LITHUANIAN UNIVERSITY OF HEALTH SCIENCES
MEDICAL ACADEMY
FACULTY OF ODONTOLOGY
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2024, OF15

IMPACT OF ELECTRIC VS MANUAL TOOTHBRUSHES IN PERIODONTAL HEALTH: A SYSTEMATIC LITERATURE REVIEW

The Master's thesis of the Master's degree study programme "Odontology"

Supervisor of the Master's thesis
Assoc. Prof Ingrida Marija Pacauskiene

(signature)

Kaunas, 2024

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Kaunas, 2024

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No	MT parts	Evaluation criteria for the Master's thesis structural and methodological requirements	Evaluation* (1-10 points)
1	Summary	Is the summary informative and in compliance with the thesis content and requirements? Do the keywords match the essence of the thesis?	
2	Introduction	Are the novelty, relevance and significance of the work justified in the introduction of the thesis?	
3	Aim and objectives	Are the aims and objectives formulated properly and clearly? Are the aim and objectives interrelated?	
4	Criteria for articles selection	Were the eligibility criteria of articles determined? Are all the information sources (databases with dates of coverage, contact with the authors of articles) described and is the last search day indicated? Is the electronic search strategy described in such a way that it could be repeated?	
5	Search methods and strategy	Is the selection process of articles (screening, eligibility for systematic review or, if applicable, for meta-analysis) described? Is the process of data selection from articles described (types of research, participants, interventions, factors analyzed, and indicators)? Were all the variables, for which data were searched and described, listed and described? What assumptions or simplifications were made? Were the key	

		measurement indicators (relative risk, mean differences) identified?	
6	Systemization and analysis of data	Is the number of checked articles given: included (after their eligibility evaluation), and rejected (with reasons at each stage of rejection indicated)? Are the characteristics of the described studies (from the included articles according to which the data were taken) provided (e.g., study sample, observation period, type of subjects)? Are systemized publication data presented in tables according to individual objectives?	

7	Discussion	Are the main findings summarized and is their significance indicated? 38 Are the limitations of the performed systematic review discussed? Does the author present the interpretation of the results?	
8	Conclusions	Do the conclusions reflect the topic, aim and objectives of the Master's thesis and are they based only on the analyzed material? Are the conclusions clear and concise? Suggestions and practical recommendations (optional)	
9	List of references	Is the references list compiled according to the requirements and are the references to the text correct? Do the cited sources not older than 10 years compose at least 70% of the references, and the sources not older than 5 years make up at least 40%?	
10	General requirements	Do the presented annexes help to understand the analyzed topic? Are the volume, structure, language, layout and quality of the text appropriate? Is the amount of plagiarism at work not exceeded> 20% (not assessed)?	

		* Final evaluation (the average evaluation of 1 to 10 sections)	

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IMPACT OF ELECTRIC VS MANUAL TOOTHBRUSHES IN PERIODONTAL HEALTH

SUMMARY

Aim and objective: The main objective of this systematic review is to compare electric toothbrushes and manual toothbrushes in different clinical parameters.

Material and methods: An electronic database was conducted through PubMed to find research articles using a combination of keywords. The articles included were no more than ten years old, and all articles were randomized controlled trials.

Results: The primary search identified 778 articles, of which seven were included in this systematic review. Electric toothbrushes showed high statistical significance in two studies, (Ccahuana-Vazques et al. and Adam R et al.). According to the gingival index were significantly greater with ETB by studies (Gallob et al. and A Ramseier C et al.) Electric toothbrushes were also found to be more effective in reducing BoP, as reported by Ccahuana-Vazquez et al.
Although the results of the study by A Ramseier c et al. were not statistically significant, they were different in that they measured cytokines in GCF and showed a decrease in inflammatory markers with the use of electric toothbrushes.

Conclusion: Electric toothbrushes demonstrated greater effectiveness than manual toothbrushes in several key aspects of dental health, such as plaque reduction and gingival health improvement. More research is required to confirm the results, which indicate possible systemic benefits from reduced inflammation (as demonstrated by cytokine levels in GCF).

Keywords: Electric toothbrush, manual toothbrush, plaque index, periodontal health

Elektrinių ir rankinių dantų šepetėlių poveikis periodonto sveikatai

Santrauka

Tyrimo tiklslas: Pagrindinis šios sisteminės apžvalgos tikslas – palyginti elektrinių ir rankinių dantų šepetėlių poveikį klinikiniams periodonto sveikatos parametrams.

Medžiaga ir metodai: Straipsnių atrankai naudota elektroninė duomenų bazė PubMed, mokslinių straipsnių paieška atlikta naudojant raktinių žodžių derinį. Įtraukti straipsniai buvo ne senesni nei dešimt metų ir visuose straipsniuse buvo nagrinėjami atsitiktinių imčių kontroliuojami tyrimai.

Rezultatai: Pirminės paieškos metu buvo atrinkti 778 straipsniai, iš kurių septyni buvo įtraukti į šią sisteminę apžvalgą. Dviejuose tyrimuose, tokiuose kaip Ccahuana-Vazques ir kt., ir Adam R ir kt. elektriniai dantų šepetėliai buvo statistiškai reikšmingi. Pagal tyrimus Gallob ir kt. bei A Ramseier C ir kt. dantenų indeksas buvo žymiai didesnis valantis elektriniais dantų šepetėliais. Taip pat buvo nustatyta, kad elektriniai dantų šepetėliai veiksmingiau mažina BoP, Ccahuana-Vazquez ir kt. Nors A Ramseier c ir kit. tyrimo rezultatai nebuvo statistiškai reikšmingi, nustatytas uždegiminių žymenų sumažėjimas naudojant elektrinius dantų šepetėlius.

Išvados: Elektriniai dantų šepetėliai yra efektyvesni už rankinius dantų šepetėlius keliais pagrindiniais dantų sveikatos aspektais, mažinant apnašas ir gerinant dantenų sveikatą. Reikia daugiau tyrimų, kad būtų patvirtinti rezultatai, kurie rodo galimą sumažėjusį uždegimą periodonto audiniuose (citokinų lygis GCF).

Raktiniai žodžiai: Elektrinis dantų šepetėlis, rankinis dantų šepetėlis, apnašų indeksas; periodonto sveikata

INTRODUCTION

Dental plaque is a prevalent inflammatory lesion that arises from the connection between the biofilm and the host's immune and inflammatory response [1]. Since periodontitis is caused by the build-up of a plaque biofilm at and below the gingival margin, controlling gingivitis is a primary and secondary preventive procedure for periodontitis. Therefore, maintaining and removing plaque is essential to preventing periodontal diseases [2]. To preserve oral health, brushing the teeth is a proven healthy habit that aims to remove dental plaque [3]. Effective plaque removal depends on the type of toothbrush and the proper brushing technique [4].

Most people are still determining how to remove dental plaque properly and, therefore, cannot perform adequate dental hygiene. Additionally, brushing can be difficult, time-consuming, and unpleasant, particularly for people with decreased manual dexterity [5]. Although a few methods are available these days for reducing bacterial plaque from teeth, brushing is thought to be the most efficient. The manual toothbrush (MTB) is a generally used, broadly accepted, low-cost equipment. The 1940s featured the first release of electric toothbrushes (ETB) with both circular and straight brush heads (1). Two recently dominated market technologies are sonic vibration and oscillation-rotation (O-R). Plaque is essentially brushed from the tooth surface by direct contact when using O-R, which involves rotating a rounded brush head. Instead, using shear forces that can be applied beyond the sense of touch, sonic toothbrushes impact dental plaque colonies through lateral, side-to-side vibration [6]. The invention of interactive electric toothbrushes with built-in timing, pressure control, and actual performance feedback via a mobile app connected to the electric toothbrush. An MTB usually necessitates a more careful brushing approach, as recommended by the American Dental Association (ADA) [7].

This systematic review focused on how effective electric toothbrushes are compared to manual toothbrushes in reducing plaque, gingival, bleeding index, and gingival crevicular fluid. Several studies have evaluated the effectiveness of MTB and ETB and found that ETB is more effective than MTB in reducing dental plaque, gingivitis, and bleeding [1].

Gingival crevicular fluid (GCF) is a fluid produced because of periodontal inflammation and plays a significant role in maintaining oral health. In many studies, GCF has been discovered to contain a range of anti-inflammatory compounds, including interleukin (IL)-1β and matrix metalloproteinases (MMPs). These compounds work together to combat the harmful effects of plaque, which is made

up of bacteria and chemicals. Plaque, in turn, is targeted by responsible agents, such as dental hygiene professionals, to maintain optimal oral health [8,9].

1.1 Aim

The aim is to assess the impacts of electric-powered and manual toothbrushes on periodontal health.

1.2 Objectives

1. Compare the efficacy of electric vs. manual toothbrushes on plaque index.
2. Determine the gingival index between electric and manual toothbrushes.
3. Assess the bleeding index of electric and manual toothbrushes.
4. Analyse the level of cytokines present in saliva GCF.

1.3 Hypothesis

Electric toothbrushes may reduce bleeding, gingival, and plaque index more than manual ones.

ABBREVIATIONS

ADA – American Dental Association

BI – Bleeding index

BoP – Bleeding on probing

ETB – Electric toothbrush

GCF – Gingival crevicular fluid

GI – Gingival index

IL-1β - interleukin-1β

OH – Oral hygiene

MTB – Manual toothbrush

MMP - matrix-metalloproteinase

PI – Plaque index

2. CRITERIA FOR ARTICLE SELECTION AND SEARCH METHODS AND STRATEGY

21. Literature search strategy

According to the PRISMA guidelines, the articles were evaluated for their eligibility in this systematic review. The articles were obtained from electronic databases, including PubMed.

Table 1 presents an overview of the databases and keywords employed in the study, along with the dates of the searches, the filters applied, and the number of results obtained.

Table 1. Overview of the search strategy

Databases	Keywords	Search dates	Filters	Search results
PubMed	Search 1 – Electric-powered vs Manual toothbrush	1/12/2023	2013-2023	3
	Search 2 – Powered toothbrush vs Manual toothbrush	1/12/2023	2013-2023	7
PubMed (advanced search)	Search 3- ((((((((electric toothbrush) AND (manual toothbrush)) AND (bleeding index)) AND (gcf)) AND (plaque index)) AND (gingival	1/12/2023	2013-2023 (Clinical and randomized trials, full text)	778

	index)) OR (powered toothbrush)) OR (oscillating)) OR (sonic electric toothbrush)			

2.2 Focus question

The focus question is formulated following the study design of the PICOS (Population, Intervention, Comparisons, Outcomes, Study Type, Focus Question).
Table 2 summarizes the focus question.

Table 2. PICOS

Population (P)	Adults >18 years with general health
Intervention (I)	Using an electric toothbrush (ETB) as part of daily OH routine
Comparisons (C)	Using a manual toothbrush (MTB) as part of daily OH routine
Outcomes (O)	Changes in PI, GI, BI, GCF
Study type (S)	Randomized controlled trial, clinical trial
Focus question	Do electric toothbrushes have higher impact on bleeding, gingival, plaque index than the manual toothbrushes?

2.3 Types of publications

This systematic review incorporated articles and studies sourced from electronic journals and databases. All analyses were conducted on human subjects and in the English language.

2.4 Types of studies

All the studies included in the analysis were published between 2013 and 2023. They were randomized clinical trials that involved human participants with plaque and bleeding control.

2.5. Population

The population included healthy participants; all participants were adults.

2.6 Data collection

The data and studies were obtained from PubMed.

2.7 Selection of studies

A set of inclusion and exclusion criteria was developed to determine the articles that may be included in this systematic review. A total of 778 publications were identified through a search of PubMed. Each search title was examined to determine its relevance to the selected topic. Relevant titles were selected for review of the abstracts. After reviewing the titles and abstracts, 738 articles were excluded, leaving 31 articles for a comprehensive eligibility review. Ultimately, seven articles were collected in this systematic review.

2.8 Eligibility criteria

The eligibility criteria for studies included were based on established inclusion and exclusion criteria.

Inclusion criteria:

1. Articles published within the past ten years.
2. Studies written in the English language.
3. Studies that evaluated clinical parameters, including bleeding on probing (BoP), plaque index (PI), gingival index (GI), and gingival crevicular index (GCF).
4. Randomized controlled clinical trials that compare the effectiveness of electric toothbrushes with manual toothbrushes.
5. Studies involve human participants 18 years or older, in good general health, and without diagnosed periodontitis, orthodontic fixed appliance, or removable prosthesis.
6. Full access articles.

7. Studies that provide sufficient data on baseline and follow-up periodontal health statuses.

Exclusion criteria:

1. Systematic reviews, literature reviews, and case reports.
2. Studies that only compare a particular group of individuals (children).
3. Studies that do not compare electric and manual toothbrushes.
4. Articles are written in languages other than English.
5. Not full access articles.
6. Small sample size (n< 25).
7. Studies with a short observation period.
8. Participants with poor oral hygiene, untreated periodontal diseases, caries, and undergoing orthodontic treatment.

2.9 Bioethics approval

LIETUVOS SVEIKATOS MOKSLŲ UNIVERSITETO
BIOETIKOS CENTRAS

Medicinos akademija (MA) Nr. 2024-BEC2-120
Vientisųjų studijų programa - Odontologija (anglų kalba)
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DĖL PRITARIMO TYRIMUI

LSMU Bioetikos centras, įvertinęs pateiktus dokumentus, moksliniam-tiriamajam darbui tema „Impact of electric vs manual toothbrush in periodontal health.“ P R I T A R I A .

dr. Aušra Urbonienė 2024-01-31 17:41:59

2.10 Risk of Bias Assessment

The Joanna Briggs Institute critical appraisal tool (JBI) evaluates the risk of bias for randomized control trials. (Criteria)

The checklist for RCTs may be found in Annex 1. The questions answered with "yes" indicate that the RCT has been performed, while "no" signifies that the RCT has not been performed. The calculated data may be found in Table 3. [10]

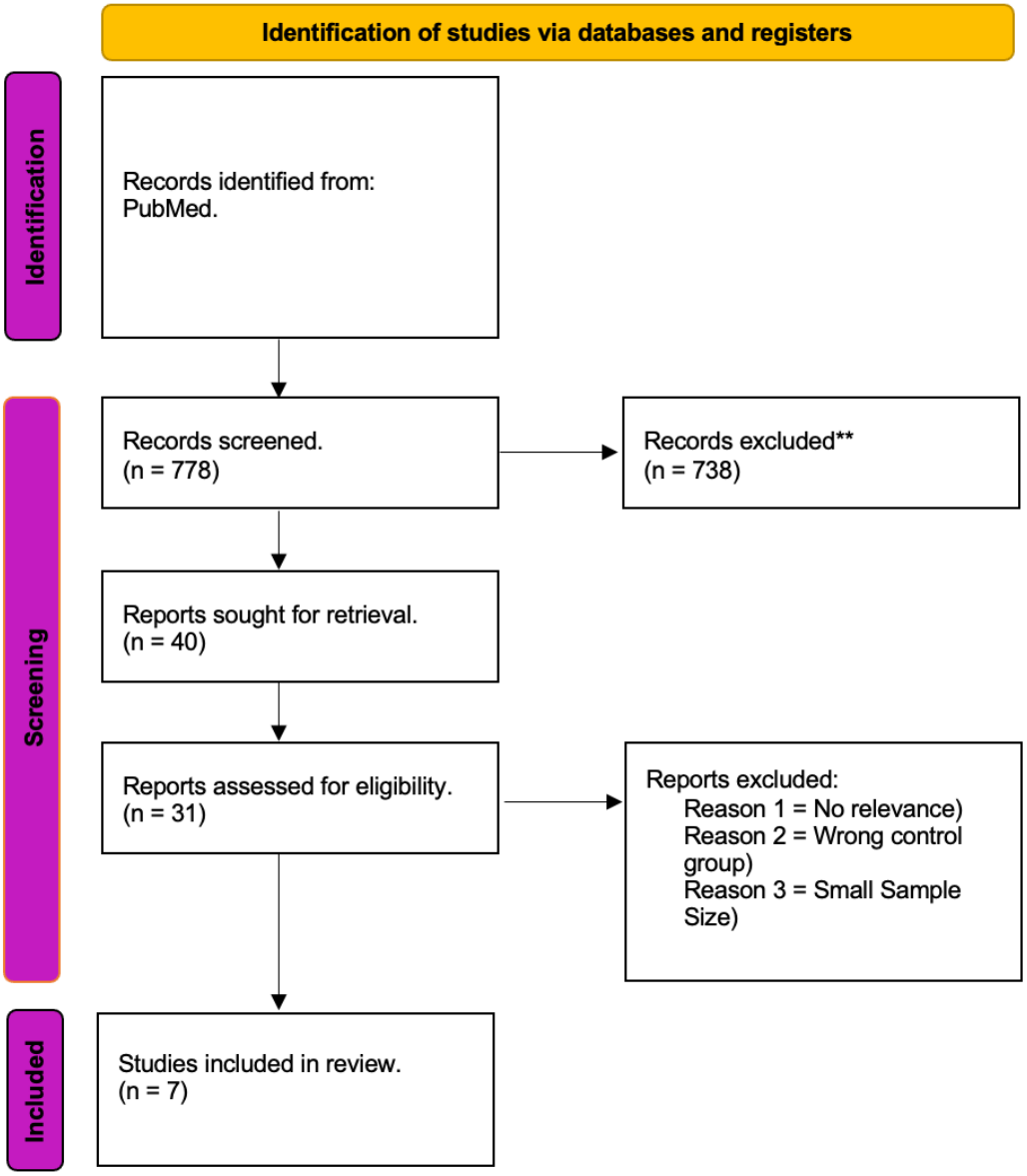
Table 3. Risk of bias.

Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13
Ccahuana-Vasquez et al. [11]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vorwerk L et al. [12]	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes	No	No	Yes	No
Nevins M et al. [13]	Yes	Yes	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No
A Ramseier C et al. [14]	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Adam R et al. [15]	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes
Gallob et al. [16]	Yes	Yes	No	No	Yes	Yes	No	No	Yes	No	No	Yes	No
Nathoo et al.(17)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Risk of bias of each study:

In summary, only two of the seven articles met all the criteria. Two articles were aware of the treatment assignment, and one article did not have a similar baseline for the treatment group. In addition, only one article ensured that the treatment was blinded. Three of the seven articles did not have complete follow-ups, and their outcomes were not reliably measured. Their trial designs also needed improvement. Only two out of the seven articles treated all participants identically. Based on these findings, four out of the seven articles were deemed to have high eligibility, while the remaining three articles did not meet as many criteria as possible.

Prisma flow chart



3. SYSTEMIZATION AND ANALYSIS OF DATA

Table 4. Demographic table

Author publication year	Study design	Country	Sample size (n=)	Age of participants (Mean age ± SD)	Gender (n=)
Ccahuana-Vasquez et al. (2018) [11]	RCT	Canada	(n=150)	(45.7 ± 12.89)	Female: (n=96) Male: (n=54)
Vorwerk L et al. (2016) [12]	RCT	USA	(n=60)	(46.20 ±11.56)	Female: (n=44) Male: 16
Nevins M et al. (2021) [13]	RCT	Italy, USA, Peru	(n=78)	(35,68 ± 13,01)	Female: (n=62) Male: (n=16)
A Ramseier C et al. (2021) [14]	RCT	Canada	(n=60)	(22.8± 3.08)	Female: (n=31) Male: (n=29)
Adam R et al (2020) [15]	RCT	Germany	(n=27)	(42.0 ±10.46)	Female: (n=14) Male: (n=13)
Gallob et al. (2015) [16]	RCT	USA	(n=79)	(49.25 ± 13.5)	Female: (n=58) Male: (n=21)
Nathoo et al. (2014) [17]	RCT	USA	(n=120)	(40.93 ± 1.18)	Female: (n=71) Male: (n=49)

RCT= Randomized control trial, SD= Standard deviation

Table 5. The studies included an overview of toothbrushes, parameters, participants, and time measured.

Author	Parameters	Toothbrushes	Participants	Time measured
Ccahuana-Vasquez et al. [11]	PI BoP GI	Manual TB ADA Electric TB Oral-B vitality	75 75	B, 5 weeks
Vorwerk L et al. [12]	PI	Manual TB ADA Electric TB Arm & Hammer spinbrush truly radiant clean & fresh battery	60 60	B, 1 week
Nevins M et al. [13]	PI BoP PD GI	Manual TB Electric TB IONPA iconic – sonic	39 39	B, 2 and 5 weeks
A Ramseier C et al. [14]	PI GI GCF BoP	Manual TB Oral-B indicator 35 soft Electric TB Oral-B professional care oxyjet 1000 center	30 30	B, 2, 4, 8 weeks
Adam R et al. [15]	PI	Manual TB ADA Electric TB Oral-B iO	27 27	B, 2, 4, 6 and 8 days
Gallob et al. [16]	PI GI	Manual TB Electric TB Colgate	40 39	B, 4 and 12 weeks
Nathoo et al. [17]	PI GI	Manual TB Electric TB ProClinical C200 sensitive brush head Electric TB ProClinical C200 triple clean brush head	40 40 40	B, 4 weeks

TB= toothbrush, PI=plaque index, BoP= bleeding on probe, PD= periodontal diseases, GI= gingival index, ADA= American Dental Association, B= baseline

	PI		GI		BoP		GCF	
	MTB	ETB	MTB	ETB	MTB	ETB	MTB	ETB
Author	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean ±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**	**Mean±SD**
Ccahuana-Vasquez et al. [11]	**W0-** 0.633±0.0486 **W5-** 0.064±0.0048*	**W0-** 0.633±0.0486 **W5-** 0.127±0.0048 *	**W0-** 2.104±0.0880 **W5-** 0.114±0.0106*	**W0-** 2.096±0.0813 **W5-** 0.275±0.010*	**W0-** 0.152±0.1173 **W5-** 0.035±0.0030*	**W0-** 0.146±0.0957 **W5-** 0.081±0.0030*	N/A	N/A
Vorwerk L et al. [12]	**W0-** 0.738±0.095 **W1-** 0.554±0.10 *	**W0-** 0.724±0.088 **W1-** 0.429±0.093*	N/A	N/A	N/A	N/A	N/A	N/A
Nevins M et al. [13]	**W0-**1.50±0.51 **W2**-0.20±0.26 **W5**-0.68±0.48*	**W0-** 1.57±0.54 **W2-** 0.36±0.38 **W5-** 0.75±0.42*	**W0-** 1.02±0.51 **W2-**0.08±0.11 **W5-** 0.52±0.31*	**W0-** 1.24±0.75 **W2-** 0.26±0.32 **W5-** 0.61±0.31*	**W0-** 13% ±0.05% **W5-** 10%±0.06%	**W0-** 15%±0.03% **W5-** 11%±0.08%	N/A	N/A
A Ramseier C et al. [14]	**W0-**1.34±0.21 **W2**-0.90±0.28 * **W4**-0.82±0.27 * **W8**-0.62± 0.32 *	**W0-** 1.29±0.21 **W2-** 0.69±0.26 * **W4-** 0.62±0.28 * **W8-** 0.35±0.21 *	**W0-** 1.07±0.14 **W2-**0.91±0.22 * **W4-**0.86±0.18 * **W8-** 0.813±0.18 *	**W0-** 1.07±0.10 **W2-** 0.74±0.21 * **W4-** 0.72±0.18 * **W8-** 0.618±0.16 *	**W0-** 34.867±10.362 **W2-** 28.17 * **W4-** 23.27 * **W8-** 22.67 *	**W0-** 34.867(10.362) **W2-** 19.07 * **W4-** 15.97 * **W8-** 13.47 *	IL-1β **W2-** 2.793±0.133 **W4-** 3.167±0.082 **W8-** 3.083±0.093 MMP-3 **W2-** 2.343±0.105 **W4-** 1.923±0.144	IL-1β **W2-** 2.824±0.135 **W4-** 2.946±0.081 **W8-** 2.792±0.093 MMP3-**W2-** 2.379±0.107 **W4-** 2.149±0.141 **W8-** 2.010±0.124

							W8- 2.230±0.124 MMP-8- **W2-** 6.727±0.241 **W4-** 7.179±0.113 **W8-** 7.383±0.143	MMP8- **W2-** 6.775±0.245 **W4-** 7.073±0.111 **W8-** 7.185±0.143
Adam R et al. [15]	**W0-** 3.924±0.0673 **W1-** 1.321±0.0938*	**W0-** 3.987±0.0674 **W1-** 2.250±0.0945 *	N/A	N/A	N/A	N/A	N/A	N/A
Gallob et al. [16]	**W0**- 0.65±0.04* **W4**-0.54±0.11* **W12**- 0.49±0.11*	**W0-** 0.66±0.04* **W4-** 0.36±0.09* **W12-** 0.29±0.08*	**W0-** 1.11±0.05* **W4**- 1.14±0.07* **W12**- 1.16±0.08*	**W0-** 1.14±0.10* W4- 1.06±0.05* **W12-** 0.99±0.07*	N/A	N/A	N/A	N/A
Nathoo et al. [17]	**W0-**0.72±0.14* **W4-**0.44±0.21*	**W0**- 0.75±0.11* **W4**- 0.24±0.11* (Triple clean brush): **W0**- 0.71±0.10 **W4**- 0.21±0.09	**W0**- 1.49±0.31* **W4**- 1.46±0.29*	**W0**- 1.56±0.31* **W4**- 1.28±0.27* (Triple clean brush): **W0-** 1.50±0.38* **W4**- 1.20±0.27*	N/A	N/A	N/A	N/A

Table 6. Baseline mean and follow-ups of PI, GI, BoP, GCF.
W0-W12 describes the timer interval between each follow-up. * = statistically significant

Comparative analysis of Plaque index (PI), Gingival index (GI), bleeding on probing (BoP), and gingival crevicular fluid (GCF) between manual and electric toothbrushes

The present study evaluated the effectiveness of manual toothbrushes (MTB) compared to electric toothbrushes (ETB) in reducing plaque accumulation, gingival inflammation, and bleeding on probing, which are pivotal oral health indicators.

All the studies utilised a randomized controlled trial design. In Ccahuana-Vasquez et al., 150 individuals were randomly allocated to a study conducted in Canada. The participants' average age was 45.7 years. Each participant was provided with either the Oral-B sensitive brush head (Oral-B virality) O-R handle or an ADA manual toothbrush. The participants brushed their teeth twice daily for five weeks with the assigned toothbrushes. Before each evaluation session, participants were instructed not to brush their teeth or use any nearby appliances for three to six hours and not to eat, chew gum, or drink anything in the morning of the evaluation session. The group using the ETB received instructions on how to use it, while the group using the MTB continued to brush as they usually would [11]. The Rustogi Modified Navy index was employed to record the occurrence of the plaque.

The study by Vorwerk et al. was conducted in the United States with 60 eligible participants. The participants were 46.2 years on average, with 16 males and 44 females. The study employed a cross-over design to compare electric and manual toothbrushes. Each participant was given a powered toothbrush (Truly Radiant) or a manual toothbrush (ADA) and instructed to brush their teeth at home for two minutes, twice a day, for one week using standard fluoride toothpaste. Before brushing, a pre-brushing plaque was recorded, and after brushing, the participants rinsed with a disclosing solution, and the plaque was re-scored. After the one-week familiarization period, the participants returned for an oral examination, and the plaque assessment was repeated using a different toothbrush [12] and used "Rustogi Modified navy index" for scoring the plaque index.

Nevins M et al. [13] carried out a study to assess the effectiveness of the IONPA iconic-sonic, a newly developed electric toothbrush, in reducing plaque and gingivitis. Out of the 78 participants, 64 completed the study. The control group (MTB) consisted of 15% male and 85% female participants, with an average age of 38.5 years. The test group (ETB) comprised 27.3% male and 72.2% female participants, averaging 35.65 years. The examination was

conducted for five weeks. Participants in a study conducted by A. Ramseier et al. [14] from Canada were predominantly younger, with a mean age of 23 years old. The gender distribution of the participants was also well-balanced, with approximately 52% of the participants being female. The subjects visited the clinic at baseline and subsequently at 2,4, and 8-week intervals. During these visits, plaque index, gingival index, and GCF samples were collected. The method of recording plaque index was found to be unreadable in the studies of Nevins M et al. and A. Ramseier C et al.

Adam et al. carried out a study to compare a newly designed oscillating-rotating electric toothbrush (Oral-B iO) to a manual toothbrush approved by the ADA. The study participants' mean age was 42 years. Participants were not permitted to brush their teeth or utilize proximal aids twelve hours before baseline. Additionally, they were prohibited from consuming food, using tobacco, drinking, or chewing gum for two hours before each evaluation session. The participants received oral hygiene instructions. The Turesky Modified Quigley-Hein Plaque Index (TMQHPI) was utilised for plaque registration, and the procedure was conducted by the same provider, with third molars removed from the registration process [15].

Gallob et al. conducted a study to evaluate the efficacy of an electric toothbrush (Colgate ProClinical A1500) compared to a manual toothbrush in reducing plaque and gingivitis among participants aged 19-69 years. Participants were required to avoid antibiotics, tobacco, and any prophylactic treatments [16]. Rustogi Modified Navy index was used to register the plaque.

Nathoo et al. performed a study to analysis the benefit of an electric toothbrush with two different brush heads (Proclinical C200 sensitive Brush head and Proclinical C200 Triple Clean Brush Head) compared to a manual toothbrush in reducing plaque and gingivitis among 120 participants with the mean age 40.93 years. One hundred twenty individuals divided into three groups with three different toothbrushes. The same caregiver carried out the plaque registration using Rustogi Modified Navy Index (RMNPI) plaque index, excluding the third molar [17].

Multiple studies have shown that electric toothbrushes are more effective at reducing plaque index (PI) and gingival index (GI) than manual toothbrushes. For example, a study by Ccahuana-Vazques et al. demonstrated a significant reduction in PI for both MTB and ETB from baseline to five weeks, with (p-values <0.001) and (<0.0001), respectively, indicating the higher efficacy of electric toothbrushes in plaque reduction. Similarly, studies by Vorwerk L et al., Nevins M et al., and Adam R et al. also showed (P-values <0.0001) for PI reductions with electric toothbrushes. Regarding GI, five studies have shown statistically significant reductions with electric toothbrushes [11,13,14,16,17] including those by Ccahuana-Vazquez et al. (2.104 to 0.114 for MTB and 2.096 to 0.275 for ETB), Nevins M et al. (1.02 to 0.52 for MTB and 1.24 to 0.61 for ETB), and A Ramseier C et al. (24% more significant decrease at week eight). Nathoo et al. also noted that the Colgate Proclinical C200, regardless of the brush head, produced a statistically significant reduction in GI than MTB after four weeks of use (P<0.05). Gallob et al. also showed high significance after week 12 (P<0.05).

Three studies analysed BoP. According to studies by Ccahuana-Vazquez et al., Ramseier C et al., Nevin M et al., all three presented more significant reductions in the number of bleeding sites for ETB versus MTB, with a 52.2% decrease from baseline for ETB that was a significant reduction compared to MTB with 23.6%. Nevin M et al. ETB was reduced in BoP from 15% to 11%, and MTB use was reduced from 13% to 10%, which both are significant improvements with a (p-value <0.0001).

Only one study presented GCF, A Ramseier C et al. indicated numerical data lower levels of IL-1β and matrix-metalloproteinase (MMP)-3, MMP-8 in GCF, showing a possible anti-inflammatory impact. However, these results were not statistically significant.

DISCUSSION

This review aimed to evaluate the differential impacts of electric toothbrushes (ETBs) and manual toothbrushes (MTBs) on plaque control, gingival health, bleeding indices, cytokines levels in saliva, and gingival crevicular fluid. Our collected data and studies suggest that electric toothbrushes (ETBs) are more effective in all examined parameters in the seven studies [11,12,13,14,15,16,17].

Two studies (Ccahuana-Vasquez et al. and Adam R et al.) showed a significant reduction in plaque index [11,15]. Plaque reduction is more effective with an oscillating-rotating motion of an electric toothbrush than a manual toothbrush. The previously mentioned studies indicate the importance of choosing a toothbrush to reduce plaque, which is also the leading cause of periodontal diseases [2,4]. The toothbrush heads of oscillating toothbrushes may rotate and pulse to dissolve and remove plaque. This is because the pulsing movements enable the brush head to go in and out of the tooth surface, in addition to oscillating and rotating [15]. A study conducted by (Jain 2013) found that an oscillating toothbrush with the same movements was more effective at reducing plaque than a manual toothbrush [21].

Moreover, studies conducted by (Gallob et al., Nathoo et al., and Nevins M et al.) reveal that electric toothbrushes, specifically sonic ones, are more effective at reducing plaque than manual toothbrushes. This can be attributed to the high-frequency speed and sweeping motion utilised by sonic toothbrushes in mechanical cleaning. The high speed facilitates non-contact plaque removal by employing sound waves to produce strong fluid flows of saliva and water, which are distributed throughout the mouth. This process prevents plaque from forming in areas where the toothbrush bristles do not come in contact with the patient's teeth [22].

According to Nevins M et al., manual toothbrushes and electric toothbrushes had the same amount of plaque reduction after the end of the study. It is possible that the participants' successful plaque reduction was aided by the oral hygiene guidelines they received before the trial and were reminded of once a week. Van der Weijden et al. emphasize that obtaining optimal conditions for plaque removal depends heavily on the brushing method. Therefore, the oral hygiene instructions provided to the participants may have influenced their brushing technique and helped them maintain it throughout the study [23].

Park et al. emphasized the significance of adhering to oral hygiene guidelines to achieve a low plaque index [24].

Likewise, studies by (Ccahuana-Vazquez et al. and Gallob et al.), showed that electric toothbrushes were more effective in decreasing GI results. The decrease in GI indicates that electric toothbrushes may provide superior gingival inflammation prevention in addition to plaque removal, potentially by removing plaque at the margins of gingival and subgingival areas more successfully [11,16]. However, a cross-over design by (Vorwerk L et al.) examined these findings while presenting the efficacy of ETB experimentally, even in short-term, single-use settings [12].

Further information about the impact of various brush heads was supplied by (Nathoo et al.), who demonstrated that even within ETB, specific designs (such as those with triple clean or sensitive heads) can affect the degree of plaque removal and gingivitis reduction [17]. (A Ramseier et al.) study provided another perspective on the biomechanical effects of combining an electric toothbrush with an oral irrigator by examining cytokine levels in gingival crevicular fluid (GCF). Within other markers, interleukin-1β (IL-1β) was the only cytokine explicitly assessed in GCF in this study. The study found that combining OH treatment improved clinical parameters like gingival and plaque indexes. However, the changes in IL-1β levels in GCF did not achieve statistical significance. Nonetheless, indications showed a reduction in IL-1β values. A few variables, such as sample size, detector sensitivity, and interindividual variability in cytokine expression, may play a role in the lack of statistical significance in cytokine changes [14].

An explanation for the superior efficacy of electric toothbrushes in reducing plaque [11,12,13,14,15,16,17] may be attributed to their method of operation. Electric toothbrushes offer a range of strokes per minute, from 3000 to 60,000, whereas manual toothbrushes typically provide 50 to 600 strokes per minute [25]. Electric toothbrushes may be more effective at removing plaque due to the higher number of strokes they provide during the recommended brushing time. This may result in a superior plaque-reducing effect compared to manual toothbrushes. Another possible reason for the superior plaque-reducing effect of electric toothbrushes may be the duration of tooth brushing. The average time spent brushing teeth among the general population is approximately 45 seconds, and the recommended

brushing time for electric and manual toothbrushes is two minutes [26]. According to Vandana KL et al., individuals who utilised an electric toothbrush allocated more time in quadrant-wise brushing than those who used a manual toothbrush.
Moreover, the study revealed that participants spent more time holding the electric toothbrush at the recommended angle than the manual toothbrush [27]. Recently introduced electric toothbrushes incorporate a built-in timer and pressure sensor, which enable users to brush their teeth for the recommended duration and with the optimal brush pressure [7]. A study conducted by Van Leeuwen et al. demonstrated the effectiveness of toothbrush pressure in reducing plaque. According to the findings of this study, the spreading of toothbrush bristles was less pronounced on an electric toothbrush than on a manual toothbrush. Manual toothbrush users generally use more force than electric ones, which can lead to increased bristle wear. As a result, the cleaning effectiveness of the toothbrush decreases, causing it to become less effective at removing plaque [28,29]. The studies did not present this information. However, there is the possibility that the manual toothbrushes became more worn than the electric toothbrushes during the study, which may have resulted in a less effective plaque-reducing effect.

Limitations:

Both (Ccahuana-Vasquez et al. and Adam R et al.) found significant results. Still, their studies were limited because of their short duration, which made it difficult for them to represent long-term results correctly. (Nevins M et al.) also had challenges due to the absence of significant variations in probing depths, emphasising the variation in clinical parameters utilised amongst research that may impact the comparability of outcomes. Although (Vorwerk L et al.) reduced the potential transference effects associated with cross-over design, they were still challenged with quickly adjusting to new brushing methods, which could have distorted efficacy evaluations. (A Ramseier C et al.), the study is limited due to the participant's age group and health status, which may not accurately reflect more significant demographics, and there was a lack of studies about GCF cytokines levels, which limits the ability to build a strong connection between periodontal tissue cytokine control and OH practices. Also, a comprehensive analysis of long-term adherence to brushing methods outside of controlled conditions was absent from a large amount of information on efficacy published by (Gallob et al. and Nathoo et al.). Articles were searched using a single database, PubMed, which contains a variety of MeSH terms and full articles. This could be viewed as a limitation, as incorporating additional databases with varied MeSH terms and accessible text

terms could potentially result in locating and incorporating more articles for the study. In this review, randomized controlled clinical trials were employed, which are widely regarded as the most effective method for investigating treatment effects [20]. The study is heterogeneous, as it includes various articles with different techniques. Studies used other methods to register plaque and gingival index, as well as different sample sizes, and duration.

Compared to previous studies, the findings from these investigations consistently support the idea that ETBs are generally a better way to manage gingivitis and control plaque than MTBs. Studies outside this review have also demonstrated that ETB improves clinical parameters; these studies have been evaluated by (Yacoob et al. 2014) and (Elkerbout et al. 2020). These findings are consistent with the outcomes of this thesis [18,19].

CONCLUSION

1. In the limitations of this study, an electric toothbrush is more effective in removing dental plaque than a manual toothbrush.
2. In the review, sentences presented a decreasing gingival index score that was more effective with an electric toothbrush than a manual toothbrush.
3. Review studies indicated a significant reduction in bleeding on probing among users of electric toothbrushes.
4. Review articles showed a tendency for electric toothbrushes to reduce cytokine levels more than manual toothbrushes.

PRACTICAL RECOMMENDATIONS

Based on the results of this review, electric toothbrushes are highly effective in removing plaque, reducing gingivitis, and achieving bleeding control. Furthermore, additional research is warranted to investigate cytokines in saliva, specifically GCF. It is worth noting that if an individual is unable to use a manual toothbrush due to other issues or lack of technique, an electric toothbrush may be a more suitable option.

CONFLICT OF INTEREST

The author has not encountered any conflict of interest.

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Annexes

	Yes	No	Unclear	NA
1. Was true randomization used for assignment of participants to treatment groups?	☐	☐	☐	☐
2. Was allocation to treatment groups concealed?	☐	☐	☐	☐
3. Were treatment groups similar at the baseline?	☐	☐	☐	☐
4. Were participants blind to treatment assignment?	☐	☐	☐	☐
5. Were those delivering treatment blind to treatment assignment?	☐	☐	☐	☐
6. Were outcomes assessors blind to treatment assignment?	☐	☐	☐	☐
7. Were treatment groups treated identically other than the intervention of interest?	☐	☐	☐	☐
8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	☐	☐	☐	☐
9. Were participants analyzed in the groups to which they were randomized?	☐	☐	☐	☐
10. Were outcomes measured in the same way for treatment groups?	☐	☐	☐	☐
11. Were outcomes measured in a reliable way?	☐	☐	☐	☐
12. Was appropriate statistical analysis used?	☐	☐	☐	☐
13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	☐	☐	☐	☐