GRADUATION PROJECT

Degree in Dentistry

Comparison between the use of manual and electric toothbrushes in pediatric patients

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RESUMEN

Introducción: Los principales puntos establecidos destacan la importancia de las medidas preventivas en la higiene oral, particularmente mediante el uso de cepillo manuales (CM) y cepillo eléctrico (CE). La evolución histórica de los cepillos dentales se remonta a 1780, cuando William Addis, en Inglaterra, diseño el primer CM comercial. Los CE fueron introducidos posteriormente en 1969. La población pediátrica presenta un mayor riesgo de desarrollar problemas de salud oral; por lo tanto, la selección de un cepillo adecuado es un factor crítico en la prevención.; **Objetivos:** El objetivo de este estudio fue evaluar y comparar la eficacia y el uso de los CM y CE en pacientes pediátricos, con especial atención a los niveles de placa, la salud gingival y los métodos motivacionales; **Metodología:** Se realizó una revisión de la literatura, seleccionando 15 estudios clínicos. Cada estudio evaluó las diferencias entre CM and CE en la población pediátricas, considerando parámetros como los niveles de placa, la salud gingival y la motivación. Los índices analizados incluyeron PI, GI, TQHPI, API, PCR; OHI-s; **Resultados:** Los CE, como los de tipo Oscilante-Rotatorio, sónico, con aplicaciones e iónicos, mostraron una mayor reducción de placa y una mayoría en la salud gingival en comparación con los CM. Además, los CE mostraron una mayor aceptación entre los niños. Algunos estudios destacan que los métodos motivacionales y la instrucción influyen significativamente en los resultados de la higiene oral; **Conclusiones:** Tanto los CM como los CE contribuyen a la reducción de la placa y a la mejora de la salud gingival. La evidencia sugiere que CE tienden a lograr una mejor eficacia, especialmente in pacientes pediátricos.

PALABRAS CLAVE

Odontología, Cepillos manuales, Cepillo eléctrico, Iónico / Sónico, Pacientes pediátricos

ABSTRACT

Introduction: The main points established where the importance of preventive measures in oral hygiene, particularly using MTB and PTB. The historical evolution of toothbrushes dates to 1780, when William Addis of England designed the first commercial of MTB. PTB were later introduced in 1969. The pediatric population presents a higher risk of developing oral health problem; therefore, the selection of an appropriate toothbrush is critical factor in prevention; **Objectives:** The aim of this study was to evaluate and compare the effectiveness and use of manual and electric toothbrushes in pediatric patients, with a focus on plaque values, gingival health and motivational methods; **Methods and Materials:** A literature review was elaborated, selecting 15 clinical studies. Each study assessed the differences between MTB and PTB in pediatric population, considering parameters such as plaque values, gingival health and motivation. The indices analyzed included, PI, GI, TQHI, API, PCR and OHI-s. **Results:** PTB such as Oscillating – rotating, Sonic, App-based, Ionic, reported a stronger and greater reduction in plaque values and gingival health compared to MTB. Additionally, PTB showed a higher acceptance among children. Some studied highlights that motivational method and instruction significantly influence oral hygiene outcome; **Conclusions:** Both MTB and PTB contributes to plaque reduction and improvement in gingival health. However, the evidence suggests that PTB tend to achieve greater effectiveness, particularly in pediatric patients.

KEYWORDS

Dentistry, Manual toothbrush, Powered toothbrush, Ionic/Sonic toothbrush, Pediatric patients

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1. INTRODUCTION

Oral health plays a crucial role in the over-all wellbeing of children, influencing and affecting general health. The World Health Organization define oral health as a multifaceted condition that affects “the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions with confidence and without pain, discomfort or disease” of the oral cavity and craniofacial complex. Especially in pediatric patient is crucial to maintain an adequate hygiene do to the fact that is a phase of constant evolution, due to tissue changes, increasing the susceptibility to microbial colonization and diseases progression. Early oral care, not only prevent disease but also introduce a lifelong hygiene habit that contribute to maintaining systemic and physiological health. (1,2)

In recent times, prevalence of oral diseases among children has remained high across the world. Studies show that almost half of the population in the world suffer of a form of oral disease, where dental caries is the most prevalent. (2,3) Studies shows that insufficient brushing habits, inadequate parental supervision and limited oral health knowledge can affected children oral hygiene. (4)

Children are particularly vulnerable to oral diseases due to the nature of their developing dentition and the oral hygiene habits of their caregivers. Studies demonstrated that parental involvement influences the effective plaque control in children aged 3-5 years. Parental involvement is crucial and significantly improve the children’s oral hygiene index, highlighting the importance of preventive programs for both children and parents. These finding embrace the importance of preventive measures, especially regarding proper toothbrushing, that should be introduced at an early age and supported by their caregiver to preserve the oral health maintenance. (5) Children who parents demonstrate a better understanding of oral health, show a significant lower rate of developing caries and gingivitis. (4)

1.1. Oral diseases in pediatric patients:

Among pediatric oral pathologies, dental caries, periodontitis and gingivitis are highly frequent and clinically significant. (3,6)The main characteristic of this disease is that they share common etiological factor such us, the accumulation of dental biofilm, that is a complex community of bacteria, that adheres to the tooth surface. The metabolic activity of specific

microorganism causes the demineralization of the enamel, inflammation of the gingival tissues and destruction of periodontal structure if left untreated. (2,3,7)

Dental caries remains the most common chronic oral condition in children. It's a multifactorial, progressive and infectious disease caused by the interaction of cariogenic bacteria (streptococcus mutants), fermentable carbohydrates and the susceptibility of the tooth surface inducing a demineralization of enamel and dentin. (3) Global survey show that 60% to 90% school aged children are affected by caries. (8)

Gingivitis is the most common form of periodontal disease in children. Is characterized by the inflammation of the gingival tissues due to plaque accumulation. If untreated it can develop into periodontitis. Although is less common in children, aggressive form can develop, in presence of systemic condition or poor hygiene. (3,6) Studies shows that gingivitis affects up to one-quarter of the pediatric population, increasing their prevalence as children grow older and oral hygiene becomes less controlled. (2)

Bacterial plaque is characterized by the communities of microorganism on the tooth surface that are covered by extracellular matrix consisting of polymers form both microbial and host origin. Plaque typically can accumulate in gingival margins and dental defects. However, these surfaces can be cleaned and protected using toothbrushes. (9)

The maintenance of oral hygiene in children is not only crucial for preventing diseases but also, for prompting better mastication, phonetics and facial growth. Preventive strategies such as fluoride use, dietary control and mechanical plaque removal are the foundation of pediatric dental care. Mechanical plaque removal through toothbrushing remain the most effective preventive method. The evidence shows that most of the oral pathologies in children can be prevented by controlled toothbrushing and regular plaque removal. (5,6)

1.1.1. Preventive role of tooth brushing

Toothbrushing is considered as the pillar of oral hygiene. Mechanical cleaning applying a brush with fluoride toothpaste is considered one of the most effective and accessible method for controlling both plaque removal and accumulation. (7,9) Studies have shown that brushing your teeth twice daily has reduce the risk of developing carries and gingivitis compared to brushing less frequently. (3) Brushing is considered as a process to deliver fluoride and so enhancing the remineralization of the enamel and strengthening the tooth structure from acid attacks.(2)

Brushing your teeth twice a day for at least 2 minutes is considered as the gold standard. However, resources indicate that brushing longer tan 2 minutes (up to three minutes) have a greater effect in plaque removal. (9,10) Children, especially those under six years, have shown to have lack of motility, so is fundamental parental supervision throughout the process. (5)

The type of toothbrush selected plays a role in maintaining optimal hygiene. Soft-bristles brushes are recommended to prevent enamel erosion and gingival trauma. On the other-hand, electric brushes have manifested a gradual improvement in the efficacy of plaque removal, especially in children with limited conditions. (7) Toothpaste choice is as important as toothbrush selection. Fluorinated toothpaste reported to have a greater coverage against caries compared to free fluorinated toothpaste. (9) Fluoride plays a fundamental role by inhibiting the demineralization, enhancing remineralization.(2)

Oral hygiene habits formed during childhood persist into adulthood, making early education play a key role for preventive strategy. Studies show that health education both for children and parents should begin early. Parents that are actively involved in educational programs for preventive measure, express over time a gradual improvement in children oral hygiene. In children aged 3-5 years old are known to have insufficient skills, so it's fundamental to involve parents. However, during this process adults should be informed and have the knowledge to avoid any future damage. Therefore, there is a correlation between parents' knowledge regarding oral health and prevalence of dental caries. (5)

Manual and electric toothbrushes do not remove 100% of the oral biofilm, even in individuals that performed correct bruising techniques. In addition to toothbrushing is important to associate other oral cleaning methods such as mouthwashes and interdental brushes. (9) Maintaining oral hygiene in children is not only fundamental to prevent oral diseases but also for ensuring an overall physical and psychological well-being. Constance and effective toothbrushing remains the simplest but the most effective preventive measure in dentistry. (1,2)

1.2. Manual vs electrical:

Oral hygiene is the main holding of human health, considering toothbrushing as the essential instrumental for cleanliness. (7) Nowadays, the act of toothbrushing is universal. The evolution of toothbrushing is represented by a technological process, cultural adaptation and scientific innovation. The comparison of manual and electric toothbrushes in pediatric patient

is not only about efficacy, but it takes also into consideration ergonomics, motivation and behavioral suitability. (7)

1.2.1.Historical development:

Toothbrushing has evolved in time. Early evidence first started in Egypt and Babylonia around 3500-3000 BC, where frayed twigs and chewing sticks were used for cleaning. Despite the simplicity of these tools, they were able to fulfill some of the basic function of modern brushes. In 15th century, China introducing bristle on toothbrushes, using big hair as a tool. Handle were made of bone and bamboo. These prototypes where introduced later onwards in Europe in the 17th century. Only later in 1780 William Addis of England designed the first commercial product, that will inspire the future designs of toothbrushes. By the 19th century, toothbrushes started to spread worldwide due to health campaigns and military hygiene. The modern nylon bristles toothbrushes were introduced later onwards in the early 20th century, transforming completely the concept of hygiene worldwide. (7)

In 1969, electric toothbrushes were first developed, assisting especially patients with lack of motor skills. (7,11)Since then, multiple technological innovation has emerged, introducing oscillating-rotation, sonic, ultrasonic and Bluetooth-connected toothbrush that provide feedback on both pressure and duration. Nowadays multiple brands are known. (11) This innovation has completely modified the use of toothbrushing, from a purely manual movement to a semi-automated movement, data driven preventive tool. (11)

Parallel to technological sophistication evolution, environmental aspect also improved. Sustainability became part of the design, starting to prompt the use of biodegradable and recyclable material for brushes, such us polyhydroxyalkanoate (PHA) or recycled aluminum. (11) These aspects improved global concern regarding plastic waste and environmental degradation.

1.2.2.Differences in mechanism, design and use:

The main difference between manual and electric brushes is in the motion. Manual toothbrush is entirely based by the user skills and consistency, applying horizontal, vertical or circular movement. Electric toothbrush is an automated motion, rotatory, oscillating or vibratory, with les manual dexterity. (9) Different studies reported that electric toothbrush

provides superior plaque removal, especially in interproximal area and along the gingival margin, compared to manual brushes. (7,11) Never-less, the clinical difference between electric and manual toothbrushes often depends on the technique, duration and user compliance, factors that are very variable in children. The evolution in the design is parallel with the improvement in the mechanism. Manual brushes come with an ergonomic handle, contoured grips and variable bristle texture. Heads shapes have been optimized depending on the age group, from a small, rounded head for children to a multi-angled or elongated ones for adults. To continue, bristles come in different stiffness, soft one's are usually recommended for children to reduce gingival trauma and prevent enamel abrasion. Electric brushes for children, often included auditory and visual cues, timers and playful element to promote a correct brushing duration and technique. (7)

However, when selecting a toothbrush is important to take into consideration behavioral and social economical aspect. From Covid- 19 pandemic, dental clinic worldwide demonstrates a decline in preventive measures so an increase in untreated caries in children, particularly in low-income settings. (8) This highlights the importance of promoting preventive care at home, including improvement in brushing techniques.

When talking about manual and electric toothbrushes if handled inadequately it can present risk overtime. Excessive brushing force or improper toothpaste can produce gingival recession, cervical wears. (10) When brushing teeth's is important the technique and the design but also the force applied. Using soft bristles can optimize and reduce the risk. (10)

Despite the design improvement and the evolution, the literature remains divided over the superiority of one over the other. While some studies show advantages over the use of electric toothbrush's, other finds comparable the use of manual if proper technique is maintained. (9)

1.2.2.1. Manual toothbrush: (MTB)

MTB due to their simplicity, effectiveness and affordability, are considered pilar of oral hygiene for decades, if used correctly. The primary objective is to mechanically remove the oral plaque through different technique, including vertical, horizontals and circular movements. (12) Manual brushes depend completely on the motor skills and consistency of the user. The level of

plaque removal is influenced by the technique, duration and applied pressure. Improper technique can lead to inadequate cleaning and excessive pressure can lead to damage of the gingival tissues. (9)

1.2.2.2. Power toothbrush: (PTB)

Electric toothbrushes are designed to reduce the user dependence generating an automated movement. Through this process there is an effective way to reduce plaque even in areas difficult to reach. Electrified toothbrushes can be beneficial for children, elderly patience and individual with limited dexterity. (9) Power toothbrushes had undergone multiple changes regarding the design and the function developing multiple brushing modes and technologies enhancing dental cleaning. (12) Despite multiple advantages, higher cost, the need for recharging or battery replacement can be cause difficulties in pediatric patients. For pediatric patients, is important to select a device, manual or electric, that suits the age, the dexterity and the motivational level while aligning with the preventive measure and caregivers' supervision. (4,5)

1.2.2.2.1. Oscillating- rotating powered toothbrush: (OR- PTB)

Uniquely designed rounded brushes that oscillates and rotate, permitting bristles to remove dental plaque and debris. Multiple studies reported that the use OR-PTB provide a reduced dental plaque and gingivitis compared to MTB. These types of devices have showed to be efficient in patients with brackets or orthodontic devices due to their motion. (7,12) Multiple devices report the capability of censoring pressure, ensuring that the pressured applied is adequate to avoid damage in the tooth or gingiva. The oscillating-rotating movement consisted in bristles moving back and forth in circular movement, showing a high efficacy in removing plaque and gingivitis. (7,12)

1.2.2.2.2. High frequency sonic power toothbrush: (HFS-PTBs)

The HFS-PTBs uses sonic waves to transfer oral hygiene benefits. This type of brush can generate up to 30000 brushes strokes per minute, significantly increasing the cleaning power standards compared to other PTB, that can generate 2500 up to 7500 brushes strokes per minute. Brush strokes are the movement generated by the head of the toothbrush over the

surface of the tooth. This rapid vibration not only increases the plaque removal but also stimulates the formation of saliva which together with water and toothpaste, generated a cleaning mixture that penetrates under gingival margins, cleaning area which are difficult to access though manual brushing. However, the use of HFS-PTBs have shown to be more effective in plaque removal than MTB, but worse than OR-PTB. (12)

1.2.2.2.3. App-based Toothbrushes:

Multiple brushes have a cohort app recording information regarding the capability of an individual to brush their teeth properly. Due to the evolution of artificial intelligence and increased amount of data that has been collected by these toothbrushes, these app are evolving and becoming more reliable with time. They provide real-time feedback, improving and inducing pediatric patients to brush their teeth more frequently. (11,12)

1.3. Relevance of the topic:

Comparing manual and electric toothbrushes provides an essential insight for evidence-based recommendations in pediatric patients. As PTB become affordable and technologically advanced, understanding their real-world effectiveness relative to manual brushing can guide preventive protocols, parental education programs and public health campaigns.

Toothbrushing is one of the most common and effective ways to maintain oral hygiene. However, compliance, technique and effectiveness can vary significantly among pediatric patients. Comparing MTB and PTB is highly relevant, because it helps understand which method better improve or promotes plaque removal, gingival health, easier habit formation and higher motivation among children. Understanding these differences can help guide parents, dental professional and public health programs, to properly select age-appropriate and evidenced-based oral hygiene tools. Moreover, the constant growing popularity in the use of electric toothbrushes and their marketing towards children, there is clear need to scientifically evaluate their real benefits and potentials drawback compared to manual toothbrushing. This research can contribute the improvement pediatric oral health outcomes and to create more effective preventive strategies.

2. OBJETIVE

The primary aim of this study is to compare the existing evidence on the effectiveness of manual and electric toothbrushes in mantling oral hygiene among pediatric patients.

2.1. Objective:

To compare the use and effectiveness of Electric and manual toothbrushes regarding reduction of plaque and improved gingival health in pediatric patients

The research aim is also to focus on exploring related factors such as compliance, brushing time, user preferences and parental supervision, to determine which approach better sustains the effectiveness and sustainability of oral hygiene habits for children.

3. MATERIAL AND METHODS

For this thesis a systematic review was conducted based on research comparing quantitative and qualitative evidence based on cohort studies, Randomized control study (RCT) studies and clinical trials. Systemic reviews/ meta-analysis will be used to map evidence.

The PICO question was elaborated based of four criteria:

- P(Population): Pediatric patients,
- I(intervention): Electric toothbrush or Powered toothbrush,
- C(comparison): Manual toothbrush,
- O(outcome): Improvement of oral health, gingival and plaque.

  Pico question: Do electric toothbrushes provide superior plaque removal and improved gingival health compared to manual toothbrushes among children under 18 years of age?

3.1. Search strategy:

The primary data base used were pre-reviewed article published between 2015 up to 2025 through PubMed, Medline and Scopus. Keywords such as pediatric, oral health, gingivitis, plaque, manual toothbrush and electric toothbrush were used for the research. Boolean operators like AND, OR and NOT to refine the search algorithm. Filters were applied to limit the search. Article not directly relevant on the topic where excluded. Additionally, the reference section of selected studies was manually reviewed to find out useful evidence.

The definitive research equation used was: *(children OR pediatric OR pediatric OR child) AND (electric toothbrush OR power toothbrush OR oscillating-rotating toothbrush OR sonic toothbrush or ionic toothbrush) AND (manual toothbrush OR conventional toothbrush)*

3.2. Inclusion criteria:

- Population: pediatric patients <18
- Studies comparing manual and electric toothbrushes
- Published in the last 10 years (up to 2015 on word)
- RCT studies, clinical trial and cohort studies

3.3. Exclusion criteria:

- Non orthodontic patients
- Specific over one toothbrush
- Patient with systemic disorders
- Bad general health
- No oral lesion or Caries
- No patient on antibiotic or pharmacological treatment

4. RESULTS

The focus of the study is to define and compare the effectiveness of manual toothbrush (MTB) and power toothbrush (PTB) on oral health in pediatric patients. The reviewed studies reported reliable resources regarding the outcomes needed. The review was established based on PRISMA statement. (figure 1)

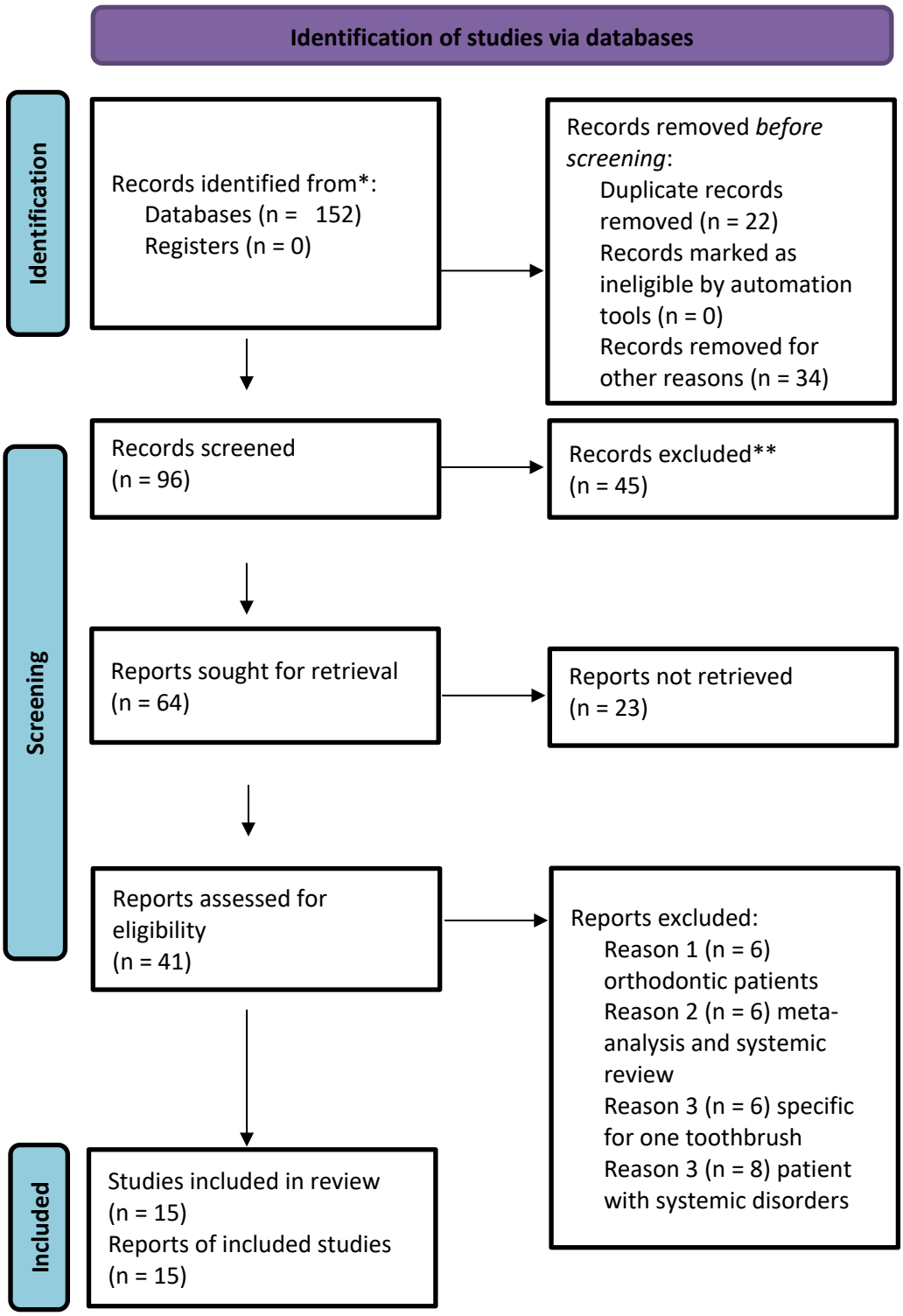


Figure 1: PRISMA 2020 flow diagram

In this review 15 articles were analyzed to sustain the objective selected. Among them article was selected from 2017 to 2025 and consisted of randomized controlled trials, crossover trials, pilot's studies and parallels groups clinical trials evaluating manual and electric toothbrushes in pediatric patient.

The sample size ranged from 10-120 with participant age from 3 to 16. Collectively, the population was diverse, and it included multiple geographic areas including North America, Europe (Italy and Turkey), South America (Argentina), Middle east (Saudi Arabia and Egypt) and India. The primary outcomes assessed in the studies was plaque reduction. Different indices are used such as Turesky modified Quigley-Hein plaque index (TMQHPI), Quigley-Hein plaque index (QHPI), Plaque index (PI), Approximate plaque index (API), Plaque control record (PCR), Oral hygiene index simplified (OHI-S), Digital image analysis (IAS) and Full mouth plaque score (FMPS). Secondary outcomes included patients' acceptance, brushing compliance and gingival health and gingival index (GI)

4.1. Manual vs electrical toothbrush:

The comparison of MTB and PTB has been widely studied in terms of plaque removal, gingival health and patient acceptance. The following table reports the main characteristics reported by the articles selected. (Table 1)

Author (years) / country	**Study design /Sample**	**Age**	**Compare**	**Follow-up**	**Index**	**Key findings**
Munot eat al. (2024) / India (13)	RCT (n=60)	4-8	Manual vs Power (Parental)	4 weeks	PI	Powered 58 % vs Manual 28% reduction ($p<0.05$)
Alzarea et al. (2025) / Saudi Arabia & Egypt(14)	RCT (n=111)	6-12	Manual, Musical, Electric Supervised	45 days	QHPI	Musical& Manual significantly outperformed manual until 30 days ($p<0.05$)

Yildirim & Kayaalti- Yüksek (2020)/ Turkey(15)	RCT (n= 60)	6-12	Manual & Electric Motivation tools	15 days	PI GI	All groups improved; PI reduced (51-55%) Musical Powered
Ludovichetti et al. (2025) / Italy (16)	Cohort (n= 55)	6-15	Manual vs Electric (Individualized Instruction)	Single session	PCR	Education improved cleanliness ($p<0.001$)
Durhan et al. (2018)/ Turkey(17)	Crossover RCT (n=10)	7-10	Manual vs Power	6 weeks	API TQHPI	Powered better plaque score (P= 0.005)
Aggarwal et al. (2019) / India(18)	RCT (n=60)	9-16	Ultrasonic, Multidirectional, Manual	4 weeks	TQHPI	Multidirectional most effective (64.6% reduction, $p<0.001$)
Chandra et al. (2019)/ India(19)	RCT (n= 30)	6-12	Ionic vs Manual	30 days	PI OHI-S	Ionic slightly superior ($p>0.05$) Both safe
Aarthi & Ramesh (2025) / India (20)	RCT (n= 78)	6-12	Manual, Electric, Sonic	6 months	PI GI	Ionic & Electric superior vs Manual
Mareddy et al. (2024) (21)	RCT (n=58)	8-14	Manual, Electric, Chewable	1 weeks	OHI-s TQHI	Electric > Chewable > Manual ($p<0.001$)
Obukavitha et al. (2024) / India(22)	RCT (n=75)	6-8	App-based vs Power vs Manual	90 days	TQHI	Better child acceptance & plaque reduction with app based ($p<0.001$)
Purushotham et al. (2021) / India (23)	RCT (n= 20, parental)	3-5	Manual vs Powered (parental)	6 months	TMQ HPI	Powered better in plaque removal ($P< 0.001$)

Abdullah et al. (2025) / Saudi Arabia (24)	RCT (n=56)	8-12	Manual regular, Battery Powered, U-shaped, control	Single session	FMPS	Electric effective (30.96%), Manual (24.15%), U-shaped (7.98%); Power superior ($p<0.001$)
Kerr et al. (2019) / USA(25)	RCT (n=120)	5-11	Manual vs Electric (Parental)	-	OHI-S	No difference in plaque reduction
Elizondo et al. (2023) / Argentina (26)	Crossover RCT (n=22)	4-6	Manual vs Electric	12 weeks	PI IAS	Powered higher reduction of biofilm, better acceptance
Shekhar et al. (2022) / Saudi Arabia (27)	RCT (n= 80)	12-16	Manual vs Oscillating-Rotating electric	4 weeks	PI GI	PTB reduce plaque (41.6%) & gingivitis (46.2%) vs manual ($p=0.001$) Not supervised

Table 1: Characteristics of included studies comparing manual and electric toothbrushes in pediatric patients

4.2. Plaque reduction outcome:

All 15 studies reported a plaque reduction outcome from baseline following toothbrushing, regardless of the selection. However, 13 out of the 15 articles reported and demonstrated a greater reduction of plaque with electric toothbrushes compared to manual. Ludovichetti et al. (2025), Kerr et al. (2019), concluded no significant difference when effective brushing technique and instructions where provided. (16,25)

Dental plaque was measured using multiple and standardized indices, including simplified oral hygiene indices (OHI-S), Plaque indices (PI), Turkey-Quigley-Hein plaque indices (TMQHPI) or digital imaging technique (IAS), Quigley-Hein plaque index (QHPI), Plaque control records (PCR), Approximate plaque index (API) and Full mouth plaque score (FMPS). Overall, both MTB and PTB reduced plaque when brushing, however multiple studies reported higher

reduction when using PTB, focusing on oscillating- rotating, sonic/ultrasonic or interactive design.

4.2.1. Studies using direct biofilm quantification (IAS):

Study based on children aged 4-6 years using a digital image analysis system (IAS) on discolored primary incisors to define the quantity of dental biofilm (% area). Both MTB and PTB reported a reduction of biofilm at baseline and at 4 weeks. Both groups reported a reduction with no significant differences; however, PTB showed a significant prospective reduction after week 4 and was preferably accepted by children. Elizondo et al. (2023) reported that the percentages of surfaces covered by biofilms decreased with both PTB 25.4% to 16.2% and MTB 19.1% to 11.7%. (26)

4.2.2. Studies using PCR:

Focused on a group aged 6-15 years, showed a PCR index decreasing from pre brushing to post brushing and further decreased after individualized operator instruction. Comparing MTB vs PTB, powered responded effectively after post brushing assessments. However, after individualized instruction both methods reported similar outcomes, suggesting that educational components strongly influence plaque reduction. (16)

4.2.3.Studies using QHPI and TMQHPI:

Other research based their studies on the use of QHPI and TMQHPI. Alzarea k. Bader et al. (2025) affirmed that the comparison between MTB, Musical and PTB in children aged 6-12 years old, constantly reported a plaque reduction within each group throughout the 45 days. It established that musical brushes have a higher response in plaque reduction using interactive entertainment. (14)

Similarly, in children aged 6-8 years; Obukavitha et al. (2024) demonstrated that app-integrated PTB reported higher plaque reduction at day 30,45 and 90 ($p<0.001$), sustaining that PTB have a greater hygiene response and full acceptance. (22)

In parallel, Aggarwal et al. (2019) recorded the plaque value with TMQHPI index, comparing the use of sonic/ultrasonic PTB, multidirectional PTB and MTB. It stated that multidirectional PTB achieved a greater mean reduction with PI of 189%. (18)

4.2.4. FMPS and plaque score outcomes:

A study based on FMPS in children aged 8-12 years old, U-shaped toothbrush, PTB and MTB where compared. Significant differences in FMPS groups were observed; Abdullah et al. (2025) showed that U-shaped brushes were proposed for easier use but demonstrated a worse response than MTB and PTB. The FMPS difference was 7.9% U-shaped vs 30.9% PTB, $p<0.001$. (24)

4.2.5.Parental brushing and supervision:

Three studies out of the 15 selected, focused on the importance of parental brushing. Purushotham et al. (2021) in children aged 3-5 years, demonstrated higher plaque reduction when using an oscillating-rotating PTB compared to MTB ($p=0.001$). Results indicated that parents brushing their children teeth using PTB achieved approximately twice the level of plaque removal. OHI-S decreases from 1.88 to 0.35 ($p<0.001$) compared to manual 1.85 to 0.78. Parents stated an increased confront-ability when managing PTB rather than MTB. Children demonstrated a favorable response to the approach. (23)

A second comparative parental brushing study, affirmed a similar response, contributing additionally that caregiver assisted PTB can improve plaque outcomes compared to manual brushing in children. Munot et al. (2024) observed that parental brushing improved plaque reduction, so higher plaque clearance despite the shorter practice ($p<0.05$). (13)

In an institutional orphan child (12-16 years), both MTB and PTB improved over baseline, but powered oscillating toothbrushes produced a higher reduction in plaque and gingivitis after 4 weeks compared to MTB. Sheckhar et al. (2022) proved that among institutionalized children, a greater plaque reduction when using oscillating-rotating PTB of 41.6%, compared to MTB of 37.7%. (27)

4.2.6. Other plaque measure:

These studies focused their research not only on TMQHPI or QHPI indices but took into consideration other values such as API, PI, OHI-s and motivational tool. Durhan et al. (2018) in children aged 7 – 10 years found that both MTB and PTB reduce plaque in short follow-up supporting the general benefits of structured brushing in children, even in small samples. (17)

In contrast, Yildirim & Kayaalti Yüksek (2020) evaluated the use of motivational tool throughout the process of toothbrushing. It reported that motivational methods and individualized oral hygiene training improve short term plaque removal. Both MTB and PTB responded positively in removing plaque in short term, in the study context. Yildirim & Kayaalti Yüksek (2020) reported that motivational tools, such as videos and timer, would improve plaque clearance, creating a fun and stimulating environment for children. (15)

Similarly, when comparing ionic PTB and MTB in children 6-12 years, the documentation reported an improvement in plaque and general oral hygiene in the groups selected. The study contributed to confirming the broader evidence that plaque control can improve with both MTB and PTB when standardized dentifrices and instructions are provided. Chandra et al. (2019) ionic PTB showed comparable, but slightly higher results versus MTB, without safety issues.(19)

In parallel Aarthi and Ramesh (2025) analyzed MTB, ionic PTB and PTB in children 6-12 years reporting an improvement in plaque reduction over time when using PTB. Ionic brushes showed an oral health related outcomes improvement over time. Aarthi and Ramesh (2025) prolongated there analyses up to 6 months. Their study revealed a controlled improvement with both power variants.(20)

Finally, a pediatric dentistry trial examined children ability to brush effectively. The study reported that children improvement in plaque reduction is associated with functional and developmental abilities. MTB and PTB could be equally effective within the trial framework, emphasizing that the performance may depend strongly on skills and readiness of the individual. Regarding self-brushing Kerr et al. (2019), concluded that age depended dexterity in pediatric patients is more relevant on the brushing effectiveness more than toothbrushing type. (25)

The mean plaque reduction for MTB was 25% to 40 %, whereas for PTB achieved 50% to 70%. Across the interventional studies, the mean relative plaque reduction favored PTB by approximately 20-35% over manual (table 2).

Author (years)	Difference	Electric outcome	Manual outcome	P-value	Comments
Munot (2024) (13)	Yes	Baseline 2.6 → 1.1 (58% reduction)	Baseline 2.5 → 1.8 (28% reduction)	<0.05	PTB > MTB Parental
Alzarea (2025) (14)	Yes	PTB baseline 1.95 → days 45 0.16; Musical baseline 1.95 → day 45 0.19	Baseline 1.95 → days 45 0.22	<0.05	PTB > Musical > MTB Motivation
Yildirim & Kayaalti- Yüksek (2020)(15)	No	PTB + video: 55.04%; PTB + Hourglass 45.83%; PTB Control: 26.14%	MTB + video: 51.75%; MTB + Hourglass 34.83%; MTB Control 27.10%	>0.05	PTB + Video best Motivation
Ludovichetti (2025)(16)	No	Baseline 74% → 36% → instruction 25-28%	Baseline 74% → 40-42% → instruction 27-29%	= 0.41	MTB = PTB
Durhan (2018) (17)	Yes	Baseline 2.25 → 2 weeks 1.37	Baseline 2.71 → 2 weeks 2.25	= 0.005	PTB > MTB
Aggarwal (2019) (18)	No	Ultrasonic 111,92% pre, post 208,14%; Multidirectional 189,06% pre, post 395.19%	42,34% pre-brushing, post 63%	<0.001	Multidirectional > Sonic > Manual

Chandra (2019)(19)	No	Baseline 2.20 → 1.05 15 d → 0.55 30 d	Baseline 2.15 → 1.40 15d → 1.15 30d	<0.001	Ionic > MTB
Aarthi & Ramesh (2025) (20)	Yes	Good plaque control & anxiety reduced	Worse PI % GI	<0.05	Sonic > PTB > MTB
Mareddy (2024) (21)	Yes	OHI-s: 0.76 TQHI: 0.66	MTB: OHI-s:0.28 TQHI: 0.24 Chewable: OHI-s: 0.60 TQHI: 0.56	=0.001	PTB > Chewable > MTB
Obukavitha(2024) (22)	Yes	Great reduction 30-90 days	Minimal long-term reduction	<0.001	App based > PTB > MTB Motivation
Purushotham(2021) (23)	Yes	81% PI: 1.52	57% PI: 1.07	<0.001	PTB > MTB Parental
Abdullah (2025) (24)	Yes	PTB post 26.32%, differences 30.96%	U-shaped post 55.53%, differences 7.98%; MTB post 41.13%, differences 25.15%	<0.001	PTB > MTB > U- shaped
Kerr (2019) (25)	No	93.7%	102.8%	<0.05	MTB = PTB, Motor ability
Elizondo (2023) (26)	Yes (after 4 weeks)	Pre 9.8% Week 4, 5.85%	Pre 7.44% Week 4, 8.57%	0.5	PTB > MTB
Shekhar (2022) (27)	Yes	Baseline 1,01→ 0.59 (41.6% reduced)	Baseline 0.98 → 0.63 (34.7 % reduced)	= 0.001	PTB > MTB

Table 2: Comparative outcome on plaque reduction (power vs manual)

4.3. Gingival health index outcome:

Among the included studies, gingival health was primarily assed using Gingival index (GI) and modified gingival index (MGI). Outcomes were compared between MTB and PTB, influenced by motivational tools or supervised brushing protocols.

Most of the studies reported a significant reduction in gingival inflammation, regardless the type. Pediatric patients undergoing brushing technique enhanced a positive response regarding gingival health. However, when comparing manual and electric, PTB demonstrated a greater and consistent improvement, particularly in those studies with longer follow-up and structured motivation.

Yildirim and Kayaalti- Yüksek et al. (2020), after 15 days a reduction in GI values was observed in the all the intervention groups ($p<0.05$), regardless the tooth type. When PTB were used in correlation with motivational aids (music video or timer), the percentages reduction of GI was significantly higher. (15)

4.3.1. Manual vs Electric toothbrushes

Most of the trials, comparing MTB and PTB stated a greater reduction of GI when using PTB, even though the findings where not always statistically significant.

The study involving children with age 6-12 years, Aarthi and Ramesh et al. (2025) indicated that MTB showed a significant and progressive growth in GI indexes over time. The group where PTB where involved, gingival health improved, decreasing the value of GI over the 6 months trials ($p<0.001$). Sonic toothbrushes enhanced and improved the gingival health, reducing GI and overall improving comfort and lower anxiety. (20)

In parallel, Aggarwal et al. (2019) stated a reduction of GI in all the groups assessed. However, MTB user evidenced a less favorable gingival outcome compared to PTB users, revealing an importance of PTB. Multi-directional power brushes revealed a pronounced 395% mean plaque improvement at week 4 ($p<0.001$). (18)

4.3.2. GI influence by supervision & motivation:

Studies which included the use of motivational aids and parental supervision, indicated a GI reduction and so an improvement on gingival health regardless on the toothbrush selected.

Munot et al. (2024), evaluated the importance of parental involvements during the process of brushing in pediatric patients, using MTB and PTB. Its focus was on the improvement of PI. Gingival inflammation is correlated with PI, and throughout this study a significant gingival improvement was confirmed every time there was a reduction in plaque value. (13)

Furthermore, Yildirim and Kayaalti- Yüksek et al. (2020) affirmed that the application of motivational tool (music, timer, video) while brushing, would positively influence gingival health and so a gradual improvement on the GI. (15) (table 3)

Authors	**Manual outcomes**	**Power outcomes**	**Comments**
Yildirim & Kayaalti-Yüksek (2020) (15)	GI reduced (0.54→0.30; 0.61→ 0.40; 34.4%))	Reduce GI (0.83→ 0.55; 0.48→0.23; 33.7%)	P<0.05, No significant difference
Aarthi & Ramesh (2025)(20)	GI increase (0.35→2.54 at 6 month) Poor improvement	GI improve (1.65→1.50 6 months, (9% less)) Sonic best (1.88→1.50)	PTB & sonic (-20%) GI improvement vs Manual (p<0.05)
Ludovichetti et al. (2025)(16)	PCR reduction, 1.08→0.66; -38,3%	PCR reduction 1.06→0.57; -46.2%	No difference; PTB 8% more
Chandra et al. (2019)(19)	GI improvement 15-30 days (20-25%)	Ionic superior (30-35%)	Both effective, Sonic best, Safe
Durhan et al. (2018)(17)	Reduced TQHPI & API 2 weeks	Significant reduction (p<0.001)	Smart(app-based)/power Superior
Mareddy et al. (2024)(21)	OHI-S reduced (2.24→ 1.96)	OHI-S reduce (2.52→ 1.79)	PTB plaque/ gingival improvement (30-35% reduction)
Aggarwal et al. (2019) (18)	29% PI reduced,	65% PI reduced	Multidirectional best gingival outcome

	Gingival improvement	Gingival improvement	
Shekhar et al. (2022) (27)	MGI 1.08 → 0,66(-38.3%)	MGI 1.06→ 0.57 (-46.2%)	PTB reduce gingivitis
Munot et al. (2024) (13)	GI correlated PI (-28%)	GI/PI reduced (-58%)	Parental PTB best
Obukavitha et al. (2024) (22)	Not specified GI, plaque related	Reduced inflammation after 30-90 days	Smart(app-based)/power superior

Table 3: Comparative outcome on gingival parameters (Manual vs Power)

5. DISCUSION

The results of this systemic review demonstrated that both manual toothbrush (MTB) and power toothbrush (PTB) are effective in the reduction of dental plaque, biofilm, and gingival inflammation in pediatric population. Across all 15 included studies, statistically significant reduction in plaque score from baseline was consistently reported regardless of toothbrush type, confirming that mechanical plaque removal is the cornerstone of pediatric oral hygiene.

However, the reduction differed across the studies. This discrepancy was mostly affected by the methodological difference:

- Supervised vs unsupervised brushing
- Given individual instruction
- Follow up length
- The type of indices used
- Type of brush (sonic, ultrasonic, ionic, multidirectional, musical, manual, U-shaped manual, ionic, oscillating-rotating PTB, App-based/smart)

5.1. Plaque reduction outcome:

Although plaque reduction was achieved with both modalities, studies have reported magnitude and persistence of plaque reduction when using PTB, indicating potential advantages.

5.1.1.Quantitative biofilm assessment using IAS (image analysis system):

Elizondo et al. (2023) stated that digital biofilm analysis had a stronger presence of biofilm destruction with PTB. (26) Unlike normal plaque indices (PCR, API…), digital quantification objectively measured the percentages of biofilm on the surface, reducing bias.

Interestingly, this study outstands the long-term superiority of PTB, whereas with Ludovichetti et al. (2025) and Alzarea et al. (2025) plaque indexes-based studies found early advantages or no difference at all. (14,16) These differences could be affected by the high sensitivity of the image analysis methods. Oscillating rotating PTB report a better destruction of mature biofilm. Therefore, the type of measurement methods may partly explain why some studies demonstrated clearer PTB superiority.

5.1.2.PCR and the role of instruction:

Ludovichetti et al (2025) demonstrated that plaque reduction highly improves when individualized instruction is given regardless of the brush type, PTB of 25-28% and MTB of 27-29%. (16) This affirmation is in contrast with Aggarwal et al. (2019), who report that PTB outrun MTB even when individualized training is performed. (18) This difference may be explained by several factors: firstly, the difference in age range of the patients included in the study (6-15, Ludovichetti et al. (2025)) vs (9-16, Aggarwal et al. (2019)). Secondly, there was a difference in the length of the follow-up period: Ludovichetti et al. (2025) carried out a single session study whereas Aggarwal et al. (2019) observed the patients for a 4-week period. Lastly, the individualized brushing training provided to the patients differed between the two studies: Ludovichetti et al. (2025) provided individualized instruction for each patient vs Aggarwal et al. (2019) reported individual instruction explaining the only bass-stillman technique.(16,18)

Similarly, Yildirim et al. (2020) also reported that motivational tools improve plaque outcome regardless the toothbrush selection, reinforcing that behavioral factor influence plaque reduction. (15)

The PCR based studies indicate that education and compliance can reduce intergroup differences, potentially masking mechanical advantages of PTB.

5.1.3.QHPI and TMQHPI and motivational outcome:

Most studies focused and assessed the plaque level using mainly Quigley-Hein plaque index (QHPI) and Turesky Modified Quigley-Hein (TQHPI). Analyzing all the studies, a significant and consistent plaque reduction was observed. However, it reported that PTB or Musical PTB or App based PTB showed greater early plaque reduction. (14,18,22)

Aggarwal et al. (2019) demonstrated that multidirectional toothbrushes reported the highest plaque reduction 189,06% compared to MTB 42,3% and Ultrasonic PTB 111,92%. Suggesting a positive response in the use of PTB ($p<0.001$). (18) Similarly, Obukavitha et al. (2024) comparing app-based PTB, PTB and MTB, app-based PTB had greater response in plaque reduction of 1.39 at baseline up to 0.31 at 90 days ($p<0.001$).(22) In contrast, Alzarea et al. (2025) reported no significant differences in the different type of toothbrushes, showing a comparable improvement in all three types especially at day 45. MTB from 0.51 to 0.22 (post-brush) with

p<0.001, musical PTB from 0.46 to 0.19 (post-brush) with p = 0.023 and PTB 0.24 to 0.16 (post-brush) with p = 0.083. (14)

Distinctively, Kerr et al. (2019) showed that child developmental capacity influenced plaque removal more than the brush selected, suggesting that MTB effectiveness improves when motor skills mature. (25)

This pattern suggests that the studies reported, show that PTB provide an advantage in reduction of plaque, suggesting that multidirectional PTB, app-induced PTB and Musical PTB are considered the most effective and relevant in the usage. Regarding the use of MTB in children is highly influenced by the adequate supervision by parents and the ability of the child to brush. PTB is better accepted due to the use of motivational tools such as videos, games, music.

5.1.4.Full mouth plaque score (FMPS):

FMPS analyzes and supports the superior performance of conventional PTB designs compared with non-traditional alternatives. Specifically, PTB achieved a greater plaque reduction compared to U-shaped or simplified designs. This indicated that toothbrush design and brushing mechanisms are important parameter to take into consideration in plaque control efficacy. (24)

Abdullah et al. (2025) affirmed that battery PTB achieved a greater plaque reduction of 30.96% compared with both MTB of 25.15% and U-shaped brushes of 7.98% with p <0.001.(24) Similarly, Mareddy et al. (2024) reported a higher plaque reduction when using PTB of 0.66 compared to MTB of 0.24 and Chewable of 0.56 (p = 0.000). (21) However, do to the fact that U-shaped brushed underperformed, this affirmed that not all PTB or MTB designs are equivalent. (24)This finding aligns with Aggarwal et al. (2019) where multidirectional PTB output MTB. (18) The similarity in these studies may be because of several factors: firstly, the alikeness in the age range of the patients included in the study (Abdullah et al. 8 – 12, Mareddy et al. 8 – 14 and Aggarwal et al. 9 – 16). Secondly, in the parameter evaluated focusing on plaque removal, Abdullah et al. (2025) FMPs, Mareddy et al. (2024) TQHI and Aggarwal et al. (2019) TQHI. (18,21)

These findings reported and showed to not assume equivalence among all PTB, and it highlights the importance of selecting an adequate toothbrush design for pediatric patients. (24)

5.1.5.Caregiver-assisted brushing and special population:

Those studies involving caregiver-assisted brushing in preschool children frequently favors PTB. Parents reported greater facility in the use and an improved plaque removal when using PTB, due to the reduced dependance on the motor skills. (13,23)

Purushotham et al. (2021) and Munot et al. (2024) both reported greater plaque removal with PTB when used by parent. (13,23) Oppositely, Ludovichetti et al. (2025) where children reported similar results between brushing type when the instruction are given. (16) The difference may be explained by several factors: firstly, in the difference of the age range of the patient included on the study, that influence the dexterity of the patient, 3-5 Purushotham et al. (2021) and 4-8 Munot et al. (2024) vs 6-15 Ludovichetti et al. (2025). Secondly, Purushotham et al. (2021) and Munot et al. (2025) reported individualized instruction with parental supervision vs Ludovichetti et al. (2025) reported individualized instruction. Parents showed positive response in the use of PTB rather than MTB with Purushotham et al. (2021) and Munot et al. (2024). (13,16,23)

Similarly, in institutionalized orphan children and adolescent population, PTB indicated a greater plaque reduction than MTB. These results indicated that PTB may be more advantageous in children with limited dexterity, reduced motivation or inconsistent brushing routines.(27)

PTB are considered more advantageous in younger age groups with reduced motor control.

5.1.6. Other plaque measure outcomes and motivational tools outcomes:

Technological intensification such as musical and app-induced toothbrushes were correlated with improved plaque outcomes, particularly in short-term follow-up. These tools seem to improve plaque control essentially by enhancing child engagement and compliance, rather by mechanical superiority alone. (15,17,19,20)

Across the four studies all toothbrushes intervention enhances oral hygiene, but the magnitude of plaque reduction varied according to both the technologies applied and the presence of motivational tools. Yildirim et al. (2020) all groups reported significant reduction in

PI and GI after 15 days, but the heists plaque reduction was observed when PTB was combined with music video of 51.8%, whereas the smallest reduction was seen in the PTB controlled of 26.1%.(15) This can suggest that interactive reinforcement can enhance brushing effectiveness. However, when comparing it with Durhan et al. (2018), an interesting difference appears, the difference in plaque reduction resulted highly significant when comparing MTB and PTB, PTB being best option. The API was of 56.4% with PTB vs 83.4% with MTB. (17) Therefore, Durhan et al. (2018) compared with Yildirim and Kayaalti-Yüksek (2020) provided a stronger and relevant support in the efficacy of PTB. (15,17)

The study of Chandra et al. (2019) similarly supports the concepts that enhanced toothbrush technology can improve plaque removal beyond MTB. They report no baseline differences between ionic PTB and MTB but at 15 and 30 days the ionic brush achieved higher plaque reduction than MTB. At day 15 MTB 1.40 to 0.50 and ionic PTB 1.05 to 0.22 ($p = 0.007$) and at day 30 MTB 1.15 to 0.67 and ionic PTB 0.55 to 0.51 ($p = 0.003$). (19) In comparison Durhan et al. (2018), both studies support technologically enhanced brushes over MTB. (17) However, Chandra et al. (2019) also argued that ionic brushes can improve acceptance and compliance, which places his finding closer to Yildirim and Kayaalti-Yüksek et al. (2020) findings, reporting that motivation and user acceptance are modifiers of plaque control. (15,19)

Aarthi and Ramesh et al. (2025) extend their study by examining behavioral outcomes such as anxiety. Their finding suggests that technologies, especially sonic brushes, may not only improve oral health but also the children experience while brushing. They found an improvement across both PTB and Sonic groups, affirming that power movements combined with strategies may synergistically improve plaque level. (20)

However, the lack of consistent statistically significant differences across all studies suggest that motivational features should be considered adjuncts rather than replacement for effective brushing technique and supervision. (15,17,19,20)

5.2. Gingival health index outcomes:

The findings stipulated that both toothbrushes significantly improve GI scores. However, PTB especially ORPTB and sonic types tend to reveal greater reduction in gingival inflammation.

Yildirim and Kayaalti-Yüksek et al. (2020) detected a significant reduction in GI parameters in all the groups after 15 days ($p<0,05$), regardless of the tooth selection. MTB with video 44.4% and PTB with video 33.7%. These finding demonstrated the biological relationship between plaque control and gingival inflammation reduction. When plaque accumulation is reduced, gingival inflammation parameter improves. Therefore, the main factors to take into consideration for gingival improvement are plaque removal and brushing consistently, rather than focusing on the toothbrush itself. (15)

5.2.1.Manual vs Power toothbrush:

The result indicated, show that both MTB and PTB reduce GI. However, PTB frequently show a greater or sustained reduction in GI scores.

Aarthi and Ramesh (2025), the MTB reports a worsening of the GI values over time going baseline 0.35 to after 6 months 2.54, whereas for the PTB from 1.65 to 1.50 and sonic group from 1.88 to 1.50 revealing a significant improvement, being the sonic the most effective ($p<0.001$). This imply that PTB can compensate for the limited manual dexterity typical in children aged 6-12 years. (20)

Similarly, Aggarwal et al. (2019) indicated that PTB groups compared to MTB show a greater plaque reduction ($p=0.005$).(18) Durhan et al. (2018) also demonstrated similar response, supporting that PTB report greater reduction on plaque. (17) Given the relationship between plaque and gingival inflammation, these findings indirectly support improved gingival outcomes in PTB user. However, Ludovichetti et al. (2025) found no relevant difference between MTB and PTB when individualized instruction where given. (16)

Collectively, these observations suggests that PTB can provide a mechanical advantage, especially in younger children or those with excellent technique, but this advantage is affected by supervision and education.

5.2.2. Supervision and motivation:

The result focuses on the importance of motivational tools and parental involvement in the gingival improvement.

Yildirim and Kayaalti-Yüksek et al. (2020) expressed that motivational tool, such as music video, timer improved both plaque and gingival scores, even though the difference were not statistically significant. This imply that behavioral support enhances brushing efficacy and indirectly improve gingival health. (15)

Mareddy et al. (2024) established that PTB achieved highest plaque reduction, followed by chewable and MTB. Even though gingival outcomes were not the primary endpoint, improved plaque removal is highly correlated with gingival inflammation reduction. (21)

This information, point out to the importance of compliance, motivation and parental monitoring in gingival improvement. In pediatric patients, behavioral components are as important as mechanical characteristics of toothbrush.

6. CONCLUSIONS

This systemic review demonstrated that both manual toothbrush (MTB) and power toothbrush (PTB) are effective in the reduction of dental plaque, gingival inflammation and biofilm in pediatric patients. However, PTB often achieved a more sustained plaque reduction and gingival improvement, especially when assessed through quantitative methods, used on younger children or to caregiver-assisted and on less compliant patients.

Therefore, PTB are tools that should be recommended in pediatric patients. However, oral hygiene education and parental involvement remain essential for optimal oral health, when considering pediatric patients.

7. SUSTAINABILITY

While the main aim of this systemic review is to evaluate and compare the effectiveness of manual toothbrush (MTB) and power toothbrush (PTB) in pediatric patients in terms of plaque reduction and gingival health, it's also fundamental to take into consideration the environmental aspects and impact of these oral devices.

MTB are highly used due to their low cost, accessibility and simplicity. Their main components are non-biodegradable materials such as polypropylene and nylon. These materials play a huge part in plastic waste, since toothbrushes should be replaced every 3-4 months according to the international oral health recommendation. The studies used in this review did not directly asses' environmental outcomes. Considering worldwide pediatric population, the amount of waste generated by MTB represent an important impact on environmental aspects. Even though biodegradable or bamboo alternatives exist they were not directly included in the study.

PTB demonstrated to be superior in plaque reduction in several reported studies, however when talking about sustainability PTB represent both advantages and challenges. PTB have reusable handles and require only head changes every 3 months. Never less, the production involves more complex material, including battery and mixed plastics. Battery disposal and electronic waste can contribute to environmental pollution. Although PTB can reduce plastic waste compared to MTB, their lifecycle environmental impact can be generally higher due to their electronic components.

Currently, no included studies evaluate directly environmental outcomes. Therefore, sustainability remains un untouched aspect in the comparison between MTB and PTB in pediatric patients.

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