Using a mobile phone–based application as an adjunct to facilitate oral hygiene practices in children with Attention Deficit Hyperactivity Disorder (ADHD)



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Abstract

Aim To evaluate the efficacy of a mobile phone application to facilitate oral hygiene practices in children with ADHD.

Study Design and Methods This was a randomized controlled study that included 54 ADHD children after obtaining informed parental consent. The children were randomly divided into 2 groups; Group 1 (conventional) participants were instructed verbally as well as demonstrated the brushing technique on models. Group 2 (mobile phone application) participants were made to download and use the 'BRUSH DJ' app developed by Ben Underwood. At baseline, the oral hygiene index-simplified (OHI-S) [Greene and Vermillion, 1964] of each child was evaluated clinically and the parents were asked to fill a questionnaire regarding the oral hygiene practices followed by their child every day. At the end of the second, sixth, and twelfth week, the parents were asked to fill the same questionnaire in addition to the evaluation of the OHI-S index.

Results A significant difference was found in the brushing time, brushing frequency, and OHI-S index between group 1 and group 2 at the end of 12 weeks. (unpaired t-test, $p<0.05$)

Conclusion The mobile phone application proved to be an effective tool in captivating the attention of these children and thus improving their oral health.

KEYWORDS ADHD,mobile application, oral hygiene

Introduction

Attention deficit hyperactivity disorder (ADHD) "is a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development, has symptoms presenting in two or more settings (e.g., at home, school, or work; with friends or relatives; in other activities), and negatively impacts directly on social, academic, or occupational functioning"[Vahia,2013]. It is the most common neurobehavioral disorder of childhood [Chandra P et al., 2009]. According to DSM-V criteria, the three subtypes of ADHD are as follows; predominantly inattentive presentation, predominantly hyperactive-impulsive presentation, and predominately combined presentation [Efron LA and Sherman JA.,2005] Among these, the combined subtype is the most prevalent, wherein patients display symptoms consistent with both, inattention and hyperactivity/impulsivity [Vahia V,2013]. A child with ADHD presents with features of impulsivity, hyperactivity, short attention span, difficulty in task completion, all of which impede the daily routine activities like performing oral hygiene practice. This leads to an impairment in the overall health of the child and affects the other spheres of life like academic performance, social interactions, and proper functioning, resulting in a large economic impact on both the patients and their families, as well as the society [Zhong W and Cappelli DP, 2018]. As said by Rebecca Eanes, so often, children are punished for being human. Many behavior management techniques including non-pharmacological and pharmacological interventions have been developed to manage the child's anxious behavior. Smartphones have brought a plethora of informative resources within the palm of one's hand and have bridged the communication gap via various social networking sites. Social media starts to dig deeper and deeper down into the brain stem and takes over kids' sense of self-worth and identity. However, very little has transpired in favor of pediatric dentistry regarding educating the patients and their parents about the various treatment protocols as well as the basic oral hygiene methods. In the present times with the progress in the field of technology, we have a mobile phone application available just at the tip of a touch. A study done by Zink et al, in children with Autism Spectrum Disorder (ASD) comparing a mobile phone application with Picture Exchange Communication System (PECS) for dentist-patient communication, reported that the mobile phone application was more effective resulting in a reduced number of appointments for preventive care [Zink AG et al., 2018]. Elicherla et al., from their study concluded that educating the child prior to a dental procedure using a smartphone application can significantly alleviate the anticipatory anxiety and engage children in dental treatment during their first visit [Elicherla SR et al. 2019]. Children with ADHD present with the characteristic symptoms of inattentiveness and hyperactivity, wherein a mobile application may prove to be effective in captivating the child's attention. Despite a large data available on healthy children, there is a dearth of studies amongst the special children. Therefore, the aim of this study was to evaluate the efficacy of

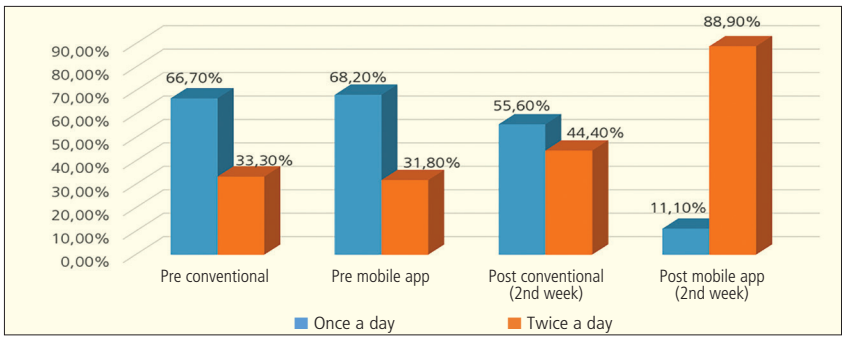


TABLE 1
Frequency of brushing Pre and Post 2nd week intervention in both the groups

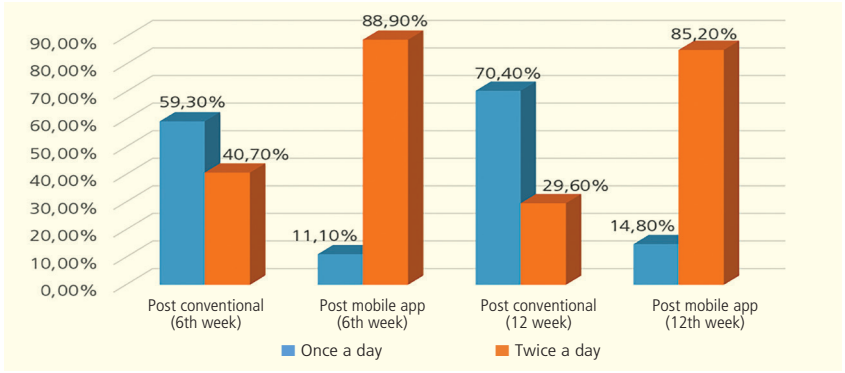


TABLE 2
Frequency of brushing Post 6th and 12th week interventions in both the groups.

a mobile phone application to facilitate oral hygiene practice in children with ADHD.

Material and Methods

Ethical approval

The study was approved by the Ethical Committee of the D Y Patil Deemed to be University – School of Dentistry, Navi Mumbai. (FRC/2019/PEDO/01).

Subject sampling and screening

This was a randomized controlled study including 58 children who were diagnosed with ADHD by their pediatricians, visiting the Out-Patient Department of Pedodontics and Preventive Dentistry of D.Y. Patil deemed to be university school of dentistry, Navi Mumbai. The children were randomly divided into two groups using the lottery method. Each participant was given a number from 1 to 58 on paper and kept in a box. Then, a chit was taken out. Odd numbers were allocated to group 1 (conventional) while even numbers were allocated to group 2 (mobile application).

Inclusion Criteria

- Age group of 7-12 years.
- Children with a medical diagnosis of ADHD under the DSM 5 criteria.
- Children whose parents were willing to participate in the study

Exclusion Criteria

- Parents who do not own or have access to a smartphone.
- Children with any severe systemic condition and/or those associated with other disorders.

All the participants in the study had no previous contact with the researcher and were first-time users of this mobile application.

Procedure

The procedure of the study was explained to the parents and informed consent was obtained before proceeding with the study. The children whose parents did not choose to give consent were given basic oral hygiene instructions and the required dental treatment was carried out. At baseline, each subject's parents were given a short questionnaire consisting of close-ended questions regarding the oral hygiene practices followed by their child every day. In addition, the oral hygiene index-simplified (OHI-S) (Greene and Vermillion, 1964) for each child was clinically recorded at baseline. The content validity of the questionnaire was performed via an expert panel of 10 pediatric dentists with a minimum experience of 5 years in dealing with children with special health care needs, especially those with ADHD. Both the consent and questionnaire were provided in English and two local languages (Hindi and Marathi). Group 1 (conventional) participants were given verbal instructions in conjunction with a demonstration of the correct brushing technique using dental models. Instructions included: Brushing their teeth twice a day, rinsing after meals, eating a healthy diet that limits sugary beverages and snacks, and regularly visiting a dentist for prevention and treatment of oral diseases. Group 2 (mobile application) participants were made to download the Brush DJ app. The Brush DJ app allows their users to set a two-minute timer during brushing with a song of choice playing in the background followed by applause music as a reward at the end of two minutes. Another striking feature of this application is a toothbrush reminder notification. In addition, the application is equipped with "how-to" videos of the correct tooth brushing technique, age-specific information regarding the amount of toothpaste as well as the type of toothbrush to be used.

The data was collected by a single calibrated examiner, through intraoral clinical examination, and recorded in individual clinical records who was blinded to the group distribution and the objectives of the study. To ensure the privacy and confidentiality of the participants, individual results were not displayed publicly or provided to other individuals or other organizations.

At the end of 2 weeks, 6 weeks, and 12 weeks, the questionnaire that was given at baseline was again distributed among the parents in addition to evaluation of the OHI-S index.

Questionnaire

Personal information (Name, Age, Gender, Education status, Occupation, and Address)

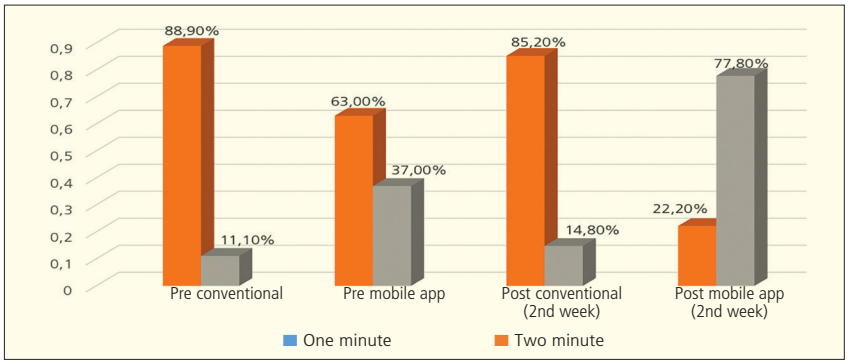


TABLE 3
Time taken to brush teeth Pre and Post 2nd week intervention in both the groups

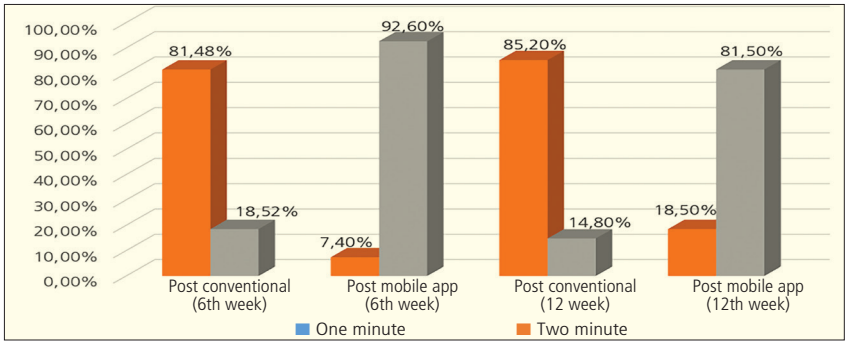


TABLE 4
Time taken to brush teeth Post 6th and 12th week intervention in both the groups

1. How many times do you brush your teeth? (Once /Twice/ More than twice a day)
2. How long do you take to brush your teeth? (Half minute/1 minute/2 minutes)
3. Do you normally brush your teeth after your meal? (Never/ Sometimes/Always)
4. Do you clean your tongue? (Yes/No)
5. Have you ever noticed bad breath/Halitosis from your mouth? (Yes/No)

Statistical Analysis

The data collected was entered into a computer and analyzed using the SPSS software. The level of significance was fixed at p=0.05 and any value less than or equal to 0.05 was considered to be statistically significant. Chi-square analysis was used to find the significance of study parameters on a categorical scale.

Results

Out of the 58 children selected for the study, 2 children from the conventional group dropped out after 2 weeks, whereas 1 more child from the same group was unavailable after the 6th week. In the mobile application group, 1 child was excluded after the 6th week as he got diagnosed with additional disorders. Therefore, a total of 54 children were evaluated at the end of 12 weeks. On the initial intervention (Table 1), in group 1 (conventional) 33.3% of children brushed twice daily whereas in group 2 (mobile application) 31.8% of children brushed twice daily. However, after the 2nd week of intervention (Table 1), in group 1 (conventional), 44.4% brushed twice daily as compared to 88.9% in group 2 (mobile application). After 6 weeks (Table 2) in group 1, 40.7% brushed twice daily and in group 2, 88.90% of children brushed twice daily. After the 12th week of intervention (Table 2), 29.6% of children in the conventional group and 85.2% in the mobile application group brushed twice respectively. Chi-square test was applied to the data and a corresponding p-value of <0.001** was obtained and was found to be highly significant in all the 3 interventions. Although the frequency of brushing teeth improved in group 1, it was not statistically significant. While observing the time taken for tooth brushing before the intervention (Table 3), in group 1 (conventional) only 11.1% brushed for 2 minutes, whereas in group 2 (mobile application), 37.0% of children did. However, after the 2nd week of intervention (Table 3), in group 1 (conventional), 14.8% brushed for 2 minutes as compared to 77.8% in group 2 (mobile application). After 6 weeks (Table 4), in group 1 (conventional), 18.5%, and in group 2 (mobile application), 92.6% of children brushed for 2 minutes. After the 12th week of intervention (Table 4), 14.8% of children in the conventional group and 81.5% in the mobile application group brushed for 2 minutes respectively. The results obtained in group 1 (conventional) showed improvement but were not statistically significant. There was a statistically significant difference seen in group 2 (mobile application) (p<0.001*). Thus, there was a significantly high statistical difference in the time taken to brush teeth between the two groups after the intervention. The oral hygiene status was evaluated using the OHI-S index, comprising of the debris index and calculus index. Table 2 shows that the mean debris index in group 2 (mobile application) significantly decreased as compared to group 1 (conventional). But there was no difference in the calculus index before and after the intervention. Thus, the mean OHI-S index decreased displaying a highly significant difference in the oral hygiene status between group 1 (conventional) and group 2 (mobile application) (<0.001**).

Discussion

ADHD children exhibit problems in executing their functions, which affects their ability to plan and organize, distractibility, and problems doing activities that are not motivating, implying that a 13 year old child with ADHD performs executive functions at a level that is comparable to that of an 8 year old non- ADHD child. Keeping these features in mind, the present study encouraged the children with ADHD to maintain good oral hygiene practices. This study also intended to improve the oral hygiene in these children by giving them instructions during

Variables	Group	N	Mean	Std. Deviation	t value	P value
Debris index	Pre conventional	27	0.426	0.0984	2.294	0.026*
	Pre mobile app	27	0.478	0.0641		
Calculus index	Pre conventional	27	0.189	0.1553	0.156	0.876
	Pre mobile app	27	0.196	0.1911		
OHI-S index	Pre conventional	27	0.615	0.1875	1.409	0.165
	Pre mobile app	27	0.689	0.1987		

TABLE 1 Comparison of Debris index, calculus index, OHIS index scores in terms of {Mean (SD)} among both the groups at baseline using unpaired t test

each intervention, which might, in turn, reduce the number of dental visits of the children, a very important factor, especially during the current COVID-19 pandemic. After randomly dividing the children into 2 groups, the group 1 (conventional) participants were instructed verbally as well as demonstrated brushing techniques on models, and group 2 (mobile application) participants downloaded the 'BRUSH DJ' app developed by Ben Underwood and were briefed about its features and functions. On the initial examination, no statistically significant difference was seen in the oral hygiene habits or time taken for toothbrushing in both groups. In our study owing to the features available on the mobile application, we observed that both, the frequency of brushing as well as the time taken to brush teeth, significantly improved in group 2 participants as around 88.9% of them started brushing twice daily, whereas only 44.40% were able to continue doing it in the conventional group. The mobile application allows the user to set a 2-minute timer along with background music of their choice while brushing followed by a sound of applause as a reward which encourages the child and this reflected in the results as 77.8% of the mobile application group children continued brushing for 2 minutes during the 2nd-week intervention as compared to only 14.8% of the conventional group. It also proved to be an advantage over the conventional group over a long period of time where only 7.40% and 14.8% continued brushing for 2 minutes during the 6th and the 12th-week intervention respectively. Another striking feature of the mobile application is a reminder notification for brushing teeth. As stated by Martinussen et al., ADHD children have trouble remembering/focusing on their current goals due to an impaired working memory [Martinussen R et al.,2005]. In addition, recent studies have demonstrated that computerized working memory and executive function training programs lead to better results than ordinary cognitive training methods in children with ADHD [Dovis S et al., 2012] and our results supported these findings as 92.60% of the mobile application children brushed for 2 minutes until the 6th week and 81.50% did for a period of 12 weeks. In addition, the mobile application is equipped with videos of brushing, information regarding the amount of toothpaste, as well as the type of toothbrush that should be used. These features significantly improved the oral hygiene practices and maintained consistency for a longer period of time in children with ADHD. They also showed improvement in the 6th and 12th-week interventions as 88.90% and 85.20% of these children brushed twice daily during the 6th and 12th weeks respectively whereas only 40.70% and 29.60% continued for 6th week and 12th week intervention respectively in the conventional group. Bimstein et al,previously stated that ADHD children have poor oral hygiene practices [Bimstein E et al., 2018]. Another study by Blomqvist et al., [2007] reported that children with ADHD at 13 years of age do exhibit poor oral health behavior as compared to children in the general population [Blomqvist M et al,. 2007].

The oral hygiene status of the participants in the current study was evaluated using the OHI-S index as given by Greene and Vermilion, 1964. We found the debris score to be higher in both the groups initially, which significantly reduced in the Group 2 children following their use of the BRUSH DJ app during all three interventions. The finding of our study was in accordance with a systematic review by AA El-Housseiny [2017] who reported that children with ADHD have higher plaque index scores when compared to healthy children [El-Housseiny AA et al., 2017] Another systematic review and meta-analysis by Chau et al., also showed significantly higher plaque scores among children with ADHD [Chau YCY et al., 2017]. The mobile application further proved to be beneficial in educating the parents in group 2 as compared to group 1 regarding oral hygiene practices. This was attributed to the features available on the mobile application providing information on the type of toothbrush, the amount of toothpaste to be used depending upon the age, the technique to brush teeth, etc. This was in harmony with a study conducted by Alqarni et al., in healthy children, who reported that the use of mobile phone applications was helpful in educating the mothers toward the oral health of their children [Alqarni A et al., 2018]. Another important outcome narrated by the parents of the BRUSH DJ app group was improved compliance and newfound enthusiasm to brush teeth amongst children. The children no longer found the process of brushing boring and looked forward to it. Therefore, through the present study, we consciously made an attempt to make use of technology to the best of the child's interest owing to a unique and powerful influence of mobile phones on child & adolescent development.

Thus we recommend the use of this mobile application for children with special health care needs other than ADHD as well as healthy children in order to captivate their attention so as to perform oral hygiene practices more efficiently.

Limitations

Most mobile applications are available only in English, which will limit a big section of the population to benefit from it owing to the language barrier especially, in multilingual countries. Therefore, we recommend that applications should be developed

Variables	Group	N	Mean	Std. Deviation	t value	P value
Debris index 2nd week	Post conventional	27	0.381	0.1962	1.471	0.147
	Post mobile app	27	0.307	0.1730		
Debris index 6th week	Post conventional	27	0.389	0.2100	3.703	<0.001**
	Post mobile app	27	0.200	0.1617		
Debris index 12th week	Post conventional	27	0.452	0.2276	7.298	<0.001**
	Post mobile app	27	0.081	0.1331		
Calculus index (2nd,6th and 12th week)	Post conventional	27	0.156	0.1450	1.016	0.314
	Post mobile app	27	0.204	0.1990		
OHI-S index 2nd week	Post conventional	27	0.537	0.2844	0.229	0.820
	Post mobile app	27	0.519	0.3089		
OHI-S index 6th week	Post conventional	27	0.544	0.2979	1.834	0.072
	Post mobile app	27	0.404	0.2653		
OHI-S index 12th week	Post conventional	27	0.604	0.3180	4.097	<0.001**
	Post mobile app	27	0.285	0.2492		

(p < 0.05 - Significant, p < 0.001 - Highly significant**)*

TABLE 2 Comparison of Debris index, calculus index, OHIS index scores in terms of {Mean (SD)} among both the groups post 2nd, 6th and 12th week interventions using unpaired t test

in local languages for a larger section of the population to reach out to the masses and yield the best results.

Conclusion

The mobile phone application was beneficial in:

1. Boosting the oral hygiene practices amongst children with ADHD.
2. Expanding the knowledge of parents regarding their child's oral health thereby improving and monitoring their overall health and quality of life.

Therefore, we conclude that the mobile phone application can be used to instill a positive attitude in children towards maintaining good oral hygiene and thus improve their overall health.

Acknowledgment

We thank the parents and children who consistently participated and gave their honest feedback during the study.

Conflicts of interest

The authors declare that they have no conflict of interest.

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