SYSTEMATIC REVIEW WITH A META-ANALYSIS OF THE EFFICACY OF SUPERVISED TOOTHBRUSHING ON CARIES PREVENTION AMONG PRIMARY SCHOOL CHILDREN

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Abstract. Dental caries among children is a public health problem worldwide and proper toothbrushing is an important preventive strategy. In this study, we aimed to compare the efficacy of supervised toothbrushing (STB) with unsupervised tooth brushing (control group) to prevent caries among primary school children by conducting a systematic review with a meta-analysis in order to inform efforts to prevent caries in the study population. We searched for studies that aimed to compare the efficacy of STB with a control group to prevent caries among primary school children (aged 5-12 years). A total of 10 studies were included in this systematic review. A meta-analysis was performed on 6 of these 10 studies. The total number of systematic review subjects was 3,905: 1,943 in STB groups and 1,962 in control groups. The total meta-analysis study population consisted of 3,014 subjects: 1,504 in STB groups and 1,510 in control groups. The systematic review revealed STB did not significantly reduce caries among study subjects compared to controls. The meta-analysis also revealed STB did not significantly reduce caries among study subjects compared to controls (risk ratio = 0.92; 95% confidence interval (CI): 0.84-1.01; *p*-value >0.05). In summary, we found no significant benefit of STB among study subjects to prevent caries. We conclude other caries prevention methods should be employed in the study population to prevent caries. Further studies are needed to determine why STB was ineffective in preventing caries in the study population and what methods can be used to correct this.

Keywords: toothbrushing, systematic review, dental caries, child

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INTRODUCTION

Dental caries among children is a public health problem (WHO, 2022). An estimated 60-90% of school children worldwide have dental caries (Ozdemir, 2014). In Thailand, the estimated prevalence of caries among children aged 12 years is 52.0% (Bureau of Dental Health, 2018).

Toothbrushing removes food deposits and bacterial plaque, reducing the chance of caries (Attin and Hornecker, 2005). Primary school children have a high prevalence of caries due to poor oral hygiene and inadequate brushing frequency (Prada, 2020; Archana *et al*, 2022). Supervised tooth brushing (STB) includes supervising correct toothbrushing and should include supervising the brushing technique, using fluoridated toothpaste and brushing twice daily. STB should be done by an adult with a knowledge about the above components of good toothbrushing (Borges-Yáñez *et al*, 2017).

A previous systematic review of STB had inconclusive results regarding the efficacy of STB to prevent caries among children and adolescents (Dos Santos *et al*, 2018).

In this study, we aimed to compare the efficacy of STB with unsupervised toothbrushing to prevent caries among primary school children using a systematic review with a meta-analysis in order to inform efforts to prevent caries in the study population.

MATERIALS AND METHODS

Our study followed the guidelines of the Cochrane

Handbook for Systematic Reviews of Interventions, version 6.49 (Higgins *et al*, 2023). Our study protocol is registered at PROSPERO CRD42022376887. The study was checked with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) 2020 checklist.

Inclusion and exclusion criteria for included studies

The inclusion criteria for papers included in our study were: papers having subjects who were primary school students aged 5-12 years; STB was conducted by a dental professional or a well-trained adult, such as a parent, caregiver or teacher; a control group was present that consisted of a non-supervised toothbrushing group (control group); the outcome was dental caries; the length of the study was at least one year; and the publication date was 1970-2024. Studies included could be those with only STB or STB with oral health education (OHE) or other supportive programs. The study type could include either randomized control trials (RCT) or a non-randomized control trial (non-RCT). Excluded studies were those that did not meet the inclusion criteria.

Search strategy

All studies meeting the above inclusion and exclusion criteria were searched for on the following sites: PubMed, Cochrane, Scopus, Web of Science and Cumulative Index to Nursing and Allied Health Literature (CINAHL), grey literature from the Prince of Songkhla University knowledge bank, electronic thesis database (e-theses) from Chiang Mai University, Mahidol University institutional repository, Chulalongkorn University intellectual repository, open access theses and dissertations, ProQuest dissertations and theses, western libraries and the BASE academic search engine. The medical subject headings search terms were: "Toothbrushing" OR "Education, Dental" AND "Child" OR "Schools" AND "Dental caries".

Only English language studies were included.

Study selection process

All the search results were input into EndNote X7 (Clarivate, Philadelphia, PA) and duplicate studies were removed. The titles, abstracts and keywords of the articles were screened by two researchers who excluded irrelevant studies. The full text of all potentially relevant studies was examined by the two reviewers to identify those meeting inclusion and exclusion criteria. Questionable studies were discussed between the 2 researchers who decided together to either include or exclude the study (Fig 1).

Data extraction and collection

The following data were recorded for each study in a Microsoft Excel (Microsoft Corporation, Redmond, WA) spreadsheet: author names, publication year, type of study, study period, descriptions of intervention and control groups and outcome.

Risk of bias assessment

RCT studies were reviewed for bias risk using the risk of bias tool (RoB 2) (Higgins *et al*, 2019). The types of bias assessed were: random sequence generation selection bias (bias due to inadequate randomization during the allocation of interventions), allocation concealment selection bias (bias due to inadequate concealment in the allocation of interventions prior to assignment), subject blinding performance bias (bias due to knowledge of the allocated interventions by subjects during the study), outcome assessment blinding detection bias (bias due to knowledge of the allocated interventions by outcome assessors), incomplete outcome data attrition bias (bias due to the amount, nature or handling of incomplete outcome data) and selective reporting bias (bias due to selective outcome reporting) (Higgins *et al*, 2019). The severity of bias was rated as "low risk" (low risk of bias for this domain),

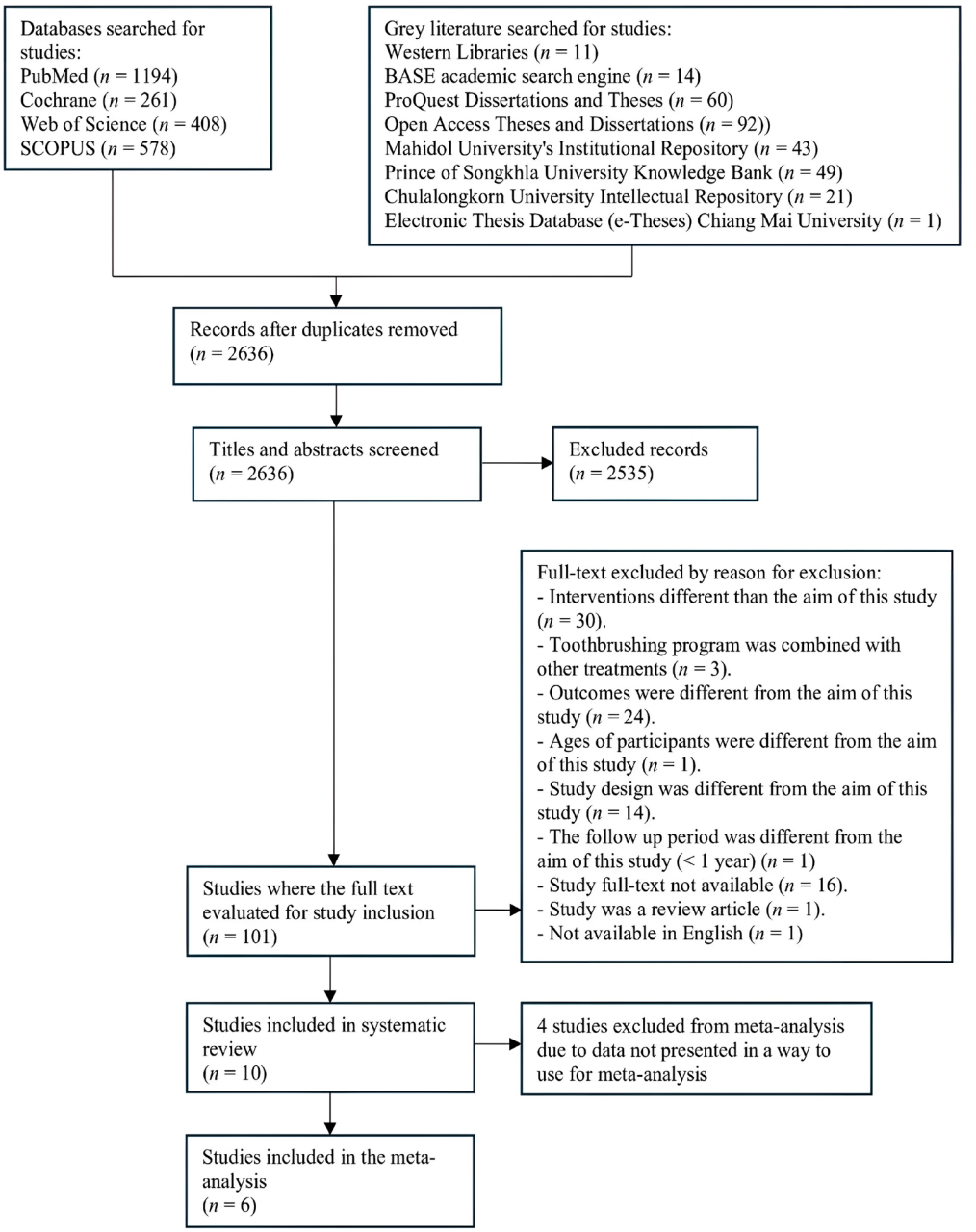

Fig 1 - PRISMA flow diagram

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

"high risk" (high risk of bias for this domain) and "unclear risk" (some concern about bias for this domain but not meet criteria for low or high risk of bias) (Higgins *et al*, 2019).

Non-RCT studies was reviewed for bias using the Cochrane Risk of Bias Assessment Tool for Non-Randomized Studies of Interventions (ACROBAT-NRSI) (ROBINS-I) (Sterne *et al*, 2016). The biases assessed were: bias due to confounding (the presence of a confounding factor causing a difference in the association between the intervention and outcome from its causal effect), bias in the selection of subjects for the study (bias where the selection of the subject was related to both the intervention and outcome), bias in the classification of interventions (bias where the intervention status was misclassified or if the outcome was misclassified or measured with an error), bias due to deviations from intended interventions (bias due to systematic differences between the intervention and control groups which represented a deviation from the intended intervention), bias due to missing data (bias due to missing subjects initially included but not followed up), bias in the measurement of outcomes (bias where the outcome assessors were aware of the intervention status) and bias in the selection of the reported result (bias due to selective reporting of results from multiple measurements of the outcome) (Sterne *et al*, 2016). The severity of bias was rated as "low risk" (comparable to a well-performed RCT concerning this domain), "moderate risk" (adequate for a non-RCT concerning this domain but not comparable to a well-performed RCT), "serious risk" (has some important problems in this domain)", "critical risk (too problematic to provide any useful evidence on the effects of the intervention for this domain)" and "no information" (no information to judge risk of bias for this domain)" (Sterne *et al*, 2016).

Meta-analysis

Meta-analysis was performed using Review Manager (RevMan), version 5.3 (The Cochrane Collaboration, Copenhagen, Denmark), following the Cochrane Handbook (Deeks *et al*, 2019). The outcome of the study was the efficacy of STB to prevent caries. This was determined by comparing the proportions of subjects with the event (caries) and without the event (no caries) between the STB subjects (intervention group) and non-STB subject (control group). The risk ratio (RR) was calculated as an estimated effect size for the outcome with a 95% confidence interval (CI). A standard chi-square test and I^2 statistics were used to assess results where there was statistical heterogeneity. Substantial heterogeneity was determined when the I^2 value was >50.0%, as described in the Cochrane Handbook (Deeks *et al*, 2019). When substantial heterogeneity occurred, a random-effect model was used. Sub-group analysis was performed based on study variation by intervention, study design and toothbrushing supervisor.

Certainty assessment of meta-analysis evidence

The certainty of the meta-analysis evidence was evaluated with a GRADE assessment using GRADEpro software (McMaster University and Evidence Prime, Hamilton, Ontario), including the risk of bias (determined for randomized trials and observational studies), inconsistency (determined when there was unexplained heterogeneity in the results of the studies), indirectness (determined when there was a difference between the study and the clinical question) and imprecision (determined when there was result imprecision due to few patients and a wide confidence interval) (Schünemann *et al*, 2019). Each assessment was classified as "not serious" (did not result in a downgrade in the certainty of the evidence), "serious" (resulted in a single downgrade in the certainty of the evidence) or "very serious" (resulted in a double downgrade in the certainty of the evidence)

(Schünemann *et al*, 2019). The certainty was classified into 4 levels, "high" (high level of confidence the true effect was close to the estimated effect), "moderate" (moderate level of confidence the true effect was close to the estimated effect), "low" (low level of confidence the true effect was close to the estimated effect) and "very low" (very low level of confidence the true effect was close to the estimated effect)" (Schünemann *et al*, 2019).

Ethical approval

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

Availability of data

Our study data are recorded in the PSU knowledge data bank at the following website: https://kb.psu.ac.th/psukb/handle/2016/19092.

RESULTS

Description of interventions of the included studies

STB using fluoridated toothpaste and an appropriate toothbrush on school days was reported in 3 studies (Curnow *et al*, 2002; Jackson *et al*, 2005; Clark, 2017). STB using fluoridated toothpaste and oral health education was reported in 4 studies (Hartono *et al*, 2002; Petersen *et al*, 2004; Al-Jundi *et al*, 2006; Babaei *et al*, 2023). STB with dental flossing after lunch on school days was reported in 1 study (Lai *et al*, 2016). STB using a plaque disclosing solution before and then again after toothbrushing and any remaining plaque removed by a dental professional was conducted every 2 weeks during the school year and reported in 1 study (Vestergaard *et al*, 1978). STB and supervised hand washing were conducted daily combined with a single dose of albendazole for deworming was reported in 1 study (Ruff *et al*, 2023) (Table 1).

Fluoride toothpaste at a concentration of 1,000 ppm was reported in 2 studies (Curnow *et al*, 2002; Babaei *et al*, 2023) and at a concentration of 1,450 ppm was reported in 3 studies (Jackson *et al*,

Table 1

Studies included in this study

No.	References	Follow up period	Population	Study design	Intervention	Control	Outcome
1.	Vestergaard *et al*, 1978	2 years	5-13-year-old school children	Experimental	Supervised toothbrushing every second week during the school year, using a disclosing solution applied before and after toothbrushing and remaining plaque removed by dental personnel	No special instructions for oral hygiene	Dental caries (DMFS index)
2.	Curnow *et al*, 2002	2 years	5-6-year-old children in their 1st year of primary school with high caries risk	Randomized controlled trial	Supervised toothbrushing with fluoridated toothpaste (1,000 ppm) on school days by local mothers	No intervention	Dental caries (D1FS and D3FS indexes)

Table 1 (cont)

No.	References	Follow up period	Population	Study design	Intervention	Control	Outcome
3.	Hartono *et al*, 2002	20 months	8-12-year-old children in primary schools	Intervention evaluation	Weekly supervised toothbrushing 12 times in 20 months and monthly oral health education by teachers who were instructed by nurses	No intervention	Dental caries (DMFT index)
4.	Petersen *et al*, 2004	3 years	6-year-old children in grade 1	Intervention evaluation	Oral health education and daily oral hygiene instructions supervised by teachers	No intervention	Dental caries (DMFT and DMFS indexes)
5.	Jackson *et al*, 2005	21 months	5-year-old children in grade 1	Randomized controlled trial	Supervised toothbrushing with fluoridated toothpaste (1,450 ppm) once a day after lunch at school	No intervention	Dental caries (DMFS index)

Table 1 (cont)

No.	References	Follow up period	Population	Study design	Intervention	Control	Outcome
6.	Al-Jundi *et al*, 2006	4 years	6-year-old (first grade) and 12-year-old (sixth grade) children	Randomized controlled trial	30-minute oral hygiene instruction sessions on school days given twice a year and dental hygienist and research assistant supervised toothbrushing	Same oral hygiene instruction sessions without practical demonstration of proper toothbrushing	Dental caries (DMFT index)
7.	Lai *et al*, 2016	10 years	10-11-year-old children in grades 4 and 5	Prospective program evaluation	Flossing and brushing guided by school dentists. after lunch for 20 weeks	Carried out their oral hygiene in their own way	Dental caries (DMFT and DMFS indexes)
8.	Clark, 2017	1 year	10-13-year-old school children	Quasi-experimental	2 minutes of supervised toothbrushing with fluoridated toothpaste (1,450 ppm) per day at school for an entire school year	No intervention	Dental caries (DMFS index)

Table 1 (cont)

No.	References	Follow up period	Population	Study design	Intervention	Control	Outcome
9.	Ruff *et al*, 2023	3 years	6-7-year-old children in first grade	Cluster-randomized trial	School-based daily group supervised toothbrushing by school teachers with fluoride toothpaste (1,450 ppm) and daily supervised handwashing and biannual deworming with a single dose of albendazole	Standard oral health education program with a commercial toothpaste and toothbrush given at the beginning of the school year	Dental caries (d index; DMFT, DMFS and PUFA indexes)
10.	Babaei *et al*, 2023	1 year	6-7-year-old school children	Community-based randomized controlled trial	School-based supervised toothbrushing with fluoride toothpaste (1,000 ppm) under the supervision of main researchers A one-day workshop on supervised toothbrushing and oral health education for parents/caregivers	No intervention	Dental caries (CAST index)

CAST: caries assessment spectrum and treatment index; d index: decayed primary teeth; DMFT: decayed, missing and filled permanent teeth; DMFS: decayed, missing and filled surfaces of permanent teeth; D1FS: the initial stage of decayed and filled surfaces of permanent teeth; D3FS: decayed in dentine and filled surfaces of permanent teeth, PUFA: pulpal involvement, ulceration, fistula and abscess index;; ppm: parts per million

2005; Clark, 2017; Ruff *et al*, 2023) (Table 1).

STB by dental hygienists, research assistants, school dentists or the main researchers was reported in 3 studies (Al-Jundi *et al*, 2006; Lai *et al*, 2016; Babaei *et al*, 2023). Trained local mothers used as non-professional toothbrushing supervisors was reported in 1 study (Curnow *et al*, 2002). STB by trained school teachers was reported in 6 studies (Vestergaard *et al*, 1978; Hartono *et al*, 2002; Petersen *et al*, 2004; Jackson *et al*, 2005; Clark, 2017; Ruff *et al*, 2023) (Table 1).

Description of control groups of included studies

No STB interventions were given to the control groups in 8 studies (Vestergaard *et al*, 1978; Curnow *et al*, 2002; Hartono *et al*, 2002; Petersen *et al*, 2004; Jackson *et al*, 2005; Lai *et al*, 2016; Clark, 2017; Babaei *et al*, 2023) meaning subjects in control groups carried out their oral hygiene as previously prior to inclusion in the study. Some oral hygiene instructions were given to control group subjects with no supervision was conducted in one study (Al-Jundi *et al*, 2006). Subjects in the control group were instructed about oral hygiene, a commercial toothpaste and a toothbrush were provided, in one study (Ruff *et al*, 2023) (Table 1).

Risk of bias assessment

Among 5 RCT studies, an unclear risk of random sequence generation for selection bias was found in 3 studies (Curnow *et al*, 2002; Jackson *et al*, 2005; Al-Jundi *et al*, 2006). A high risk or unclear risk of allocation concealment was detected in all 5 RCT studies (Curnow *et al*, 2002; Jackson *et al*, 2005; Al-Jundi *et al*, 2006; Ruff *et al*, 2023; Babaei *et al*, 2023). Four studies had a high risk of performance bias in blinding subjects (Curnow *et al*, 2002; Jackson *et al*, 2005; Al-Jundi *et al*, 2006; Ruff *et al*, 2023) (Fig 2).

Moderate to serious risk of bias due to confounding was seen in 5 non-RCT studies (Vestergaard *et al*, 1978; Hartono *et al*, 2002; Petersen *et al*, 2004; Lai *et al*, 2016; Clark, 2017).

Fig 2 - Risk of bias assessment summary for RCT studies

Note: + refers to low risk; − refers to high risk; ? refers to unclear risk

RCT: randomized controlled trial

A serious risk of bias in the selection of participants was found in 3 studies (Vestergaard *et al*, 1978; Hartono *et al*, 2002; Clark, 2017). A serious risk of bias in the measurement of outcomes was found in 4 studies (Vestergaard *et al*, 1978; Hartono *et al*, 2002; Petersen *et al*, 2004; Clark, 2017). A moderate to serious risk of bias in reporting results was found in 3 studies (Hartono *et al*, 2002; Petersen *et al*, 2004; Clark, 2017) (Table 2).

Meta-analysis

The heterogeneity of the study as determined by I^2 was 79%, indicating variability among the studies. To reduce variability, the prevalence of caries in the STB and control groups were compared using subgroup analyses based on the type of intervention, study design (RCT and non-RCT) and type of toothbrushing supervisors (professional versus non-professional).

The first subgroup analysis was based on the type of intervention, (STB, STB with OHE, and STB with dental flossing). Subjects in the STB group had significantly fewer caries than the control group (RR = 0.88; 95% CI: 0.82-0.95; *p*-value <0.05), subjects in the STB with dental flossing group also had significantly fewer caries than subjects in the control group (RR = 0.80; 95% CI: 0.70-0.91; *p*-value <0.05) but subjects in the STB with OHE group did not have significantly fewer caries than the control group (RR = 1.03; 95% CI: 0.98-1.07; *p*-value >0.05). The results of the above 3 studies (STB vs controls, STB with OHE vs controls and STB with flossing vs controls) were significantly different among each other (*p*-value <0.05) (Fig 3).

The second subgroup analysis compared RCT and non-RCT studies. Among RCT, we found no significant difference in caries prevalence between the intervention and control groups (RR = 0.91; 95% CI: 0.82-1.02; *p*-value >0.05). Among non-RCT, we found no significant difference in caries prevalence between intervention and control groups (RR = 0.92;

Table 2

Bias assessment among non-RCT studies

Bias assessment	Bias by study				
	Vestergaard *et al* (1978)	Hartono *et al*, (2002)	Petersen *et al* (2004)	Lai *et al* (2016)	Clark (2017)
Bias due to confounding	Serious risk	Serious risk	Serious risk	Moderate risk	Moderate risk
Bias in the selection of participants for the study	Serious risk	Serious risk	Low risk	Low risk	Serious risk
Bias in the classification of interventions	Low risk	Moderate risk	Low risk	Low risk	Low risk
Bias due to deviations from intended interventions	Low risk	Low risk	Low risk	Low risk	Low risk
Bias due to missing data	Serious risk	No information	Moderate risk	No information	Serious risk
Bias in the measurement of outcomes	Serious risk	Serious risk	Serious risk	Low risk	Serious risk
Bias in the selection of the reported result	Low risk	Serious risk	Moderate risk	Low risk	Moderate risk

RCT: randomized controlled trial

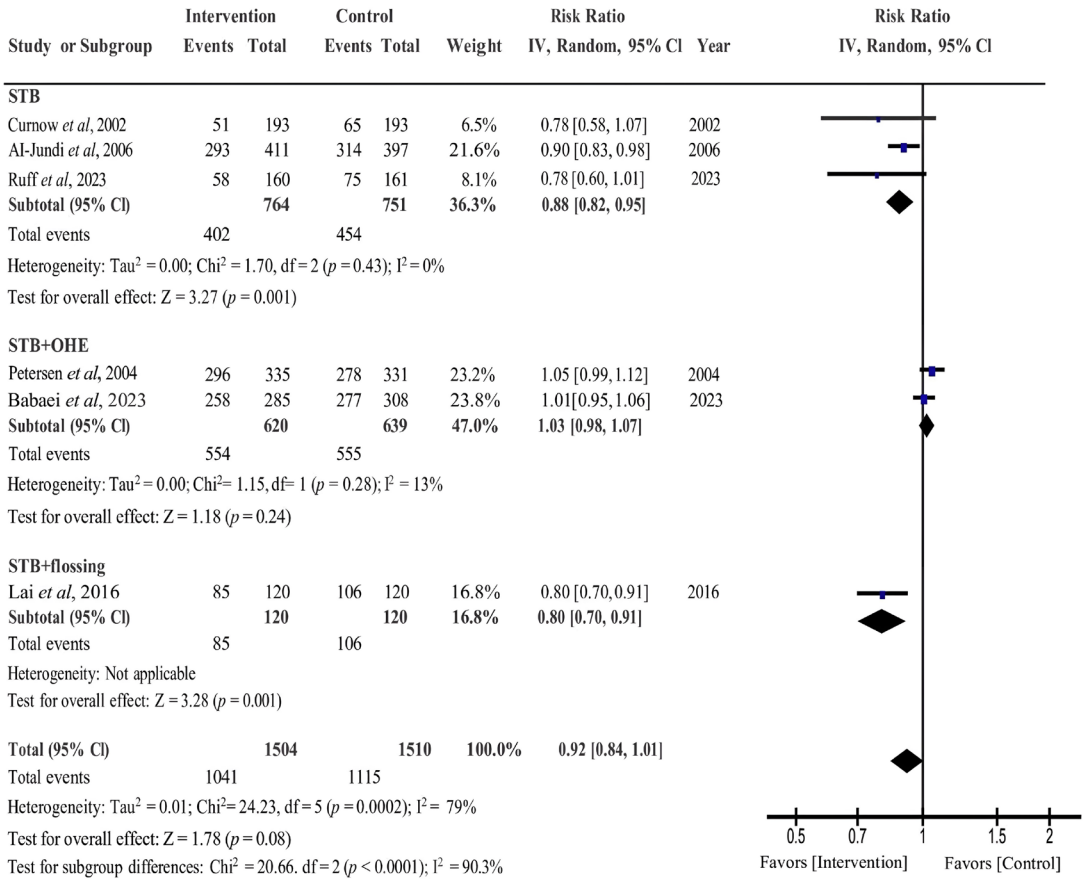

Fig 3 - Comparison of supervised toothbrushing type with non-supervised toothbrushing to prevent caries among study subjects

CI: confidence interval; df: degree of freedom; IV: inverse variance; OHE: oral health education; STB: supervised toothbrushing

95% CI: 0.71-1.21; *p*-value >0.05). No significant difference was seen between RCT and non-RCT caries prevalence (*p*-value >0.05) (Fig 4).

The third subgroup analysis was by toothbrushing supervisor (professional versus non-professional). We found no significant difference in caries

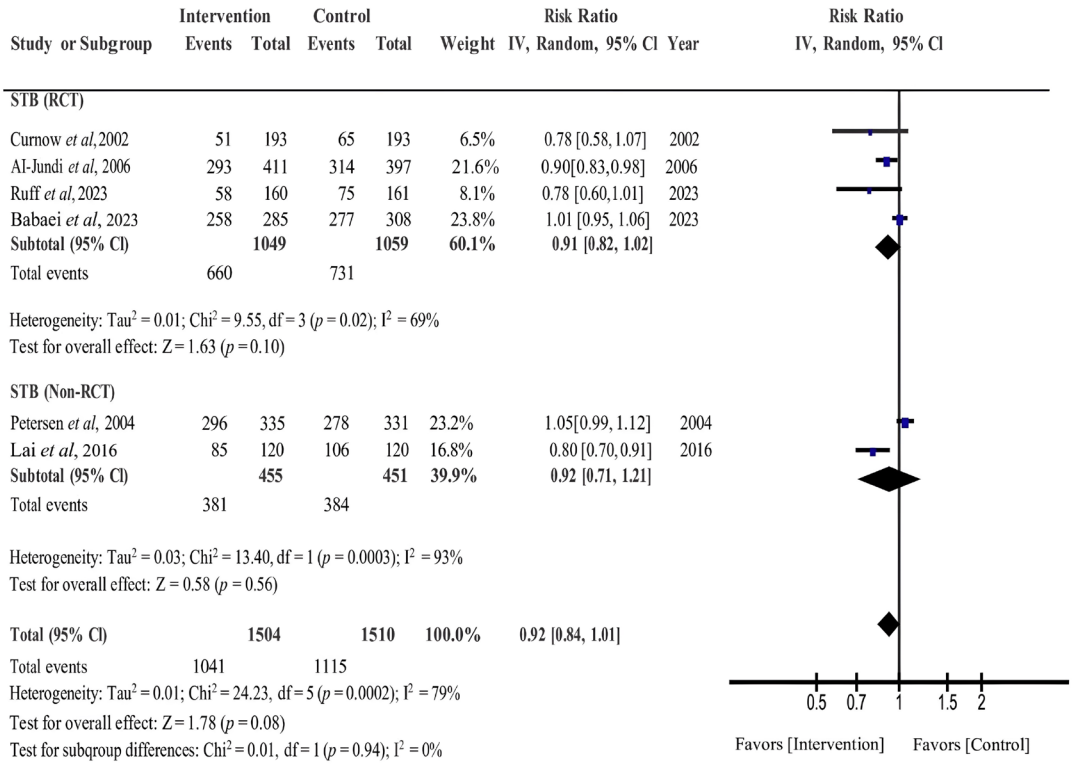

Fig 4 - Comparison of study type results between supervised toothbrushing and non-supervised toothbrushing groups to prevent dental caries among study subjects

CI: confidence interval; df: degree of freedom; IV: inverse variance; RCT: randomized controlled trial; STB: supervised toothbrushing

prevalence between the intervention and control groups when the STB supervisor was a professional (RR = 0.91; 95% CI: 0.81-1.03; *p*-value >0.05) and we found no significant difference in caries prevalence between the intervention and control groups when the STB supervisor was a non-professional (RR = 0.89; 95% CI: 0.70-1.13; *p*-value >0.05). We found no significant difference in caries prevalence

between the studies of type of toothbrushing supervisor (*p*-value >0.05) (Fig 5).

Although we found significant differences in caries prevalence by intervention type, between intervention and control groups, overall, we found no significant difference between intervention and control groups (RR = 0.92; 95% CI: 0.84-1.01 *p*-value >0.05).

In the 4 studies included in the systematic review but not included in the meta-analysis, 2 reported supervised toothbrushing program resulted in a significant reduction in caries incidence (Jackson *et al*, 2005; Clark, 2017) and the other 2 found no significant difference in caries prevalence between intervention and control groups (Vestergaard *et al*, 1978; Hartono *et al*, 2002).

Certainty assessment of the evidence used in the meta-analysis

We found all the RCT studies used for meta-analysis were at high risk for allocation concealment (Curnow *et al*, 2002; Jackson *et al*, 2005; Al-Jundi *et al*, 2006; Babaei *et al*, 2023; Ruff *et al*, 2023). One study was at high risk for blinding outcome bias (Al-Jundi *et al*, 2006). One non-RCT study used for meta-analysis had a serious risk of confounding bias and outcome measurement bias (Petersen *et al*, 2004). Thus, the risk of bias among both the RCT and non-RCT was high for certainty assessment of the evidence. We found a low risk of inconsistency in the RCT studies, since we found no substantial variations in intervention, population or study design among these studies. We found a high risk of inconsistency among the non-RCT studies due to methodological heterogeneity. For example, one study evaluated a program of daily supervised flossing and brushing over 20 weeks (Lai *et al*, 2016). We found a low risk for indirectness among both RCT and non-RCT studies because the participants, intervention, comparison, outcome and study design were compatible with the eligibility criteria. We found a high risk for imprecision in 2 of the 4 RCT studies because

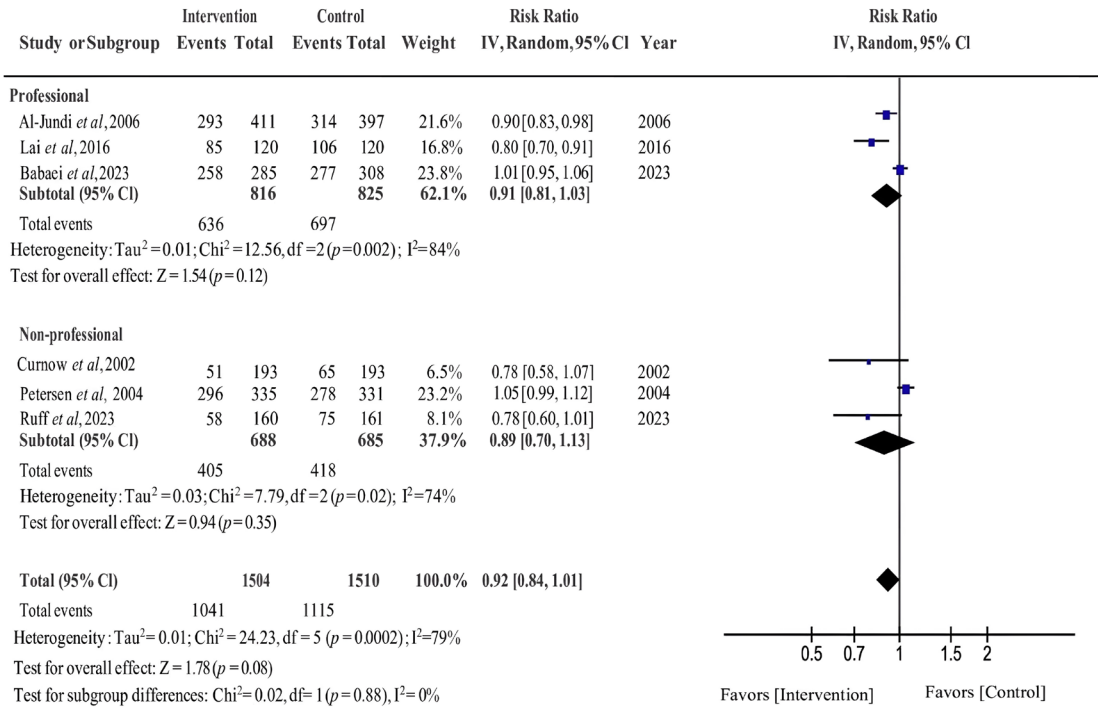

Fig 5 - Comparison of supervisors between supervised toothbrushing and non-supervised groups to prevent dental caries among study subjects

CI: confidence interval; df: degree of freedom; IV: inverse variance

the confidence interval of these 2 studies was wide even in spite of a relatively large sample size (Curnow *et al*, 2002; Ruff *et al*, 2023). We found a low risk for imprecision among non-RCT studies since the confidence interval of the studies was not wide and the sample size was adequate (Table 3).

We determined the certainty of the evidence in the RCT studies was low and in the non-RCT was moderate. Overall, STB was not more effective in preventing caries among subjects in RCT but the certainty of the evidence was low. STB was also not effective in preventing caries among subjects

Table 3

Caries prevention bias certainty assessment by study type

Numbers of study	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Percentage of patients		Effect		Certainty	Importance
							STB	Control	Relative effect (95% CI)	Absolute effect (95% CI)		
4	Randomized trials	Serious[a]	Not serious	Not serious	Serious[b]	None	660/1049 (62.9%)	731/1059 (69.0%)	RR = 0.91 (0.82 - 1.02)	62 fewer per 1,000 (from 124 fewer to 14 more)	Low	Critical[e]
2	Non-randomized studies	Serious[c]	Serious[d]	Not serious	Not serious	All plausible residual confounding would reduce the demonstrated effect	381/455 (83.7%)	384/451 (85.1%)	RR = 0.92 (0.71 - 1.21)	68 fewer per 1,000 (from 247 fewer to 179 more)	Moderate	Critical[e]

[a]High risk in the blinding of outcome assessment in the study (Al-Jundi *et al*, 2006) and a high risk of allocation concealment in all studies.

[b]The confidence intervals of the studies (Curnow *et al*, 2002 and Ruff *et al*, 2023) are wide for the studies.

[c]Serious risk of bias due to confounding and bias in the measurement of outcomes in the study (Petersen *et al*, 2004).

[d]Heterogeneity between the studies was high (Lai *et al*, 2016).

[e]Global burden of disease (WHO, 2022) that impacts the health and quality of life of populations worldwide.

Low certainty: low level of confidence that the true effect was close to the estimated effect; Moderate certainty: moderate level of confidence that the true effect was close to the estimated effect

CI: confidence interval; RCT: randomized controlled trial; RR: risk ratio; STB: supervised toothbrushing

in the non-RCT studies and the certainty of this evidence was moderate.

DISCUSSION

This systematic review and meta-analysis assessed the effectiveness of school-based toothbrushing (STB) programs compared to non-STB interventions for caries prevention in primary school children. Overall, we found STB was not consistently more effective than non-STB in reducing caries incidence in the study population.

The meta-analysis showed no significant advantage of STB over non-STB interventions. This finding aligns with earlier studies that also reported no additional benefit of STB, including those by Vestergaard *et al* (1978), Hartono *et al* (2002), and Petersen *et al* (2004). However, some studies have reported STB was more effective than non-supervised toothbrushing to prevent caries among school children (Curnow *et al*, 2002; Jackson *et al*, 2005; Al-Jundi *et al*, 2006; Lai *et al*, 2016; Clark, 2017; Ruff *et al*, 2023; Babaei *et al*, 2023). This difference highlights the heterogeneity in study designs and interventions across the literature. This is variation by intervention was seen in our study where results significantly varied among studies where the interventions included STB only, STB with OHE and STB with flossing (Hartono *et al*, 2002; Petersen *et al*, 2004; Lai *et al*, 2016; Babaei *et al*, 2023). Our subgroup analysis suggested STB with supportive interventions may be more effective in caries prevention than STB alone.

In our study, we found no significant differences in caries prevalence by study design (RCT vs non-RCT) or type of supervisor (professional vs non-professional). This may have been influenced by the low high risk of imprecision among RCT and suggests study quality may have been a factor in these results. It may also suggest the type of supervisor is less important than the type of intervention and requires further study was well-designed, well performed studies.

Our study had several limitations. Four of the 10 included studies could not be pooled in the meta-analysis due to differences in outcome reporting, which could have affected the quantitative findings. Another limitation was the high risk for imprecision among half the RCT studies used in the meta-analysis. A strength of our review was our rigorous adherence to PRISMA 2020 guidelines, which enhances transparency and reproducibility.

In summary, we found no significant difference in caries prevention between subjects who had STB non-supervised toothbrushing among study subjects. However, the quality of studies available was not ideal. Other proven methods of caries prevention, such as sealants, instead of STB, should be considered for the study population. Further, well designed and performed studies should be considered to identify which types of interventions are effective in preventing caries and to determine why STB was not significantly more effective than non-supervised toothbrushing in preventing caries in the study population.

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CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflict of interest.

REFERENCES

Al-Jundi SH, Hammad M, Alwaeli H. The efficacy of a school-based caries preventive program: a 4-year study. *Int J Dent Hyg* 2006; 4(1): 30-4.

Archana SP, Gupta N, Rajmohan S,

Deepika, Sharma S, Asmin PK. Dental caries prevalence in the children of age group 6 and 12 years on the basis of various oral hygiene factors in the Himachal Population: a cross-sectional study. *J Posit Sch Psychol* 2022; 6(3): 10153-61.

Attin T, Hornecker E. Toothbrushing and oral health: how frequently and when should toothbrushing be performed? *Oral Health Prev Dent* 2005; 3(3): 135-40.

Babaei A, Pakdaman A, Shamshiri AR, Khazaei P, Hessari H. One-year oral health outcome of a community-based trial in schoolchildren aged 6-7 years old in Tehran, Iran. *PLoS One* 2023; 18(4): e0284366.

Borges-Yáñez SA, Castrejón-Pérez RC, Camacho MEI. Effect of a school-based supervised toothbrushing program in Mexico City: a cluster randomized intervention. *J Clin Pediatr Dent* 2017; 41(3): 204-13.

Bureau of Dental Health. The 8th Thailand National Oral Health Survey Report 2017, 2018 [cited 2024 May 01]. Available from: URL: https://dental.anamai.moph.go.th/web-upload/migrated/files/dental2/n2423_3e9aed89e-b9e4e3978640d0a60b44be6_survey8th_2nd.pdf [in Thai]

Clark E. Supervised toothbrushing in Northland [thesis]. Dunedin, New Zealand: University of Otago; 2017.

Curnow MM, Pine CM, Burnside G, Nicholson JA, Chesters RK, Huntington E. A randomized controlled trial of the efficacy of supervised toothbrushing in high-caries-risk children. *Caries Res* 2002; 36(4): 294-300.

Deeks JJ, Higgins JP, Altman DG. Analyzing data and undertaking meta-analyses. In: Higgins JPT, Thomas J, Chandler J, *et al*, editors. Cochrane Handbook for Systematic Reviews of Interventions; 2019. p. 241-84.

Dos Santos AP, de Oliveira BH, Nadanovsky P. A systematic review of the effects of supervised toothbrushing on caries incidence in children and adolescents. *Int J Paediatr Dent* 2018; 28(1): 3-11.

Hartono SW, Lambri SE, van Palenstein Helderman WH. Effectiveness of

primary school-based oral health education in West Java, Indonesia. *Int Dent J* 2002; 52(3): 137-43.

Higgins JPT, Savović J, Page MJ, Elbers RG, Sterne JA. Assessing risk of bias in a randomized trial. In: Higgins JPT, Thomas J, Chandler J, *et al*, editors. Cochrane Handbook for Systematic Reviews of Interventions; 2019. p. 205-28.

Higgins JPT, Thomas J, Chandler J, *et al*, editors. Cochrane Handbook for Systematic Reviews of Interventions version 6.4, 2023 [cited 2025 Apr 10]. Available from: URL: https://www.cochrane.org/authors/handbooks-and-manuals/handbook/archive/v6.4

Jackson RJ, Newman HN, Smart GJ, *et al*. The effects of a supervised toothbrushing program on the caries increment of primary school children, initially aged 5-6 years. *Caries Res* 2005; 39(2): 108-15.

Lai H, Fann JC, Yen AM, Chen LS, Lai MH, Chiu SY. Long-term effectiveness of school-based children oral hygiene program on oral health after 10-year follow-up. *Community Dent Oral Epidemiol* 2016; 44(3): 209-15.

Ozdemir D. Dental caries: the most common disease worldwide and preventive strategies. *Int J Microbiol Res Rev* 2014; 6(5): 340-4.

Petersen PE, Peng B, Tai B, Bian Z, Fan M. Effect of a school-based oral health education program in Wuhan City, Peoples Republic of China. *Int Dent J* 2004; 54(1): 33-41.

Prada I. Prevalence of dental caries among 6-12-year-old schoolchildren in social marginated zones of Valencia, Spain. *J Clin Exp Dent* 2020; 12(4): e399-408.

Ruff RR, Monse B, Duijster D, Itchon GS, Naliponguit E, Benzian H. Effectiveness of school-based strategies to prevent tooth decay in Filipino children: A cluster-randomized trial. *Community Dent Oral Epidemiol* 2023; 51(2): 219-27.

Schünemann HJ, Higgins JP, Vist GE, *et al*. Completing 'Summary of findings' tables and grading the certainty of the evidence. In: Higgins JPT, Thomas J, Chandler J, *et al*, editors. Cochrane Handbook for Systematic Reviews of Interventions; 2019. p. 375-402.

Sterne JA, Hernán MA, Reeves BC, *et al*. ROBINS-I: a tool for assessing risk of bias in non-randomized studies of interventions. *BMJ* 2016; 355: i4919.

Vestergaard V, Moss A, Pedersen HO, Poulsen S. The effect of supervised tooth cleansing every second week on dental caries in Danish school children. *Acta Odontol Scand* 1978; 36(4): 249-52.

World Health Organization (WHO). Global oral health status report: towards universal health coverage for oral health by 2030, 2022 [cited 2024 May 01]. Available from: URL: https://iris.who.int/bitstream/handle/10665/364538/9789240061484-eng.pdf?sequence=1