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Knowledge, Practices, and Perspectives of Artificial Intelligence–Enabled Behaviour Management Techniques in Children during Dental Treatment: A Cross-Sectional Questionnaire Study

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Abstract

Background: Child dental anxiety remains a major barrier to care. Recent advances in Artificial Intelligence (AI) offer new management methods, yet their awareness and clinical integration are underexplored.

Aim: To assess the knowledge, practices, and perspectives of pediatric dental practitioners in India regarding AI-enabled behavior management.

Materials and Methods: An analytical cross-sectional survey was conducted among 200 dental professionals (students, trainees, and academicians). Data assessed familiarity, utility, safety, and scope of AI tools.

Results: Inferential analysis showed a significant positive correlation between professional category and awareness, indicating familiarity increased with professional qualification. Nevertheless, nearly half (47.5%) were unfamiliar with AI use, and 73% viewed it as an "early adopter fringe" concept. Professionals reported high perceived utility (85.5% manage disruptive, 88.4% reinforce), with Virtual Reality (83%) and mobile applications (61.5%) being the most recognized tools. A strong consensus emerged: 87.5% supported AI as an adjunct, and 75.9% favored a hybrid model, while 85% opposed automation.

Conclusion: Pediatric dental practitioners show openness to AI-assisted behavior management but maintain skepticism regarding full automation. Continuous education and ethical guidelines are essential for responsible, evidence-based integration.

Keywords: Artificial Intelligence, Pediatric Dentistry, Behavior Management, Virtual Reality, Dental Anxiety

Introduction

Dental anxiety in children represents a longstanding challenge that significantly affects treatment outcomes and the overall experience of pediatric dental care. [1,2] It is characterized by feelings of fear, uneasiness, or apprehension, often without a clearly identifiable cause.[3,4] Effective behavior management is therefore central to pediatric dentistry, enabling clinicians to deliver care while fostering positive attitudes toward oral health.[1,5] Despite major advances in materials and techniques, managing anxiety related to dental environments remains an obstacle globally.[6,7]

Recent developments in artificial intelligence (AI) have introduced innovative strategies to address such behavioral and emotional challenges.[8,9] AI refers to computational systems capable of performing tasks that typically require human intelligence, including perception, learning, and adaptive decision-making. [10, 11] The integration of AI into pediatric dentistry has opened new avenues for enhancing behavioral guidance through tools such as virtual reality (VR), mobile applications, 4D goggles, animations, and eye-tracking systems, all of which aim to engage children, distract from anxiety-inducing stimuli, and improve cooperation during dental procedures. [7,12,13]

Given the growing prominence of these technologies, it has become essential to evaluate the awareness, understanding, and practical application of AI-enabled behavioral management among dental professionals.[11,14] This study therefore aimed to assess the knowledge, familiarity, and implementation of AI-based behavioral management techniques in pediatric dentistry, to compare their effectiveness with conventional methods, and to explore potential safety concerns and future scope of these approaches in clinical practice.

Materials and Methods

Ethical clearance for the study was obtained from the Institutional Ethics Committee (IEC. No. 2024/PG/PEDO/59). This study adopted an observational analytical cross-sectional design and was conducted between March and September 2025 among dental professionals across India. The survey targeted individuals engaged in pediatric dental care, including final-year undergraduate students, interns, postgraduate trainees, academicians, and private practitioners. A structured, self-administered questionnaire was distributed electronically through email and messaging platforms to ensure wide geographic representation across the north, south, east, and west regions of the country.

The required sample size was determined using Epi Info 7, assuming a finite population of 465, a 95% confidence level, 5% margin of error, and 50% expected frequency, yielding a minimum sample requirement of 120 participants. A total of 200 valid responses were received and analyzed, exceeding the calculated requirement and thus improving the statistical precision of the study.

The questionnaire was designed by the principal investigator based on an extensive literature review and previously validated tools. It comprised five sections intended to assess familiarity, knowledge and implementation, relative effectiveness, safety and concerns, and future potential of AI-enabled behaviour management techniques in pediatric dentistry. The instrument included multiple-choice and open-ended questions, enabling both quantitative and qualitative insights. Content validity was established by six subject experts, and a pilot test involving ten eligible participants confirmed the clarity, comprehensibility, and reliability of the instrument. As all pilot participants reported good

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understanding of the questions, no modifications were deemed necessary.

Data collection was performed using an anonymous online survey. Responses were electronically recorded, compiled, and transferred into Microsoft Excel 2021 for cleaning and coding. The dataset was then exported to SPSS version 23.0 for statistical analysis. Binary and multiple-choice items were scored, with correct responses assigned a value of one and incorrect responses a value of zero. Knowledge scores were aggregated to a maximum of six, and participants scoring ≥70% were categorized as having good knowledge. Descriptive statistics were used to summarize demographic characteristics and response patterns. Spearman's correlation coefficient was applied to evaluate relationships between awareness and professional qualifications, while one-way ANOVA was employed to assess group differences. A p-value of less than 0.05 was considered statistically significant.

All participants provided informed consent prior to completing the survey. Confidentiality and anonymity were maintained throughout data collection and analysis in accordance with the ethical standards for human research.

Results

Demographics

A total of 200 participants completed the survey. The largest group were interns, followed by final-year undergraduate students, postgraduates, general dentists, pedodontists and academicians.

Familiarity and Perception

Nearly 47.5% were not familiar with AI use in child behavior management. Most (73%) regarded AI as being in the "early adopter fringe" stage. A substantial knowledge gap exists among dental professionals regarding AI applications in behavior management. The perception of AI as an "early adopter fringe" concept indicates that while professionals are aware of the technology, they view it as nascent and not yet widely integrated or proven in mainstream pediatric dental practice.

Perceived Utility

- 85.5% believed AI could manage disruptive behaviors such as fear and anxiety.
- 88.4% felt it reinforced desirable behaviors in cooperative children.
- 79.9% agreed it aided treatment delivery in special care children.

Despite low overall familiarity, there is widespread optimism and a strong belief in AI's potential utility across different behavioral scenarios. Professionals acknowledge its therapeutic value not only for managing disruptive behavior but also for reinforcing positive cooperation and aiding complex special care cases.

Familiarity with AI-Enabled Tools

Technique	Awareness (%)
Virtual Reality (VR) games	83.0
Mobile applications	61.5
Animations	60.5
4D goggles	35.0
Eye-tracking systems	35.0
Movies	22.0

Table 1: depicts the familiarity of participants with various AI-enabled tools.

Virtual Reality (VR) is clearly the most recognized AI-enabled tool, consistent with its established use in distraction therapy. The high awareness of VR and mobile applications suggests that interactive, immersive digital technologies are the primary way dental professionals currently encounter AI in this context. Other specific tools like 4D goggles and eye-tracking systems have significantly lower awareness.

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Implementation and Helpfulness

About 69% had used AI tools clinically, though only 47.5% found them helpful. There is a significant gap between the high rate of clinical use (69%) and the perceived helpfulness (47.5%). This suggests that current AI implementations may not be effective, user-friendly, or consistently reliable, indicating a need for better training, tool validation, or more evidence-based integration.

Safety and Adverse Effects

While 73% reported no adverse effects, 27% cited concerns such as dependency on VR (67.5%), difficulty distinguishing reality (46.5%), and reduced stress-coping development (40%). While adverse effects are not a dominant reported experience, the identified concerns highlight psychological and developmental worries. Professionals are most concerned about over-reliance on virtual environments and potential negative impacts on a child's natural ability to cope with stress or distinguish between the virtual and real worlds.

Ethical and Practical Perspectives

- 87.5% supported using AI as an adjunct to traditional techniques.
- 85% opposed automation of time-intensive treatments.
- 86.5% believed written consent was not necessary for AI use.
- 90% denied that AI has a superior long-term scope over conventional methods.
- 75.9% preferred a hybrid approach, combining AI with human skills.

There is a strong professional consensus in favor of a hybrid model where AI serves to augment existing conventional methods. This perspective is driven by significant reluctance toward full automation and widespread skepticism about AI's superior long-term effectiveness compared to established, human-centric approaches. The majority also views AI tools as therapeutic aids that do not require specialized written consent, aligning with existing protocols for standard behavioral techniques.

Descriptive statistics revealed variation in AI awareness across professional categories, with interns and undergraduate students demonstrating lower familiarity compared to postgraduates and academicians.

Correlation between Professional Category and AI Awareness Score among Indian Dental Professionals.

Spearman's rank-order correlation was used to assess the association between professional category and awareness of AI in child behaviour management. The analysis (Spearman's ρ=0.183 and p=0.009) indicated a significant positive correlation between the professional category and awareness. This suggests that awareness increases with higher professional qualification or experience.

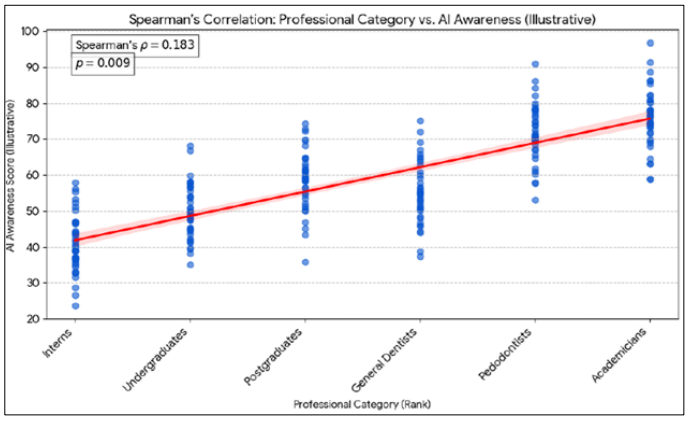

Figure 1: Scatter plot illustrating the positive correlation between the ranked professional category and the illustrative AI Awareness Score.

Mean AI Awareness Score across Professional Categories

A one-way Analysis of Variance (ANOVA) further assessed differences in awareness levels among the professional categories. The result (F=5.12 and p<0.001) indicated a statistically significant difference in

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awareness among the groups. This confirms that the level of professional qualification significantly influences familiarity with AI-enabled behaviour management techniques

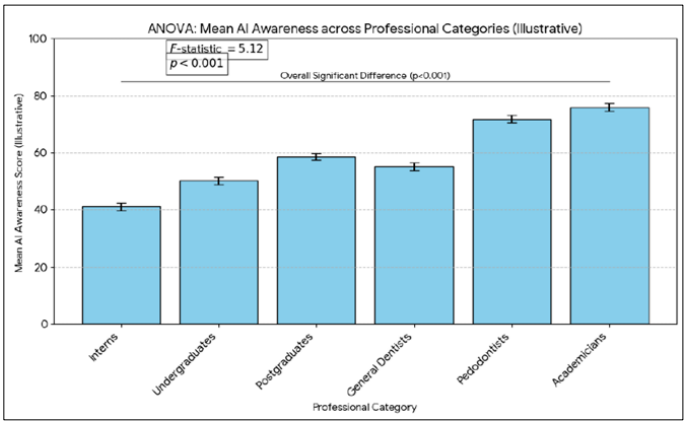

Figure 2: Bar chart representing the illustrative mean AI Awareness Score for each professional category.

Discussion

The present study illuminates a nuanced perception among Indian dental professionals toward AI-enabled behavior management in pediatric practice. While there is enthusiasm for AI as a complementary tool, this optimism is strategically tempered by skepticism regarding its full automation and long-term replacement of human expertise. The findings contribute empirical insights into the current awareness landscape, ethical considerations, and practical acceptance of digital tools in pediatric dentistry within the Indian context.

The Professional Scaffolding of AI Awareness

A central and critical finding of this study is the significant positive correlation between the professional category and awareness of AI (Spearman's ρ=0.183, p=0.009). This correlation, substantiated by the statistically significant group differences identified by the One-Way ANOVA (F=5.12, p<0.001), suggests that advanced training and clinical exposure are key determinants of familiarity with AI-based behavioral management approaches. The pattern—where postgraduates and academicians showed higher awareness than students and interns—underscores the critical role of specialized education in the adoption of emerging technologies. This observation is highly consistent with the need for continuous education as proposed in the conclusion, suggesting that knowledge dissemination primarily occurs through specialty training and academic engagement rather than general curriculum or initial clinical exposure.

Virtual Reality and Digital Distraction as the Current Benchmark

The high awareness of Virtual Reality (VR) games (83%) in the present study underscores its dominance in AI-assisted pediatric behavior management. This recognition is strongly supported by existing literature. Zhang et al. (2020) previously reported that Virtual Reality Exposure Therapy (VRET) significantly lowers patient anxiety compared to in vivo exposure, establishing VR as an effective anxiety-reducing tool.[15] Similarly, Evans et al. (2020) demonstrated that VR reduced behavioral distress and anxiety scores in pediatric dental patients.[16] This high level of familiarity, alongside significant awareness of Mobile applications (61.5%) and Animations (60.5%), indicates that interactive and immersive digital tools are currently the most familiar and accepted forms of AI-related intervention. Priyanka et al. (2022) described AI-enabled pain-control systems, such as 4D goggles and VR-based games, as promising "injection-free" distraction tools,[17] while Patil et al. (2022) reported superior anxiety reduction with smartphone-based interventions over conventional methods, aligning with the observed familiarity with these smart and immersive tools.[18]

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Ethical Boundaries and the Automation-Reliability Gap

Despite the enthusiasm for utility, the study revealed a critical automation-reliability gap. Although 69% of respondents reported using AI tools, only 47.5% found them helpful, suggesting that current implementations may not consistently meet clinical needs or expectations. This concern is reflected in the strong professional consensus: 87.5% support using AI only as an adjunct to traditional techniques, and 85% explicitly opposed the automation of time-intensive treatments. This cautious approach aligns with the cautionary perspective of Bohnlein et al. (2020),[19] who emphasized AI's role in personalized treatment through predictive analytics but cautioned that clinical interpretation and human empathy remain essential components of pediatric care. The reluctance toward automation echoes the recommendation by Acharya et al. (2024)[20] that AI should augment, not replace, human interaction in pediatric settings.

Psychological Concerns and Long-Term Scope

The concerns reported regarding safety and adverse effects, specifically dependency on VR (67.5%) and reduced stress-coping development (40%), are essential psychological considerations. These apprehensions mirror the foundational concerns discussed by Cabibihan et al. (2013), who examined socially interactive robots in autism therapy and highlighted the delicate balance required between technology use and the fostering of empathy and genuine emotional skills.[21] The widespread denial that AI has a superior long-term scope over conventional methods (90%) further emphasizes the professional belief that the most effective and enduring outcome in pediatric dentistry—successful behavior modification and rapport development—remains primarily a human interaction. This reinforces the preference for a hybrid approach (75.9%), where AI is leveraged for efficiency but human oversight is maintained, as noted by Clark-Turner et al. (2017) regarding learning-from-demonstration robots, which require human supervision for ethical compliance and emotional sensitivity.[22].

Scope and Acceptance of AI in behaviour management

Collectively, these findings illustrate a cautious optimism: AI-enabled behavior management is perceived as beneficial for enhancing child cooperation and clinician efficiency, but practitioners emphasize maintaining human oversight to preserve empathy, safety, and individualized care. The study provides empirical insights into AI adoption in pediatric behavior management within India, establishing a foundation for curriculum enhancement, policy formulation, and the development of standardized clinical guidelines to integrate AI responsibly.

Conclusion

The study concludes that while pediatric dental professionals in India recognize the potential of AI-enabled behavior management techniques—particularly virtual reality and mobile-based tools—they remain cautious about their independent application. Awareness is significantly influenced by professional level, suggesting a need for greater integration of AI training into the core dental curriculum for students and interns. AI is viewed best as an adjunct to conventional methods, not a replacement for human interaction. Bridging the awareness-practice gap through training, research validation, and ethical regulation is imperative for responsible integration into pediatric dentistry.

Scope

This pioneering cross-sectional study provides empirical insights into AI adoption in pediatric behavior

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management within India. It establishes a foundation for curriculum enhancement, policy formulation, and the development of standardized clinical guidelines to integrate AI responsibly. Future studies should explore longitudinal effects on behavior modification, emotional outcomes, and child-dentist rapport in AI-augmented dental care.

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