



## EFFECTIVENESS OF VARIOUS TOOTHBRUSHES ON GINGIVAL HEALTH IN CHILDREN

Hristina Tankova, Zornitsa Lazarova

*Department of Pediatric Dentistry, Faculty of Dental Medicine, Medical University - Sofia, Bulgaria.*

### ABSTRACT:

**Purpose:** Comparative evaluation of manual, electric, sonic and ultrasonic toothbrush effectiveness on children's gingival status.

**Material and methods:** The study involved 106 children aged 11 to 13 years, divided into four groups according to the type of toothbrush used. A group based preventive program for motivation and training was developed for each type of toothbrush. The program was assessed over four visits, during which the gingival status was recorded at each visit using the Full Mouth Bleeding Score (FMBS) index with the aid of an electronic periodontal probe.

**Results:** Values of bleeding on probing were reduced by half (baseline FMBS -26-29% to 14% at the end of study) at the end of the study in all study groups.

**Conclusion:** The establishment of effective oral hygiene behaviors through comprehensive instruction in the appropriate use of various toothbrush modalities is fundamental to the maintenance of gingival health in children.

**Keywords:** manual toothbrush, powered toothbrushes, children's gingival health, children's periodontal prevention,

### INTRODUCTION:

Periodontal diseases represent the second most common group of plaque-induced oral diseases in children and adolescents [1, 2]. The relatively asymptomatic progression of early stages of plaque-induced gingivitis in children often leads to these conditions being neglected by patients and their parents, and unfortunately, also by the dental practitioner, which frequently results in the worsening of gingival pathology [3].

In childhood, gingival inflammation is mainly associated with increased microbial load, which is directly proportional to the children's oral hygiene habits and their effective implementations [4]. The presence of improperly established oral hygiene habits and lack of conscious behavior, combined with anatomical and morphological changes in periodontal tissues during growth and development, are considered the main risk factors for gingival pathology in this age group [5].

The first signs of gingival inflammation can initially be noticed by the child themselves [6]. However, very often, children and their parents associate bleeding during tooth brushing with brushing too hard rather than a pathological change in the tissues. In most of these cases, the child or their parents reduce brushing pressure to "protect" the gums, which in turn leads to ineffective removal of dental biofilm and further progression of gingival inflammation [7].

Primary prevention of periodontal diseases is usually a focus of pediatric dentistry and forms part of comprehensive oral prevention during childhood and adolescence. Primary periodontal prevention includes all preventive measures aimed at limiting the development of clinically manifest inflammation in the periodontium, which is a prerequisite for future periodontal destruction [5]. In this regard, effective removal of dental biofilm, as the main etiological factor, depends not only on the type of toothbrush but also on the correct brushing technique [8]. This, in turn, requires manual dexterity, motivation, and specific training of children [9].

To date, no study has been conducted in the country to assess the influence of different toothbrushes on the gingival status of adolescents within a specially designed program for motivation and training in their proper use. This study aims to determine if and to what extent various personal oral hygiene tools (toothbrushes) affect the gingival health of children.

## PURPOSE:

The aim of this study is to evaluate the influence of different toothbrushes on the gingival status of adolescents within the framework of a group preventive oral health program.

## MATERIALS AND METHODS:

### Materials

For the purposes of the study, 54 boys and 52 girls aged 11–13 years, students at 11th Primary School “Hristo Botev,” Blagoevgrad, were examined. Inclusion criteria for the children in the study were:

- Signed informed consent from a parent, approved by the Ethics Committee (KENIMUS) under protocol No. 6/22.10.22;

- Absence of systemic diseases associated with risk to gingival health;

- Absence of fixed orthodontic appliances.

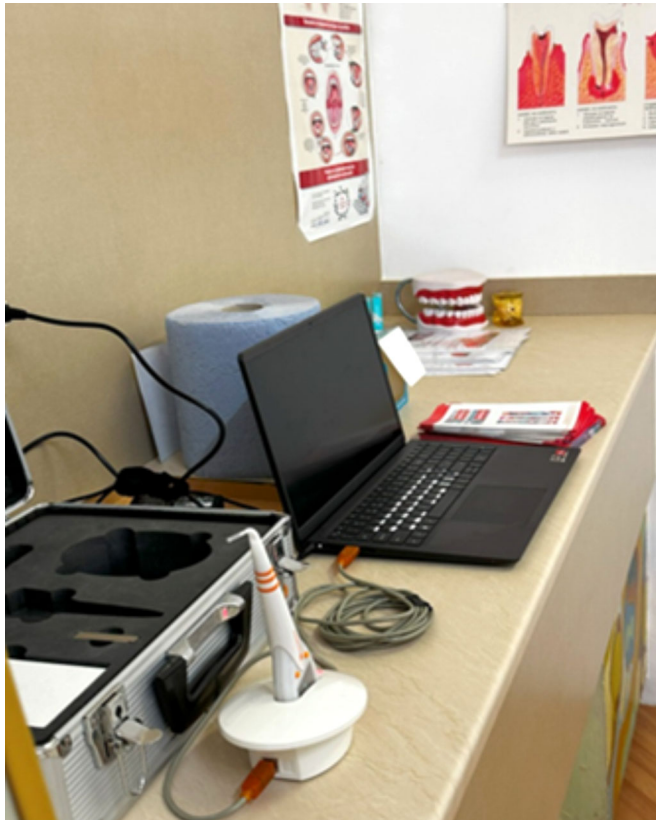
The children were divided into four groups according to the different types of toothbrushes they received — manual, electric, sonic, and ultrasonic toothbrushes.

### Other materials used in the study:

A specially designed questionnaire form was used to assess the children’s oral hygiene habits.

To evaluate the gingival status of the children, an electronic periodontal probe PA-ON (Orangedental) with integrated software was used (Fig. 1).

**Fig. 1.** Electronic Periodontal Probe PA-ON (Orangedental)



## Methodology

### Survey Method

Initially, all children completed a questionnaire for the analysis and assessment of their oral hygiene habits. The questionnaire included questions related to the frequency and duration of oral hygiene procedures, as well as anamnesis data regarding the presence of bleeding during these procedures at home. At the end of the follow-up period, the children completed the questionnaire again to assess behavioral changes based on the conducted group preventive program.

### Clinical Method

The assessment of oral hygiene status was performed using the Full Mouth Plaque Score (FMPS) index [10], examining all permanent teeth in four sites — three buccal and one oral. The results of the children’s oral hygiene status are subject to a separate publication [11].

The gingival status was assessed using the Full Mouth Bleeding Score (FMBS) index. The assessment was conducted on all fully erupted permanent teeth at four gingival sites — three buccal and one oral. The presence or absence of bleeding was recorded, and the index was automatically calculated by the software of the periodontal probe as the relative proportion of gingival units exhibiting bleeding on probing.

All children participated in a group-based oral disease prevention program tailored for the objectives of this study. The monitoring and evaluation of the effectiveness of different toothbrushes on the children’s gingival status were carried out in four visits as follows:

- **Visit I** – Anamnestic data and baseline assessment of oral hygiene and gingival status;

- **Visit II** – Three days later, following motivation and training in the correct use of different toothbrushes according to the group (using interactive, demonstration, and gamification methods) – oral hygiene and gingival status assessment;

- **Visit III** – One week later – oral hygiene and gingival status assessment;

- **Visit IV** – Forty-five days later – oral hygiene and gingival status assessment.

**Statistical Methods:**

For statistical analysis of the data, the specialized software IBM SPSS version 19.0 was used. The accepted critical significance level for testing the null hypothesis H0 was  $\alpha = 0.05$ .

The following methods were employed to objectify the results of the analyses:

1. Descriptive analysis;
2. Paired samples T-test for comparison of related groups;
3. Independent T-test for comparison of independent groups;
4. Pearson Chi-Square test ( $\chi^2$ ).

**RESULTS:**

1. Distribution of children in groups by gender

The following table presents the distribution of children in the different study groups according to gender (Table 1).

**Table 1.** Grouping of Children According to Oral Hygiene Tools

Sex	Manual toothbrush		Electric toothbrush		Sonic toothbrush		Ultrasonic toothbrush		Total	
	N	%	N	%	N	%	N	%	N	%
Boys	14	26%	18	33%	8	15%	14	26%	54	100
Girls	12	23%	10	19%	16	31%	14	27%	52	100
Total	26	24%	28	26%	24	23%	28	26%	106	100

Pearson Chi square=5,070  $p > 0,05$

From the table, it can be seen that the children are evenly distributed by gender across the four study groups ( $p > 0.05$ ).

2. Assessment of oral hygiene habits during the study

The following table presents the oral hygiene habits of all examined children at the beginning and end of the program (Table 2).

**Table 2.** Oral Hygiene Habits During the Program

Oral hygiene habits	Visit	I visit		IV visit		Pearson Chi square
		N child	%	N child	%	
Frequency	Twice daily	41	39%	79	75%	$\chi^2=5,434 p < 0,05$
	Sometimes	65	61%	27	25%	
	Total	106	100%			
Bleeding during brushing	Yes	69	65%	13	12%	$\chi^2=9,660 p < 0,05$
	No	37	35%	93	88%	
	Total	106	100%			

From the table, it can be seen that at the beginning of the study, over two-thirds of the children reported irregular tooth brushing procedures (61%). After the motivation and training, as part of the group preventive program for regular oral hygiene habits, a significantly higher proportion of children (75%) reported regular brushing ( $p < 0.05$ ). Bleeding during tooth brushing was reported by 65% of the children at the start of the study, whereas at the end of the program, this percentage dropped to 12%,

showing a reduction of over 50% ( $p < 0.05$ ).

These results indicate that oral hygiene habits improved significantly under the influence of the group preventive program.

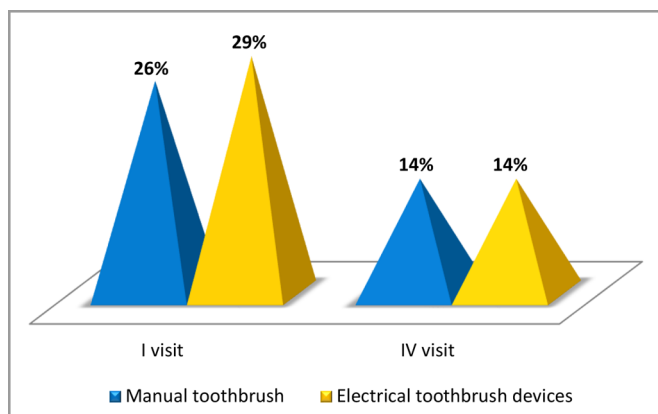
3. Dynamics of gingival status at the beginning and end of the program according to the type of toothbrush

For the purposes of the study, we initially combined the electric personal oral hygiene devices into one group to compare the difference between manual and elec-

tric toothbrushes on the gingival status of the children.

The following chart presents the values of bleeding on probing measured by the FMBS index between manual and electric toothbrushes at the beginning and at the end of the conducted study (Chart 1).

**Chart 1.** Bleeding on probing values – baseline and end of study in children from both groups



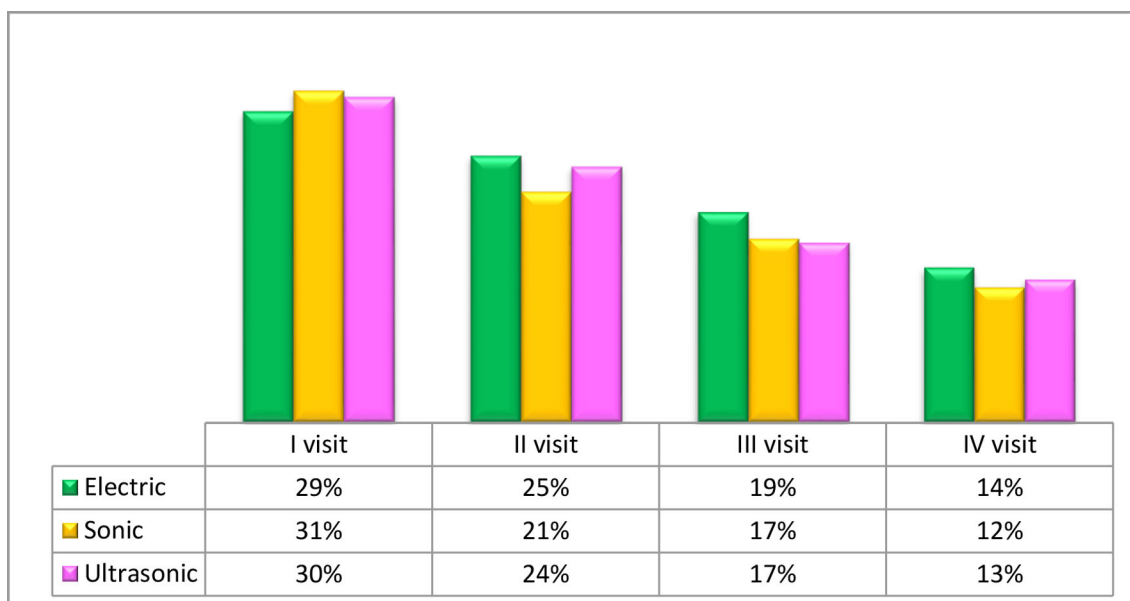
From the chart, it can be seen that the baseline values of the FMBS index ranged between 26–29%, which, according to the current classification of periodontal diseases, corresponds to localized gingival inflammation [3]. It is noteworthy that in all children, the values for bleeding on probing were reduced by half at the end of the study, reaching levels consistent with periodontal health — 14% ( $t = 11.121, p < 0.05$ ).

No statistically significant differences were found in the values of bleeding on probing between the groups using manual and electric toothbrushes ( $t = 0.848, p > 0.05$ ).

Considering that the preventive program we developed included a special module for training in the proper use of each type of toothbrush, which optimized brushing technique for each, the results indicate that the choice of toothbrush is of secondary importance. Their effectiveness and impact on gingival status is determined by the correct brushing technique.

4. Evaluation of the effectiveness of different electric toothbrush devices on gingival status during the study  
 The following chart demonstrates the dynamics of bleeding on probing values across visits in the groups using electric, sonic, and ultrasonic toothbrushes (Chart 2).

**Chart 2.** Dynamics of bleeding on probing values in children using different electrical toothbrush devices



From the chart, it can be seen that during the program, there was a gradual decrease in the values of bleeding on probing values in all children ( $t = 8.564, p < 0.05$ ).

In the group using sonic toothbrushes, a more pronounced decrease in provoked bleeding was observed during the second visit, approximately 10%, while the decreases in the other groups were 6% (ultrasonic) and 4% (electric), although these differences were not statistically significant ( $t = 1.232, p > 0.05$ ).

It can be concluded that the effectiveness of different types of electric toothbrushes on the gingival status of children is approximately the same.

**DISCUSSION:**

Oral hygiene habits and proper behavior related to oral health are best established during childhood. Researchers believe that the active participation of children in structured training to develop consistent manual skills is of paramount importance for establishing and changing their behavior related to maintaining oral health [12]. Furthermore, the largest and most accessible group for such health education is the school environment.

The aim of the present study was to evaluate the influence of different toothbrushes on gingival health in children within the framework of a specially designed group preventive program for motivation and training.

The anamnesis data showed that, initially, over two-thirds of all children had improperly established oral hygiene habits and reported gingival bleeding during daily oral hygiene procedures. The development of periodontal diseases results from the interaction between the immune response of the body and the activity of the subgingival biofilm on gingival tissues [4]. These interactions depend on and can be controlled through properly developed and lasting oral hygiene habits [5].

Our group motivation and training program aimed precisely to create long-lasting motivation in children to perform daily oral hygiene procedures. It also included specific training in using different toothbrushes according to the group. At the end of the follow-up period, the oral hygiene habits of the children significantly improved. We consider these results due to the group motivation and training program conducted, which should be an integral part of oral prevention in childhood and adolescence.

Besides classical manual toothbrushes, two main types of electric toothbrushes are widely available on the market — oscillating-rotating and sonic. Comparative analyses show that oscillating-rotating brushes are more effective both in removing dental biofilm and in maintaining gingival health [13, 14, 15, 16]. Ultrasonic toothbrushes also exist, but due to their high cost, they are not widely used by the population. Clinical studies on the effectiveness of sonic toothbrushes show high efficiency in plaque removal, although these studies have mostly been conducted on adult patients [17, 18].

The results of the present study showed that at the end of the follow-up period, the gingival health of the children improved significantly. Initially, a localized form of plaque-induced gingivitis was recorded in children from all groups (FMBS – 26-29%), and at the end of the follow-up period, the values of provoked gingival bleeding were half as much (FMBS – 14%).

Similar results have been obtained by other authors investigating the effectiveness of different types of toothbrushes on oral health in children [12, 19, 20, 21]. Grossman et al. tracked the influence of electric and manual toothbrushes on the oral status of children aged 8–12 years, finding an improvement in oral hygiene and gingival status of over 20% by the end of the study [20]. Damle et al. studied 200 children aged 12–15 years and observed similar patterns in a 3-month follow-up of ado-

lescents [12]. Each of the cited studies included patient behavior instructions and advice regarding the frequency and duration of oral hygiene procedures. This fact, together with participants' awareness of being part of a scientific study (Hawthorne effect), likely explains the improvement in both oral hygiene and gingival status in adolescents.

In this study, we also found that at the end of the follow-up period, there were no significant differences between children in the groups using manual and electric toothbrushes regarding the index values objectifying gingival status. A group of researchers conducting a controlled oral hygiene training program in adolescents also found a decrease in gingival index values in all children regardless of the type of toothbrush [12]. Contrary to these results, Davidovich et al. found a significant advantage of electric toothbrushes over manual ones on the gingival health of children aged 6–9 years [21].

The results of the present study comparing the effectiveness of electric, sonic, and ultrasonic toothbrushes on the gingival status of children also showed no significant differences, although the sonic toothbrush group had the greatest decrease in bleeding on probing values (FMBS – 19%). We believe that the lack of significant differences in the effectiveness of various toothbrushes on children's gingival status is due to the conducted training on their correct use.

These results support the assumption that with targeted training in the proper use of different toothbrushes, as well as a structured motivation program for maintaining oral health, the type of toothbrush has a secondary influence on the effectiveness of plaque removal and gingival health.

#### CONCLUSION:

The establishment of effective oral hygiene behaviors through comprehensive instruction in the appropriate use of various toothbrush modalities is fundamental to the maintenance of gingival health in children.

#### Acknowledgements:

This contribution is published in accordance with project Grant 2023 with Contract 168/03. 08. 2023 themed “Specialized Program for periodontal prevention in children with permanent dentition – effectiveness of contemporary means for individual oral hygiene.”

---

#### REFERENCES:

1. Sađlam G, Dađ A. Gingival and periodontal diseases in children. *J Dent Sci Educ.* 2023 Jun;1(2):55-60. [[Crossref](#)]
2. Califano JV, Committee AAP. Position paper: periodontal diseases of children and adolescents. *J Periodontol.* 2003 Nov;74(11):1696-704. [[PubMed](#)]
3. AAPD. Classification of periodontal diseases in infants, children, adolescents, and individuals with special health care needs. The Reference Manual of Pediatric Dentistry. Chicago: AAPD. 2023; p.493-507. [[Internet](#)]
4. Teles FR, Teles RP, Uzel NG, Song XQ, Torresyap G, Socransky SS, et al. Early microbial succession in re-developing dental biofilms in periodontal health and disease. *J Periodontol Res.* 2012 Feb;47(1):95-104. [[PubMed](#)]
5. Tonetti MS, Eickholz P, Loos BG, Papapanou P, van der Velden U, Armitage G, et al. Principles in prevention of periodontal diseases: consensus report of group 1 of the 11th European Workshop on Periodontology on Effective Prevention of Periodon-

tal and Peri Implant Diseases. *J Clin Periodontol.* 2015 Apr;42 Suppl 16:S5-S11. [PubMed]

6. Mandova VD, Stefanov RS. Case-Control Study to Evaluate the Oral Hygiene Habits in 31 Children with Hemophilia in Bulgaria Using the Oral Health Impact Profile-14 (OHIP-14) Questionnaire. *Med Sci Monit Basic Res.* 2022 Apr 21;28:e936560. [PubMed]

7. Mlenga F, Mumghamba EG. Oral hygiene practices, knowledge, and self-reported dental and gingival problems with rural-urban disparities among primary school children in Lilongwe, Malawi. *Int J Dent.* 2021 Mar 9;2021:8866554. [PubMed]

8. Saxer UP, Yankell SL. Impact of improved toothbrushes on dental diseases. I. *Quintessence Int.* 1997 Aug; 28(8):513-25. [PubMed]

9. Claydon N, Addy M. Comparative single-use plaque removal by toothbrushes of different designs. *J Clin Periodontol.* 1996 Dec;23(12): 1112-6. [PubMed]

10. Mühlemann HR, Son S. Gingival sulcus bleeding—a leading symptom in initial gingivitis. *Helv Odontol Acta.* 1971 Oct;15(2):107-13. [PubMed]

11. Tankova H, Lazarova Z. Comparative evaluation of manual and powered toothbrushes on oral hygiene in adolescents: a group-based preventive study. *Int J Sci Res.* 2025

May;14(5):1371-7. [Crossref]

12. Damle SG, Patil A, Jain S, Damle D, Chopal N. Effectiveness of supervised toothbrushing and oral health education in improving oral hygiene status and practices of urban and rural school children: a comparative study. *J Int Soc Prevent Communit Dent.* 2014 Sep;4(3):175-81. [PubMed]

13. Goyal CR, Qaqish J, He T, Grender J, Walters P, Biesbrock AR. A randomized 12-week study to compare the gingivitis and plaque reduction benefits of a rotation-oscillation power toothbrush and a sonic power toothbrush. *J Clin Dent.* 2009; 20(3):93-8. [PubMed]

14. Klukowska M, Grender JM, Goyal CR, Mandl C, Biesbrock AR. 12-week clinical evaluation of a rotation/oscillation power toothbrush versus a new sonic power toothbrush in reducing gingivitis and plaque. *Am J Dent.* 2012 Oct;25(5):287-92. [PubMed]

15. Klukowska M, Grender JM, Conde E, Goyal C. A 12-week clinical comparison of an oscillating-rotating power brush versus a marketed sonic brush with self-adjusting technology in reducing plaque and gingivitis. *J Clin Dent.* 2013; 24(2):55-61. [PubMed]

16. Ccahuana-Vasquez RA, Conde EL, Cunningham P, Grender J, Goyal C, Qaqish J. An 8-week clinical com-

parison of an oscillating-rotating electric rechargeable toothbrush and a sonic toothbrush in the reduction of gingivitis and plaque. *J Clin Dent.* 2018 Mar;29(1):27-32. [PubMed]

17. Digel I, Kern I, Geenen EM, Akimbekov N. Dental plaque removal by ultrasonic toothbrushes. *Dent J (Basel).* 2020 Mar 23;8(1):28. [PubMed]

18. Takenouchi A, Otani E, Satoho Y, Kakegawa Y, Arai H, Matsukubo T. Comparison of the effects of ultrasound toothbrushes with different frequencies on oral hygiene: a randomized-controlled clinical trial. *Int J Dent Hyg.* 2021 Nov;19(4):376-81. [PubMed]

19. Aykol-Sahin G, Ay-Kocabas B, Mert B, Usta H. Effectiveness of different types of toothbrushes on periodontal health in orthodontic patients with gingivitis: a randomized controlled study. *BMC Oral Health.* 2024;24(1):1289. [PubMed]

20. Grossman E, Proskin H. A comparison of the efficacy and safety of an electric and a manual children's toothbrush. *J Am Dent Assoc.* 1997 Apr; 128(4):469-74. [PubMed]

21. Davidovich E, Ccahuana-Vasquez RA, Timm H, Grender J, Zini A. Randomised clinical study of plaque removal efficacy of an electric toothbrush in primary and mixed dentition. *Int J Paediatr Dent.* 2021 Sep;31(5):657-63. [PubMed]

*Please cite this article as:* Tankova H, Lazarova Z. Effectiveness of various toothbrushes on gingival health in children. *J of IMAB.* 2025 Jul-Sep;31(3):6339-6344. [Crossref - <https://doi.org/10.5272/jimab.2025313.6339>]

Received: 26/01/2025; Published online: 14/07/2025



#### Address for correspondence:

Hristina Tankova

Department of Pediatric Dentistry, Faculty of Dental Medicine, Medical University – Sofia;

1, St. Georgi Sofiisky Str., Sofia, Bulgaria.

E-mail: [la\\_svetichi@yahoo.com](mailto:la_svetichi@yahoo.com),