

The Effectiveness of Electric and Manual Toothbrush Use on the Loe and Silness Plaque Index Among Students with Intellectual Disabilities at SLBN Branjangan Jember, East Java, Indonesia

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ABSTRACT

Background: Intellectual disability refers to a significantly below-average level of general intellectual functioning. These limitations prevent them from having the skills to maintain their oral hygiene independently. One method for maintaining oral hygiene is the use of manual and electric toothbrushes.

Purpose: This study aimed to determine the effectiveness of manual and electric toothbrush use in reducing the Loe and Silness plaque index score in children with intellectual disabilities.

Methods: This study was conducted among students with intellectual disabilities at SLBN Branjangan Jember. This research employed a pre-experimental design with a one-group pretest-posttest design.

Results: The results showed that both manual and electric toothbrush use were effective in reducing plaque index scores, with p-values < 0.05. The use of a manual toothbrush reduced the plaque index score by 1.01 (48.09%). The use of an electric toothbrush reduced the plaque index score by 1.10 (48.45%). However, there was no significant difference between the effectiveness of manual and electric toothbrushes in reducing plaque index scores (p = 0.512).

Conclusions: Based on this study, it can be concluded that both manual and electric toothbrushes are effective in reducing the Loe and Silness plaque index in school-age children with intellectual disabilities at SLBN Branjangan Jember. Statistically, there is no significant difference in effectiveness between a manual toothbrush and an electric toothbrush, but numerically, using an electric toothbrush is more effective.

KEYWORDS: Intellectual Disabilities, Loe and Silness Plaque Index, Electric Toothbrush, Manual Toothbrush

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I. INTRODUCTION

Intellectual disability is a condition in which a child has an intelligence quotient (IQ) of less than 70. It occurs before the age of 22. According to the American Association on Developmental and Intellectual Disabilities, intellectual disability is characterised by significant limitations in intellectual functioning and adaptive behaviour, including difficulties with communication, learning, and problem-solving.¹ This can result in children with intellectual disabilities lacking the skills to clean their teeth and mouth

independently. Therefore, children with intellectual disabilities are at higher risk of dental and oral health problems, particularly caries.² Children with intellectual disabilities have moderate tooth brushing habits (79.6%) and a high prevalence of dental caries (73.5%).³

Intellectual disabilities are a common disability category globally. Based on WHO data (2019), the prevalence of intellectual disability worldwide is estimated at 450 million people, or 2.3% of the world's population.⁴ The prevalence of intellectual disability tends to increase throughout the year.

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The prevalence of intellectual disability in Indonesia is currently estimated at 1-3% of the total population, or around 6.6 million people.⁵ In the population of children aged 5-17 years, the prevalence in Indonesia reaches 3.3%, or around 265,469 people.⁶ The characteristics and prevalence of intellectual disability indirectly give rise to various problems, including those related to dental and oral health. The 2023 Indonesian Health Survey (Survei Kesehatan Indonesia/SKI) reported a caries prevalence of 82.8% in Indonesia, with 84.8% among children aged 5-9 years and 63.8% among those aged 10-14 years.⁷ In East Java, the prevalence of cavities was 38.6% across all age groups.⁷

Children with special needs have the same basic rights as all people, and every child is a gift from God, endowed with unique potential and talents despite their limitations. In East Java Province, there are 438 special schools (Sekolah Luar Biasa/SLB) across various levels, accommodating 20,466 students.⁸ One of these is the Branjangan State Special School (SLB Negeri Branjangan), located on Jl. Branjangan, Bintoro Village, Patrang District, Jember Regency, East Java Province. According to data from Branjangan State Special School for the 2025/2026 academic year, there were 32 students with mild and moderate intellectual disabilities.⁹ Based on the author's observations of students with mild and moderate intellectual disabilities at Branjangan State Special School, children with intellectual disabilities were found to have poor oral hygiene. This condition can lead to a range of dental and oral health problems. Therefore, appropriate efforts are needed to improve the dental and oral health of children with intellectual disabilities, particularly through plaque control.

Plaque control refers to the removal of established plaque or the control of biofilm formation.¹⁰ It can be achieved through mechanical and chemical means.¹¹ Chemical plaque control involves the use of antiseptic mouthwash. Mechanical plaque control uses dental floss and toothbrushes. Mechanical plaque control is more effective because it removes plaque from the interdental and supragingival areas. Improper brushing can compromise oral and dental health.¹² Toothbrushes come in a variety of shapes, sizes, textures, and designs. Advances in technology have led to innovations in toothbrushes, including the creation of electric toothbrushes.¹³ An electric toothbrush is a battery-powered toothbrush. Electric toothbrushes are recommended for people with disabilities who have difficulty mastering effective manual brushing techniques.¹⁴ Electric toothbrushes offer several advantages, including rotating-oscillating movements that enhance cleaning ability, and a small brush

head that can reach narrow areas, especially the lingual surface of the lower jaw, where plaque easily forms.¹³

Electric toothbrushes are more effective at controlling plaque than manual/conventional toothbrushes. Electric toothbrushes can reduce plaque accumulation by an average of 58.3%.¹³ This figure is higher than that of manual toothbrushes, which average 38.17%. A study in children with Down syndrome found that electric toothbrushes reduce plaque accumulation more effectively than manual toothbrushes.¹⁵ Electric toothbrushes reduced Patient Hygiene Performance Index scores by 2.50, whereas manual toothbrushes reduced Patient Hygiene Performance Index scores by 1.89. The effectiveness of brushing with manual and electric toothbrushes in children with intellectual disabilities was assessed using the Loe and Silness index.¹⁶ The Loe and Silness index is a simple method for measuring plaque based on the location and quantity of plaque near the gingival margin. Based on the above background, the author is interested in conducting this study, which aims to determine the effectiveness of electric toothbrushes as a plaque control tool in children with intellectual disabilities at the Branjangan State Special Needs School in Jember, using the Loe and Silness index as the measurement tool. This study is expected to inform strategies to improve oral hygiene among children with special needs, particularly those with intellectual disabilities.

II. MATERIAL AND METHODS

This study received ethical approval from the Health Research Ethics Committee of the Faculty of Dentistry, University of Jember, under approval No. 3707/UN25.8/KEPK/DL/2026, dated February 18, 2026. The study was conducted at SLB Negeri Branjangan in March 2026. The research design was pre-experimental, using a One-Group Pretest–Posttest Design. The sampling technique was total sampling. The study participants were from elementary school (50%), junior high school (20%), and senior high school (30%). The instruments used in this study were manual and electric toothbrushes.

The toothbrushing training was conducted in the hall using the Tell-Show-Do technique, with assistance from 7 teachers and 5 members of the research team. In the Tell stage, students were explained toothbrushing steps in simple language, accompanied by visual aids such as posters. On the Show stage, a demonstration was given on how to brush teeth using the roll technique, with a tooth model or a live toothbrush. In the final stage, namely the Do stage, students were asked to practice the demonstrated technique to ensure the proper development of motor skills.

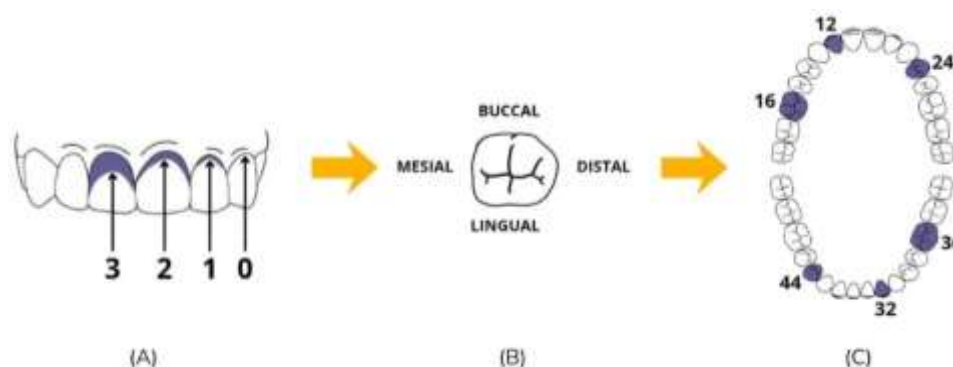


Figure 1. Loe and Silness plaque index examination method: (A) applying disclosing solution, (B) divide the tooth surface into 4 areas, (C) examination of teeth 16, 12, 24, 36, 32, and 44

The measurement used was the Loe and Silness Plaque Index (1964).¹⁶ Researchers dripped a disclosing agent solution onto the teeth to be examined using tweezers and cotton pellets (Figure 1A). The examination was conducted on four surfaces: mesial, distal, facial, and lingual or palatal (Figure 1B). Researchers conducted examinations and recorded plaque index scores on teeth 16, 12, 24, 36, 32, and 44 (Figure 1C). The plaque index score ranges from 0 to 3, with the following criteria:

0 = No plaque

1 = A small amount of plaque at the gingival margin

2 = Moderate accumulation of plaque within the gingival sulcus and along the gingival margin, visible to the naked eye

3 = Abundant plaque accumulation within the gingival sulcus or along the gingival margin.

The plaque index score was calculated using the following formula:

$$X = \frac{\sum X}{n}$$

Description:

X: Plaque index score

$\sum X$: Total plaque score of all examined teeth

n: Number of tooth surfaces examined

The oral hygiene status, based on the Loe and Silness plaque index, is categorised as follows: excellent for a score of 0; good for scores ranging from 0.1 to 0.9; fair for scores ranging from 1.0 to 1.9; and poor for scores ranging from 2.0 to 3.0.¹⁶

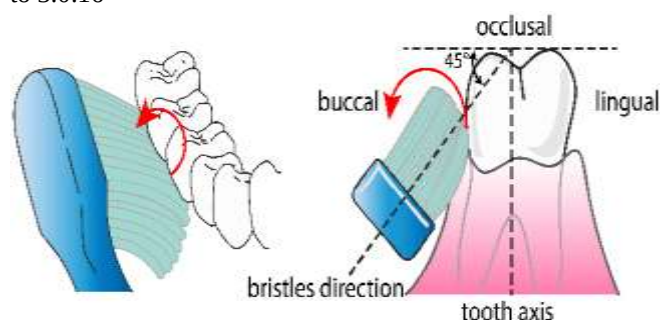


Figure 2. Roll toothbrushing technique

The study was conducted in two phases. During the first phase, a first-stage examination (pretest) and training in the roll technique were conducted. The technique is applied with the bristles positioned at a 45-degree angle to the occlusal or incisal surface of the tooth. The bristles should contact the junction between the free gingival margin and the tooth. Repeated circular motions are then used (Figure 2). The roll technique was selected because it is easy to learn, safe for gingival tissues, and effective at cleaning interproximal areas and the gingival margin. The training was conducted with the assistance of teachers to facilitate communication. After training, the study subjects brushed their teeth for 2 minutes with a manual toothbrush and fluoridated toothpaste. The second-stage brushing plaque index score (posttest) was measured immediately after the activity. The second phase was conducted one week after the first, using the same procedures but with a rotating-oscillating electric toothbrush (Figure 3).

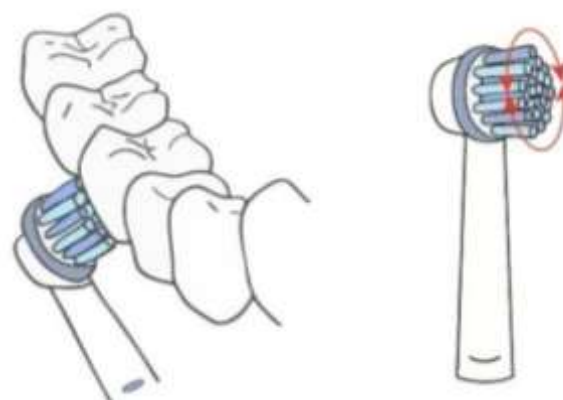


Figure 3. Rotating-oscillating movement of an electric toothbrush

III.RESULTS

The results of the Loe and Silness plaque index assessment in the manual toothbrush group are presented in Table 1. The mean pre-intervention score was 2.10, categorised as poor (2.0–3.0). After using a manual toothbrush, the mean score decreased to 1.09, corresponding to the fair category (1.0–1.9). The mean difference between

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pre- and post-intervention plaque index scores in the manual toothbrush group was 1.01 (48.09%).

The results of the Loe and Silness plaque index assessment in the electric toothbrush group are also presented in Table 1. The mean pre-intervention score was 2.27, categorised as poor (2.0–3.0). After using an electric toothbrush, the mean score decreased to 1.17, corresponding to the fair category (1.0–1.9). The mean difference between pre- and post-intervention plaque index scores in the electric toothbrush group was 1.10 (48.45%). Following data collection, statistical analyses were performed, including tests of normality, homogeneity, and a paired t-test.

Table 1. Mean plaque index scores of manual and electric toothbrush use

Toothbrush	ΣN*	Mean Plaque Index Score ($\bar{x}$)		
		$\bar{x}_1^{**}$	$\bar{x}_2^{***}$	$\bar{x}_1 - \bar{x}_2^{****}$
Manual	30	2,10	1,09	1,01
		±	±	±
		0,46	0,38	0,41
Electric	30	2,27	1,17	1,10
		±	±	±
		0,48	0,56	0,59

*ΣN = Total number of study subjects; ** $\bar{x}_1$ = Plaque index score before training in manual and electric toothbrushing skills; *** $\bar{x}_2$ = Plaque index score after training in manual and electric toothbrushing skills; **** $\bar{x}_1 - \bar{x}_2$ = Difference between pre- and post-training plaque index scores for manual and electric toothbrushing skills

The results of the Shapiro–Wilk normality test are presented in Table 2. All study data had p-values greater than 0.05, indicating that the data were normally distributed.

Table 2. Results of the Shapiro-Wilk Normality Test

Normality Test	
Plaque Index	Shapiro-Wilk P-value
X_{M1}^{**}	0,113*
X_{M2}^{***}	0,864*
$X_{M1} - X_{M2}^{****}$	0,775*
X_{E1}^{*****}	0,189*
X_{E2}^{*****}	0,053*
$X_{E1} - X_{E2}^{*****}$	0,287*

*Sig. $\geq 0,05$; ** X_{M1} = Before manual toothbrushing intervention; *** X_{M2} = After manual toothbrushing intervention; **** $X_{M1} - X_{M2}$ = Difference between pre- and post-manual toothbrushing intervention scores; ***** X_{E1} = Before electric toothbrushing intervention; ***** X_{E2} = After electric toothbrushing intervention; ***** $X_{E1} - X_{E2}$

= Difference between pre- and post-electric toothbrushing intervention scores

The results of Levene's test for homogeneity are presented in Table 3. All study data had p-values greater than 0.05. These findings indicate that all study data were homogeneous. Therefore, the data were considered suitable for analysis using a paired t-test. The results of Levene's test for homogeneity are presented in Table 3. All study data had p-values greater than 0.05. These findings indicate that all study data were homogeneous. Therefore, the data were considered suitable for analysis using a paired t-test.

Table 3. Results of Levene's Test of Homogeneity

Homogeneity Test	
Plaque Index Scores	P-value Based on the Mean Values
	0,069*

*Sig. $\geq 0,05$

The results of the paired t-test are shown in Table 4. Group 1 showed a significance value (two-tailed) of less than 0.05. This value indicates that the use of a manual toothbrush effectively reduces plaque index scores. Group 2 showed a significance value (two-tailed) of less than 0.05. This value indicates that the use of an electric toothbrush effectively reduces plaque index scores. According to data from Group 3, the significance value (two-tailed) was greater than 0.05. These results indicate that training in brushing teeth with manual and electric toothbrushes is not statistically significant, but there is a numerical difference.

Table 4. Results of Paired t-Test

Paired t-Test			
Group	Pre – Post	Manual	Sig. (2-tailed)
1	Toothbrush		<0,001*
2	Toothbrush		<0,001*
3	Pre-Post Electric	Manual and Toothbrush Differences	0,512

*Sig (2-tailed) $< 0,05$

IV. DISCUSSION

Table 1 shows that manual toothbrush use reduced the Loe and Silness plaque index score by an average of 1.01 (48.09%). The paired t-test results in Table 4 (Group 1) show a significance value (two-tailed) of less than 0.05. This value indicates that manual toothbrush use effectively reduces plaque index scores. These results are consistent with a study in Karnataka, India, which reported a reduction in plaque index scores of 0.72 (48%).¹⁷ The training lasted 45 days, with caregiver assistance during the initial phase of the study.

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Research in Jazan, Saudi Arabia, reported an analysis of children with Down syndrome with an average reduction of 53.4 (65.12%).¹⁸ The training was conducted for 2 months with caregiver assistance. Manual toothbrushes are likely effective because the children with intellectual disabilities in the study had a daily habit of brushing their teeth with them, thereby training their motor skills. However, their toothbrushing technique remains flawed due to poor grasping ability.

The effectiveness of manual toothbrushes depends on the brushing technique, toothbrush design, and dental floss.¹⁹ In this study, toothbrushing training for students with intellectual disabilities used the roll brushing technique due to its simple and repetitive movements. This technique is applied with the bristles positioned at a 45-degree angle to the occlusal or incisal surface of the tooth. The bristles should contact the junction between the free margin of the gingiva and the tooth. Repeated circular motions are then performed. This technique massages the gingiva and removes food debris from the interdental area.²⁰ This study used a brush head length of 22 mm for ages 5–12 years and 25 mm for ages 13–19 years. Toothbrush design determines the toothbrush's ability to reach anatomically difficult areas, such as molars and the lingual surfaces of anterior teeth.²¹ This study used a dental filling the size of half a pea for children aged 5-12 years, and a pea-sized one for children aged 13-19 years. This aimed to minimise the risk of fluorosis from the involuntary swallowing reflex in children with intellectual disabilities, who have impaired motor coordination and cognitive function.²²

Table 1 shows that the use of an electric toothbrush reduces the Loe and Silness plaque index score by an average of 1.10 (48.45%). The paired T-test results in Table 4 (Group 2) show a significance value (two-tailed) of less than 0.05. This value indicates that the use of an electric toothbrush effectively reduces the plaque index score. These results are consistent with a study of a Down syndrome population in Jember, Indonesia, which reported a reduction in plaque index scores with an electric toothbrush, with an average of 0.68 (33.66%), compared to a manual toothbrush, with an average of 0.42 (21.42%).²³ Electric toothbrushes are effective, likely because the cleaning process does not require physical effort or ability. Research in Karnataka, India, reported the results of an analysis on children with intellectual disabilities with an average reduction of 0.43 (31%). Electric toothbrushes are considered more effective because they can remove plaque without requiring complex hand movements.¹⁷

Electric toothbrushes have an on/off button, which can benefit children with intellectual disabilities.^{17,24} Children with intellectual disabilities often have difficulties with fine motor coordination, which involves the small muscles in the hands and fingers. Electric toothbrushes have larger handles to make them easier for children with intellectual disabilities

to hold, given their impaired motor skills.²⁵ The rotating-oscillating of the bristles produces consistent circular and back-and-forth movements, effectively removing plaque.¹⁹ These toothbrushes have a small brush head, allowing them to reach narrow areas such as the lingual surface of the lower jaw.¹³ Using an electric toothbrush is an effective alternative for children with intellectual disabilities because it does not require mastering complex brushing techniques.¹⁴

Table 1 shows data on the reduction in the Loe and Silness plaque index score after using a manual toothbrush of 1.01 (48.09%) and an electric toothbrush of 1.10 (48.45%). The results of the paired T-test in Table 4 (Group 3) show a significance value (2-tailed) greater than 0.05. These results indicate that training in brushing teeth with manual and electric toothbrushes is not statistically significant, but shows a numerical difference. The results of this study are consistent with the analysis conducted in Spain, which reported a reduction in the plaque index with an electric toothbrush (average 1.23) compared with a manual toothbrush (average 1.22).²⁶ Research in Brazil reported a reduction in the plaque index with an electric toothbrush, with an average of 1.66 (72.22%), compared to a manual toothbrush, with an average of 1.52 (70.96%).²⁷ A study in Surabaya, Indonesia, reported a decrease in plaque index of 1.6 (78.43%) using an electric toothbrush compared to a manual toothbrush with an average of 0.69 (51.49%).²⁸ The study stated that there was no significant difference in the OHI-S scores of children with Down syndrome using electric and manual toothbrushes because they had not yet adapted to the movement and sound of an electric toothbrush, causing fear or anxiety. Research in Turkey reported a decrease in plaque index of 0.74 (37.37%) using an electric toothbrush compared to a manual toothbrush, with an average of 0.74 (33.33%).²⁹ This study explained that the sound and movement of an electric toothbrush are new and unfamiliar to children with intellectual disabilities, so they are not yet accustomed to it.

The greater effectiveness of electric toothbrush use is likely due to the cognitive characteristics of children with intellectual disabilities, who have IQ scores below 70, which hinder their ability to grasp knowledge and absorb skills during toothbrushing training.³⁰ Manual toothbrush use is highly dependent on individual ability, while electric toothbrushes can automate the brushing process and reduce reliance on user technique.¹⁹ Manual toothbrushes produce 36 strokes per minute, while electric toothbrushes produce 7,600 strokes per minute, making them more effective in cleaning teeth.³¹ The small handle design of manual toothbrushes is a constraint because it requires a precise pincer grasp between the thumb and forefinger.³² The design of electric toothbrushes with larger handles allows children with intellectual disabilities to use a palmar grasp.¹⁴

A training frequency of only two sessions with a one-week interval is likely insufficient to develop adequate muscle memory, given that subjects with intellectual

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disabilities require consistent repetition to master a motor skill. Therefore, the advantages of an electric toothbrush with rotating-oscillating movements are still not fully realised due to a lack of mastery among children with intellectual disabilities. The results of this study will likely be more significant if the training duration is increased and implemented continuously among children with intellectual disabilities.

CONCLUSIONS

The results of this study indicate that both manual and electric toothbrushes are effective in reducing the Loe and Silness plaque index scores. The use of a manual toothbrush resulted in a mean reduction of 1.01 (48.09%) in plaque index scores, whereas the use of an electric toothbrush resulted in a mean reduction of 1.10 (48.45%). There is no statistically significant difference in effectiveness between manual and electric toothbrushes ($p > 0.05$), but electric toothbrushes are clinically more effective.

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