Systematic Review

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Effectiveness of Supervised Toothbrushing in Preschool Children: Systematic Review and Meta-Analysis

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Abstract:

Objective: This study aimed to determine the effectiveness of a supervised toothbrushing program in preventing the progression of dental caries among preschool children through a systematic review and meta-analysis.

Material and Methods: Eligible studies published until 2024 from four databases: Cochrane, PubMed, Web of Science, and SCOPUS were included. The studies aimed to establish the effect of supervised toothbrushing compared to control groups for dental caries among preschool children who were included as eligible for the studies. The type of studies included were randomized controlled trials (RCTs) and interventional studies. The primary outcome was regarded as dental caries. The Cochrane Handbook was used as a guideline for the systematic review, meta-analysis, and risk of bias assessment with specific domains for the included studies.

Results: A total of eight studies were included in the review, and a meta-analysis was conducted on five of these eight studies. The results showed significant prevention of caries by favoring the supervised toothbrushing intervention over the control group with an effect size of risk ratio (RR)=0.91 [0.83, 1.00] (p-value=0.05) for RCT studies and 0.77 [0.71, 0.83] (p-value<0.05) for non-RCT studies.

Conclusion: The evidence suggests supervised toothbrushing probably reduces the caries development risk in preschool children, but certainty remains moderate to low due to methodological limitations. Supervised toothbrushing should be encouraged among preschool children by considering which scheme is effective.

Keywords: children, dental caries, meta-analysis, supervised toothbrushing, systematic review

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Introduction

Dental caries is considered a global burden, as it is one of the most common oral diseases[1]. The number of children with primary teeth who suffer carious problems is estimated to be 514 million globally[1]. As dental plaque is a primary etiological factor in dental diseases, such as gingivitis, periodontal disease, and dental caries, effective plaque control plays a role in preventing dental diseases[2-4]. Toothbrushing can remove food deposits and dislodge bacterial plaque that facilitates dental disease[5]. Hence, toothbrushing is recommended as a daily preventive measure for oral hygiene. For children, the correct toothbrushing technique with fluoridated toothpaste is required for effective oral hygiene care. Supervised toothbrushing or correct toothbrushing instructions for children means that dental health professionals, trained schoolteachers, or parents run a toothbrushing scheme in the classroom or at home using appropriate toothbrushing techniques[6].

Some empirical evidence on the effectiveness of toothbrushing programs on dental caries is equivocal. In a systematic review and meta-analysis of the evidence for the effectiveness of oral health education on oral hygiene and caries in schoolchildren, traditional oral health education was found to be effective in reducing plaque as a short-term effect, but not in preventing gingivitis, although there was not enough evidence on caries in the study[7]. In another systematic review, the authors concluded that there was an inconclusive declaration for the effectiveness of supervised toothbrushing on caries incidence among children and adolescents. Thus, they did not explore a meta-analysis[8]. Therefore, we decided to conduct a systematic review and meta-analysis on the effect of toothbrushing programs on dental caries among preschool children.

The study evaluated the evidence for the effectiveness of supervised toothbrushing in preventing dental caries in preschool children versus a control by conducting a systematic review and meta-analysis.

Material and Methods

A systematic review and meta-analysis were performed following the guidelines of the Cochrane Handbook for Systematic Reviews of Interventions version 6.49[9] and statistical guidance for introduction to a meta-analysis[10]. It was checked by the PRISMA 2020 checklist supplementary file (Table S1). The protocol was registered at PROSPERO CRD42022376887.

Eligibility criteria

Studies with randomized controlled trials, individual or school cluster trials, quasi-randomized controlled trials, prospective studies, or interventional studies were included. The participants were preschool children from 0 to 5 years old. The intervention was supervised toothbrushing (STB) with fluoride toothpaste or toothbrushing instructions by trained teachers, parents, or dental professionals. Moreover, STB or toothbrushing instructions with oral health education or other supportive programs were also included. The control groups were not provided with any toothbrushing program or toothbrushing instructions, nor with any oral health education. However, some studies in which oral hygiene instructions were provided in the control group were included. The outcome was the effectiveness of the intervention versus the control in preventing caries as a long-term effect. The follow-up period of the included studies was at least one year for caries. The settings were school-based or home-based interventions.

Search strategy

All published articles until 2024 were searched. The databases included Cochrane, PubMed, Web of Science, and SCOPUS. The search terms were ("Toothbrushing" [Mesh] OR "Education, Dental" [Mesh]) AND ("Child" [Mesh] OR "Child, Preschool" [Mesh]) OR "Schools" [Mesh]) AND ("Dental caries"[Mesh]). Searches were also conducted in grey literature, including Western Libraries, BASE academic search engine, ProQuest Dissertations and

Theses, Open Access Theses and Dissertations, Mahidol University's Institutional Repository, Prince of Songkla University's Knowledge Bank, Chulalongkorn University's Intellectual Repository, and the Electronic Thesis Database (e-Theses) of Chiang Mai University. There was a restriction on the language of the articles since only the English language was used.

Selection of studies

All electronic database searches were imported into EndNote X7, and duplicate studies were removed. Titles, abstracts, and keywords of studies were scanned by two reviewers to eliminate irrelevant studies. Potentially relevant studies were selected as full-text records and thus met the eligibility criteria. The two reviewers examined the available full-text reports to identify the included studies. Questionable studies for inclusion were resolved by discussion between the two reviewers. The final decision for the included studies was reached after agreement between the two reviewers.

Data collection and data extraction

An Excel spreadsheet was created for the data extraction of the included studies. Author names with year of publication, length of follow-up, study design, type of intervention and control groups, number of participants in the intervention and control groups, and outcome measures (dental caries) were input into an Excel sheet. The outcome was dental caries measured with a caries index. The proportion of participants with the event (caries experienced) and non-event (no caries experienced) in the intervention and control groups of the included studies was extracted for the meta-analysis. One reviewer performed the above process, and the collected data of the included studies were confirmed after discussion and agreement between the two reviewers.

Risk of bias assessment

The risk of bias for randomized controlled trial (RCT) studies was assessed following the criteria of risk of bias assessment (RoB 2) by the two reviewing authors[11]. Random sequence generation and allocation concealment for selection bias, blinding of participants for performance bias, blinding of outcome assessment for detection bias, incomplete outcome data for attrition bias, and selective reporting for reporting bias were assessed. This assessment was rated as "low risk," "high risk," and "unclear risk."

The non-randomized controlled trial (non-RCT) studies were assessed for bias according to the Cochrane Risk of Bias Assessment Tool for Non-Randomized Studies of Interventions (ACROBAT-NRSI) (ROBINS-I) by the two reviewers[12]. Bias due to confounding, bias in the selection of participants into the study, bias in the classification of interventions, bias due to deviations from intended interventions, bias due to missing data, bias in the measurement of outcomes, and bias in the selection of the reported results were all assessed. The bias was rated as "low risk", "moderate risk", "serious risk", "critical risk", and as having "no information".

Meta-analysis

The meta-analysis was performed using the Cochrane Handbook[13]. The Review Manager (RevMan) in version 5.3 was used for analysis. The studies' outcomes or effectiveness were considered the estimated effect sizes. The Risk Ratio (RR) was regarded as an estimated effect size with a 95% confidence interval. The outcome was the number of participants with the event (caries experienced) and non-event (no caries experienced) measured with a caries index between the intervention and control group. The risk for each group was calculated by dividing the number of events by the total number of participants in that group. To calculate a risk ratio (RR), the risk of an outcome in the intervention group was divided by the risk of the same outcome in the control group.

The statistical approach to test the heterogeneity was conducted using the standard chi-square test and I^2

statistics. I^2 values of more than 50.0% were considered to indicate substantial heterogeneity as interpreted in the Cochrane Handbook[13]. A random-effect model was used because substantial heterogeneity existed. Heterogeneity in this study was due to variations across the included studies, such as the type of intervention, study design, and supervision. Therefore, subgroup analyses were performed based on the type of intervention, study design, and supervision.

Quality assessment for the evidence of meta-analysis

The evidence for the meta-analysis was qualified by determining the GRADE[14], using GRADEpro software[15]. The factors that determined the quality of evidence were the risk of bias, inconsistency, indirectness, and imprecision[14].

Ethics approval

This study was approved by the Human Research Ethics Committee of the Faculty of Dentistry, Prince of Songkla University, EC6503-011, on 7 March 2022.

Results

The results of the search and the selection process are presented as a PRISMA flow diagram (Figure 1). The characteristics of the included studies are presented in Table 1. A total of eight studies were included in this review[16-23]. Meta-analysis was conducted for five of the studies[17-19,21,23].

Interventions of the included studies

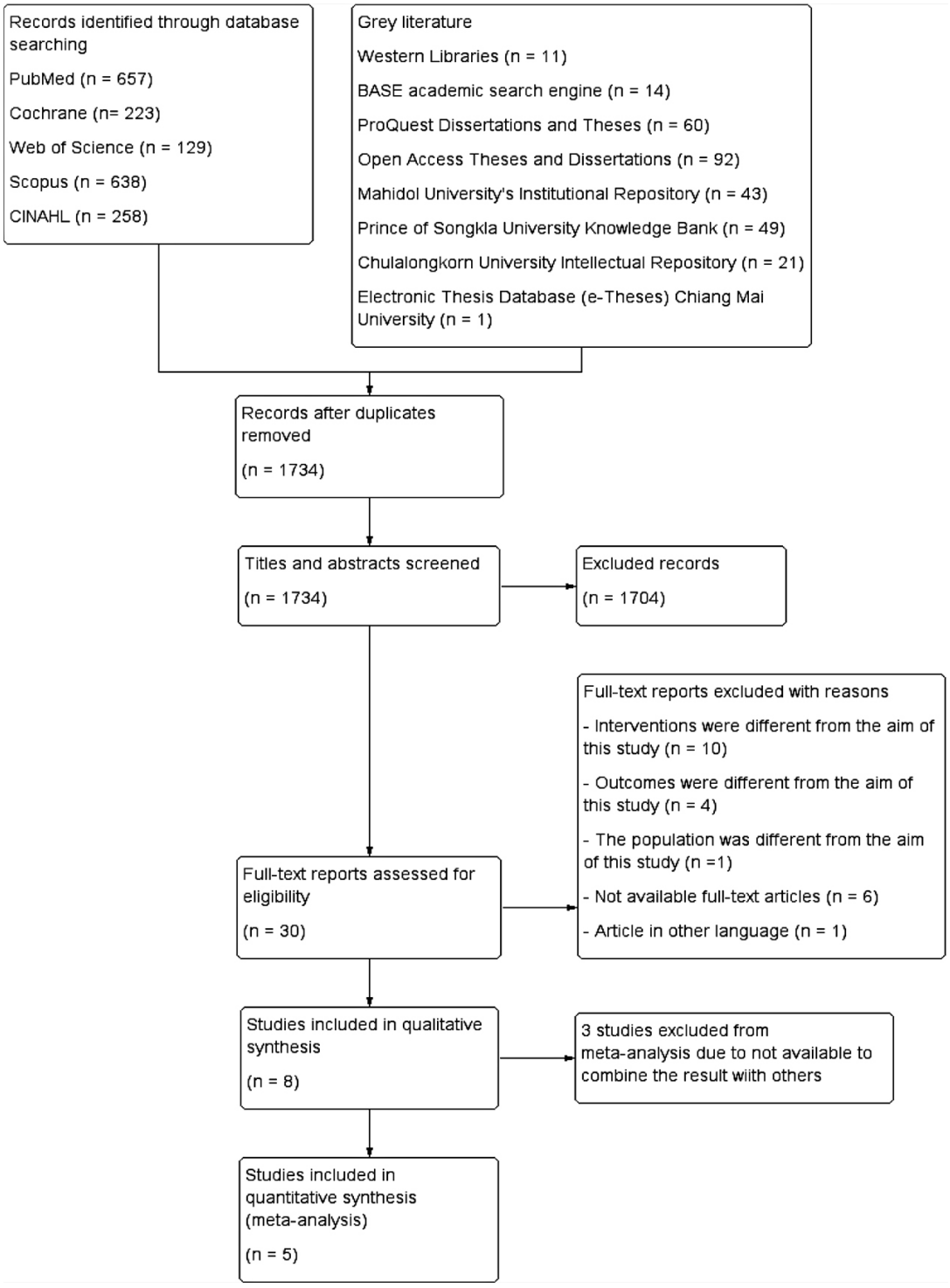
The interventions described in four of the studies were daily supervised toothbrushing (STB), including the correct toothbrushing method with fluoride toothpaste and the use of appropriate toothbrushes on school days or at home[17,19,21,23]. Three studies provided not only STB but also oral health education, including the importance of the prevention of caries and oral hygiene instructions to children, teachers, and parents[16,20,22]. In one study, fluoride tablets were also provided along with STB[18]. Toothpaste with 500 ppm of fluoride was used for toothbrushing in two studies[19,21], and 1,000-1,100 ppm of fluoride in the toothpaste was used in five other studies[16-18,22,23]. One other study provided toothbrushing with 1,450 ppm fluoride toothpaste[20].

Before the intervention, teachers, parents, or guardians were instructed by dental professionals to follow the protocol, ensuring the brushing and cleaning procedure for their children. The children performed toothbrushing under the supervision of teachers on school days in five of the studies[17,19,20,22,23]. Parents or guardians were advised to brush their child's teeth in two of the studies[16,18]. Lastly, children performed toothbrushing under the supervision of specially trained dental nurses in only one of the studies[21]. Therefore, only one study had professional supervision (dental nurses)[21,] and the others were under the supervision of non-professional personnel (teachers and parents or guardians)[16-20,22,23].

Risk of bias assessment summary

Risk of bias assessment for the RCT studies was conducted (Figure 2). One study was assessed as having four low risks of bias[22]. An unclear risk of random sequence generation for selection bias and a high or unclear risk of allocation concealment were found in all the studies. All studies except one[22] had a high risk of bias, blinding participants to performance bias. Nevertheless, the studies were randomized based on having schools or classrooms as cluster-randomized trials, which often randomize all clusters at once. Therefore, the lack of concealment of an allocation sequence would not usually be an issue[9]. Besides that, it is not possible to blind participants to toothbrushing interventions.

Bias assessment for non-RCT studies was also performed (Table 2). One study had five low risks of bias[18], and two other studies had three low risks of bias[16,19]. There



PRISMA=preferred reporting items for systematic reviews and meta-analyses

Figure 1 PRISMA flow diagram

Table 1 Characteristics of the included studies in the systematic review

No	Author/Publication years	Follow-up	Population	Study design	Intervention	Control	Outcome
1	Ekstrand KR et al., (2000)[16]	2.5 years	3-year-old kindergarten children	Interventional study	Education of the children and parents in caries disease, caries prevention, and training in toothbrushing with fluoridated toothpaste (1,100 ppm)	No intervention	Dental caries (deft, defs index)
2	Rong WS et al., (2003)[17]	2 years	3-year-old kindergarten children	Randomized controlled trial (RCT)	Brushing the teeth with fluoridated toothpaste (1,100 ppm) twice a day under the supervision of teachers during school days	No intervention (Children were provided with the most common non-fluoridated toothpaste)	Dental caries (dmfs index)
3	Wennhall I et al., (2005)[18]	1 year	2-year-old children registered in the study area (Most of the children were immigrants)	Interventional study	Toothbrushing with fluoridated toothpaste (1,000-1,100 ppm) under the guidance of guardians who were instructed and trained at each visit by two specially trained dental assistants who provided fluoride tablets	No intervention (Regular oral health care at the Public dental service)	Dental caries (deft index)
4	Andruškevičienė V et al., (2008)[19]	2 years	3-year-old kindergarten children	Interventional study	Supervised toothbrushing with fluoridated toothpaste (500 ppm) applied twice daily at the kindergarten in the morning and at home in the evening	No intervention	Dental caries (dmft, dmfs index)
5	Petersen PE et al., (2015)[20]	2 years	4- to 6-year-old schoolchildren	Randomized controlled trial (RCT)	Supervised tooth brushing with fluoridated toothpaste (1,450 ppm) by teachers in the school after lunch and oral health education to children at least twice each semester or four times a year	Toothbrushing after lunch without supervision by teachers	Dental caries (DMFT, DMFS index)
6	Pieper K et al., (2016)[21]	2 years	2- to 4-year-old kindergarten children	Randomized controlled trial (RCT)	Specially trained dental nurses supervised daily toothbrushing with fluoridated toothpaste (500 ppm)	Tooth brushing instructions (3 to 4 times a year)	Dental caries (dmft, dmfs index)
7	Samuel SR et al., (2020)[22]	2 years	3- to 5-year-old preschool children with very low socioeconomic status	Parallel arm clinical trials (RCT)	Supervised toothbrushing with fluoridated toothpaste (1,000 ppm) to children on school days, oral health education to teachers and students for a week by principal investigators and reinforced every 6 months	Only oral health education	Dental caries (d1-d4+f index)
8	Natapov L et al., (2021)[23]	2 years	5-year-old kindergarten children	Interventional study (Program evaluation)	Brushed once daily at kindergartens with fluoridated toothpaste (1,000 ppm) for two school years	No intervention (did not participate in the program)	Dental caries (dmft index)

RCT=randomized controlled trial, ppm=parts per million, dmft/DMFT=decayed, missing, filled teeth, dmfs/DMFS=decayed, missing, filled surface of teeth, deft=decayed, extraction, filled teeth, defs=decayed, extraction, filled surface of teeth, d=decayed, f=filled

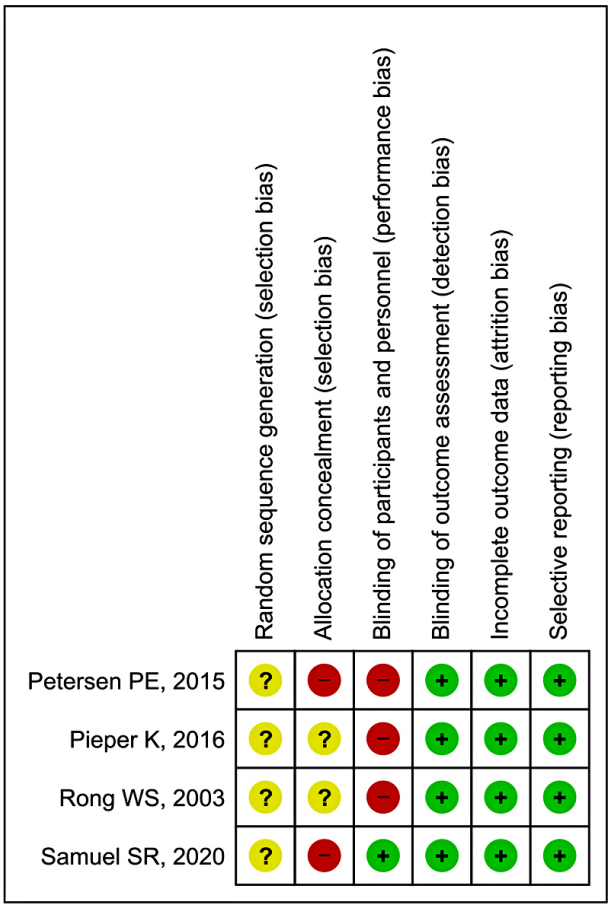


Figure 2 Risk of bias assessment summary for the randomized controlled trial (RCT) studies

was only one study with no risk of low bias[23]. A serious or moderate risk of bias due to confounding was observed in all the studies. In two of the studies, a moderate risk of bias in the selection of the participants was found[19,23]. A serious risk of bias in the measurement of outcomes was reported in all of the studies. In one study, a serious risk of bias in the selection of the reported results was also found[19].

Meta-analysis

Five studies were included in the meta-analysis[17-19,21,23]. The overall estimated effect size (RR) of the five studies in Figures 3, 4, and 5 presented 0.83 [0.75, 0.92] (p-value<0.05) with a heterogeneity of I^2=68.0%, favoring the intervention group over the control group. Due to the existence of substantial heterogeneity, subgroup analyses were explored to ensure the variability of the findings and to avoid the overestimation of the pooled results. It is based on the variation of interventions (STB and STB with fluoride tablets), study designs (RCT and non-RCT), and the type of supervision (professional supervision and non-professional supervision).

Subgroup 1 (STB) showed RR=0.86 [0.78, 0.95] (p-value<0.05), and subgroup 2 (STB with fluoride tablets) showed RR=0.75 [0.69, 0.81] (p-value<0.05) (Figure 3).

Table 2 Risk of bias assessment summary for the non-RCT studies

Bias assessment	Risk levels classified by different studies			
	Ekstrand KR et al., (2000)[16]	Wennhall I, et al., (2005)[18]	Andruškevičienė V, et al., (2008)[19]	Natapov L, et al., (2021)[23]
Bias due to confounding	Serious risk	Serious risk	Moderate risk	Serious risk
Bias in the selection of participants into the study	No information	Low risk	Moderate risk	Moderate risk
Bias in the classification of interventions	Low risk	Low risk	Low risk	Moderate risk
Bias due to deviations from intended interventions	Low risk	Low risk	Low risk	Moderate risk
Bias due to missing data	Low risk	Low risk	Low risk	No information
Bias in the measurement of outcomes	Serious risk	Serious risk	Serious risk	Serious risk
Bias in the selection of the reported result	Moderate risk	Low risk	Serious risk	Moderate risk

Non-RCT=non-randomized controlled trial

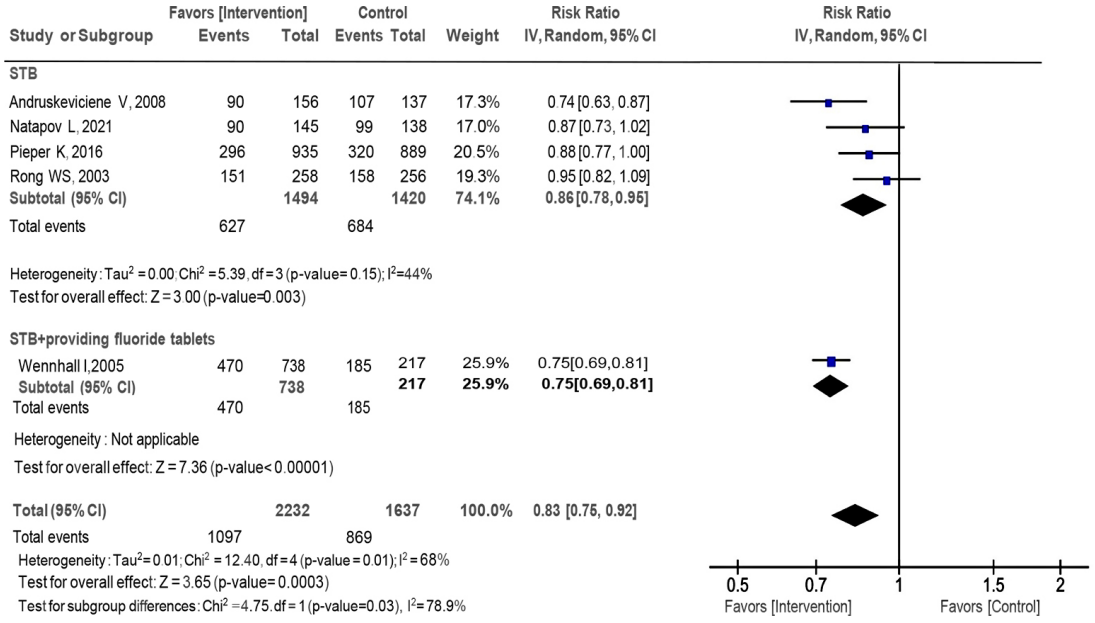
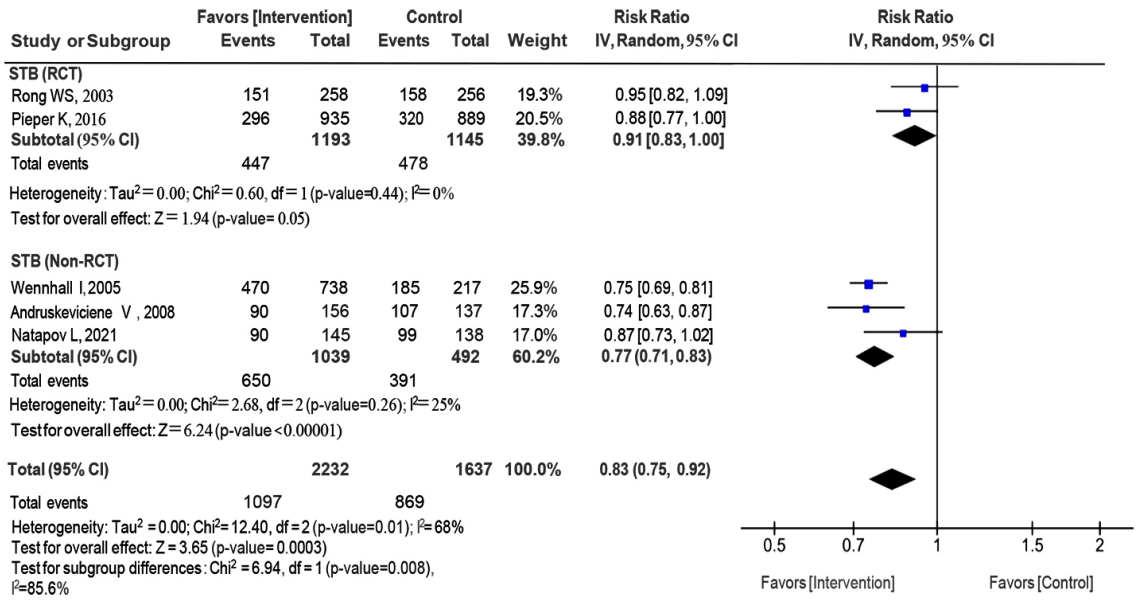


Figure 3 Comparison of supervised toothbrushing (STB) versus the control for dental caries in preschool children (Sub-group analysis: Intervention)

Both subgroups favored the intervention, showing that the STB was effective for caries prevention compared to the control.

The RR of subgroup 1 (RCT) was 0.91 [0.83, 1.00] (p-value=0.05), and for subgroup 2 (non-RCT) it was 0.77 [0.71, 0.83] (p-value<0.05) and favored the intervention group over the control group (Figure 4).

Professional supervision, subgroup 1 showed the RR=0.88 [0.77, 1.00] (p-value=0.05), and non-professional supervision, subgroup 2 showed the RR=0.82 [0.72, 0.92]



STB=supervised toothbrushing, CI=confidence interval, IV=inverse variance, df=degree of freedom

Figure 4 Comparison of supervised toothbrushing (STB) versus the control for dental caries in preschool children (Sub-group analysis: RCT and non-RCT studies)

(p-value<0.05) (Figure 5). Both subgroups favored the intervention to prevent caries.

Three studies were excluded from the meta-analysis due to the differences in data reporting when combined with the results of the other five studies in the meta-analysis[16,20,22]. A study reported STB was effective in controlling dental caries among preschool children by showing mean caries deft 3.62±0.38 in the STB group versus 5.67±0.41 in the control group (p-value<0.001)[16]. Another study showed that the mean DMFT caries increment was 1.04±1.33 in the STB group and 1.19±1.46 in the control group (p-value=0.005), indicating that the STB had a significant impact on the reduction of caries incidence in preschool children[20]. Another study also reported STB was effective in preventing caries in preschool children, with a mean caries d1-d4+f 3.4±0.2 in the STB group and 4.9±0.5 in the control group (p-value<0.05)[22]. Their results are aligned with the overall estimated result of the meta-analysis, which shows STB was effective in preventing dental caries compared to the control group among preschool children.

Quality assessment for the evidence of meta-analysis

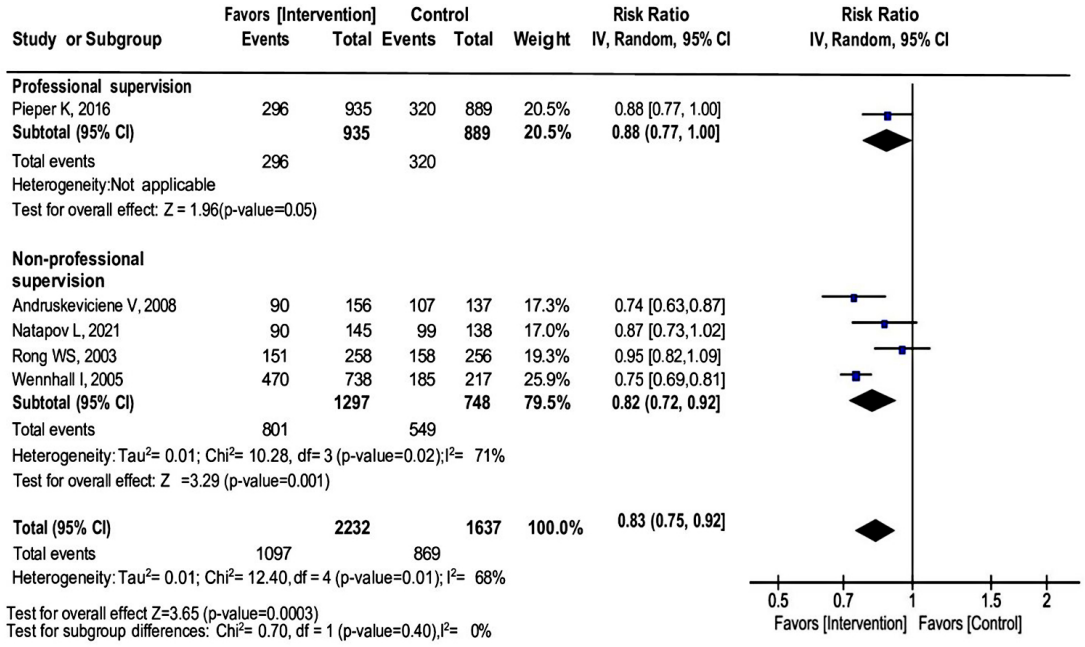
The findings of the GRADE assessment are shown in Table 3. The risk of bias for the RCT studies was regarded as serious since an unclear risk of bias in random sequence generation, a high and unclear risk of bias in allocation concealment, and blinding of the participants were detected in the studies. A serious risk of bias was also found for the non-RCT studies, as a serious risk of bias in the measurement of outcomes was assessed in all the studies, and confounding was found in two studies[18,23].

Inconsistency was not serious for the RCT studies, as substantial heterogeneity was not found among the

Table 3 Supervised toothbrushing compared to the control for dental caries in preschool children (Quality assessment)

Certainty assessment							No of patients		Effect		Certainty	Importance
No of studies	**Study design**	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Supervised toothbrushing**	**Control**	**Relative (95% CI)**	**Absolute (95% CI)**		
Dental caries (preschool children) – STB (RCT)												
2	Randomized trials	Serious[a]	Not serious	Not serious	Not serious	None	447/1193 (37.5%)	478/1145 (41.7%)	**RR 0.91** (0.83 to 1.00)	**38 fewer per 1,000** (from 71 fewer to 0 fewer)	Moderate	CRITICAL[d]
Dental caries (preschool children) – STB (Non-RCT)												
3	Non-randomized studies	Serious[b]	Serious[c]	Not serious	Not serious	All plausible residual confounding would reduce the demonstrated effect	650/1039 (62.6%)	391/492 (79.5%)	**RR 0.77** (0.71 to 0.83)	**183 fewer per 1,000** (from 230 fewer to 135 fewer)	Moderate-to-low	CRITICAL[d]

a=The studies have an unclear risk of bias in random sequence generation and allocation concealment, and a high risk in blinding of participants.
b=All three studies have a serious risk of bias in the measurement of outcomes and serious risks of bias due to confounding in two studies (Wennhall I, et al., (2005)[18], Natapov L, et al., (2021)[23]).
c=Heterogeneity is high between the studies due to the study (Natapov L, et al., (2021)[23] being the program evaluation.
d=Global burden of disease (World Health Organization (WHO), 2022)[1] and effect on the health and quality of life of the general population.STB=supervised toothbrushing, RCT=randomized controlled trial, Non-RCT=non-randomized controlled trial, CI=confidence interval, RR=risk ratio



STB=supervised toothbrushing, CI=confidence interval, IV=inverse variance, df=degree of freedom

Figure 5 Comparison of supervised toothbrushing (STB) versus control for dental caries in preschool children (sub-group analysis: professional supervision and non-professional supervision)

studies. Although baseline differences existed throughout the studies, there were no variations in intervention, population, or study design. Inconsistency was regarded as serious for the non-RCT studies, as heterogeneity exists among the studies because one study[23] was a program evaluation.

Indirectness for both the RCT and non-RCT studies was not serious, as the type of intervention, comparison, participants, outcome, and study design did not deviate from the inclusion criteria.

The confidence intervals of both the RCT and non-RCT studies were not very wide, with enough sample sizes, and the imprecision was assessed as not serious.

When there are limitations in the studies, such as inconsistencies or the possibility of bias, moderate-certainty evidence is suggested[24]. Due to the serious risk of bias among the RCT studies, mainly allocation concealment and blinding, the certainty of evidence was downgraded once, resulting in moderate-certainty evidence for RCT studies. For non-RCT studies, a serious risk of confounding, outcome measurement bias, and inconsistency of study type warranted an additional downgrade, resulting in moderate-to-low certainty. Hence, the true effect is likely close to the effect estimate, but there remains the possibility of substantial differences. Therefore, evidence suggests STB probably reduces caries risk, but certainty remains moderate to low due to methodological limitations.

Discussion

It is estimated that STB has a positive effect on reducing the risk of caries in preschool children compared to the control group. Comparing the two subgroups in

Figure 3, the risk of caries developing is lower in subgroup 2, where STB was provided together with fluoride tablets, than in subgroup 1, where only STB was provided. Additional supportive programs would likely benefit the intervention. The role of additional supportive programs should be considered when encouraging the intervention.

The beneficial effect of STB on caries prevention was found in the RCT studies and also in the non-RCT studies (Figure 4). While comparing the two study types as subgroups, the risk of caries developing is lower in the non-RCT studies subgroup. However, both inconsistency and serious risk of bias were detected in the non-RCT studies for the certainty evidence, while no inconsistency was found in the RCT studies, which suggests that study design is a factor to consider for enhancing the intervention.

Conversely, there is no significant difference in caries developing risk between the type of supervision (professional supervision and non-professional supervision) (Figure 5). Only one study supported dental nurses as professional supervisors of children's toothbrushing[21], and other studies used teachers and parents or guardians as non-professional supervisors. It may be because the teachers, parents, or guardians were well-trained and instructed by dental professionals to follow the protocol and supervise the toothbrushing procedure for their children. It is concerning that the type of supervision may not have been an issue influencing the results. However, only one professional supervision study was included for comparison.

In addition, toothbrushing with 1,000-1,100 ppm fluoride toothpaste concentration was provided in three studies[17,18,23], and two studies provided 500 ppm fluoride toothpaste[19,21]. Although all these studies reported a positive effect on caries prevention, the difference in fluoride concentration in the toothpaste is a concerning issue regarding whether it influences the benefit of the toothbrushing intervention. Only one study[18] had a one-year follow-up for the program. The other studies had two-year follow-ups, showing the beneficial effect of the toothbrushing program. It should be noted that the STB program should have a duration of at least one year to be effective in caries prevention. Besides, other variations, such as baseline caries risk and differences in socioeconomic background across the studies, have to be considered regarding their impact on the intervention.

The available evidence is sufficient to support the conclusion that STB has a positive effect on reducing the risk of caries in preschool children compared to the control group, with moderate certainty, primarily from RCT studies. But inclusion of non-RCT studies increases uncertainty to moderate-to-low certainty due to methodological limitations. Thus, further research could still impact the strengthof the evidence.

A previous systematic review showed a conflicting conclusion regarding the STB on caries incidence in children and adolescents[8]. No meta-analysis was performed because of differences in interventions and reporting data. Compared to the previous review, the present review conducted meta-analyses by exploring subgroup analyses and concluded that the toothbrushing program had benefits in controlling caries progression over long-term periods in preschool children; however, more evidence is needed for a complete appraisal. Preschool children must follow the supervision of their parents and teachers. The finding of a favorable effect in preschool children is possibly due to that fact. However, the drawback of this study is that the number of full texts, particularly those published before 1977, is inaccessible. This may have influenced the study's findings.

Some studies were excluded from the meta-analysis due to differences in the reported data, combined with the results of other studies in the meta-analysis. Another limitation was that some of the study results were based on the presence of caries experienced using different caries indices across the studies, which may have reduced the analytic precision of the study. Moreover, every study variation cannot be attempted as a subgroup analysis, which is a limitation. But, as the review focused on the STB

intervention, the variability in the toothbrushing intervention and supervision was performed as subgroup analyses. Since the review is focused on STB with fluoride toothpaste and specific oral hygiene guidance compared to not performing STB, another limitation to address is the impact of STB without fluoride toothpaste and specific oral hygiene guidance on caries. It was not considered in this review.

Dental caries is a global public health problem, although it is preventable. More efforts in dental care programs for children are required to prevent dental diseases, strengthen their oral hygiene habits, and encourage better oral health. Toothbrushing and oral health education programs in schools and communities are the primary preventive strategies[25,26]. The role of primary preventive programs should be promoted since STB has a positive effect on caries, according to this review, although some limitations are admitted. Such a program would be aimed at helping developing countries, where the role of primary prevention is important due to financial challenges with high dental disease trends.

More encouragement in toothbrushing programs should be considered by admitting the effectiveness of intervention schemes and the types of resources used. Moreover, more evidence of the effectiveness of supervised toothbrushing should be observed, and the cost-effectiveness of individual studies or systematic reviews should also be evaluated to underline their importance.

Conclusion

This study suggests that supervised toothbrushing probably reduces the risk of caries development among preschool children, but certainty remains moderate to low due to methodological limitations.

Acknowledgement

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Conflict of interest

The authors have no competing interests to declare.

Data availability statement

Data are available at https://kb.psu.ac.th/psukb/handle/2016/19092 from the PSU Knowledge Data Bank.

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Supplementary Table S1 PRISMA 2020 Checklist

Section and topic	Item #	Checklist item	Location where item is reported
Title			
Title	1	Identify the report as a systematic review.	Page 1
Abstract			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Page 1 (Abstract)
Introduction			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Page 2
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Page 2
Methods			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Page 3 (Eligibility criteria)
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Page 3 (Search strategy)
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Page 3 (Search strategy)
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Page 4 (Selection of studies)
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	Page 4 (Data collection and data extraction)
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Page 4 (Data collection and data extraction)
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Page 4 (Data collection and data extraction)
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Page 5 (Risk of bias assessment)
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Page 5 (Meta-analysis)
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Page 3 (Eligibility criteria)
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Not Applicable
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Not Applicable
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Page 5 (Meta-analysis)
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Page 5 (Meta-analysis)
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Not Applicable

Supplementary Table S1 (continued)

Section and topic	Item #	Checklist item	Location where item is reported
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Not Applicable
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Page 6 (Quality assessment for the evidence of meta-analysis)
Results			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Flow diagram Figure 1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Flow diagram Figure 1
Study characteristics	17	Cite each included study and present its characteristics.	Table 1
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Figure 2 and Table 2
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Figures 3, 4, and 5
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Pages 7 and 8 (Intervention of included studies, Risk of bias assessment summary)
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Page 8 (Meta-analysis)
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Page 8 (Meta-analysis)
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Not Applicable
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Not Applicable
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Page 9 (Quality assessment for the evidence of meta-analysis)
Discussion			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Page 11–12 (first six paragraphs of Discussion)
	23b	Discuss any limitations of the evidence included in the review.	Page 12 (7th paragraph of Discussion)
	23c	Discuss any limitations of the review processes used.	Page 12 (7th paragraph of Discussion)
	23d	Discuss implications of the results for practice, policy, and future research.	Page 13 (last two paragraphs of Discussion)
Other information			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Page 3, PROSPERO CRD42022376887
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Page 3, PROSPERO CRD42022376887
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Not Applicable

Supplementary Table S1 (continued)

Section and topic	Item #	Checklist item	Location where item is reported
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Page 14 (Funding sources)
Competing interests	26	Declare any competing interests of review authors.	Page 14 (Conflict of interest)
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Page 14 (Data availability statement)

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71
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