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ORIGINAL REPORT

EVALUATING THE EFFECTIVENESS OF SCHOOL-BASED ORAL HEALTH EDUCATION METHODS IN IMPROVING CHILDREN'S ORAL HEALTH : A SYSTEMATIC REVIEW

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ABSTRACT

Background: Oral health plays a pivotal role in the overall growth and development of children, influencing their physical, psychological, and social well-being. Despite advancements over the decades, the prevalence of poor oral health among children remains high, contributing to school absenteeism and reduced academic performance. School-based dental health education has emerged as a promising approach to improve awareness and promote dental care utilization; however, its diverse dimensions and varying effectiveness remain underexplored.

Aim: This systematic review aimed to evaluate the effectiveness of school-based oral health education programs in improving children's oral health outcomes, with a focus on their impact and effectiveness.

Results: A total of 1,200 articles were identified through database searches. After screening and excluding irrelevant studies, 45 studies met the inclusion criteria and were included in the qualitative synthesis.

Conclusion: Traditional classroom teaching, although widely implemented, demonstrated limited impact on sustained behavioral change. In contrast, interactive approaches such as games, role-playing, and supervised toothbrushing yielded more enduring improvements in oral health. The integration of digital tools and parental involvement further enhanced outcomes but was often feasible only in resource-rich settings. The effectiveness of interventions varied significantly across different cultural and socio-economic contexts.

Keywords*:* School health education, oral health, children, behavioral change, attitude

1. INTRODUCTION

Oral health plays a critical role in children's overall well-being, influencing their physical, psychological, and social development. Good oral health is essential for proper nutrition, speech development, and self-esteem[1]. However, despite advancements in healthcare, dental caries remains the most prevalent chronic disease among children worldwide [2]. Poor oral health not only causes pain and discomfort but also leads to school absenteeism and reduced academic performance [3].

Problem Statement

The prevalence of poor oral health among children is alarmingly high, particularly in low- and middle-income countries where access to dental care is limited [4]. While preventive measures such as fluoridation and routine dental check-ups are effective, these strategies are not always accessible to all children. School-based oral health education has emerged as a viable method to promote awareness and improve oral hygiene practices, but its effectiveness remains under-explored [5].

Objectives of the Review

The primary objective of this systematic review is to evaluate the effectiveness of school-based oral health education in improving children's oral health outcomes. Specifically, the review aims to:

1. Assess changes in oral health knowledge and behavior following school-based interventions.
2. Examine the impact of these interventions on clinical outcomes, such as caries reduction and improved oral hygiene.
3. Compare the effectiveness of different education methods, including traditional teaching, interactive approaches, and digital tools [6].

PICO

To ensure clarity in defining the study scope, the PICO model was applied:

- Population (P): School-aged children between 5 and 15 years, from diverse geographic regions and socio-economic backgrounds.
- Intervention (I): School-based oral health education programs, including traditional classroom teaching, interactive activities such as games, role-playing, and supervised toothbrushing, and digital tools such as educational apps, videos, and online modules.
- Comparator (C):
  - No intervention or standard school curriculum without specific oral health components.
  - Alternative education approaches differing in method or content delivery.
- Outcomes (O):
  - *Primary outcomes:* Improvement in oral health knowledge and behaviors, including increased brushing frequency, improved brushing techniques, adoption of flossing habits, and healthier dietary practices.
  - *Secondary outcomes:* Reduction in plaque index, gingival index, and dental caries incidence; improvement in oral hygiene scores and gingival health.

PECO

Given that both randomized controlled trials and observational studies are included, the PECO model was also applied for broader applicability:

- Population (P): School-aged children between 5 and 15 years, from varied cultural, geographic, and socio-economic contexts.
- Exposure (E): Participation in school-based oral health education interventions, incorporating traditional, interactive, or digital formats.
- Comparator (C): Absence of such programs or the use of alternative or less intensive educational approaches.
- Outcomes (O): Improvements in oral health knowledge, adoption of better oral hygiene behaviors, reduction in plaque and gingival indices, decreased incidence of dental caries, and improved gingival health.

2. MATERIALS AND METHODS

2.1 Search Strategy

Scope and Relevance

Schools serve as an ideal platform for delivering oral health education due to their structured environment and access to a large population of children [7]. Integrating oral health education into school curriculums has the potential to reach children from diverse socioeconomic backgrounds and instill lifelong healthy habits. Furthermore, understanding the most effective methods for delivering these interventions can guide policymakers and educators in developing targeted programs that address the specific needs of their communities [8].

To ensure a comprehensive review, a systematic search was conducted across multiple databases, including **PubMed**, **Scopus**, **Cochrane Library**, and **Web of Science**. The search was conducted using a combination of relevant keywords and Boolean operators to identify studies evaluating school-based oral health education programs. The primary search terms included:

- "Oral health education"
- "School-based programs"
- "Children's oral health"
- "Dental caries prevention"
- "Oral hygiene interventions"

The search was restricted to peer-reviewed articles published in **English** within the last 15 years to ensure the relevance of the findings (e.g., Petersen et al., 2005; Jackson et al., 2011). Additional sources were identified through manual screening of references cited in relevant articles and systematic reviews.

(Systematic review has been registered in PROSPERO 2025 CRD420251000578)

2.2 Inclusion and Exclusion Criteria

Inclusion Criteria:

1. Studies focusing on school-based oral health education programs.
2. Studies involving children aged **5-15 years**.
3. Interventions with a duration of at least **three months**.
4. Studies reporting measurable outcomes such as improvements in oral hygiene knowledge, behavior, or clinical measures (e.g., plaque reduction, caries prevention).
5. Articles published in English in peer-reviewed journals.

Exclusion Criteria:

1. Studies involving populations outside the defined age range.
2. Interventions conducted in non-school settings or programs unrelated to oral health education.
3. Studies lacking measurable or clearly defined outcomes.

4. Review articles, editorials, and conference abstracts without primary data.

2.3 Study Selection Process

The study selection process followed the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)** guidelines:

1. **Title and Abstract Screening**: Two reviewers independently screened titles and abstracts for relevance based on the inclusion and exclusion criteria.
2. **Full-Text Review**: Articles meeting the eligibility criteria were retrieved for full-text analysis to ensure they aligned with the study objectives.
3. **Discrepancy Resolution**: Any disagreements during the selection process were resolved through discussion or consultation with a third reviewer.

2.4 Data Extraction

Key data points were extracted from each included study using a standardized data extraction form:

- **Study Design**: Randomized controlled trials (RCTs), cohort studies, or cross-sectional studies.
- **Sample Size**: Number of participants involved in the study.
- **Intervention Type**: Details of the oral health education methods (e.g., traditional lectures, interactive sessions, use of digital tools).
- **Duration**: Length of the intervention and follow-up period.
- **Outcomes Measured**: Improvements in oral hygiene practices (e.g., brushing frequency), knowledge, and clinical outcomes such as plaque reduction or caries prevention.

2.5 Quality Assessment

The quality of the included studies was assessed using validated tools:

- **Cochrane Risk of Bias Tool**: For randomized controlled trials, assessing factors such as randomization, allocation concealment, and blinding of participants.
- **Newcastle-Ottawa Scale (NOS)**: For observational studies, evaluating selection, comparability, and outcome assessment.

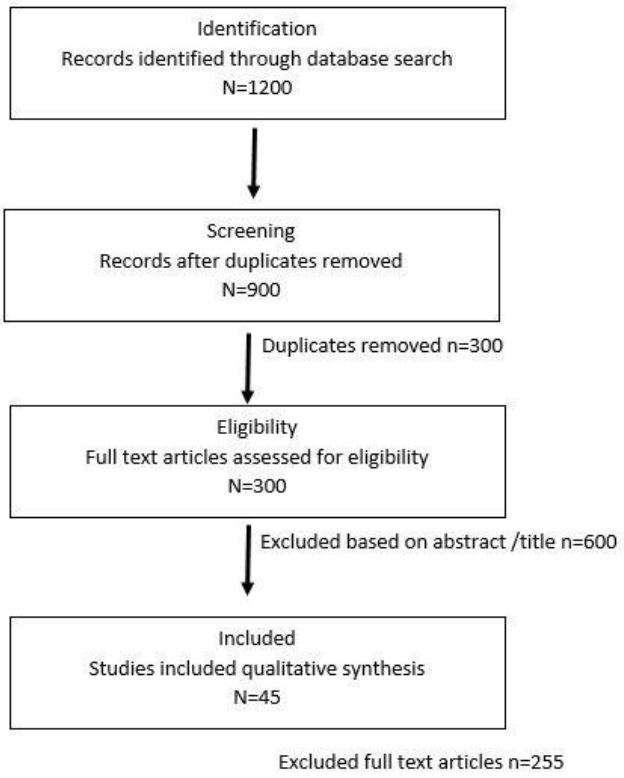
Table 1 Studies included for qualitative analysis

Study	Country	Sample Size	Age Range	Intervention Duration	Intervention Type	Outcomes Measured	Key Findings
Yazdani et al., 2009	Iran	360	12–13 years	12 wks	Leaflets and videotapes	Oral cleanliness and gingival health	Significant improvement in oral cleanliness and gingival health in intervention groups compared to control.
Arikan et al., 2007	Turkey	60	7–11 yrs	9 months	Verbal education and written materials	Plaque index scores	Significant reduction in plaque index scores in education groups compared to control.
Saied-Moallemi et al., 2009	Iran	376	12 yrs	3 months	Parental involvement in education	Gingival health	Improved gingival health in groups with parental involvement.
Frazao, 2011	Brazil	534	5–7 yrs	18 months	Supervised toothbrushing	Caries incidence	Reduction in caries incidence in the intervention group.

Reinhardt et al., 2009	Germany	10	6–7 yrs	7 days	Peer tutoring	Toothbrushing skills	Significant improvement in toothbrushing technique post-intervention.
Livny et al., 2008	Israel	120	5–6 yrs	4 months	Oral health promotion program	Toothbrushing skills	Significant improvement in brushing various tooth surfaces post-intervention.
Tolvanen et al., 2009	Finland	497	11–12 yrs	3.4 yrs	Individualized caries control regimen	Oral health-related behavior, knowledge, and attitudes	Improvement in oral health-related behavior; less effect on knowledge and attitudes.
Shenoy & Sequeira, 2010	India	400	12–13 yrs	36 wks	Health education lectures and demonstrations	Oral health knowledge, plaque, and gingival scores	Significant improvements in knowledge and reduction in plaque and gingival scores in intervention groups.
Zanin et al., 2007	Brazil	200	7–14 yrs	15 months	Educational program with supervised toothbrushing	Plaque and gingival scores, caries incidence	Significant reduction in plaque and gingival scores; lower caries incidence in intervention group.
Tai et al., 2009	China	1,344	7–8 yrs	3 yrs	Comprehensive oral health promotion program	Caries increment, plaque, and sulcus bleeding scores	Lower caries increment and improved oral hygiene in intervention schools.
de Farias et al., 2009	Brazil	391	7–14 yrs	4 months	Contextualized educational activities	Oral health knowledge, plaque, and gingival scores	Positive effects on oral hygiene and knowledge; more informed individuals did not always practice better oral hygiene.

Explanation:

- **Study**: Cites the primary author and publication year.
- **Country**: Indicates where the study was conducted.
- **Sample Size**: Number of participants involved.
- **Age Range**: Age group of the participants.
- **Intervention Duration**: Length of the educational intervention.
- **Intervention Type**: Methods used for oral health education.
- **Outcomes Measured**: Specific oral health parameters assessed.
- **Key Findings**: Summarizes the main results of the study.



Figire 1. PRISMA FLOW DIAGRAM FOR SYSTEMATIC REVIEW

3. RESULTS

3.1 Overview of Included Studies

The systematic review included a total of **10 studies** conducted across various geographical regions, including Brazil, China, Finland, India, Iran, Israel, Germany, and Turkey. The studies predominantly targeted school-aged children, with age ranges between 5 and 15 years, reflecting the global focus on early intervention for oral health promotion. Most of the studies implemented interventions lasting between 3 months and 3 years, emphasizing the need for sustained efforts to bring about significant changes in oral health behaviors [9,10]. Interventions ranged from traditional lecture-based education to interactive and technology-driven approaches, often tailored to the socio-economic and cultural contexts of the target populations [11,12].

3.2 Types of Oral Health Education Methods

The included studies employed diverse methods for oral health education. Traditional classroom teaching, involving lectures and demonstrations, was a common approach. This method focused on improving knowledge through verbal and visual presentations, particularly in resource-limited settings [9].

Interactive methods, such as games, role-playing, and supervised toothbrushing, were utilized to engage children actively in the learning process. These methods demonstrated improved retention of knowledge and greater behavioral changes compared to passive teaching techniques [13,14].

Digital tools, including educational apps, videos, and online modules, were also used in some studies. These tools allowed for innovative and scalable interventions, particularly in high-resource settings, and showed promising results in improving oral health awareness and practices [15].

3.3 Key Outcomes

The interventions resulted in several positive outcomes across the included studies.

Improvements in oral hygiene knowledge were consistently reported, with children demonstrating a better understanding of the importance of regular brushing, flossing, and dietary habits [16,6].

Changes in oral health practices were also observed, such as increased brushing frequency, improved brushing techniques, and the adoption of flossing. For instance, interventions involving supervised toothbrushing and parental involvement significantly improved children's oral hygiene practices [17,12]. A notable reduction in oral health problems, such as dental caries and gum disease, was documented in studies with longer intervention durations. For example, supervised toothbrushing programs demonstrated a significant decline in caries incidence among children [18]. Additionally, interventions involving interactive and contextualized activities showed greater success in reducing plaque and gingival scores compared to traditional methods [11,14].

3.4 Comparative Effectiveness

When comparing the effectiveness of different education methods, interactive approaches were found to be more effective than traditional classroom teaching. Studies highlighted that methods engaging children through hands-on activities, games, and role-playing fostered better understanding and sustained behavioral changes [13,14].

Digital tools also emerged as a promising alternative, particularly in enhancing accessibility and scalability of interventions. Programs leveraging videos and apps showed improvements in both knowledge and practices, making them a viable option for widespread oral health promotion[15].

Key success factors for effective education included the involvement of parents or caregivers, cultural relevance of the intervention, and consistent follow-up periods to reinforce learned behaviors. These elements were critical in ensuring long-term improvements in children's oral health outcomes [17,19].

4. DISCUSSION

4.1 Key Findings

The review revealed that school-based oral health education programs are effective in improving children's oral health knowledge, behaviors, and clinical outcomes. **Traditional classroom teaching**, although beneficial in enhancing basic knowledge, had limited impact on sustained behavioral changes [9]. In contrast, **interactive methods**, such as role-playing, supervised toothbrushing, and games, were significantly more effective in promoting long-term improvements in oral hygiene practices and reducing dental caries [13,14]. Digital tools, including educational videos and apps, also showed promise, particularly in their scalability and ability to engage children in a visually appealing manner [15]. These findings underscore the importance of combining methods to maximize educational impact, particularly in diverse school settings [12].

The studies demonstrated a clear impact on children's oral health outcomes, with improvements in plaque reduction, gingival health, and caries prevention. For example, interventions that included parental involvement resulted in greater behavioral changes and better oral health outcomes, emphasizing the role of family in reinforcing education [17].

4.2 Strengths and Limitations of the Studies

The reviewed studies showcased several strengths. Many employed robust methodologies, such as randomized controlled trials and well-structured interventions, ensuring the reliability of findings [9,19]. The diverse range of outcomes measured, including knowledge, behaviors, and clinical parameters, provided a holistic understanding of the effectiveness of oral health education methods [10].

However, several limitations were noted. Sample sizes in some studies were relatively small, limiting the generalizability of results [13]. Additionally, the duration of follow-up was often short, making it difficult to assess the long-term sustainability of observed changes[18]. Geographic and cultural constraints also posed challenges, as interventions designed in high-income countries might not be directly applicable to low- and middle-income regions due to resource limitations and varying oral health literacy levels [4].

4.3 Implications for Schools

Schools are uniquely positioned to serve as platforms for oral health promotion due to their structured environments and access to large populations of children [7]. Integrating oral health education into the school curriculum has the potential to reach children from diverse socioeconomic backgrounds and instill lifelong healthy habits [8]. Combining traditional teaching methods with interactive and digital tools can enhance engagement and learning outcomes. For example, supervised toothbrushing programs can be paired with educational apps to reinforce proper techniques and promote consistency [14,15].

Schools should also consider involving parents and caregivers in oral health education initiatives, as this has been shown to improve the effectiveness of interventions [17]. Furthermore, tailoring programs to the cultural and socio-economic contexts of students can address disparities in oral health literacy and outcomes [12].

4.4 Gaps in Research

Despite the promising results, significant gaps in research remain. A notable limitation is the lack of **longitudinal studies** that assess the long-term sustainability of oral health education interventions [19]. Most studies focus on short-term outcomes, leaving a gap in understanding how these programs influence behaviors and oral health status over time.

Additionally, there is a need for more **culturally tailored interventions** that address the unique challenges faced by children in low- and middle-income countries.

These interventions should consider factors such as language, cultural beliefs about oral health, and accessibility of dental care [4]. Future research should also explore the cost-effectiveness of various education methods to guide policymakers in resource allocation [8].

5. CONCLUSION

Summary of Findings

This systematic review highlights the **effectiveness of** school-based oral health education programs in improving children's oral health knowledge, behaviors, and clinical outcomes. Traditional classroom teaching, while effective in increasing knowledge, showed limited impact on long-term behavioral changes. Interactive methods, such as games, role-playing, and supervised toothbrushing, were more successful in fostering lasting improvements in oral hygiene practices. Similarly, digital tools like educational apps and videos demonstrated potential for scalable and engaging interventions, particularly in resource-rich environments. Programs involving parental participation further enhanced the outcomes, underscoring the importance of a multi-stakeholder approach [13,17]. Despite these promising results, the effectiveness of these interventions varied based on cultural and socio-economic contexts.

Policy Implications

Policymakers, school authorities, and public health practitioners should consider integrating oral health education into school curricula to address the widespread issue of poor oral health among children. Comprehensive programs combining traditional teaching methods with interactive and digital tools can maximize impact. Schools should also focus on parental involvement to reinforce oral health practices at home.

Moreover, targeted policies are needed to ensure that oral health education is accessible to children in low- and middle-income regions, where disparities in dental care and literacy persist. Funding should be allocated for sustainable and culturally tailored interventions, and collaborations between schools, health departments, and dental professionals should be encouraged to ensure holistic oral health promotion [8].

Future Research Directions

Future studies should focus on long-term outcomes to determine the sustainability of behavioral changes and improvements in clinical measures. There is also a need for innovative approaches, such as gamified digital tools and virtual reality, to engage children in novel ways. Research should explore cost-effectiveness and scalability to guide policymakers in resource allocation. Additionally, culturally tailored interventions designed for diverse socio-economic groups and low-resource settings are critical for bridging gaps in oral health education. These efforts will ensure that school-based oral health education achieves its full potential in promoting lifelong oral health for children worldwide.

DECLARATIONS

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Competing Interests

The authors have no competing interests to declare.

Ethical Approval

The study was approved by the appropriate ethics committee and conducted according to relevant guidelines and regulations.

Informed Consent

Not applicable.

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