

## Effectiveness of Oral Dental Health Education for Preschool Children: A Randomized Controlled Trial

### Okul Öncesi Çocuklarına Verilen Ağız Diş Sağlığı Eğitiminin Etkinliği: Randomize Kontrollü Çalışma

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#### ÖZ

**Amaç:** Ağız hijyeni konusunda erken eğitim, yaşam boyu sağlıklı alışkanlıkların oluşturulması için çok önemlidir. Bu çalışma, ebeveyn katılımı eğlenceli bir ağız ve diş sağlığı eğitim programının 4-6 yaş arası çocuklarda plak indeksi, diş eti sağlığı ve ağız hijyeni bilgisi üzerindeki etkilerini incelemektedir.

**Araçlar ve Yöntem:** Dört anaokulunda 80 çocukla (40 deney, 40 kontrol) küme randomize kontrollü bir çalışma yürütülmüştür. Müdahale grubuna animasyon filmler, dental modeller ve interaktif aktiviteler kullanılarak ebeveyn katılımı dört haftalık eğlenceli bir eğitim programı verilmiştir. Kontrol grubuna ise bir kerelik ağız sağlığı eğitimi verilmiştir. Veriler başlangıçta, bir haftada ve üç ayda toplanmıştır. Ağız hijyeni bilgisi, plak indeksi ve diş eti sağlığı standartlaştırılmış ölçekler kullanılarak değerlendirilmiştir.

**Bulgular:** Müdahale grubu, kontrol grubuna kıyasla anlamlı derecede daha yüksek oral hijyen bilgisi ( $F=26.767$ ,  $p<0.001$ ) ve daha düşük plak indeksi ( $F=6.774$ ,  $p<0.001$ ) ve diş eti problemi skorları ( $F=13.922$ ,  $p<0.001$ ) göstermiştir. Etki büyüklüğü analizi, bilgi ( $T2=4.41$ ) üzerinde büyük bir etki ve plak indeksi ( $T2=1.53$ ) ve diş eti sağlığı ( $T2=0.88$ ) üzerinde büyük bir etki ortaya koymuştur.

**Sonuç:** Program, 4-6 yaş arası çocuklarda ağız hijyeni bilgisinde artışa, plak indekslerinde iyileşme ve diş eti sorunlarında azalma sağlamıştır. Bu durum, sağlık eğitiminde oyunlaştırmanın kullanılmasının küçük çocukların ilgisini çekmek ve sağlık sonuçlarını iyileştirmek için etkili bir yol olabileceğini göstermektedir.

**Anahtar Kelimeler:** ağız sağlığı; diş fırçalama; erken çocukluk; oyunlaştırılmış müdahaleler; plak indeksi

#### ABSTRACT

**Purpose:** Early education on oral hygiene is crucial for establishing lifelong healthy habits. This study examines the effects of a fun oral and dental health education programme with parent participation on plaque index, gingival health and oral hygiene knowledge in children aged 4-6 years.

**Materials and Methods:** A cluster randomised controlled trial was conducted with 80 children (40 experimental, 40 control) in four kindergartens. The intervention group received a four-week fun educational programme with parental involvement using animated films, dental models and interactive activities. The control group received a one-time oral health education session. Data were collected at baseline, one week and three months. Oral hygiene knowledge, plaque index and gingival health were assessed using standardised scales.

**Results:** The intervention group showed significantly higher oral hygiene knowledge ( $F=26.767$ ,  $p<0.001$ ) and lower plaque index ( $F=6.774$ ,  $p<0.001$ ) and gingival problem scores ( $F=13.922$ ,  $p<0.001$ ) compared to the control group. Effect size analysis revealed a large effect on knowledge ( $T2=4.41$ ) and a large effect on plaque index ( $T2=1.53$ ) and gingival health ( $T2=0.88$ ).

**Conclusion:** The programme led to an increase in oral hygiene knowledge, improvement in plaque indices and reduction in gingival problems in children aged 4-6 years. This suggests that using gamification in health education can be an effective way to engage young children and improve health outcomes.

**Keywords:** early childhood; oral health; plaque index; playful interventions; tooth brushing

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## **INTRODUCTION**

Oral and dental health issues are significant public health concerns that adversely affect a child's quality of life and, if left untreated, can predispose to other chronic diseases.<sup>1</sup> Dental caries, gingival, and periodontal diseases are common and preventable conditions among children.<sup>2</sup> Oral health problems at an early age are important determinants of dental issues that may arise later in life, primarily dental caries.<sup>3</sup>

Regular brushing with fluoridated toothpaste twice a day is recommended to maintain oral and dental health across all age groups.<sup>4</sup> Although significant efforts have been made to improve oral health, nearly half of the global population remains affected by oral health problems.<sup>5</sup> In European countries, although there has been a decrease in dental caries among children in previous years, worsening trends persist.<sup>6,7</sup> The reported prevalence of dental caries among Turkish children aged 3-6 years ranges from 40.0% to 66.8%.<sup>8,9</sup>

Schools are places where children regularly come together, are open to learning, and are in a structured environment, making them ideal for delivering important health education such as oral hygiene.<sup>10</sup> Most studies in the literature focus predominantly on elementary school children.<sup>11-14</sup> Angelopoulou et al.<sup>15</sup> evaluated the effectiveness of experiential learning in oral health education compared to traditional lecture-based teaching in improving oral health knowledge, attitudes, and behaviors, as well as oral hygiene and gum health in 10-year-old children. In this 18-month study, both methods were found to improve the children's oral health knowledge, attitudes, and behaviors, but better results were achieved with experiential learning. More research is needed on the effects of play-based interventions on different age groups or their long-term outcomes. However starting tooth brushing education from preschool age can help establish it as a lasting habit into later years.<sup>16</sup> Understanding the long-term effects of early acquired knowledge and behaviors on oral and dental health is crucial for health policies and educational strategies. This study is anticipated to add to the literature, particularly in enhancing oral and dental health among preschool children. Nurses and dentists can be considered

appropriate professionals in schools to provide children and families with information and support to protect and improve oral and dental health.<sup>17</sup> The best way to promote oral hygiene in young children is through practices that involve close collaboration among teachers, parents, and healthcare professionals.<sup>18</sup> Additionally, auditory-visual aids and dental models used in oral hygiene education are highly effective.<sup>19</sup>

In this study, the impact of parent-involved playful oral and dental health education on plaque index, gum problems, and oral hygiene knowledge levels in children aged 4-6 years is aimed to be examined.

## **MATERIALS and METHODS**

### **Ethical Approval and Compliance**

This study was approved by Karabük University Non-Interventional Research Ethics Committee (dated 11.04.2022 and numbered 821). The institutional permission for the study was obtained from the Karabük Provincial Directorate of National Education (date: 23.5.2022, number: E-44653020-605.01-50138026). Children and their parents were informed about the study, and "informed consent" was acquired from them. Written consent was granted by all participants' parents or legal guardians in accordance with the principles outlined in the Helsinki Declaration.

### **Study Design**

This study adopted a cluster randomized controlled experimental framework with pretest-posttest evaluations and repeated measurements. Follow-ups for the groups were conducted prior to the intervention and at the 1<sup>st</sup> week and 3<sup>rd</sup> month afterward.

### **Hypothesis**

The learning objectives of our study are to teach children the importance of oral and dental care and to help them develop the habit of proper tooth brushing.

H1: The post-program oral dental health knowledge level of children participating in the oral dental health program is higher than the pre-program and control groups.

H2: The tooth brushing behaviors of children participating in the oral dental health program after the program are better than the pre-program and control groups.

### Study Setting and Sampling

The study was carried out in four kindergartens within the Safranbolu district of Karabuk province, all of which shared similar socio-demographic features. Using a simple random selection process, two schools were assigned to the experimental group, while the remaining two were designated as control groups. Volunteering children were randomly assigned to experimental and control groups by draw method. Assignments to the experimental and control groups were made by a researcher who had no affiliation with the study.

### Participants

The study population consisted of children aged 4-6 years (N=310) enrolled in four kindergartens in Safranbolu. The study included children aged 4 to 6 who volunteered to participate, had written consent from their families, were present at school on the study days, and had no visual or hearing impairments. Children who could not obtain written consent from their families and those with major health problems that would affect their tooth brushing behavior (such as physical and mental disabilities etc.) omitted from the research. Using the study by Akkaya and Sezici (2021) as a reference, the sample size was calculated through a G-Power analysis.<sup>19</sup> Accordingly, it was determined that at least 26 children were needed in each of the groups with  $d=1.028$ , 95% power and  $\alpha=0.05$ . In this study, 40 children were sampled for each group (Figure 1). There were no data loss in the study.

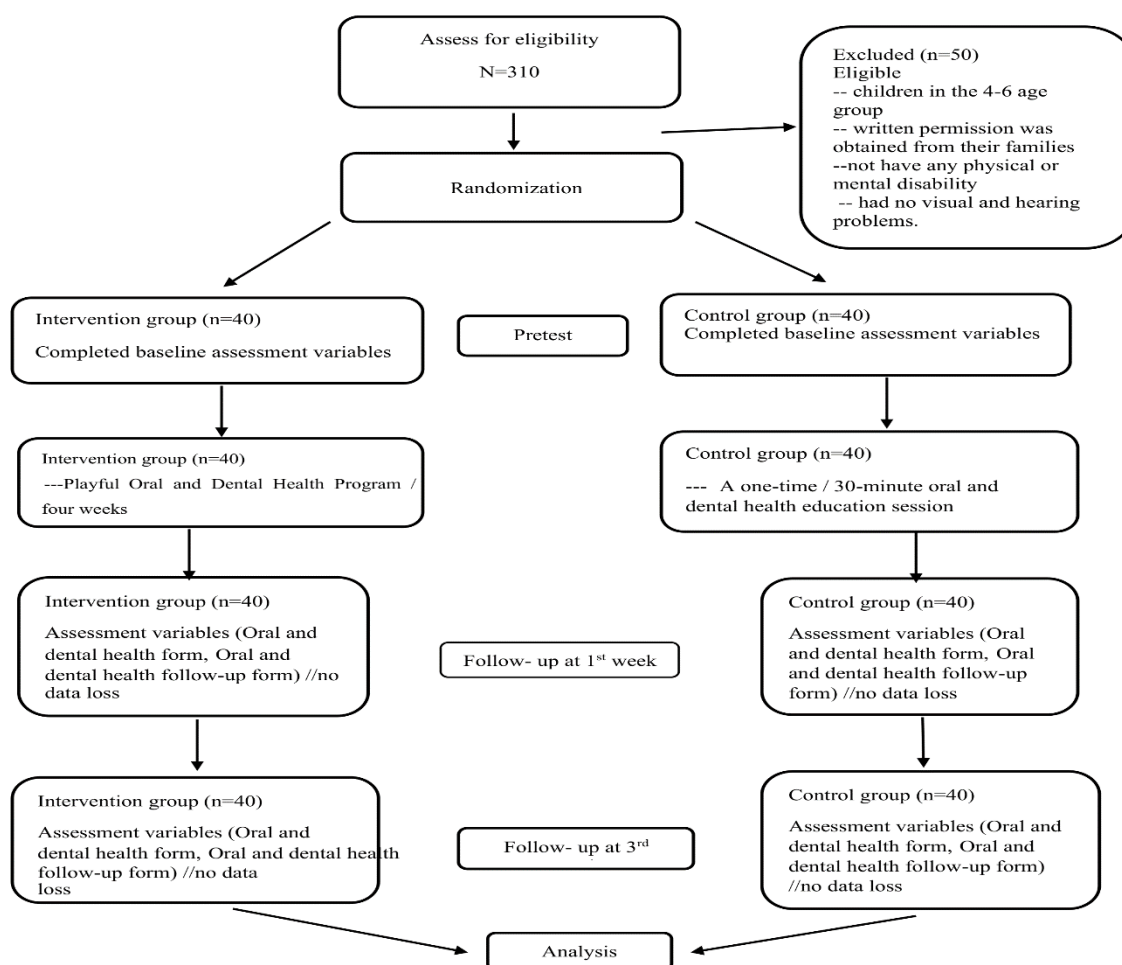


Figure 1. CONSORT flowchart of the study.

## **Intervention**

### **Playful Oral and Dental Health Program**

The program was created based on the oral hygiene instructions found in the literature.<sup>20,21</sup> Before the intervention, expert opinions were obtained from kindergarten teachers and pediatric dentists for the educational booklet prepared within the program. Before the program, families were invited to the school and informed about the program. The program was conducted by the researchers for four weeks, three days a week for 30 minutes in schools, and on weekends for two days with the help of families at home. Parents were given a one-time 45 minute training session on oral hygiene before the program. Families were asked to be role models for their children in maintaining tooth brushing behaviors on weekends. Thus, it was ensured that the teaching was reinforced and disseminated at every stage. The program was explained to the children in groups. During the training, children watched an animated film illustrating how brushing removes food particles, prevents cavities, and the consequences of poor oral hygiene. Next, dental models, plush animals with large teeth, and oversized toothbrushes were used to demonstrate proper brushing techniques step by step. Children then practiced the demonstrated method individually on tooth models. Finally, to reinforce learning, they engaged in activities such as coloring oral health-themed pictures, completing related puzzles, and playing matching games, helping them internalize the information effectively. After each training session, children individually practiced tooth brushing behaviors. Each practice session lasted approximately 7 minutes. In practice, the children were taught to brush the front, back, and side surfaces of their teeth, as well as their tongues, using the correct brushing technique and an adequate amount of toothpaste. Strengthening specific behaviors with external motivations, such as reinforcements, can positively enhance the behavior change process.<sup>22</sup> For this purpose, the children were given badge-shaped reinforcements to increase their motivation and encourage learning. Reinforcements were given at different intervals when the children displayed correct tooth brushing behaviors and answered knowledge questions correctly. To assess the

condition of their oral and dental health, the children were examined by a dentist under light, using a mirror, as recommended by the WHO.<sup>20</sup> The researcher conducting the dental examinations did not wear a white coat to avoid frightening the children. At the end of the program, the children were given participation certificates.

The control group children attended a one-time, 30-minute oral and dental health education session (September, 2023), held simultaneously with the experimental group. In the training provided to the control group, the importance of tooth brushing, proper brushing techniques, and methods for removing food particles from the teeth were demonstrated using presentation techniques and a dental model.

### **Data Collection**

This study was implemented in four pre-schools in Safranbolu, between September 2023 and January 2024. Data collection and intervention stages were carried out face to face. The research design is presented in Figure 1. The variables in both groups were measured three times by the researchers pre-intervention (T0 / September 2023) and in the 1<sup>st</sup> week (T1/ October 2023) and in the 3<sup>rd</sup> month (T2/ January 2024) post-interventionally. During these follow-ups, children's verbal responses to the investigators' questions were recorded by the investigators in the Oral and Dental Health Form. All measurements and training sessions took place in the school. By a pediatric dentist / Intraoral examinations were conducted in the children's own classrooms while they were seated on chairs, after having their breakfast in the morning. The evaluations were performed half an hour after tooth brushing. This approach allowed for an assessment of brushing effectiveness while preventing misinterpretation of plaque accumulation. The practices within the program were recorded using the oral dental health follow-up chart.

### **Demographic Form**

The demographic form was created by the researchers. It consists of questions about the age and sex of children and parents, and the education level of the parents.

### Oral and Dental Health Form

This form, which was prepared by the researchers in line with the literature, consists of information questions on how many times a day and how many minutes the teeth should be brushed, how many times a year the teeth should be examined and which areas should be covered by brushing.

### Oral and Dental Health Follow-Up Form

Dental assessment was performed utilizing a mirror and artificial lighting. Gingival index and plaque index were measured from mesial, distal, buccal and lingual/palatal surfaces of primary second molars and anterior teeth. The surfaces of teeth were visually examined without probing to assess visible plaque and gingival information. For each tooth, the mean value was determined as the average of the values across its four surfaces. The mean index value for a patient was derived by dividing the total value by the number of teeth.

The gingival index was evaluated according to Löe and Silness's gingival index 0 indicates healthy gums without inflammation; 1 indicates mild colouration with no bleeding upon probing; 2 indicates visible inflammation accompanied by bleeding upon probing, while 3 signifies pronounced redness, swelling, and a tendency for spontaneous bleeding.<sup>23</sup>

The plaque index was assessed using Silness and Löe's method. A score of 0 represents no plaque adjacent to the gum. A score of one indicates a thin layer of plaque on the gum edge, detectable with an examination probe. A score of two reflects visible plaque along the gingival margin. Lastly, a score of three signifies an excessive plaque layer along the gingival margin, with plaque visibly present in the interdental areas.<sup>24</sup>

### Statistical Analysis

Data analysis was performed on the IBM SPSS Statistics 23 software package. Descriptive data were presented using frequency distribution or mean and standard deviation values. Independent samples t-test and chi-square were used to determine whether there was a difference between the two groups. The Repeated

Measures ANOVA test was used for variance over time. In statistical analysis, significance was accepted as 0.05 and the confidence interval at 95% level. To evaluate the effect size of the significant difference in the measurements, Cohen's d analysis was employed. Cohen's d small effect size ( $\leq 0.49$ ), medium effect size (0.50-0.79), large effect size (0.80- 1.19), very large effect size (1.20 - 1.99), huge size ( $\geq 2.00$ ).<sup>25,26</sup>

### RESULTS

The mean age of the total children was  $4.85 \pm 0.657$ , and 52.5% (n=42) were girl. Intervention and control groups were statistically similar regarding age, parents' education, and frequency of tooth brushing, frequency of visits to the dentist, frequency of parental tooth brushing, economic status, cognitive and behavior variables ( $p > .05$ ; Table 1,2).

Following the program, a significant difference was observed between the experimental and control groups in terms of children's oral and dental health knowledge, as well as their mean plaque index scores and gingival health outcomes (Table 3). According to repeated measures ANOVA, the oral and dental health knowledge levels of children in the intervention group ( $F=26.767$ ) were found to be significantly higher than those in the control group ( $p < 0.001$ ). Additionally, the mean dental plaque index scores ( $F=6.774$ ) and gingival problem index scores ( $F=13.922$ ) of the children in the intervention group were found to be significantly lower than those in the control group ( $p < 0.001$ ). In pairwise comparisons using the Bonferroni correction, significant differences were found in the children's oral and dental health knowledge levels between T0 and T1, T2 ( $p < 0.001$ ), in the mean gingival problem index scores between T0 and T1, T2 ( $p < 0.001$ ), and between T1 and T2 ( $p = 0.026$ ), and in the mean dental plaque index scores between T0 and T1, T2 ( $p < 0.001$ ), and between T1 and T2 ( $p = 0.030$ ) (Table 3).

The results indicated that the playful oral and dental health program had a huge effect on children's knowledge levels, with Cohen's d values of 3.51 (T1) and 4.41 (T2). This suggests a substantial and sustained increase in children's understanding of oral health practices. Regarding plaque index scores, the program had a large effect at T1 (0.93)

and a very large effect at T2 (1.53), indicating a significant reduction in plaque accumulation over time. For gum problems, the effect size was medium at T1 (0.76) and large at T2 (0.88), reflecting a progressive improvement in

gingival health. These findings highlight the strong impact of the intervention, particularly in knowledge retention and plaque reduction, which are key indicators of improved oral hygiene behaviors (Table 3).

**Table 1.** Characteristics of adolescent baseline in the intervention and the control groups.

Characteristics	Intervention n=40 Mean(SD)		Control n=40 Mean(SD)		p	Statistics
Age	4.80 (.563)		4.90 (.744)		0.50	-0.677 <sup>a</sup>
Sex	n	%	n	%		
Female	22	55	20	50	.654	.201 <sup>b</sup>
Male	18	45	20	50		
<b>Frequency of tooth brushing of children</b>						
Never	2	5	2	5		
Sometimes	11	27.5	10	25	.863	.947 <sup>c</sup>
Once in a day	15	37.5	19	47.5		
Twice or more in a day	12	30.0	9	22.5		
<b>Frequency of pedodontics visits</b>						
When dental pain occurs	13	32.5	12	30.0		
Once every 3 months	4	10.0	6	15.0	.265	4.198
Once in 6 months	9	22.5	3	7.5		
Once per year and more	14	35.0	19	47.5		
<b>Mother's education</b>						
≤ secondary school	9	22.5	7	17.5	.646	.875 <sup>b</sup>
High school	17	42.5	15	37.5		
University and above	14	35.0	18	45.0		
<b>Father's education</b>						
≤ secondary school	6	41.7	5	12.5		
High school	15	38.3	19	47.5	.664	.819 <sup>b</sup>
University and above	19	20	16	40.0		
<b>Frequency of tooth brushing of mothers</b>						
Once in a day	15	37.5	18	45		
Twice or more in a day	25	62.5	22	55	.496	.464 <sup>b</sup>
<b>Frequency of tooth brushing of fathers</b>						
Sometimes	7	17.5	14	35		
Once in a day	11	27.5	11	27.5	.161	3.658 <sup>b</sup>
Twice or more in a day	22	55	15	37.5		
<b>Monthly income</b>						
Family income is equal to expenses	22	55.0	24	60.0		
Family income is less than expenses	12	30.0	6	15.0	.226	3.087 <sup>c</sup>
Family income is more than expenses	6	15.0	10	25.0		

a= Independent t test, b= Chi-square, c= Fisher freeman halton exact, p >.05

**Table 2.** Comparison of variables before the program.

Variable	Intervention n=40 Mean (SD)	Control n=40 Mean (SD)	t	Statistics p
level of knowledge	2.27 (0.960)	2.60 (1.057)	-1.439	.154
df-t index	4.75 (4.330)	4.95 (4.651)	- .199	.843
gingival index	0.96 (.699)	0.97 (.660)	-.033	.974
plaque index	1.60 (.608)	1.40 (.762)	1.463	.120

p>.05, t: Independent t test; df-t: decay, filling, teeth

**Table 3.** Effects of the program on outcome variables.

Variables	Groups	Baseline (T0)	Post Intervention 1st Week (T1)	3rd month (T2)	Statistics	
		Mean (SD)	Mean (SD)	Mean (SD)	F	p
Level of knowledge	Intervention	2.27 (.960)	4.72 (.221) <sup>†††</sup>	5.35 (.227) <sup>†††</sup>	<b>26.767</b>	<.001* T0 < T1, T2
	Control	2.60 (1.057)	2.87(0.220)	2.90 (.227)		
df-t index	Intervention	4.75 (.711)	4.75 (.821)	4.82 (.694)	<b>2.054</b>	.135
	Control	4.95 (.711)	4.95 (.712)	5.22 (.697)		
Gingival index	Intervention	0.96 (.699)	0.58 (.092) <sup>†</sup>	0.42 (.508) <sup>††</sup>	<b>6.774</b>	<.001* T0 >T1, T2 T1 >T2
	Control	0.97 (.660)	0.77 (.093)	0.78 (.094)		
Plaque index	Intervention	1.60 (.608)	1.01 (.650) <sup>††</sup>	0.77 (.465) <sup>†††</sup>	<b>13.922</b>	<.001* T0 >T1, T2 T1 >T2
	Control	1.40 (.762)	1.18 (.793)	1.17 (.685)		

\*p<0.05, F= Repeated Measures ANOVA / Bonferroni test, Cohen's d ††† huge, † medium, †† large, ††† very large effect size; df-t: decay, filling, teeth

## DISCUSSION

In recent years, oral and dental health problems have been increasing and require early intervention. Screenings and early interventions conducted in schools can support children's oral health through preventive and therapeutic care.<sup>27</sup> Preventing dental caries is known to have positive long-term outcomes in terms of well-being and cost-effectiveness.<sup>6</sup>

In this study, interactive oral hygiene education supplemented with games was implemented three days a week for four weeks among children aged 4-6 years. Recognizing that parents are responsible for their preschool children's oral health, parents were included in the program by providing them with oral and dental health education. They were encouraged to follow up on their children's learned knowledge and behaviors and serve as role models at home, aiming to create a sustainable impact within the family environment. Our results indicated a significant increase in oral and dental health knowledge levels among children who received the education compared to the control group, showing a strong effect size. Alongside the increase in knowledge levels, there was a significant reduction in gum problems and plaque indices of large effect size, which persisted for three months. These findings suggest that children transferred their learned knowledge into behaviors. There was no significant difference in initial decayed, filled teeth (df-t) levels between the groups in the study. However, at the evaluation conducted at the end of the third month, a significant increase in df-t index was observed in the control group, whereas this increase was less pronounced in the experimental group compared to the control. This result indicates that the playful oral hygiene education received by the experimental group was effective and yielded positive outcomes. The education program enabled children in the experimental group to be more conscious about oral hygiene, leading to better preservation of their oral and dental health.

In other studies conducted in school settings with children aged 4-12 years, similar to our study, desired changes have been observed in children's oral hygiene knowledge, tooth brushing behaviors, and plaque indices.<sup>11,14,17,18,22</sup> In a study conducted with 100 preschool children,

interventions using game-based learning to improve proper tooth brushing behaviors resulted in the acquisition of appropriate tooth brushing behaviors and a reduction in plaque levels.<sup>19</sup> Another study in Tanzania where 8-9 years primary school children's tooth brushing skills were supervised by parents, it was found that children were more successful in performing correct tooth brushing steps and that plaque levels decreased and gum health improved after the education.<sup>28</sup> The results of the current study are consistent with the literature, suggesting the need for more emphasis on game-based intervention programs and parental education in research studies.

Although the 30-minute educational intervention provided to the control group resulted in improvements in knowledge levels, gum problems, and plaque indices, these improvements were lower compared to the experimental group. It is speculated that the improvement observed in the control group could be due to the Hawthorne effect during oral hygiene checks. Additionally, although not included in the study findings, parents reported that practicing oral hygiene together with their children strengthened their bond.

The long-term effects of such interventions are crucial in reducing the prevalence of dental caries.<sup>18,28</sup> By fostering better oral hygiene habits from a young age, these programs may contribute to a decline in future dental decay rates.<sup>18,27</sup> The results of this study provide promising evidence that game-based interventions combined with parental involvement can not only improve immediate oral health behaviors but also have lasting impacts on children's oral health over time. Early interventions like this may help reduce the risk of developing dental issues, such as tooth decay and gingivitis, in the future, potentially lowering the need for more invasive treatments later in life. These study results offer short and medium-term positive outcomes in maintaining desired oral health knowledge and behaviors in preschool children.

## Conclusions

In this study conducted in a school setting, the playful oral and dental health education program demonstrated its feasibility, yielding positive outcomes in oral hygiene knowledge levels, plaque indices, and gingival health among in 4-6 year old children over time in the medium - huge effect range. However, for a sustainable effect, the program needs to be carried out in this age group in different cultures and in a larger sample. By embedding these initiatives in both schools and homes, there is the potential to significantly reduce the incidence of tooth decay globally, paving the way for a healthier future worldwide. Future research could also examine the effect of parent and teacher involvement in oral and dental health interventions on study outcomes. There is also a need for research examining the experiences of participants in intervention programs.

## Strengths and Limitations

The main advantages of this study are that the sample was randomized, the program effect lasted for 3 months, the investigators were multidisciplinary dentists and nurses, and there was parental involvement. None of the children dropped out of the program and did not report any adverse events during the study. The study is limited to the sample.

## Conflict of Interest

The authors declare that there is not any conflict of interest regarding the publication of this manuscript.

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## Ethics Committee Permission

This study was approved by Karabük University Non-Interventional Research Ethics Committee (dated 11.04.2022 and numbered 821).

## Authors' Contributions

Concept/Design: NA. Data Collection and/or Processing: NA. Data analysis and interpretation: NA, MGT. Literature Search: NA, MGT. Drafting manuscript: NA, MGT. Critical revision of manuscript: NA, MGT. Supervisor: NA.

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