Original Article

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Dentistry Section

Maternal Oral Health Education for Predicting Early Childhood Caries among Preschool Children: A Systematic Review and Meta-analysis

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ABSTRACT

Introduction: Early Childhood Caries (ECC) is a pressing public health issue in preschool-aged children. Preventive guidelines have not significantly reduced ECC incidence. Maternal education programmes have been proposed as interventions, but systematic reviews on their effectiveness are scarce.

Aim: To evaluate the effectiveness of oral health education programmes for mothers in preventing ECC.

Materials and Methods: Eight eligible Randomised Controlled Trials (RCTs) were identified through searches in the Cochrane Oral Health Group's Trial Register, PubMed, and Google Scholar, as well as manual review of references from English-only studies. The interventions targeted mothers starting from 12 weeks of pregnancy onwards, with the exclusion of treatment-based methods, pharmacological interventions, and post-pregnancy programmes. The primary outcome assessed was ECC incidence, analysed following Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach. Participants exclusively received oral health educational programmes designed to prevent ECC in their children, highlighting the importance of early preventive measures during pregnancy.

Results: Global studies varied in interventions and outcomes. A study from Brazil showed no reduction in ECC, while a study from Uganda reported reduced dental caries. Another study from Australia demonstrated a significant reduction in severe ECC. Risk of bias analysis revealed that five studies had a low risk of bias while one study had an unclear risk of bias. Moderate risk of bias was found in one study.

Conclusion: Evidence suggests a positive impact of maternal education on ECC prevention, supporting tailored programmes for mothers with lower education. The overall recommendation strength is modest due to intervention variations and limited trials. Tailored educational programmes for mothers, especially those with lower education levels, should be integrated into maternal and child health services to effectively address social determinants of oral health.

Keywords: Child development, Dental caries, Prenatal education

INTRODUCTION

The ECC is a significant public health concern that affects preschool-aged children [1]. Severe ECC (S-ECC) is diagnosed when smooth-surface caries is present in children under the age of three. ECC, a major public health issue, refers to the presence of decayed, missing, or filled tooth surfaces in any primary tooth of a child under six years [2].

After reviewing 190 publications from 88 different countries, El Tantawi M et al., found that the average ECC prevalence was 23.8% [3]. ECC rates were 23.8% in children under 36 months and escalated to 57.3% for those aged 36 to 71 months. Despite comprehensive preventive guidelines from organisations such as the American Academy of Paediatrics (AAP), the American Academy of Paediatric Dentistry (AAPD), the American Dental Association (ADA), and the American Association of Public Health Dentistry (AAPHD), there has not been a sustained reduction in ECC incidence [4].

AAPD recommends adopting preventive measures to reduce a child's susceptibility to ECC. Elevated levels of cariogenic oral bacteria in mothers can increase the risk of ECC in their children, highlighting the importance of perinatal oral health for both mother and newborn. Providing parents with educational information and preventive therapies could enhance children's oral health and simultaneously reduce ECC occurrences. Thus, implementing a maternal perinatal oral healthcare preventive program is crucial [5].

Existing reviews often overlook oral health educational intervention programmes for mothers. These programmes encompass a range of interventions aimed at equipping mothers with the knowledge and tools necessary to prevent ECC in their children. These interventions can include anticipatory guidance, education on oral health, promotion of healthy habits, counseling on diet and nutrition, motivational interviewing, follow-up communication, and the distribution of informative materials such as postcards, home visits, pamphlets, or DVDs.

To rigorously evaluate the effectiveness of preventive interventions, a systematic review incorporating RCT is considered the most robust method. Following the PRISMA guidelines [5], the research question, framed using the Patient/Population, Intervention, Comparison and Outcomes (PICO) format, is: "Can educational programmes on oral health for mothers effectively reduce the occurrence of ECC in their children?" The purpose of this review is to bring together existing research findings regarding the efficacy of oral health education initiatives specifically designed for mothers to combat ECC and determine which interventions have yielded the greatest success.

MATERIALS AND METHODS

This systematic review and meta-analysis specifically emphasise maternal oral health education as an imperative tool for the prevention of ECC, a common menace among preschool children. Thus, RCTs featuring atleast one oral health educational intervention targeted at mothers were included.

Inclusion criteria: Those studies and trials with educational intervention given for prenatal and postnatal mothers and published in English were included in the review.

Exclusion criteria: Those trials that employed treatment based methods, such as providing preventive procedures and restorations to children and also those trials involving pharmacological interventions were excluded from the study.

Review Procedure

The main emphasis in this study was on the incidence of ECC, evaluated through diverse indices including Decayed, Missing, And Filled Surfaces (DMFS), Decayed, Missing, and Filled Teeth (DMFT), International Caries Detection and Assessment System (ICDAS), Decayed, Tooth indicated for Extraction, Filled (DEFT), Decayed, Filled Surface (DFS), or Decayed, Filled Teeth (DFT). Secondary outcomes included any additional reported adverse effects.

Search strategy: The search process adhered to the guidelines outlined in the PRISMA statement [5], a widely recognised framework for systematic reviews and meta-analyses. The authors conducted a comprehensive electronic search across various databases, including the Cochrane Oral Health Group's Trial Register, PubMed, and Google Scholar, without any restrictions on the publication dates. For each database, the authors developed specific and detailed search strategies. Additionally, a manual review of the bibliographic references from the identified RCTs and review articles was performed to ensure the comprehensive inclusion of pertinent studies conducted in English.

The search terms comprised combinations of MeSH terms, text words, and their variants, structured as follows: ('oral health' OR ('oral' AND 'health') AND 'child' OR 'children' AND 'pregnancy' AND ('dental caries' OR ('dental') AND 'caries') AND ('motivational interviewing' OR ('motivational' AND 'interviewing') OR ('counseling') AND ('prevention and control') AND oral health promotion AND ('education' OR 'educational status' OR ('educational' AND 'status') AND ('mothers' OR 'maternal'). This search approach was devised to comprehensively identify pertinent studies for this review.

Data collection and analysis: Two reviewers undertook the initial screening of studies by evaluating the titles and abstracts of all identified research. They adhered to the PICO criteria during this screening process. For studies meeting the inclusion criteria but lacking sufficient data in their titles and abstracts, complete copies were obtained to support well-informed decisions. Data extraction followed a structured approach utilising specially designed and pre-tested forms tailored for RCTs, based on the Cochrane review group's template. The extracted information encompassed details such as publication date, objectives, and eligibility criteria.

Bias assessment: Two authors conducted a thorough assessment of bias in the included studies, following the risk assessment tool provided by the Cochrane Collaboration. The evaluation encompassed different aspects such as allocation sequence methods, blinding, and handling of incomplete outcome data, among others, in accordance with the PRISMA guidelines [5] and the Cochrane Handbook for Systematic Reviews of Interventions, version 5.0.2 [6].

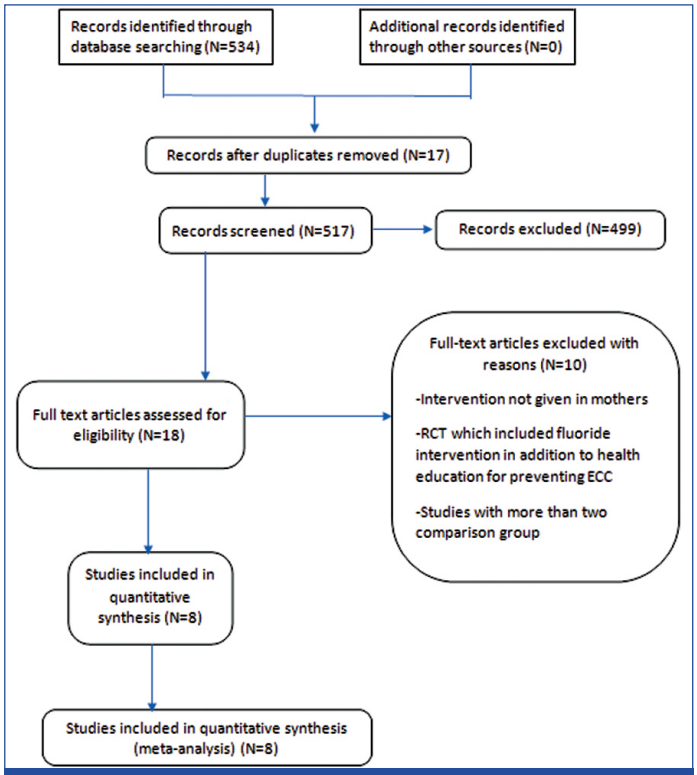
STATISTICAL ANALYSIS

Data analysis utilised the Review Manager [7] (RevMan) software from the Cochrane Collaboration. For dichotomous outcomes, the Risk Ratio (RR) was employed, and results were presented with their corresponding 95% Confidence Intervals (CIs). To evaluate heterogeneity, the researchers visually examined the Forest plot and calculated the I^2 statistic, which measures the extent of variability among the studies. I^2 values of 25%, 50%, and 75% indicate low, moderate, and high levels of heterogeneity, respectively. The GRADE system was used to assign grades to the evidence [8].

RESULTS

This systematic review focused exclusively on RCTs that included oral health educational interventions targeted specifically towards mothers. The research process involved the initial identification of 534 records through database searching, with no additional records identified from other sources. After eliminating duplicate records (N=17), the screening process involved evaluating 517 records. Out of these, 499 records were excluded for various reasons: systematic reviews that included fluoride intervention in addition to health education for preventing ECC, interventions not given to mothers, cross-sectional studies, studies that were not RCTs, interventions given to mothers and women who had recently given birth, and studies that were not RCTs. After evaluating 18 full-text publications for eligibility, 10 were rejected.

The number of reports that were found, screened, and evaluated for eligibility, as well as the subsequent exclusion and inclusion in the review, is depicted in a PRISMA flow diagram [Table/Fig-1]. Diet and nutrition counselling, motivational interviewing, and oral health promotion were the main interventions used in the studies. There were similarities in the participant profiles and results among the included studies, even though each study's interventions were unique.



[Table/Fig-1]: PRISMA flow diagram.

The characteristics of the included studies are described in [Table/Fig-2] [9-16].

Risk of bias: The risk of bias analysis revealed that the studies by Chaffee BW et al., Engh MS et al., Harrison RL et al., Feldens CA et al., Basir L et al., had a low risk of bias, while the studies by Muhoozi GKM et al., Shenoy R et al., Plutzer K et al., had unclear and moderate risk of bias, respectively [Table/Fig-3] [9-16].

A review of the studies' biases shows that there was a low risk associated with selection bias or random sequence creation. It was unclear how allocation bias (selection bias) was concealed. The blinding of participants and outcome evaluators (performance bias and detection bias) were found to have low risk of bias, respectively. There was a dual finding regarding incomplete outcome data (attrition bias), with both low risk (65%) and high-risk (25%) of bias. While other biases indicated a split with 75% having a low risk and 25% having a high-risk of bias, selective reporting (reporting bias) demonstrated a low risk of bias [Table/Fig-4].

Forest Plot

A Forest plot was generated using Review Manager 5.4 [Table/Fig-5]. In the current review, a fixed-effect model was employed to construct a forest plot based on the premise that the true effect size remained constant throughout all the studies under consideration.

The only reasons for any reported difference in effect sizes among studies are sampling variability or random error. The Odds Ratio (OR) and 95% CI for several aspects were positioned incorrectly in the forest plot. By presenting the p-value, the overall effect size was evaluated for statistical significance.

The Mantel-Haenszel method was used to calculate the OR's 95% CI [17]. A total of 1294 pregnant women who served as controls were compared with 1297 pregnant women in the intervention group. The results of the analysis showed that controls had higher chances of dental caries occurrence, which were significant at p<0.00001 and 1.77 (95% CI; 1.47-2.13). This suggests that maternal education plays a key role in reducing the risk of dental caries. The above analysis showed a heterogeneity of 62%. This could be associated with methodological differences such as the modes of delivering health education, socio-economic status of the mothers, and different methods of caries assessment performed in the studies.

Funnel Plot

A funnel plot was generated using Review Manager 5.4 [Table/Fig-6]. The analysis of the funnel plot for studies on maternal education interventions for oral health outcomes revealed diverse findings. Chaffee BW et al., in the Brazil study, displayed no statistically significant reduction in ECC or S-ECC, indicating symmetry in the funnel plot [9]. Conversely, Engh MS et al., in the Uganda study, showed a significant reduction in dental caries, supported by an asymmetric funnel plot, suggesting potential publication bias or study heterogeneity [10].

Harrison RL et al., in the Canadian study, with no statistically significant difference in caries prevalence, aligned with the symmetric funnel plot [11]. Plutzer K and Spencer AJ, in the Australian study, demonstrating a significant reduction in severe ECC incidence, contributed to an asymmetrical funnel plot [12].

Authours reference	Country	Study design	Sample size description	Population intervention	Intervention	Mode of delivery of intervention	Outcome measures	p-value	Conflicts of interest
Chaffee BW et al., 2015 [9]	Brazil	Cluster-randomised trial	Control group: 221 Intervention group: 237	Pregnant women	Maternal education	By health trainer-nurses, physician, administrative staff through posters and pemplates	ECC, cavitated decay, S-ECC assessed when child was 2-3 years old	The overall reduction in ECC (RR 0.92; 95% CL, 0.75, 1.12) severe ECC (RR, 0.87; 95% CI, 0.64, 1.19) were not statistically significant.	No
Engh MS et al., 2022 [10]	Uganda	RCT	Control group: 157 Intervention group: 200	Mothers of six to eight-month-old	Maternal education	By nutrition education team	Dental caries five to six- year old children	Dental caries (odds ratio 0.46; 95% CI 0.24-0.86) p-value-0.02.	No
Harrison RL et al., 2012 [11]	Canada	Cluster RCT	Control group: 131 Intervention group: 110	Pregnant women	Maternal education	By community health representatives	Dental caries 30-month-old children	The control group's caries prevalence was 76% (100/131), while the treatment group's caries prevalence was 65% (72/110). The permutation test's two-sided p-value of 0.17 indicated that the group difference was not statistically significant. While the RR was 65/76=0.86 (95% CI: 0.66 to 1.07), the absolute risk difference was 11% (95% CI: -3 to 30%). The estimate of intra-class correlation was 0.006.	No
Plutzer K and Spencer AJ, 2008 [12]	Australia	RCT	Control group: 322 Intervention group: 327	Pregnant women	Maternal education	Three rounds of printed material applied as anticipatory guidance were given to the test group	Severe Early Childhood Caries (S-ECC) of two to three-year-old children	In the test group, the incidence of S-ECC was 1.7%, while in the control group, it was 9.6% (p<0.001).	No
Feldens CA et al., 2010 [13]	Brazil canaoas	Parallel RCT	500 mother-child pairs (200 intervention, 300 control) enrolled, 340 (141 intervention, 199 control) completed 4 year follow-up	Trial was conducted in mothers	Maternal education	Maternal education and oral hygiene promotion through nutrition educators given by home visits	A 32% reduction in the incidence of S-ECC was observed (RR 0.68; 95% CI 050-0.92). As compared to the control group (4.15), the intervention group's mean number of afflicted teeth (3.25) was lower (Mann Whitney U-test; p=0.023)	340 mother-child couples (141 intervention, 199 control) out of the 500 that were enrolled—200 intervention, 300 control—completed the 4-year follow-up. With 76 (53.9%) intervention children and 138 (69.3%) controls having ECCs, home counseling decreased incidence by 22% (RR 0.78; 95% CI 0.65-0.93). 340 (141 intervention, 199 control) of the 500 mother-child pairs who were enrolled finished the 4-year follow-up. With a 32% decrease in severe cases (RR 0.68; 95% CI 0.50-0.92), home counseling decreased the incidence of caries in early childhood by 22% (RR 0.78; 95% CI 0.65-0.93). The mean number of affected teeth was reduced in the intervention group (3.25 vs. 4.15, p=0.023), and no adverse effects were noted.	No

Basir L et al., 2017 [14]	Iran	Parallel-group design RCT experimental study was carried out through a parallel-group design	The subjects were divided into two groups at random: the experimental group (n=52) and the control group (n=52). 52 people make up either the experimental group or the control group	The study population included women with children aged 12-36 months old pregnant women	Educational intervention (consisting of one individual session and a group (4–6 person) lasting for half an hour) was designed with the aid of women referring to the health center for monitoring their children's growth maternal education	Maternal education and oral hygiene promotion through pamphlets	the intervention could reduce the incidence of ECC	Pre-intervention differences were not observed between women (31±6.68y) and children (18±7.21mnth). However, after the intervention, the experimental group had superior health literacy (20.98±2.15 vs. 19.76±2.70, p=0.01) and higher perceived dangers (41.15±4.46 vs. 38.2 6±4.21, p=0.001). Additionally, they had decreased incidence of ECC (13% vs. 35%, p=0.001) and improved oral health practices (7.75±2.30 vs. 6.15±2.65, p=0.01). The average age of the children was 18±7.21 months and the average age of the women was 31±6.68 years. Prior to the intervention, p>0.05 indicated that there was no discernible difference between the groups for the research variables. However, following the intervention, there was a significant difference in the incidence of ECC (13% in the experimental group and 35% in the control group, p=0.001), oral health behaviours (7.75±2.30 in the experimental group and 6.15±2.65 in the control group, p = 0.01), health literacy (20.98±2.15 in the experimental group and 19.76±2.70 in the control group, p=0.001), and perceived threats (41.15±4.46 in the experimental group and 38.26±4.21 in the control group, p=0.001).	No
Muhoozi GKM et al., 2018 [15]	Uganda.	A cluster RCT	When the children were 36 months old, data were available from 399 mother/child pairs (78%) in the initial experiment (203 in the intervention group and 198 in the control group)	The study population included women with children aged 12-36-months-old pregnant women	Maternal education	Maternal education and oral hygiene promotion through Nutrition educators	ECC	Lesions with cavitation were more common in the control group than in the intervention group (27.8% vs. 18.2%; p=0.04). The intervention group significantly decreased the extraction of "false teeth" (ebiino), a painful and rudimentary traditional procedure (8.9% vs. 24.7%; p=0.001).	No
Shenoy R et al., 2020 [16]	India	RCT	155 in the intervention group and 156 in the control group	Pregnant women	Maternal education	Oral health education through verbal and pamphlet information	ECC	There was no significant difference in ECC in both the intervention and control groups. ECC affected 21 children (13.46%) in the intervention group and 22 children (14.19%) in the control group.	No

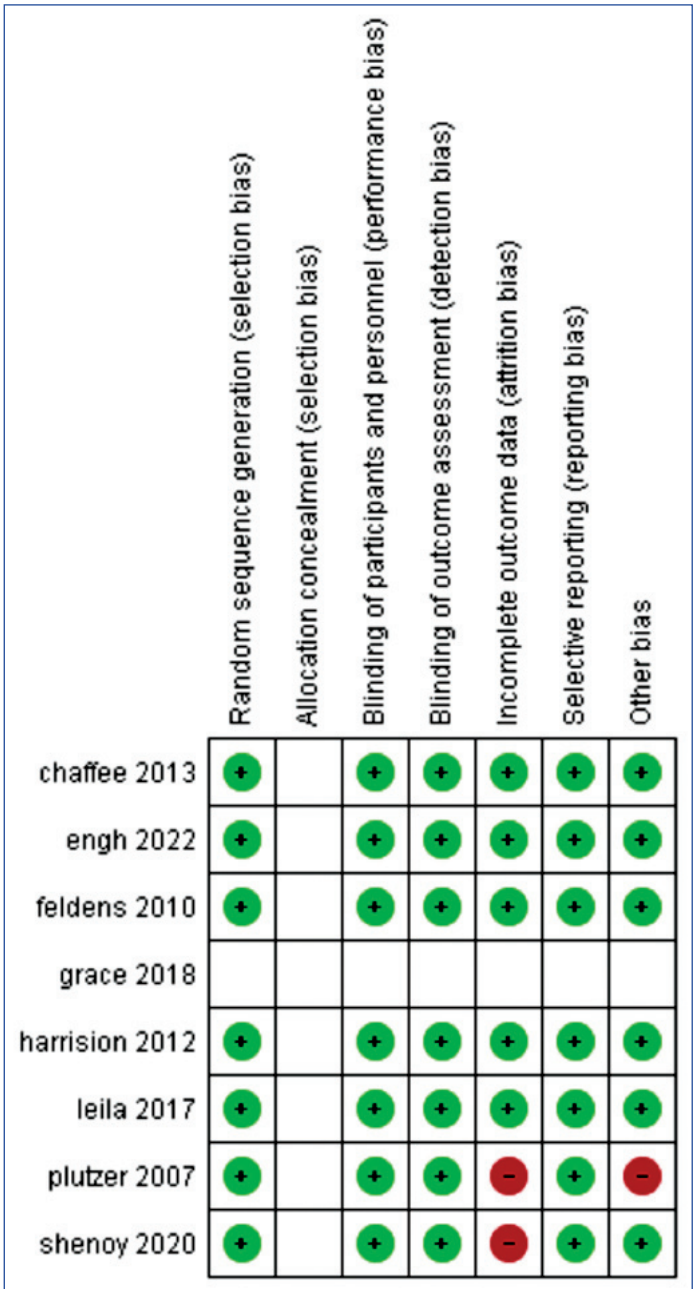
[Table/Fig-2]: Characteristics of included studies [9-16].

The study by Feldens CA et al., in Canoas lacked specific outcome details, making interpretation challenging [13]. Basir L et al., in the Iranian study, showing significant differences post-intervention, correlated with the asymmetry in the funnel plot [14].

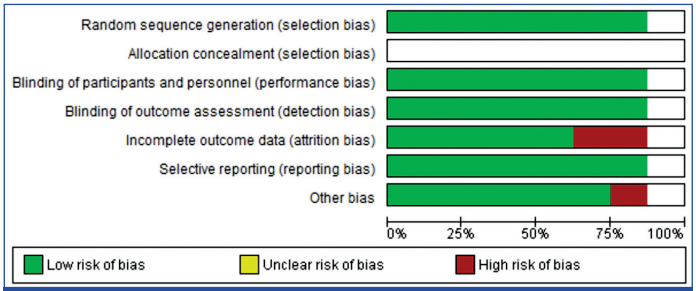
Muhoozi GKM et al., in the Uganda study, indicating reduced cavitated carious lesions in the intervention group, matched the asymmetry of the funnel plot [15]. Combining these individual findings, the overall funnel plot underscores variability in study outcomes, emphasising the importance of considering study design and intervention specifics when assessing the effectiveness of maternal education programmes on oral health.

The funnel plot serves to compare the precision of how closely the estimated intervention effect size aligns with the true effect size. The funnel plot is directly influenced by individual studies; near the top of the graph, larger, more accurate studies tend to have a narrower spread, while the scatter of smaller research effects is usually wider at the bottom. Smaller sample sizes may result in scattered studies and potential outliers, underscoring the importance of both precision and effect size to address publication bias. Heterogeneity is also crucial in meta-analysis representation.

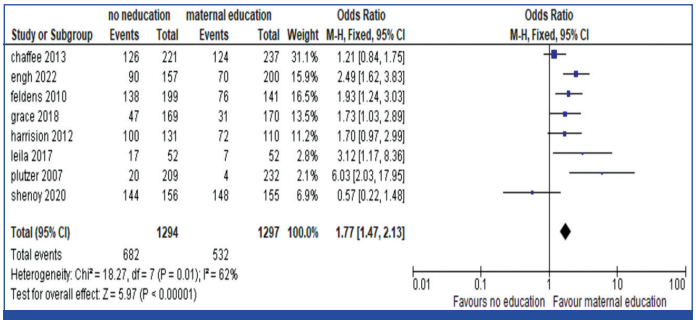
The funnel plot in the present study appears symmetrical and inverted, with the size of each dot signifying the effect magnitude and each study represented by a dot. The standard error is shown on the y-axis. Research with lesser precision, like Basir L et al., constitutes the bottom of the list [14], while larger, more accurate research, like Chaffee BW et al., Harrison RL et al., Plutzer K et al.,



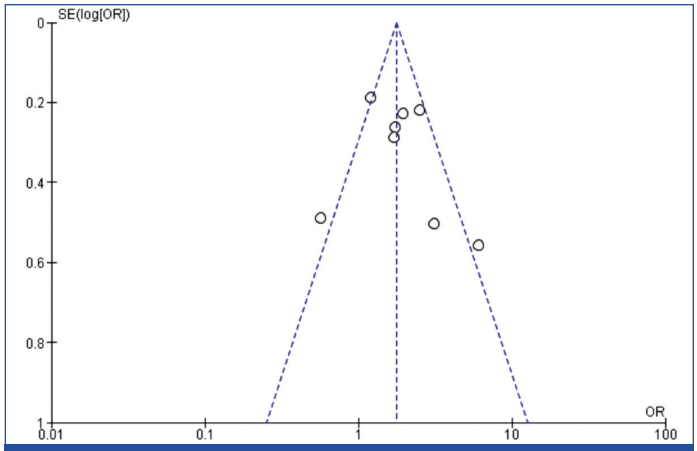
[Table/Fig-3]: Risk of bias assessment of included studies.
+ low-risk of bias; – high-risk of bias; blank: Unclear risk of bias



[Table/Fig-4]: Percentage involvement of various reasons of bias assessment.



[Table/Fig-5]: Forest plot.



[Table/Fig-6]: Funnel plot.

Muhoozi GKM et al., and Shenoy R et al., form the top [9,11,12,15,16]. Kowash MB et al., an outlier study, was disregarded [18]. Odds are shown on the x-axis as a RR plotted as mean difference on a logarithmic scale.

The plot suggests an absence of both bias and heterogeneity, with 95% of studies lying within the CI. Funnel plot asymmetry is minimal, with only two outliers among the 08 studies, indicating a low likelihood of significant bias. The GRADE method was used by the writers to evaluate the overall quality of the evidence [Table/Fig-7]. An analysis of eight RCTs involving 2,591 patients explored the relationship between maternal education and dental caries prevention. The evidence's certainty is deemed high, signifying a robust association between maternal education and a substantial reduction in dental caries incidence. The OR of 1.77, with a 95% CI of 1.47 to 2.13, underscores a significant positive effect. Notably, the absolute effect of maternal education is emphasised, revealing 142 fewer cases of dental caries per 1,000 individuals compared to those without education. The certainty assessment categorises the evidence as of high quality, highlighting the reliability of the identified association. This underscores the importance of maternal education as a significant factor in preventing dental caries, making it a crucial consideration in public health initiatives.

DISCUSSION

The research question investigating the impact of maternal education on oral health and dental caries prevalence in preschoolers between the ages of two and six is crucial for understanding the social determinants of oral health. The findings of this study align with existing literature emphasising the impact of maternal education on health outcomes in children.

Numerous studies [19-21] have identified a clear association between maternal education and various health indicators in children, including dental health. For instance, a study by Rong WS et al., highlighted that children of mothers with higher education levels tend to have better oral health outcomes, including lower rates of dental caries [19]. The mechanisms through which maternal education affects children's oral health are multifaceted and may include improved health literacy, better access to healthcare resources, and the adoption of healthier behaviours within educated households.

The findings underscore the relationship between reduced dental cavity prevalence in preschoolers and maternal oral health education, especially when considering the prevalence of dental caries. These findings are in line with other studies, such as the one by Bhardwaj SV and Bhardwaj A, which repeatedly demonstrates a negative relationship between maternal oral health education and the incidence of dental caries in children [20].

Even though the evidence supports the association, it is crucial to acknowledge potential confounding factors that might influence the observed relationship. Socioeconomic status, access to preventive dental care, dietary habits, and oral hygiene practices are essential

Certainty assessment							No. of patients		Effect		Certainty	Importance
No. of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Maternal education	No education	Relative (95% CI)	Absolute (95% CI)		
Dental caries												
8	RCT	Not serious	Not serious	Not serious	Not serious	Strong association	682/1294 (52.7%)	532/1297 (41.0%)	OR 1.77 (1.47 to 2.13)	142 more per 1,000 (from 95 more to 187 more)	⨁⨁⨁⨁ High	Important

[Table/Fig-7]: Grade assessment for certainty of evidence for association between maternal educational innervation and dental caries in pre-school children.
CI: Confidence interval; OR: Odds ratio

considerations. Further research, such as the work of Wang J and Geng L, has explored how these factors interact with maternal education to influence dental health outcomes in children [21].

Public health interventions aimed at reducing educational disparities in oral health are warranted based on the present findings. Tailored educational programmes for mothers with lower education or no formal education should be integrated into existing maternal and child health services. This approach is consistent with recommendations from the World Health Organisation (WHO) and the AAPD to address social determinants of oral health [22].

Limitation(s)

It is important to consider limitations at various levels when interpreting the findings of this review.

Study level: The studies involved diverse interventions, participants, and outcome measures, potentially impacting the generalisability of findings. Some studies had relatively small sample sizes, increasing the possibility of chance findings and reducing generalisability. Not all studies included blinding for participants or assessors, potentially introducing bias. Different studies utilised various indices to measure ECC (e.g., DMFT, DFS), making direct comparisons challenging. Some studies had short follow-up periods, potentially missing long-term effects of interventions. Studies included subjective outcomes like perceived threats or behaviours, which can be prone to bias.

Review level: The review might have missed relevant studies due to specific search strategies or language restrictions. While the review used established tools like GRADE, potential subjective judgments during bias assessment and quality grading could exist. The limited number of included studies and heterogeneity restricted the use of robust meta-analysis techniques, potentially affecting the precision of the estimated effect. Overall, while the review suggests a potential benefit of maternal oral health education for preventing ECC, the limitations mentioned above highlight the need for further research with robust designs, standardised outcomes, and larger sample sizes to confirm the findings and identify the most effective interventions.

CONCLUSION(S)

This review indicates that providing oral health education to mothers could potentially contribute to preventing ECC in their children. However, the recommendation strength is not robust, and determining the most effective intervention is challenging due to differences in interventions and few studies conducted on this topic.

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