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The Effectiveness Of Chewable Toothbrush In Reduction Of Dental Plaque Among Under-Graduate Students

Author

Abstract
Objective*: This study aimed to evaluate the effectiveness of fuzzy chewable toothbrushes in reducing dental plaque among undergraduate students compared to traditional manual toothbrushes.*
Methodology*: A randomized controlled trial was conducted with 40 participants, divided into two groups: one using manual toothbrushes and the other using fuzzy chewable toothbrushes. The study included participants aged 19 to 25 years, who had no history of periodontal disease or systemic health issues. Plaque levels were measured at four time intervals: before brushing, immediately after brushing, after 6 hours, and after 12 hours. Statistical analysis was performed using paired t-tests and one-way ANOVA to compare plaque scores between the two groups.*
Results*: The study found significant differences in plaque reduction between the two groups at all time points ($p < 0.001$). The manual toothbrush group showed a higher baseline plaque index (1.25) compared to the chewable group (0.79). After 12 hours, the manual group had a plaque index of 2.71, while the chewable group maintained a lower index of 0.71. The chewable toothbrush demonstrated a more consistent reduction in plaque levels over time.*
Conclusion*: The findings suggest that chewable toothbrushes can be an effective alternative to manual toothbrushes for plaque reduction among undergraduate students. Their ease of use may encourage better oral hygiene practices, highlighting the importance of integrating innovative tools into oral health education.*
Keywords: *Plaque, Toothbrushing, Plaque Reduction, Chewable Toothbrush*

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I. Introduction

Maintaining good oral hygiene is crucial for overall health and well-being. Oral health is not merely the absence of dental disease but encompasses a state of physical, mental, and social well-being related to the oral cavity. Poor oral hygiene can lead to various health issues, including dental caries, periodontal disease, and systemic conditions such as cardiovascular disease and diabetes (1). The importance of effective oral hygiene practices cannot be overstated, particularly in preventing the accumulation of dental plaque, which is a biofilm of bacteria that can lead to significant oral health problems if not adequately managed. Regular brushing, flossing, and dental check-ups are essential components of a comprehensive oral health regimen that can mitigate these risks (2).

Toothbrushes are fundamental tools in the maintenance of oral hygiene. Traditional manual toothbrushes have been the standard for plaque removal and oral care for decades. However, the effectiveness of these tools is highly dependent on the technique employed by the user, including factors such as frequency, duration, and brushing method (Kumar et al., 2010). Previous studies such as those by Rajpar et al., 2016 have shown that improper brushing techniques can lead to ineffective plaque removal and may even cause damage to the gums and tooth enamel. This highlights the necessity for effective educational programs that teach proper brushing techniques, especially among populations like undergraduate students who may lack adequate training in oral hygiene practices (3).

In recent years, alternative oral hygiene tools, such as chewable toothbrushes, have emerged as innovative solutions to enhance plaque removal and improve compliance among users. Chewable toothbrushes, which combine the mechanical action of chewing with the cleaning action of brushing, offer a unique approach to oral care. They are particularly appealing to younger demographics, including undergraduate students, who may prioritize convenience and ease of use in their daily routines as seen by Farsi et al., 2020. The design of these products aims to make oral hygiene more accessible and engaging, potentially leading to better oral health outcomes in populations that struggle with traditional brushing methods (4).

The Plaque Index is an important tool in dentistry that measures the amount of dental plaque present on tooth surfaces, serving as an indicator of a person's oral hygiene. By using the basic Plaque Index, dental practitioners can effectively monitor plaque levels over time and evaluate the impact of oral hygiene practices or interventions. This index is particularly useful in clinical settings where rapid assessments are needed,

enabling dentists to provide tailored advice and strategies to improve patients' oral hygiene and overall dental health. the basic Plaque Index serves as a valuable metric for assessing oral hygiene, allowing for efficient monitoring and intervention in dental care.

Moreover, chewable toothbrushes often contain beneficial ingredients, such as xylitol, which can further enhance their effectiveness in preventing dental caries and promoting oral health (6). The dual action of mechanical cleaning and chemical intervention positions chewable toothbrushes as a promising adjunct to traditional oral hygiene methods (7).

Despite the promising results associated with chewable toothbrushes, it is essential to consider the broader context of oral health education among undergraduate students. Many studies have highlighted a gap in knowledge regarding effective oral hygiene practices among this population as seen by Saber, 2023. Educational interventions that emphasize the importance of proper brushing techniques, regular dental visits, and the use of innovative tools like chewable toothbrushes could significantly improve oral health outcomes (8).

In summary, the effectiveness of chewable toothbrushes in reducing dental plaque among undergraduate students is an area of growing interest. As this research continues to explore it's efficacy and application, these innovative tools may play a crucial role in enhancing oral hygiene practices and promoting better oral health among young adults. The integration of chewable toothbrushes into oral health education could foster a culture of preventive care that benefits future generations.

II. Methodology:

This study investigated the effectiveness of fuzzy chewable toothbrushes in reducing dental plaque among undergraduate students, utilizing a randomized controlled trial design. A total of 40 participants were recruited, comprising 20 individuals assigned to the control group using traditional manual toothbrushes and 20 individuals assigned to the experimental group using fuzzy chewable toothbrushes. The study population specifically consisted of dental undergraduates enrolled in our dental college, ensuring that the findings were directly relevant to individuals with a foundational understanding of oral hygiene practices.

For this study, the inclusion criteria specifically targeted undergraduate students aged 19 to 25 years who were enrolled in a university program. Participants had no history of periodontal disease, orthodontic treatment, or systemic health issues that could affect oral hygiene practices. Non-undergraduate individuals, including those outside the specified age range or those with dental or medical conditions that may influence plaque accumulation, were excluded from participation. This focused approach ensured that the study results were relevant to the target population of undergraduate students and enhanced the validity of the findings.

The study was conducted in four distinct phases to assess plaque reduction at various time intervals. The study setting took place within our dental college, where participants were called early in the morning to ensure consistency in plaque measurement and brushing conditions. The basic Plaque Index typically employs a scoring system that ranges from 0 to 3, where 0 indicates no plaque, and higher scores reflect increasing amounts of plaque. In the first phase (R1), baseline plaque levels were measured before any toothbrushing occurred. This initial assessment utilized the plaque index. Following this, participants were instructed to brush their teeth using their assigned toothbrushes under the supervision of the researcher.

In the second phase (R2), plaque levels were assessed immediately after toothbrushing to evaluate the immediate effectiveness of each toothbrush type in plaque removal. The third phase (R3) occurred six hours post-brushing, at which point plaque accumulation was measured again to determine the re-accumulation of plaque over a half-day period. Finally, in the fourth phase (R4), plaque levels were assessed again after 12 hours, specifically at 9 PM, to evaluate the long-term effectiveness of the toothbrushes in maintaining oral hygiene throughout the day.

Ethical approval for this study was obtained from the Institutional Review Board (IRB) of our dental college, ensuring that all research protocols adhered to ethical standards for human subjects research. Informed consent was obtained from all participants prior to their involvement in the study, ensuring they were fully aware of the study's purpose, procedures, potential risks, and benefits.

Statistical analysis was performed to compare the plaque scores across the four time intervals for both groups, allowing for a comprehensive evaluation of the fuzzy chewable toothbrush's effectiveness relative to the manual toothbrush. The statistical analysis for this study involved the use of paired t-tests and one-way ANOVA to evaluate the effectiveness of fuzzy chewable toothbrushes in reducing dental plaque among undergraduate students. The paired t-test was employed to compare the plaque scores within each group (fuzzy chewable toothbrush and manual toothbrush) at different time intervals (before brushing, immediately after brushing, after 6 hours, and after 12 hours). This method was appropriate as it allowed for the assessment of mean differences in plaque levels before and after the intervention within the same group, thereby controlling for individual variability. In addition to the paired t-test, one-way ANOVA was utilized to compare the mean plaque scores between the two groups (Group 1 fuzzy chewable toothbrush vs. Group 2 manual toothbrush)

across the four time intervals. This analysis helped determine if there were statistically significant differences in plaque reduction between the two types of toothbrushes at each time point.

III. Results:

The study involved a total of 40 participants, who were systematically divided into two distinct groups for comparative analysis. The first group, designated as the control group, consisted of 20 participants who employed traditional manual toothbrushes for their oral hygiene practices. In contrast, the second group also comprised 20 participants, but these individuals utilized chewable toothbrushes as an alternative method for maintaining dental health. The gender distribution within the cohort is 52.6% identifying as female and 47.4% as male. The age of the study participants was 22.9 years, with a standard deviation of 1.4 years.

In examining brushing habits, a significant majority of participants (75%) reported brushing their teeth twice daily, while the remaining 25% indicated that they brush once daily. This positive attitude towards oral hygiene is crucial for assessing the potential effectiveness of chewable toothbrushes, as consistent brushing is key to reducing plaque. Additionally, all participants used a combination of toothbrushes and mouthwash, indicating a uniform choice of dental care products. The techniques employed by participants indicate a preference for a combination of methods. Specifically, 90% reported using both horizontal and circular brushing techniques, while a smaller percentage, 10%, utilized either technique exclusively. This trend towards a multifaceted approach to oral hygiene may enhance the effectiveness of chewable toothbrushes, which are designed to accommodate various brushing techniques.

Regarding the duration of brushing, the data indicates that 75% of participants typically brush for 1-2 minutes, while the remaining 25% brush for 2-3 minutes. This duration aligns with the recommendations from dental health professionals, who advocate for a minimum of two minutes of brushing to ensure effective plaque removal and maintain overall oral health. The incorporation of chewable toothbrushes into this routine may further enhance plaque reduction during these brushing sessions.

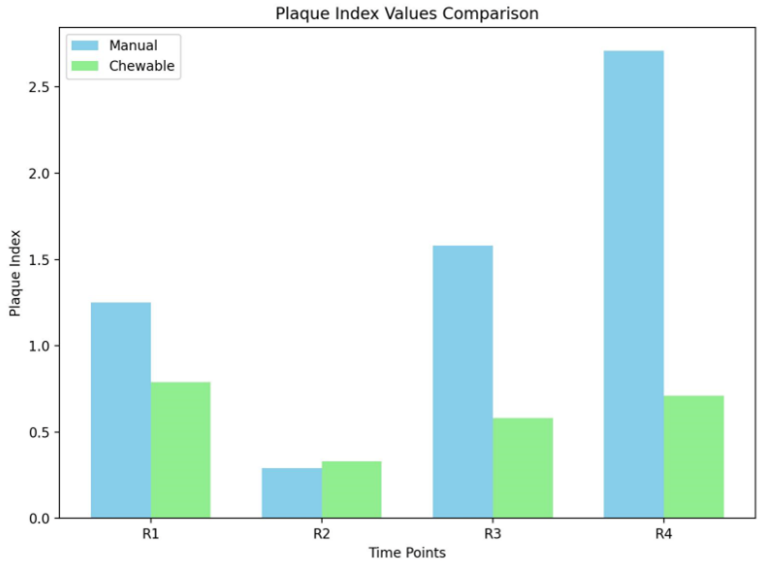

Fig 1: Plaque Index Values Comparison among 2 groups at different Time Intervals

The results from the Fig. 1 shows the effectiveness of manual and chewable toothbrushes at different time points. The time intervals measured include

R1- Before Tooth brushing: This serves as the baseline measurement for plaque levels.
R2- Immediately After Tooth brushing: This measures the immediate impact of brushing on plaque reduction.
R3- After 6 Hours: This interval assesses how well plaque levels are maintained after a period of time post-brushing.
R4- After 12 Hours: This final measurement evaluates the long-term effectiveness of each brushing method.

The graph illustrates the comparative plaque index values between manual and chewable toothbrush methods across four distinct time points, represented in a bar chart format. At the initial time point, the manual method shows a higher baseline plaque index value of 1.25 compared to the chewable method's value of 0.79.

Both methods achieve their lowest values at the second time point, with the manual method recording a plaque index of 0.29 and the chewable method at 0.33. However, at the subsequent time points, the manual method exhibits substantially higher plaque accumulation, with values of 1.58 and 2.71 at the third and fourth time points, respectively, compared to the chewable method's values of 0.58 and 0.71.

Table 1: Mean Plaque Reduction at Different Time Intervals in a Day Among Two Groups

Time Point	Manual Value	Chewable Value	Difference	**p-value**
Before tooth brushing	1.25	0.79	0.46	**<0.001**
Immediately after tooth brushing	0.29	0.33	-0.04	**<0.001**
After 6 hours	1.58	0.58	1.0	**<0.001**
After 12 hours	2.71	0.71	2.0	**<0.001**

Paired T-Test P value 0.001 (highly significant)

The paired t-test results in Table 1 reveal significant differences between the two methods at various time points, with all p-values less than 0.001, indicating statistically significant differences in plaque reduction. For instance, before tooth brushing, the manual method shows a value of 1.25 compared to 0.79 for the chewable method, with a difference of 0.46.

However, the manual method also exhibits greater variability in plaque reduction, particularly noticeable at the 12-hour measurement, where the manual method shows a difference of 2.0 compared to 0.71 for the chewable method. This suggests that while the manual toothbrush may be more effective overall, its performance can fluctuate. On the other hand, the chewable toothbrush, although less effective in absolute terms, offers a more consistent reduction in plaque levels. This reliability may be beneficial for users who prefer a dependable oral hygiene solution.

Table 2: Mean Plaque Reduction Among Two Groups

Method	Mean ± SD
Manual	1.46 ± 0.86
Chewable	0.60 ± 0.17

Table 2 presents the overall mean plaque Index values with their associated standard deviations. The manual method exhibits a mean plaque index of 1.46 with a standard deviation of ±0.86, while the chewable method shows a mean of 0.60 and a standard deviation of ±0.17. These representations indicate the chewable method's better overall performance and more consistent outcomes compared to the manual method.

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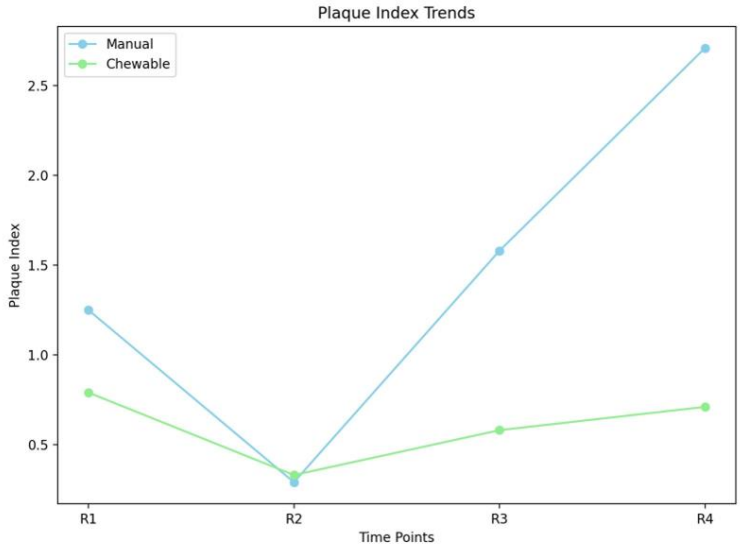

Fig. 2

Fig. 2 Illustrates the temporal progression of plaque accumulation through a line chart, tracking both methods across the same four time points. The manual method shows a steep upward trajectory after the second time point, indicating rapid plaque accumulation, while the chewable method maintains a relatively stable, near-horizontal line. This contrast highlights the chewable method's superior ability to maintain consistent plaque control.

To Summarize, the dataset reveals that participants exhibit consistent oral hygiene practices, marked by a strong preference for utilizing a variety of materials and techniques to maintain their dental health. The findings indicate that this cohort is actively engaged in effective oral hygiene behaviors, which may positively influence their overall dental health outcomes. Furthermore, the study highlights the potential of chewable toothbrushes as a viable alternative for plaque reduction among undergraduate students. This suggests a need for further investigation into their long-term effectiveness and user acceptance.

IV. Discussion

The effectiveness of chewable toothbrushes compared to traditional manual toothbrushes has become an important area of research, particularly for improving oral hygiene among various populations, including children and young adults. This discussion synthesizes findings from several studies to provide a comprehensive understanding of the efficacy of chewable toothbrushes in plaque removal.

Chewable toothbrushes have been shown to be effective in reducing dental plaque. For example, Nekkanti et al. in 2020 found that chewable toothbrushes were as effective as manual toothbrushes in plaque removal among children aged 10 to 12 years, indicating their potential as a suitable alternative for younger users (14). Similarly, Bezgin et al. reported significant reductions in plaque scores when using chewable toothbrushes, suggesting they can serve as an effective adjunct for oral hygiene in children. This aligns with findings from Myoken et al., who demonstrated comparable results in elderly populations, reinforcing the versatility of chewable toothbrushes across different age groups (14). For instance, a study by Dhadwal & Baysa, 2017 has shown that these devices can achieve comparable or even superior plaque removal compared to manual toothbrushes, particularly in populations that may not adhere to conventional brushing practices. This is particularly relevant for undergraduate students, who often experience time constraints and may neglect their oral hygiene due to busy schedules (5). The novelty and ease of use of chewable toothbrushes may encourage more consistent oral hygiene practices among this demographic.

However, some studies have highlighted variations in effectiveness based on specific areas of the mouth. Yiğit et al. in 2023 noted that while chewable toothbrushes were effective, they performed better on the lingual surfaces of teeth compared to manual toothbrushes, which excelled on buccal surfaces (16). In our study the effectiveness of toothbrushes may vary depending on the area being cleaned, indicating that users might benefit from a combination of both types of toothbrushes for optimal plaque removal.

In a study by Kayalvizhi et al. in 2019, no statistical difference was found in plaque removal effectiveness between chewable and manual toothbrushes among children (17). This finding suggests that chewable toothbrushes can be a viable alternative for children who may struggle with traditional brushing techniques, thereby promoting better oral hygiene practices.

Goyal et al. in 2011 conducted a study comparing manual tooth brushing reinforced with audiovisual instruction to powered toothbrushes among institutionalized individuals. They found that both methods were effective, emphasizing the importance of proper technique and user compliance, which are critical factors influencing the effectiveness of any toothbrush type (18). This highlights the need for educational programs that teach proper brushing techniques, regardless of the type of toothbrush used.

Moreover, Mallam et al. in 2017 found that manual toothbrushes were equally effective compared to powered toothbrushes in removing plaque, reinforcing the idea that manual brushing, when done correctly, can be just as effective as newer technologies (15). This suggests that chewable toothbrushes, which combine the mechanical action of chewing with brushing, may also provide a comparable level of effectiveness if used properly.

V. Conclusion

In conclusion, the evidence suggests that chewable toothbrushes can be as effective as manual toothbrushes in reducing dental plaque, particularly among children and young adults. While some studies indicate that chewable toothbrushes may excel in specific areas of the mouth, others show no significant difference in overall effectiveness compared to manual brushes. The key takeaway is that user technique and education play a crucial role in maximizing the benefits of any toothbrush type. Therefore, integrating chewable toothbrushes into oral health education could foster better hygiene practices among young adults and children, ultimately leading to improved oral health outcomes.

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