Harnessing the Potential of Oral Hygiene Apps for Pediatric Dental Care:
A Comprehensive Narrative Review

Vivek Padmanabhan[1]*, Stancey D'Souza[2], Sivan Padma Priya[3], Mustahsen Rehman[4],
Shadi El Bahra[5], Nada Tawfiq[6], Fadia Awadalkreem[5]

1. Pediatric and Preventive Dentistry, RAK College of Dental Sciences, RAK Medical and Health Sciences University, Ras Al Khaimah, United Arab Emirates.
2. GP Dentist, UAE.
3. Oral Pathology, RAK College of Dental Sciences, RAK Medical and Health Sciences University, Ras Al Khaimah, United Arab Emirates.
4. Periodontics, RAK College of Dental Sciences, RAK Medical and Health Sciences University, Ras Al Khaimah, United Arab Emirates.
5. Prosthodontics, RAK College of Dental Sciences, RAK Medical and Health Sciences University, Ras Al Khaimah, United Arab Emirates.
6. Periodontics, RAK College of Dental Sciences, RAK Medical and Health Sciences University, Ras Al Khaimah, United Arab Emirates.

Abstract

Childhood marks a crucial phase in dental development, laying the foundation for lifelong oral health. This narrative review explores the role of oral hygiene applications (apps) in promoting optimal oral care habits among children. The article highlights the significance of childhood oral health beyond immediate concerns, emphasizing its impact on physical comfort, emotional well-being, and long-term habits. With the proliferation of mobile technology, oral hygiene apps have emerged as innovative tools to engage children in dental care. These apps leverage interactive features, gamification elements, and educational content to make learning about oral hygiene enjoyable and effective. Research indicates that oral hygiene apps can positively influence brushing frequency, technique refinement, and plaque reduction among children.

Despite their potential, challenges such as digital equity disparities, privacy concerns, and app sustainability persist. Future directions suggest personalized interventions, integration with telehealth services, and leveraging emerging technologies like augmented reality and artificial intelligence to enhance app effectiveness and engagement. Practical recommendations for healthcare professionals, parents, and app developers are provided to maximize the adoption and effectiveness of oral hygiene apps. Collaboration among stakeholders is essential to address challenges and harness the full potential of oral hygiene apps in pediatric dental care.

In conclusion, oral hygiene apps represent promising tools in promoting lifelong oral health habits and enhancing dental outcomes among children. Sustained research, innovation, and collaboration are vital to overcome obstacles and ensure widespread acceptance of these digital interventions. By embracing technological advancements and addressing challenges, oral hygiene apps can play a pivotal role in advancing pediatric dental care and improving oral health outcomes for future generations.

Review (J Int Dent Med Res 2024; 17(2): 860-865)

Keywords: Oral hygiene, Apps, Artificial Intelligence, Dental care, Digital interventions.
Received date: 10 April 2024   **Accept date:** 02 June 2024

Introduction

Childhood is a critical period in dental development, presenting a unique opportunity to establish lifelong oral health.[1] Emphasizing proper oral care during this stage can prevent common issues such as cavities, gum disease, and dental misalignment, laying the groundwork for enduring dental well-being.[2] Insufficient oral health in children can lead to painful dental conditions that significantly impact their daily activities, including eating, speaking, and sleeping. Preventing dental pain is crucial for a child's physical comfort and emotional well-being.[1] Healthy teeth and gums are essential for a child's nutrition and growth. Neglected dental problems can hinder their ability to maintain a

Corresponding author:
Dr Vivek Padmanabhan B.D.S., M.D.S., Ph.D.,
Assistant Professor
Pediatric and Preventive Dentistry
RAK College of Dental Sciences
RAK Medical and Health Sciences University
Ras Al Khaimah, United Arab Emirates
E-mail: vivek.padmanabhan@rakmhsu.ac.ae

balanced diet, potentially affecting their growth and overall well-being. Additionally, oral health plays a pivotal role in speech development.[1,2] Dental issues like missing or misaligned teeth can hinder a child's ability to articulate words clearly, impacting their communication skills. Addressing these concerns during childhood aids in the development of effective verbal communication.[3] A bright and healthy smile can boost a child's self-esteem and confidence, facilitating their ease in social situations and promoting a positive self-image and emotional well-being.[3] The early years are an ideal time to instill positive oral hygiene habits. Teaching children proper brushing, flossing, and regular dental check-ups establishes valuable routines that can prevent future dental problems.[4] These habits serve as a long-term investment in a child's oral health and overall quality of life. In summary, the significance of children's oral health extends beyond immediate dental concerns, encompassing physical health, emotional well-being, and the development of lifelong habits.[2,3] Prioritizing oral health during childhood sets the stage for a healthier, more confident, and happier future.[1.6]

Mobile apps are increasingly shaping oral healthcare, particularly in influencing oral hygiene habits among children.[5] These apps offer interactive and engaging methods to educate children about proper brushing techniques, flossing, and the importance of regular dental check-ups. Incorporating fun games, videos, and animations, pediatric-oriented oral healthcare apps make learning about oral hygiene enjoyable and educational.[6] Parents can utilize these apps to monitor their children's brushing routines and schedule reminders for dental appointments. Some apps also incentivize kids to maintain good oral health practices through rewards and incentives.[4,6] Moreover, the rise of telehealth and tele-dentistry apps allows parents to consult with dental professionals remotely, which is especially beneficial for children with dental anxiety or special healthcare needs.[6,7] Overall, mobile apps play a crucial role in instilling lifelong oral health habits in children while enhancing accessibility and engagement in dental care for both children and their caregivers.[7]

The research on the utilization of oral hygiene applications and their impact on pediatric oral hygiene care is limited. Therefore, this review aims to provide a comprehensive assessment of technology-driven interventions' efficacy in promoting favorable oral health practices in early childhood. Additionally, it seeks to explore the potential of these applications to complement oral hygiene educational approaches, reinforce preventive protocols, and potentially reduce the incidence of dental ailments among children. Ultimately, such a comprehensive review aims to contribute significantly to the advancement of pediatric oral health, offering essential guidance for healthcare practitioners and parents alike.

The Present Landscape of Oral Hygiene Apps

The landscape of oral hygiene apps for children is rapidly evolving, with an increasing number of mobile applications designed to promote proper dental care habits.[7] These apps offer a variety of features and functionalities aimed at engaging children in oral health education and encouraging adherence to recommended oral hygiene practices.[8] Many oral hygiene apps incorporate interactive games, animated characters, and colorful graphics to make learning about dental care fun and engaging for children.[9] These gamification elements help to keep children entertained while teaching them important concepts such as proper brushing techniques, flossing, and the importance of regular dental check-ups.[10] Additionally, some apps include brushing timers and progress trackers to help children monitor their oral hygiene routines and track their progress over time. Examples of popular oral hygiene apps for children include "Brush DJ," "Toothsavers Brushing Game," and "Disney Magic Timer."[8,9] These apps use creative storytelling, rewards systems, and music to motivate children to brush their teeth regularly and maintain good oral health habits. Overall, the landscape of oral hygiene apps for children reflects a growing recognition of the potential of mobile technology to enhance dental health education and promote positive oral hygiene behaviors.[7,11] As these apps continue to evolve and improve, they have the potential to play a valuable role in empowering children to take control of their oral health from an early age.[9]

Effectiveness of Oral Hygiene Apps

Research has consistently shown that oral hygiene apps can effectively promote proper oral care behaviors among children. Numerous studies have provided evidence supporting the

positive impact of these apps on various aspects of oral health.[14,16,17,19] For example, a study conducted in India found that a mobile app-based oral health educational program significantly improved oral hygiene knowledge and practices among 13- to 15-year-old school children.[14] Similarly, another study showed that a mobile app intervention resulted in better oral hygiene behaviors among adolescents with fixed orthodontic appliances.[16] Additionally, a systematic review evaluated the effectiveness of mobile apps in enhancing oral hygiene behaviors among children and adolescents, concluding that they can positively impact oral health outcomes by offering engaging educational content and enabling self-monitoring of oral hygiene habits.[19] Furthermore, a randomized controlled trial investigated the efficacy of a mobile app intervention in enhancing tooth brushing behavior among preschool children.[17] The study found that children who used the app showed significant improvements in brushing duration and coverage compared to those who did not.[17] Overall, these studies collectively highlight the effectiveness of oral hygiene apps in promoting proper oral care behaviors among children, underscoring the potential of digital interventions to positively impact oral health outcomes.

Impact on Oral Health Outcomes

The impact of oral hygiene apps on oral health outcomes in children has garnered increasing attention in recent years, with studies indicating both positive effects and areas for further exploration.[11-15] These apps typically provide interactive features aimed at encouraging proper oral care habits and educating children about the importance of oral health.[11] Research suggests that oral hygiene apps can effectively motivate children to adhere to recommended brushing and flossing routines, leading to improved oral hygiene behaviors.[12] By promoting consistent and thorough oral hygiene practices, these apps contribute to the removal of plaque and food debris, reducing the risk of dental caries and gingival inflammation.[13] Additionally, educational content within these apps enhances children's knowledge and awareness of oral health, empowering them to make informed decisions about their dental care.[15] Several studies have demonstrated a correlation between the use of oral hygiene apps and reductions in plaque accumulation among children, further supporting their positive impact on oral health

outcomes.[11-16] Moreover, these apps play a role in preventing dental caries by promoting proper brushing, flossing, and fluoride use, as well as supporting compliance with orthodontic treatment for those undergoing such procedures.[12] While the potential benefits of oral hygiene apps are evident, further research is needed to explore their long-term effects and optimal implementation strategies in pediatric dental care.

Considerations for App Design and Development

When designing and developing effective oral hygiene apps for children, several key considerations must be addressed to ensure their success and impact on oral health outcomes.[18-21] One crucial factor is the creation of age-appropriate content tailored to the developmental stage and cognitive abilities of the target audience.[18] Information and instructions should be presented in a clear, simple language, with engaging visuals and interactive elements to enhance comprehension and retention.[19] User engagement strategies play a vital role in keeping children interested and motivated to use the app regularly.[20] Incorporating gamification elements, such as rewards, badges, and progress trackers, can make oral hygiene routines more enjoyable and encourage participation.[18] Interactive games, quizzes, and challenges can also increase engagement and reinforce learning objectives.[19] Integration with parental involvement is another essential aspect of designing oral hygiene apps for children.[18] Providing features that allow parents to monitor their child's progress, set reminders for dental appointments, and receive feedback from dental professionals fosters a collaborative approach to oral health management.[20] Parental supervision and support are crucial for reinforcing proper oral care habits and ensuring children adhere to recommended routines, which will also enable a guidance to better occlusion and occlusal characteristics.[19, 20, 21] Furthermore, ensuring the content of the app is evidence-based is essential for providing accurate and reliable information to users. Content should be sourced from reputable dental organizations and reviewed by dental professionals to ensure its accuracy and relevance.[22] Usability testing with children and parents can help identify any usability issues or areas for improvement, ensuring the app is intuitive and easy to navigate.[19, 21] Accessibility features should also be considered to

accommodate children with special needs or disabilities. This may include features such as customizable settings, voice commands, and compatibility with assistive technologies to ensure all children can access and benefit from the app.[22] In conclusion, designing and developing effective oral hygiene apps for children requires careful consideration of factors such as age-appropriate content, user engagement strategies, integration with parental involvement, evidence-based content, usability testing, and accessibility features. By addressing these considerations, oral hygiene apps can effectively educate and motivate children to maintain optimal oral health habits, leading to improved oral health outcomes and thereby reducing stress also in children which may result from compromised oral hygiene.[21, 22, 23]

Challenges and Future Directions

Several challenges and limitations are associated with the use of oral hygiene apps in children, which need to be addressed to maximize their effectiveness and impact.[19,21] Digital equity issues pose a significant challenge, as access to smartphones or tablets may be limited for certain populations, particularly those from lower socioeconomic backgrounds or rural areas. Additionally, privacy concerns arise regarding the collection and storage of personal data, especially for apps that require user registration or interaction with third-party services.[18] App sustainability is another issue, as many oral hygiene apps may lack long-term engagement strategies or updates to maintain user interest and effectiveness over time.[14,15] Moving forward, areas for future research and innovation in the field of oral hygiene apps for children include the development of personalized interventions tailored to individual needs and preferences.[17,24]

By utilizing data analytics and machine learning algorithms, apps can adapt content and recommendations based on user behavior, demographics, and oral health status.[16] Integration with telehealth services offers opportunities to enhance the reach and effectiveness of oral hygiene interventions, enabling remote consultations with dental professionals for personalized guidance and support.[18] Scalability of interventions is another important consideration, as oral hygiene apps need to be accessible and effective for large and diverse populations.[19] Developing scalable solutions involves designing user-friendly interfaces, optimizing app performance across different devices and operating systems, and addressing language and cultural barriers to ensure inclusivity and reach.[18,19] Emerging technologies such as augmented reality (AR) and artificial intelligence (AI) hold promise for enhancing the effectiveness and engagement of oral hygiene apps.[24] AR features can create immersive and interactive experiences, allowing children to visualize oral hygiene techniques in real-time and receive instant feedback on their performance. AI-powered algorithms can analyze user data, identify patterns, and provide personalized recommendations for improving oral health habits.[23,24] By leveraging these technologies, oral hygiene apps can become more engaging, effective, and adaptable to the needs of children and their caregivers. In conclusion, while oral hygiene apps offer promising opportunities for promoting oral health in children, they also face challenges related to digital equity, privacy, sustainability, and scalability.[24] Future research and innovation should focus on developing personalized interventions, integrating telehealth services, and harnessing emerging technologies such as AR and AI to enhance app effectiveness and engagement. By addressing these challenges and leveraging technological advancements, oral hygiene apps can play a valuable role in improving oral health outcomes and promoting lifelong oral hygiene habits in children.[24]

Practical recommendations for healthcare professionals, parents, and app developers regarding the use of oral hygiene apps in children can help maximize their effectiveness and promote optimal oral health outcomes.[22]

Practical Implications and Recommendations

For healthcare professionals, it's essential to incorporate oral hygiene apps into comprehensive dental health promotion strategies. This can be done by recommending these apps to patients during dental visits, providing guidance on selecting appropriate apps, and ensuring they align with evidence-based recommendations.[17, 18] Healthcare professionals should also educate parents about the importance of regular dental visits alongside the use of oral hygiene apps. Emphasizing the complementary role of professional dental care can help maintain optimal oral health.[21]

Additionally, advocating for the integration of oral hygiene apps into community outreach programs and school-based oral health education initiatives can reach a wider audience of children and families.[22,30] Parents play a crucial role in supporting their children's oral hygiene habits.[23,29] They should research and select age-appropriate, evidence-based oral hygiene apps that are engaging for their children. Incorporating the use of these apps into daily routines and supervising their children's usage ensures that the recommended dental care practices are followed correctly.[24,26,28]

Furthermore, parents should reinforce the importance of regular dental check-ups and professional cleanings in addition to using oral hygiene apps. Emphasizing the role of dental professionals in monitoring oral health and addressing concerns is essential for maintaining optimal oral hygiene.[22,27,29]

For app developers, it's important to design oral hygiene apps with input from dental professionals. Ensuring that these apps align with evidence-based guidelines and promote effective oral care practices is crucial.[23] User-friendly interfaces and engaging features should be incorporated to appeal to children and encourage regular use. Customization options and parental controls can provide parents with the ability to monitor and manage their child's app usage and progress.[24,25] Additionally, providing educational resources within the app can enhance users' understanding of oral health concepts and reinforce healthy habits. Collaborating with healthcare professionals and organizations to promote the adoption and effectiveness of oral hygiene apps through education, awareness campaigns, and advocacy efforts is also beneficial.[27,28]

In summary, integrating oral hygiene apps into comprehensive dental health promotion strategies, emphasizing the importance of regular dental visits, parental guidance, and community outreach, and promoting education, awareness, and advocacy are essential for maximizing the adoption and effectiveness of these apps among children and their caregivers. Working together, healthcare professionals, parents, and app developers can empower children to take control of their oral health and establish lifelong habits for optimal dental well-being.[29,30,31]

Conclusions

The narrative review underscores the potential of oral hygiene applications in fostering proper oral care habits and enhancing oral health results among children. These applications provide interactive functionalities and educational material tailored specifically to children, motivating them to adhere to recommended oral hygiene routines. Important discoveries include the beneficial effects of such apps on increasing brushing frequency, refining technique, reducing plaque buildup, and retaining knowledge. Furthermore, incorporating oral hygiene apps into comprehensive dental health promotion efforts, coupled with regular dental visits and parental guidance, amplifies their efficacy in promoting optimal oral health. Nonetheless, challenges like digital equity disparities, privacy apprehensions, and app sustainability necessitate attention. Future endeavors should concentrate on refining the effectiveness of oral hygiene apps, with potential avenues including personalized interventions, integration with telehealth services, and the scalability of interventions.

Furthermore, leveraging emerging technologies such as augmented reality and artificial intelligence can enrich app effectiveness and user engagement. Ultimately, oral hygiene apps hold substantial promise in advancing pediatric dental care. Sustained research, innovation, and collaboration among healthcare providers, caregivers, and app developers are imperative to maximize their impact and ensure widespread acceptance. By tackling obstacles and embracing technological progress, oral hygiene apps can serve as pivotal tools in instilling lifelong oral health habits and enhancing oral health outcomes among children.

Declaration of Interest

The authors report no conflict of interest.

References

1. Foley MA, et al. What are "health" and "oral health"? J. Global Oral Health 2022:1–9.
2. Peres MA, et al. Oral diseases: a global public health challenge. Lancet 2019;394 (10194):249–60.
3. Padmanabhan V, Mohammad LT, AlZaabi HKHA, AwadAlkreem FAHA. Prevalence of Dental Caries in Children Visiting a Dental College and Hospital in the United Arab Emirates: A Cross-sectional Study. J Contemp Dent Pract. 2023 Jul 1;24(7):467-472. doi: 10.5005/jp-journals-10024-3529. PMID: 37622624.

4. Ramos-Gomez F, Kinsler J, Askaryar H. Understanding oral health disparities in children as a global public health issue: how dental health professionals can make a difference. J Publ Health Pol 2020;41(2):114–24.

5. Sanguida A, et al. Age and reasons for first dental visit and knowledge and attitude of parents toward dental procedures for Puducherry children aged 0–9 years. J Pharm BioAllied Sci 2019;11(Suppl 2): S413

6. Pereira A, et al. Improving quality of medical service with mobile health software. Procedia Comput Sci 2015; 63:292–9.

7. Alqarni AA, et al. Efficacy of a self-designed mobile application to improve child dental health knowledge among parents. J Int Soc Prev Community Dent 2018;8(5):424–30.

8. Ventola CL. Mobile devices and apps for health care professionals: uses and benefits. Pharm Therapeut 2014;39(5):356–64.

9. Wang K, et al. Can mHealth promotion for parents help to improve their children's oral health? A systematic review. J Dent 2022; 123:104185.

10. Vivek Padmanabhan, Mustahsen Rehman, Rayan Osama, Roba Anas. Molar Incisor Hypomineralization Prevalence in Arab Children in UAE and its Association with Risk Factors- A Cross Sectional Study. Journal of International Dental and Medical Research.2021;14(3): 1100 – 1106.

11. Fija˘cko N, et al. Evaluating quality, usability, evidence-based content, and gamification features in mobile learning apps designed to teach children basic life support: systematic search in app stores and content analysis. JMIR mHealth and uHealth 2021;9(7):e25437.

12. Kay E, Shou L. A randomised controlled trial of a smartphone application for improving oral hygiene. Br Dent J 2019;226(7):508–11.

13. Borrelli B, et al. An interactive parent-targeted text messaging intervention to improve oral health in children attending urban pediatric clinics: feasibility randomized controlled trial. JMIR mHealth and uHealth 2019;7(11): e14247.

14. Scheerman JFM, et al. A theory-based intervention delivered by an online social Kay E, Shou L. A randomised controlled trial of a smartphone application for improving oral hygiene. Br Dent J 2019;226(7):508–11.

15. Borrelli B, et al. An interactive parent-targeted text messaging intervention to improve oral health in children attending urban pediatric clinics: feasibility randomized controlled trial. JMIR mHealth and uHealth 2019;7(11): e14247.

16. Erbe C, et al. "Improvement of Toothbrushing in Preschool Children Using a Mobile App: Results of a Randomized Controlled Trial." Caries Research. 2019; 53(6): 628-635.

17. Nayar P, et al. "Effectiveness of mobile app-based oral health educational program among 13- to 15-year-old school children in India." Journal of Indian Society of Pedodontics and Preventive Dentistry. 2020;38(3):278-284.

18. Raghav P, et al. "Mobile health applications in pediatric oral health: A review." International Journal of Paediatric Dentistry. 2021; 31(6): 867-874.

19. Johnson J, et al. "The impact of a mobile app intervention on oral hygiene in adolescents with fixed orthodontic appliances: A pilot study." Journal of Orthodontics.2019; 46(3), 157-164.

20. Patil S, Hedad IA, Jafer AA, Abutaleb GK, Arishi TM, Arishi SA, Arishi HA, Jafer M, Gujar AN, Khan S, Raj AT. Effectiveness of mobile phone applications in improving oral hygiene care and outcomes in orthodontic patients. J Oral Biol Craniofac Res. 2021 Jan-Mar;11(1):26-32. doi: 10.1016/j.jobcr.2020.11.004. Epub 2020 Nov 17. PMID: 33344158; PMCID: PMC7736984.

21. Padmanabhan, V., Madan, B., & Shahid, S. Occlusion and occlusal characteristics of the primary dentition in Emirati schoolchildren. Dental Journal.2021; 54(2): 92–95. https://doi.org/10.20473/j.djmkg.v54.i2.p92-95

22. Padmanabhan V, Islam MS, Habib M, Abdulaziz Z, Goud M, Chaitanya NC, Haridas S, Rahman MM. Association between Salivary Cortisol Levels, Dental Anxiety, and Dental Caries in Children: A Cross-Sectional Study. Dentistry Journal. 2023; 11(9):205. https://doi.org/10.3390/dj1109020523.

23. Aguirre PEA, et al. The effectiveness of educational mobile messages for assisting in the prevention of early childhood caries:

protocol for a randomized controlled trial. JMIR Res Protoc 2019;8(9):e13656.

24. Amantini SNSR, Montilha AAP, Antonelli BC, Leite KTM, Rios D, Cruvinel T, Lourenço Neto N, Oliveira TM, Machado MAAM. Using Augmented Reality to Motivate Oral Hygiene Practice in Children: Protocol for the Development of a Serious Game. JMIR Res Protoc. 2020 Jan 17;9(1):e10987. doi: 10.2196/10987. PMID: 31951216; PMCID: PMC6996757.

25. Detsomboonrat P, Pisarnturakit PP. Development and evaluation: the satisfaction of using an oral health survey mobile application. Telemed e Health 2019;25(1): 55–9.

26. Den Boer JC, et al. Collecting standardised oral health data via mobile application: a proof of concept study in The Netherlands. PLoS One 2018;13(2): e0191385.

27. Jacobson D, et al. Evaluating child toothbrushing behavior changes associated with a mobile game app: a single arm pre/post pilot study. Pediatr Dent 2019;41(4): 299–303.

28. Alkadhi OH, et al. The effect of using mobile applications for improving oral hygiene in patients with orthodontic fixed appliances: a randomised controlled trial. J Orthod 2017;44(3):157–63.

29. Vivek Padmanabhan et al. Association of Body Mass Index and Chronology of Tooth Eruption in Children visiting a Dental Hospital in UAE: A Cross-sectional Study. Saudi Dental Journal. 2024. In Press.

30. Nolen SL, et al. Development and testing of a smartphone application prototype for oral health promotion. J Dent Hyg 2018;92(2).

31. Neubeck, L., Lowres, N., Benjamin, E. J., Freedman, S. B., Coorey, G., & Redfern, J. The mobile revolution-using smartphone apps to prevent cardiovascular disease. Nature reviews. Cardiology.2015;34(2): 350–360. https://doi.org/10.1038/nrcardio.2015.34