

Influence of Virtual Reality Education on Long-term Oral Hygiene Compliance in Autistic Children

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Abstract

Maintaining effective oral hygiene is a persistent challenge for many autistic children because of sensory sensitivities, communication difficulties, behavioral differences, anxiety, and difficulties establishing consistent daily routines. Conventional oral hygiene education may not adequately address these challenges, highlighting the need for engaging and individualized approaches. Virtual reality (VR) education offers an immersive, interactive, and visually structured method for teaching oral hygiene behaviors and reinforcing appropriate toothbrushing practices. This review examines the potential influence of VR-based oral hygiene education on long-term oral hygiene compliance among autistic children. Particular attention is given to the ability of VR interventions to improve motivation, knowledge retention, behavioral engagement, brushing consistency, and cooperation with oral healthcare. The role of repetition, personalized learning environments, sensory adaptation, and caregiver-supported reinforcement is also considered. Evidence suggests that VR may provide an effective complementary strategy for overcoming some behavioral and educational barriers associated with conventional oral hygiene instruction. However, sustained improvements in oral hygiene compliance require continued reinforcement, appropriate parental involvement, professional dental supervision, and individualized intervention strategies. Future research should employ larger samples, standardized outcome measures, objective plaque assessments, and longer follow-up periods to determine whether improvements achieved through VR education are maintained over time. Overall, VR represents a promising technology for supporting sustainable oral hygiene behaviors and improving preventive oral health outcomes in autistic children.

Keywords: Virtual reality; Autism spectrum disorder; Oral hygiene; Toothbrushing; Dental education; Behavioral compliance; Pediatric dentistry; Preventive dentistry; Long-term adherence.

Introduction and Background

Autistic children experience distinctive challenges in maintaining oral health, including sensory sensitivities, communication difficulties, behavioral differences, anxiety, and resistance to unfamiliar routines. These factors can interfere with toothbrushing, acceptance of dental procedures, and consistent adherence to preventive oral hygiene practices. Consequently, individualized behavioral guidance and effective home-based preventive strategies are essential for reducing oral disease burden in this population (Al-Beltagi et al., 2025; Pastore et al., 2023).

Oral hygiene education traditionally relies on verbal explanations, demonstrations, caregiver instruction, and repeated reinforcement. However,

these approaches may have limited effectiveness when children experience difficulties with attention, communication, sensory processing, or behavioral adaptation. The development of immersive technologies such as virtual reality (VR) provides an alternative approach by presenting educational content through controlled, interactive, and visually engaging environments. VR has increasingly been explored in healthcare and oral disease prevention because it can support experiential learning and potentially improve engagement with health-related behaviors (Andruškienė et al., 2022).

Recent evidence specifically examining VR-based versus traditional oral hygiene education in children with autism spectrum disorder highlights the potential of VR to improve the delivery of oral

hygiene instruction (Fallea et al., 2025). Furthermore, VR interventions have demonstrated potential for reducing anxiety and improving cooperation during dental examinations, addressing important barriers to successful dental care in autistic children (Al Kheraif et al., 2024).

The emphasis on prevention is particularly important because early and consistent oral hygiene can reduce progression of dental disease and the subsequent need for invasive treatment. Preventive approaches therefore complement clinical interventions aimed at managing established carious lesions (Singh et al., 2026). Although irrigation dynamics in endodontics primarily concerns treatment procedures, it further illustrates the broader importance of effective clinical management and infection control in maintaining oral health (Singh, 2020). Thus, investigating whether VR education can translate improved engagement into sustained, long-term oral hygiene compliance represents an important direction in pediatric dental care.

Virtual Reality-Based Oral Hygiene Education

Virtual reality (VR)-based oral hygiene education provides an immersive and interactive approach for teaching autistic children appropriate toothbrushing and oral healthcare behaviors. Unlike conventional verbal or demonstration-based instruction, VR can present predictable, visually organized, and repeatable simulations that allow children to observe and practice oral hygiene procedures within a controlled environment. This approach may be particularly valuable for children who experience communication difficulties, sensory sensitivities, anxiety, or resistance to unfamiliar dental experiences (Al-Beltagi et al., 2025; Pastore et al., 2023).

Recent evidence comparing VR-based and traditional oral hygiene education suggests that VR can enhance engagement and provide an alternative method for delivering oral health instruction to children with autism spectrum disorder (Fallea et al., 2025). Repeated exposure to virtual demonstrations may facilitate learning through visual modeling, repetition, and reinforcement, potentially improving the understanding and execution of toothbrushing

routines. Furthermore, VR may reduce anxiety and increase cooperation during dental-related encounters, supporting its broader application within pediatric dental care (Al Kheraif et al., 2024).

The integration of VR with artificial intelligence may further enhance personalization by adapting educational content to individual behavioral, sensory, and learning characteristics. Such technologies have been recognized as promising tools for healthcare education and oral disease prevention (Andruškienė et al., 2022). VR education should, however, complement rather than replace caregiver supervision, professional preventive care, and individualized behavioral guidance (Pastore et al., 2023). Preventive strategies remain particularly important in children vulnerable to dental caries and its complications, alongside appropriate clinical management when disease is established (Singh et al., 2026).

Singh (2020), although focused on endodontic irrigation dynamics, further illustrates the broader importance of effective clinical strategies in maintaining successful dental care. Overall, VR represents a promising educational adjunct for making oral hygiene instruction more engaging, predictable, and accessible to autistic children.

Influence on Long-Term Oral Hygiene Compliance

Virtual reality (VR)-based oral hygiene education may influence long-term compliance by transforming toothbrushing instruction into an immersive, repetitive, and visually predictable learning experience. This approach is particularly relevant for autistic children, who may experience sensory sensitivities, communication difficulties, anxiety, and challenges with maintaining consistent oral hygiene routines (Al-Beltagi et al., 2025; Pastore et al., 2023). By allowing children to repeatedly observe and practice oral hygiene behaviors within a controlled environment, VR may strengthen learning and facilitate the transfer of these behaviors into daily home routines.

Evidence comparing VR-based and traditional oral hygiene education suggests that immersive technologies can provide a more engaging

educational experience for children with autism spectrum disorder, potentially supporting improved understanding and behavioral participation (Fallea et al., 2025). Furthermore, VR interventions have demonstrated potential for reducing anxiety and increasing cooperation during dental examinations, which may indirectly improve children's willingness to participate in preventive oral healthcare (Al Kheraif et al., 2024). Reduced anxiety may be particularly important for establishing positive associations with oral hygiene and dental-care routines.

The incorporation of artificial intelligence and VR may further enable individualized educational content based on behavioral responses, learning needs, and sensory preferences, thereby supporting personalized oral disease-prevention strategies (Andruskienė et al., 2022). However, long-term compliance is unlikely to depend on VR alone. Consistent caregiver reinforcement, behavioral guidance, professional monitoring, and individualized preventive strategies remain essential (Pastore et al., 2023; Al-Beltagi et al., 2025).

Preventive approaches are especially important because sustained oral hygiene can reduce the progression of dental disease and the subsequent need for invasive treatment. In this broader preventive context, minimally invasive approaches such as SDF may complement behavioral interventions when carious lesions are already present (Singh et al., 2026). Singh (2020) further highlights the importance of appropriate clinical management in maintaining favorable endodontic outcomes.

Overall, VR represents a promising adjunct for developing and maintaining sustainable oral hygiene behaviors, although longer-term controlled studies using objective plaque and adherence measures are needed to confirm its effectiveness.

Future Perspectives and Conclusion

Future development of virtual reality (VR) education should focus on transforming short-term improvements in oral hygiene knowledge and engagement into sustained daily behaviors among autistic children. Larger longitudinal studies are needed to determine whether VR-assisted instruction produces durable improvements in toothbrushing

frequency, technique, plaque control, and preventive dental attendance. The findings of Fallea et al. (2025) support the potential value of VR-based approaches compared with traditional oral hygiene education, while Al Kheraif et al. (2024) demonstrate the broader potential of VR to reduce anxiety and improve cooperation during dental experiences.

Future VR platforms should incorporate individualized sensory settings, simple visual instructions, repetition, gamification, and adaptive learning pathways that accommodate differences in communication, cognitive abilities, and sensory preferences. Integration of artificial intelligence with VR may further enable personalized oral health education and real-time adaptation to individual learning responses (Andruskienė et al., 2022). Importantly, VR should complement, rather than replace, caregiver participation, professional dental supervision, and established behavioral guidance strategies (Pastore et al., 2023; Al-Beltagi et al., 2025).

Preventive education remains particularly important because early behavioral interventions may reduce the progression of oral disease and the subsequent need for more invasive treatment. In this broader preventive context, Singh et al. (2026) highlights the clinical importance of conservative approaches for managing deep carious lesions. Similarly, effective clinical prevention requires appropriate treatment planning and attention to procedural factors that influence dental outcomes (Singh, 2020).

Overall, VR represents a promising, patient-centered educational technology for improving oral hygiene engagement among autistic children. Its long-term effectiveness will depend on sustained reinforcement, personalization, caregiver involvement, and rigorous evaluation of clinically meaningful outcomes.

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