8-11]. The costs associated with dental care can be prohibitive, contributing to household poverty and long-term debts [12]. Healthcare professionals generally regard the willingness to pay (WTP) as a popular approach and a reliable metric for evaluating the acceptability of treatment modalities [13,

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14]. The tool has been effectively utilized to assess patients' perceptions in various medical disciplines [15-18].

The government sector's provision of free healthcare services to both Saudi and non-Saudi employees substantially elevates the cost of healthcare financing in Saudi Arabia. Further exacerbating this situation are the rising costs of medical technology and the rapid population growth [19]. Saudi Arabia is expanding its extensive healthcare system in anticipation of change, as Vision 2030 prioritizes the private sector [20]. Consequently, the Saudi Ministry of Health has encouraged the private sector to increase health expenditure by promoting alternative financing and delivery methods, such as health insurance, and facilitating stakeholder collaboration [21].

WTP for goods and services can be estimated using various methods. Bidding represents the most established and commonly accepted method for evaluating a patient's financial capacity to pay for a specific treatment modality [13, 22, 23]. Hence, this study aimed to assess the parents' WTP for NOIS for their children during dental procedures in Riyadh City, Saudi Arabia. This study tests the hypothesis that parental willingness to pay for NOIS is influenced by the various demographic characteristics of the parents. This study provides healthcare professionals and third-party payers with a reliable estimate of a patient's financial resources for a specific treatment.

Materials and Methods

This study was registered and approved by the Research and Innovation Center of a private university, Riyadh, Saudi Arabia (IRB #:FRP/2024/540/1268/1138). This population-based cross-sectional survey was conducted among parents in Saudi Arabia from December 2024 to February 2025. This study was conducted by inviting parents to participate via an online Google Forms survey shared on social media platforms. Parents consenting to participate in this study were registered using their email addresses to prevent duplicate entries. Before the main study, a pilot study was conducted with 15 parents to evaluate the questionnaire's clarity, validity, and reliability, and adjustments were made based on the feedback received.

Criteria

The parents considered in this study were based on the following inclusion and exclusion criteria:

Inclusion criteria: Saudi father/mother having at least one child aged 3 - 14 years and expressing their willingness to participate in the study.

Exclusion criteria: parents who were unwilling to participate in the survey, and parents with children older than 14 years or younger than 3 years.

The study's participants were parents aged 20 to 65 years, accompanied by a child aged 3 to 14. The participants were assured of the confidentiality of their responses throughout the study.

Sample Size Estimation

The requisite sample size was determined using the G-Power sample size calculator, which indicated that a minimum of 200 participants would be necessary to detect an effect size of 0.5 with a power of 0.95. The present study was conducted on a sample of 293 parents.

Questionnaire

An online questionnaire comprising two main sections was developed. The initial section of the study included a consent form, a concise explanation of the study's objectives, demographic questions assessing the parents' age, educational level, monthly income, relationship to the child, the child's age and gender, and previous dental experiences.

In the second section, participants were presented with an educational video in Arabic that encompassed the definition, advantages, side effects, and clinical applications of NOIS. Subsequently, the subjects were instructed to respond to the bidding process, which was administered in two stages.

Stage 1: The parents were queried about their willingness to incur the average NOIS expense for their child in Riyadh city, which was determined to be 600 SAR.

Stage 2: The parents were allowed to submit bids for the price they were willing to pay. Parents who are unwilling to pay the average price will have the price reduced by 50 SAR until they reach a price they would be willing to pay, or the amount reaches 0 SAR. The parents willing to pay the median price were subjected to a series of price increases. The prices increased until it was indicated that they would no longer be willing to pay. The prices were increased until the maximum price charged for NOIS in Riyadh city reached 2000 SAR.

Statistical Analyses

Descriptive statistics of frequency distribution and percentages were calculated for the categorical variables. While mean, standard deviation, and mean ranks were calculated for the continuous variables. Data showed non-normal distribution. The WTP for the maximum and reasonable amounts was compared between the two groups using the Mann-Whitney U test, while the Kruskal-Wallis test was used to compare the mean ranks across more than two groups. The chi-square test was applied to find the relationship between different questionnaire items and the child age groups. The value of $p<0.05$ was considered significant for all the statistical tests. All statistical analyses were performed using the statistical analysis program SPSS version 25 (IBM SPSS, Armonk, NY, USA).

Results

Sociodemographic Characteristics

Table 1 summarizes the demographic characteristics of the study participants. A total of 293 parents participated in this study, comprising 211 mothers (72.0%), 29 fathers (9.9%), and 53 individuals categorized as others (18.1%). The parents' ages ranged from 20 to 65 years, with the mean age of the mothers being 37.69 years (SD ± 7.27) and that of the fathers being 42.63 years (SD ± 8.22). Regarding the parents' highest level of education, 18.1% of mothers and 21.8% of fathers reported having completed postgraduate studies. Additionally, 65.5% of mothers and 59.7% of fathers held a bachelor's degree, while 16.4% of mothers and 18.4% of fathers had completed high school or less. The study also included 133 boys and 160 girls, aged between 3 and 16 years, with a mean age of 7.26 years (SD ± 3.28).

Table 1. Demographic Information of the Study Participants (n=293)

Variables		**Response**	**n**
Relation to child	Mother	211	72.0%
	Father	29	9.9%
	Others	53	18.1%
Mother's level of education	≤High school	48	16.4%
	Bachelors	192	65.5%
	Postgraduates	53	18.1%
Father's level of education	≤high school	54	18.4%
	Bachelors	175	59.7%
	Postgraduates	64	21.8%
Monthly income (SAR)	>20K	110	37.5%

	10-20K	101	34.5%
	10-5K	61	20.8%
	<5K	21	7.2%
Child age (in years)	< 6	94	32%
	6-12	161	55%
	12-16	38	13%
[SAR] Saudi Arabian Riyal			

Dental History of the Child

Table 2 reveals the dental history of the child patient. Among the children included in the study, 21.5% had never visited a dentist, whereas 78.5% had a previous dental visit. Of those who had undergone dental treatment, 51.2% received care using basic behavior management techniques (BBMT), 14.3% had been treated with NOIS, 4.8% had undergone treatment under general anesthesia, and 8.2% received no treatment during their visit. Nearly 43.1% accepted the treatment willingly, while 22.9% reported being fearful, and 12.3% expressed extreme fear. Additionally, 7.5% required treatment to be completed by force, and 1.75% received treatment under other conditions. Notably, 47.8% of parents reported experiencing difficulty in persuading their children to attend dental appointments.

Table 2. Dental History of the Child

Variables	**Responses**	**n**	**%**
Has the child ever visited a dentist?	Yes	230	78.50
	No	63	21.50
How was your child treated?	Behaviour management technique	150	51.20
	Nitrous oxide	42	14.30
	General anaesthesia	14	4.80
	Not treated	24	8.20
How did your child respond to the treatment provided?	Accepting	100	34.10
	Fearful	67	22.90
	Extreme fear	36	12.30
	Treatment by force	22	7.50
	Could not treat	5	1.70
Did you face any difficulty in convincing your child to visit the dentist?	Yes	140	47.80
	No	90	30.70

Table 3 presents WTP for the maximum and reasonable amounts for NOIS. Parents willing to pay the average cost for NOIS for their children comprised 81 (27.60%), while 212 (72.40%) parents found it expensive and were unwilling to pay. The mean and median amounts parents were WTP for their children were the mean for the maximum amounts was 816.05 (SD ± 297.26), and the mean for the reasonable amounts was 164.86 (SD ± 90.17).

Table 3. WTP for the Maximum and Reasonable Amount for NOIS

Maximum Amount			**Reasonable Amount**		
Amount (SAR)	**n**	**%**	**Amount (SAR)**	**n**	**%**
650.00	43	53.1	50.00	34	16.0
700.00	6	7.4	100.00	53	25
750.00	2	2.5	150.00	39	18.3
800.00	7	8.6	200.00	34	16.0
850.00	2	2.5	250.00	21	9.9
900.00	1	1.2	300.00	20	9.4
1000.00	13	16.0	350.00	9	4.2
1050.00	1	1.2	400.00	1	0.47
1200.00	1	1.2	500.00	1	0.47
1500.00	2	2.5	NA	NA	NA
2000.00	3	3.7	NA	NA	NA
Total	81	100	Total	212	100
[SAR] Saudi Arabian Riyal					

Table 4 presents the potential factors of WTP for the maximum and the reasonable amounts of dental treatment under NOIS. The WTP for a reasonable amount differed significantly based on the father's level of education (p = 0.014) and monthly income (p = 0.004). In contrast, WTP for the maximum amount did not show any significant difference based on different factors (p>0.05). Fathers with lower education demonstrated significantly lower WTP for a reasonable amount of NOIS than those with bachelor's and postgraduate education. Similarly, parents with a monthly income of 10-5K and <5K showed significantly lower WTP for a reasonable amount for NOIS compared to those with >20K and 11-20K. Moreover, parents with income levels >20K showed significantly higher WTP for NOIS. Moreover, there were no statistical differences in parents' WTP in terms of child gender (p=0.825), child age (p = 0.064), and mothers' education (p=0.211) were observed.

Table 4. Comparison of Willingness to Pay Maximum and Reasonable Amount for N2O and Sedation

Variables		**Maximum amount**				**Reasonable amount**			
		Mean	SD	Mean rank	*p*	Mean	SD	Mean rank	*p*
Mother education	</=high school	846.15	424.98	34.27	0.169	147.14	91.51	93.07	0.211
	Bachelors	768.48	182.99	39.68		164.04	85.85	107.03	
	Postgraduates	897.73	386.21	47.73		188.71	105.44	119.16	
Father education	</=high school	727.78	154.34	32.22	0.093	130.00	73.39	83.26[A]	0.014
	Bachelors	772.22	222.48	39.51		174.79	89.94	113.66[B]	
	Postgraduates	991.67	455.44	49.86		172.83	98.72	110.40[B]	
Monthly income (SAR)	>20,000	846.59	329.97	43.22	0.160	193.94	98.65	125.01[A]	0.004
	10001-20000	808.70	296.44	40.96		157.05	78.43	103.30[B]	
	5000-10000	793.75	186.01	43.19		155.66	92.33	98.86[BC]	
	<5000	650.00	.00	22.00		110.00	63.25	68.70[C]	

Child gender	Male	823.44	283.69	44.45	0.246	162.87	87.94	105.54	0.825
	Female	811.22	308.60	38.74		166.67	92.52	107.37	
Child age	< 6 years	827.78	335.79	39.33	0.595	166.42	82.29	109.32	0.064
	6-12	808.00	286.49	41.09		174.32	98.13	111.57	
	12-16	837.50	188.75	51.13		130.88	69.65	84.38	

[SAR] Saudi Arabian Riyals, [SD] Standard Deviation

Discussion

This is the first study to quantify parents' WTP for NOIS for their children's dental procedures. The use of NOIS in the field of dentistry is considered an essential component of pharmacological behavior management techniques, especially for anxious children. Therefore, this study evaluated parents' WTP for NOIS during various dental procedures carried out by dental professionals in Riyadh City, Saudi Arabia. The parents were asked about their WTP for a NOIS for their children during a dental procedure. An effort was made to educate the patients before the bidding process. The reason for doing this was to ensure that a baseline amount on WTP was familiarized with the participants. Bidding is one of the oldest and most widely used methods of WTP among the various approaches, and it has the advantage of providing a realistic guide to the amount.

Pharmacological behavior management techniques are used in dentistry to relieve dental anxiety and are particularly effective for children. Moderate and deep sedation is often used as an alternative to general anesthesia for invasive pediatric dental procedures and has proven safer and cost-effective. [24]. Parents' attitudes and knowledge about the use of sedation vary and may be a significant reason for their WTP.

Several factors influence WTP for oral and dental care, such as gender, age, income, employment status, number of children, previous treatment experiences, [25]. This study examined the premise that multiple demographic factors influence parental WTP for NOIS. The presented hypothesis has been accepted, as the father's education and monthly income were determined to affect the reasonable amount to pay for their children's dental treatment under NOIS.

It has been reported that parents educational level considerably affects their readiness to pay for dental care under sedation. Parents with advanced educational qualifications are more inclined to comprehend the advantages and disadvantages of sedation, resulting in increased acceptance and readiness to finance these services. Education improves parents' understanding of the processes and their ability to make informed decisions about their children's dental care [26, 27].

In line with these findings, the current study observed that fathers with ≤ high school education demonstrated a significantly lower reasonable amount to pay for NOIS than those with a bachelor's and postgraduate level of education. However, parents with bachelor's and master's degrees of education did not differ significantly in paying a reasonable amount for NOIS. Several other studies have reported similar findings in which the education of parents played a significant role in the WTP [28, 29].

Income level is a crucial factor influencing parents' readiness to spend on sedative methods in pediatric dentistry. Research indicates that families with higher incomes are more inclined to accept and finance modern sedation techniques, such as nitrous oxide and oxygen inhalation, owing to their financial capacity to purchase these services [26, 30]. In contrast, families with lower incomes may exhibit greater reluctance due to financial limitations, although recognizing the advantages of sedation (Wanyonyi et al., 2016). It has been noted that the family income significantly influenced the acceptance

of dental general anesthesia (DGA), with parents of higher income demonstrating greater willingness to consent to DGA for their children [30]. A study examining the social gradient of sedation services in England revealed that impoverished areas had a greater number of patients receiving sedation, indicating that socioeconomic position affects both access to and the propensity to pay for these treatments [31]. In line with these findings, the current study showed that the parents with an income level of>20000 SAR were willing to pay a significantly higher reasonable amount for NOIS compared to other income levels. Therefore, it is obvious that monthly income has consistently been a factor influencing WTP reported by several studies [11, 32, 33].

It should be noted that access to dental care is influenced by the extent of dental insurance coverage [34]. Dental insurance coverage may play a significant role in oral health inequalities, as NOIS in most dental care centers is often paid out of pocket. Therefore, policymakers must consider the factors that influence service valuation [11]. When the child's age and gender were investigated in relation to parents' WTP for NOIS, no statistical differences were observed in parents' WTP, consistent with several studies [29, 35, 36].

Strength of the Study

This is the first study to report the parental WTP for NOIS for the dental care of their children in Saudi Arabia. The WTP for the maximum and reasonable amounts for NOIS was assessed through a bidding process, which provided realistic estimates of the payments. Diverse demographic factors influencing WTP were explored in this study. Moreover, the current study provides baseline estimates on WTP for NOIS upon which future studies can be undertaken. This also provides a clue for the clinicians and dental care administrators to determine the cost of dental care for the children under NOIS. Study results may help in the assessment of NOIS services in governmental dental centers.

Limitations of the Study

NOIS is an effective strategy for alleviating anxiety in young dental patients. Nevertheless, this study did not explore parental financial worries, awareness of WTP for NOIS, safety fears of NOIS, and a preference for alternative sedation techniques. Moreover, the limited sample size and cross-sectional nature of the study design may have affected the results. Hence, caution should be exercised while generalizing the study findings to the larger population in Saudi Arabia.

Conclusion

The results showed that 27.60% of parents were willing to pay the mean cost for NOIS for their children during dental treatment. In contrast, most parents found it to be expensive. Monthly income and the father's education level were the only factors that affected the parents' willingness to pay for NOIS. There were no statistically significant differences in child gender, child age, or mothers' education in willingness to pay for NOIS.

Conflict of Interest

Authors declare that they have no conflicts of interest to disclose.

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