Review

Evaluation of Clinical Evidence on the Efficacy and Safety of Fluoride Varnishes Compared to High-Concentration Topical Gels in Preventing Dental Caries in Preschool Children

Bashayer Alhersh *

Posted Date: 19 December 2025

doi: 10.20944/preprints202512.1697.v1

Keywords: early childhood caries; topical fluoride; ECC prevention; fluoride varnish; fluoride gel; patient compliance

Review

Evaluation of Clinical Evidence on the Efficacy and Safety of Fluoride Varnishes Compared to High-Concentration Topical Gels in Preventing Dental Caries in Preschool Children

Bashayer Ayed Alhersh

Faculty of Dentistry, Jordan University of Science and Technology, Jordan; drhem.1@outlook.com; Tel.: (00962782914800)

Abstract

Early Childhood Caries remains the most prevalent chronic condition globally in preschool children, necessitating effective preventive protocols. Among professional topical fluorides, fluoride varnishes (FV) and high-concentration gels (FG) are widely utilized, yet the optimal balance between efficacy and safety remains a critical clinical concern. This structured critical review aimed to compare the clinical evidence regarding the caries preventive efficacy (measured by DMFS/dmfs reduction) and safety profile (specifically the risk of systemic fluoride ingestion) between professionally applied fluoride varnishes and high-concentration fluoride gels in children under six years of age. A structured search was conducted across major electronic databases (e.g., PubMed, Scopus, Cochrane Library) for Randomized Controlled Trials (RCTs) and systematic reviews directly comparing or assessing FV and high-concentration FG in preschool children. Clinical evidence demonstrates that FV offers comparable, and often superior, caries reduction rates compared to FG (up to 75% reduction reported in some FV trials). Crucially, FV exhibits a significantly higher safety margin; due to its rapid adherence and sustained-release mechanism, the risk of acute ingestion and subsequent systemic fluoride exposure is markedly lower than with the tray-applied gel method. Additionally, FV demonstrates superior patient compliance and application efficiency in young children. Based on the synthesis of clinical data, Fluoride Varnish is the safer and preferred professional topical fluoride agent for children under six years. Its superior safety profile, coupled with strong evidence of efficacy and practicality, firmly establishes it as the recommended first-choice protocol for ECC prevention in pediatric dental practice.

Keywords: early childhood caries; topical fluoride; ECC prevention; fluoride varnish; fluoride gel; patient compliance

1. Introduction

Definition and Problem Statement

Early childhood caries is one of the most common chronic conditions in young children and a major global public health concern, affecting approximately 530 million children worldwide , with a pooled prevalence estimated at 49%. It is characterized by the presence of one or more decayed, missing, or filled primary tooth surfaces in any primary tooth of a child under 71 months of age. Severe early childhood caries (S-ECC) is diagnosed in children under three years of age when smooth-surfaced caries is present. Additionally, for children aged 3 to 5 years, S-ECC is defined as one or more cavitated, missing (due to caries), or filled smooth surfaces in the primary maxillary anterior teeth. Contributing factors include poor tooth structure, early colonization by carious bacteria, particularly *Streptococcus mutans*, and the bacterial breakdown of dietary sugars into acids

 doi:10.20944/preprints202512.1697.v1

that gradually demineralize the enamel and dentin. This complex etiology is often described by Keyes' triad, involving the interaction of a susceptible host, fermentable carbohydrates, and cariogenic microbial flora. The impact of S-ECC extends beyond the teeth. Children with S-ECC are at increased risk of developing new caries lesions in both primary and permanent teeth, experience pain and infections, and may require emergency dental care or hospitalization. In addition, early childhood caries can affect proper nutrition, speech development, and sleep, increase financial burdens, contribute to school absenteeism, and negatively impact overall quality of life. Furthermore, severe cases can lead to malocclusions, abscesses, and growth deficits , while visible tooth decay may also diminish a child's self-esteem and hinder social interactions due to appearance concerns. [1–3]

Economic Burden

Early Childhood Caries (ECC) imposes a tremendous economic burden, not only on health systems but also on children's families and society as a whole. The costs of treating this condition exceed routine care, as it consumes a disproportionate share of dental expenditures due to the disease's prevalence and the critical need for complex treatments.[4] In the United States alone, dental expenditures for children under five years of age exceeded $1.55 billion in 2010. The primary reason for this high cost is that treating advanced cases often requires extensive restorative procedures, tooth extractions, or the use of general anesthesia, which is extremely expensive.[5]

For example, one study showed that the average cost of a hospital admission for treating a single odontogenic infection across five children's hospitals was $3,223 , while the average cost of treatment under general anesthesia was estimated at approximately $1,508 per admission.[4] Beyond the direct costs to the health system, families bear additional burdens including lost workdays, transportation costs, and psychological stress, which negatively affect quality of life, especially among low-income families.[4,5]

Conversely, prevention offers an effective and money-saving solution; models have demonstrated that early interventions to prevent and manage ECC are cost-effective and cost-saving compared to restorative therapy.[4,5] These non-invasive preventive measures include the use of fluoride (such as varnish and fluoridated toothpaste). Shifting from payment systems that reward surgical and restorative treatment to systems that reimburse preventive care such as providing nutritional counseling and fluoride application—can have a significant impact on reducing disease prevalence and alleviating the associated financial burden.[5]

The Role of Fluoride

Early childhood caries in primary teeth is a predictor of future caries in childhood and adulthood [6,7]. Fluoride is considered the most important non-invasive approach in the therapeutic and preventive management of caries [6,7]. Its primary mechanism is topical, whereby fluorapatite crystals are incorporated into the enamel, increasing its resistance to acid dissolution [6,7]. Fluoride promotes the remineralization of early caries lesions and prevents demineralization of the hard tissues of teeth, making it a cornerstone of caries prevention [6,7]. Topical fluorides are generally classified as either professionally applied, such as solutions, gels, foams, and varnishes, or self-applied [6,7]. By promoting remineralization and inhibiting bacterial activity, fluoride reduces the risk of caries development and supports long-term oral health [6,7].

Mechanism of Action (Chemical Process)

The transformation of enamel occurs when fluoride ions interact with the tooth mineral structure. Specifically, the hydroxyl ion ($\boldsymbol{HO^-}$) within the hydroxyapatite crystal lattice is substituted by a fluoride ion ($\boldsymbol{F^-}$), converting it into fluorapatite ($\boldsymbol{Ca_{10}(PO_4))_6F_2}$), which is thermodynamically more stable and less soluble in acid than the original enamel1. Additionally, topical agents facilitate the formation of calcium fluoride ($\boldsymbol{Ca\,F_2}$) deposits on the enamel surface2. These deposits act as a critical pH-controlled reservoir; upon exposure to acid (low pH), the $\boldsymbol{Ca\,F_2}$ dissolves to release

 doi:10.20944/preprints202512.1697.v1

fluoride ions, which then diffuse into the enamel to drive the remineralization of early lesions and the precipitation of acid-resistant fluorapatite.[8]

Solution and Goal

Topical fluoride application is one of the most effective, evidence-based preventive strategies against early childhood caries. Fluoride varnish (FV) contains a high concentration of fluoride (typically 22,600 ppm as sodium fluoride) in a fast-drying resin medium that adheres to the enamel surface. In contrast, fluoride gels (FG) are designed for controlled professional use and typically contain 12,300 ppm of fluoride in the form of acidified phosphate. The primary objective of this review is to thoroughly evaluate the clinical evidence and identify the most effective and safe protocol for topical fluoride application in children under six years of age.

2. Materials and Methods

Study Design and Scope

This study was classified as a systematic critical narrative review of clinical evidence. Its primary objective was to consolidate and critically evaluate the published literature to determine the optimal balance between the efficacy and safety of fluoride varnish (FV) versus high-concentration fluoride gel (FG) in preventing dental caries in preschool children.

Research Question and Eligibility Criteria

The primary clinical research question was precisely defined using the PICO framework:
Category: Preschool children (under six years old).
Intervention: Application of topical fluoride varnish (FV).
Comparison: Application of high-concentration topical fluoride gel (FG).
Outcome: Efficacy in preventing caries (reduction of DMFS/DMFS) and safety (side effects and risks of systemic ingestion).

The study targeted randomized controlled trials (RCTs), systematic reviews, and clinical studies that directly compared FV and FG or evaluated the efficacy/safety of one agent over the other in the target population. Studies published in English in peer-reviewed journals were included. Laboratory studies and individual case reports were excluded.

Reference Search Strategy

A comprehensive search was conducted in the following academic databases and search engines up to December 2025: PubMed/MEDLINE, Scopus, the Cochrane Library, and Google Scholar. Search terms included, but were not limited to: (fluoride varnish or FV), fluoride gel or high-concentration fluoride gel), preschool children or early childhood caries or dmfs, and efficacy, safety, toxicity, or ingestion.

Data Extraction and Critical Synthesis

Main data were extracted manually, focusing on reported caries reduction rates and safety data. No meta-analysis was performed on the raw data. Instead, evidence was collected, and a critical narrative synthesis was conducted.

Ethical Considerations

Since this study relies solely on the review and analysis of publicly available secondary data, it does not involve any direct interaction with participants and therefore does not require ethical approval from the Institutional Review Board.

 doi:10.20944/preprints202512.1697.v1

3. Results

Fluoride Varnishes

Early investigations into fluoride varnishes demonstrated their clear effectiveness in preventing dental caries among children [9]. Later research using semi-annual applications reported success, achieving reductions of up to 75% [9]. Further studies confirmed these positive outcomes, with trials showing nearly a 44% reduction in decayed, missing, and filled surfaces (DMFS) in three-year-old children [9]. This suggests that the main preventive mechanism of fluoride varnishes may not solely depend on the amount of fluoride bound to enamel, but rather on the continuous low-level release of fluoride that enhances enamel remineralization and inhibits bacterial activity [9].

High-Concentration Fluoride Gels

High-concentration fluoride gels (typically containing fluoride concentrations ranging from 1.23% to 5% NaF) are an effective method for preventing dental caries. Studies have shown that periodic application significantly reduces caries incidence, especially in high-risk children. However, the use of high-concentration gels carries some important risks, primarily the potential for the child to swallow a significant amount of fluoride, which may result in acute fluoride toxicity or dental fluorosis. Clinical guidelines recommend using the gel under professional supervision to ensure maximum safety.

Table 1. Comparison Between Fluoride Varnishes and High-Concentration Fluoride Gels.

Feature	Fluoride Varnish	High-Concentration Fluoride Gel
Application Time	**Rapid (a few minutes)**	**Longer (1–4 minutes)**
Application Method	**Brushed directly onto the teeth**	**Applied using a tray**
Effectiveness (Caries Reduction)	**50–70% across all age groups**	**40% in children**
Best Suited For	**Children and patients with limited mobility**	**Adults seeking comprehensive fluoride treatment**

4. Discussion

Critical Aspect (Safety)

The fluoride concentration in 5% sodium fluoride (NaF) varnish is approximately 22.6 mg/mL—about twice the concentration in acidulated phosphate fluoride gel (APF gel) [10]. However, clinical studies indicate that the actual amount of fluoride exposure from varnish application is significantly lower than that from gels [10]. In contrast, studies show that ingestion from fluoride varnish application is only about 5 mg per treatment [10]. This is due to the varnish's ability to adhere tightly to the tooth surface and release fluoride slowly over several hours, resulting in minimal systemic absorption and a negligible risk of symptoms such as nausea or vomiting [10]. The approximate toxic dose of fluoride for a 20-kg child is around 100 mg (5 mg/kg), which is far above the levels encountered in typical clinical applications of varnish [10]. Preventive initiatives have confirmed the safety of fluoride varnish, reporting no adverse events after hundreds of thousands of applications to children [10].

 doi:10.20944/preprints202512.1697.v1

Patient Acceptance and Behavioral Considerations

Parental Satisfaction and Acceptance of Non-Invasive Treatments The acceptance of non-invasive caries management techniques, such as Silver Diamine Fluoride (SDF) and fluoride varnish, is generally high among both parents and children. In a study comparing SDF, Tiefenfluorid, and a placebo, 96% of parents in all groups reported that they would choose non-invasive caries management methods again for their children. It was also found that child and parental satisfaction with these treatments is high, indicating that patients accept non-invasive options [11]. Similarly, fluoride varnish is frequently used due to its safety, ease of application, and high acceptance among children [12].

Aesthetic Concerns and Quality of Life The main concern regarding SDF is the permanent black staining of arrested dental caries, which is often cited as a barrier to its use [11,13]. However, evidence suggests that this aesthetic drawback may not significantly reduce overall parental satisfaction or Oral Health-Related Quality of Life (OHRQoL). One trial found no significant difference in parental satisfaction or children's quality of life between the SDF and placebo groups, despite the presence of staining. It was found that parental satisfaction is more strongly correlated with the child's dental health status (number of decayed teeth) rather than the treatment method or the presence of staining. While parents were less satisfied with the color of anterior teeth in the presence of staining, the effect of staining on satisfaction with the overall dental appearance was small [13].

Anxiety, Gag Reflex, and Compliance Barriers Child compliance (cooperation) with treatment is significantly influenced by dental fear and physiological responses such as the gag reflex. The prevalence of the gag reflex among children in dental clinics was reported to be 34.1%. Factors that increase the risk of gagging—and thus reduce compliance—include higher levels of dental fear, negative past experiences, and a history of invasive treatments using local anesthesia [14]. Additionally, there is a strong correlation between the child's gag reflex and the mother's gagging or anxiety.

To improve compliance and manage these barriers, distraction techniques (such as mental games or puzzles) have proven effective in reducing anxiety and gagging severity. The efficacy of nitrous oxide (laughing gas) has also been verified as a method for managing severe gagging cases to facilitate treatment tolerance [15]. Furthermore, minimizing invasive intervention and changing the environment aid in compliance; it was found that children visiting private clinics suffer from gagging significantly less compared to those visiting crowded public hospitals, possibly due to environmental factors and reduced chair time [14].

Behavior Modification and Education Integrating behavior modification (BM) with clinical treatment is crucial for long-term success. Interventions combining fluoride applications with oral hygiene and dietary counseling showed efficacy in preventing major complications [11]. The "Hawthorne effect" was also observed, where oral health habits improve (such as reduced dental plaque and gingival bleeding) simply because participants know they are being observed and evaluated, highlighting the role of follow-up and education in behavioral compliance [12].

Critical Axis (Efficacy)

Fluoride Varnish (FV) demonstrates a notable advantage in balancing clinical efficacy and safety [12]. Its prophylactic efficacy has been proven to be "similar or even superior to acidulate gel" [12]. Furthermore, randomized clinical trials confirmed that the varnish and Neutral Fluoride Gel exhibit "similar efficacy in the management of ECC after 12 months of follow-up" [12]. This empirical evidence is reinforced by a unified international consensus; both the American Academy of Pediatric Dentistry (AAPD) and the European Academy of Paediatric Dentistry (EAPD) agree on the prioritization of fluoride varnish for young children [16,17] While the AAPD and ADA guidelines explicitly recommend varnish for children under age 6 to minimize the ingestion risks associated with gels [16] the EAPD similarly advocates for the periodic application of varnish for caries prevention, establishing a global standard of care that favors varnish for early intervention [17]

 doi:10.20944/preprints202512.1697.v1

Regarding safety, clinical recommendations affirm this preference, concluding that the 2.26 percent fluoride varnish is characterized by "Benefit outweighs potential harm" [18].

Cost-Effectiveness & Efficiency

Economic cost considerations and time efficiency are critical factors in selecting prevention and treatment strategies in dentistry, especially in public health programs and pediatric treatment.

1. Comparative Cost-Effectiveness and Efficiency
   Cost-effectiveness: SDF is classified as a "Cost-effective" and "Affordable" option. This treatment is considered a direct and ideal intervention for health systems with limited resources due to its simplicity and low costs.[19]
   Time Efficiency: SDF is characterized by reducing the "Chair time" required for treatment, which facilitates dealing with children. [19] The material's effectiveness in arresting caries appears within a few hours of application.[19] Modern techniques have been developed using "Light curing" for only 20 seconds after application, which speeds up the material's drying process and significantly reduces clinical working time.[19]
2. Fluoride Varnish (FV) Time Efficiency: Applying fluoride varnish is considered a quick and easy procedure, taking between one to 4 minutes only per patient, which enhances its efficiency in school environments.[20]
   Economic Analysis: Some studies (such as Wu et al.) indicated that the cost of preventing caries using fluoride in permanent molars (approximately $22.23) is considered economical when compared to the costs of complex treatments like root canal and crown therapy (approximately $184.20), although it may be close to the cost of a simple filling ($21.06). Conversely, other studies in different contexts (such as the UK and South Africa) showed that fluoride varnish might not be "cost-effective" in some school programs due to logistic costs, where the cost of preventing caries progression for one child was estimated at around 685 GBP in one trial. This indicates that economic value depends significantly on program design and local resources.[20]

1. Diagnostic Methods Visual Examination: It is characterized as a "Cost-effective" and simple method for diagnosing white spot lesions, as it does not require additional equipment. Digital Technologies: Despite their accuracy, the use of digital cameras and advanced technologies suffers from drawbacks related to the "High cost of equipment." [21]
2. Policy Perspective There is a global lack of "Cost-effectiveness analysis" studies for interventions combating Early Childhood Caries (ECC), representing a critical gap in the evidence needed to prioritize funding. It is emphasized that the long-term costs of treating advanced caries cases (which may require general anesthesia in hospitals) far exceed the costs of early preventive interventions, justifying investment in preventive policies to raise the economic efficiency of the health system.[22]

Research Gaps

A critical knowledge gap remains regarding the optimal treatment protocol for children classified as being at Very High-Risk for Caries. Current literature lacks sufficient data from clinical trials specifically designed to compare the long-term effectiveness of more intensive and frequent application protocols (e.g., four times per year vs. biannually) in this demographic. Furthermore, there is a pressing need for research to evaluate the comparative efficacy of varnish and gel, either alone or in combination with other potent preventive agents like Silver Diamine Fluoride (SDF).

Limitations

This review is limited by the variability of the included studies, the differences in fluoride protocols, and the lack of standardized outcome measures across all trials. Additionally, no meta-analyses were performed, limiting the ability to quantitatively compare effect sizes between studies.

 doi:10.20944/preprints202512.1697.v1

5. Conclusions

Based on the clinical evidence, Fluoride Varnish (FV), particularly 5% sodium fluoride varnish, emerges as the optimal choice for preventing dental caries in children under six years of age.

- Superior Safety Profile: The total amount ingested during application (approximately 5 mg) is significantly lower than the potential toxic dose (100 mg for a 20 kg child) [10].
- Clinical Efficacy: FV has demonstrated high clinical effectiveness [9], with efficacy proven to be similar or even superior to acidulated gel [12].
- Enhanced Compliance and Efficiency: Unlike gels, fluoride varnish is well-tolerated by preschool children (minimizing gag reflex) and allows for rapid application, making it highly efficient for both clinical and public health settings [11,20].
- Optimal Balance: Fluoride varnish embodies the best balance between comparable efficacy, superior safety, and practical utility.

In contrast, High-Concentration Fluoride Gels require careful application supervision and are more suitable for older children who can expectorate effectively, due to the increased risk of ingesting a large amount of fluoride.

6. Recommendations

1. Primary Clinical Recommendation: Adopt Fluoride Varnish (FV) as the First-Line Agent

- **Standardized Use of 5% Sodium Fluoride Varnish:** FV should be universally adopted and routinely applied as the standard primary preventive measure for children under six years of age.
- **Rationale:** This preference is driven by FV's superior safety profile, proven clinical efficacy, and high acceptance among children due to its rapid and non-invasive application.

2. Clinical Application Protocols

- **Intensified Regimen for High-Risk Groups:** The application frequency of fluoride varnish should be increased to four times per year (quarterly) for children classified as Very High-Risk for caries progression.
- **Cautious Use of High-Concentration Gels:** The use of high-concentration fluoride gels should be restricted primarily to older children and adolescents who possess the cognitive ability to effectively expectorate and rinse following application.

3. Public Health and Policy Implications

- **Expansion to Non-Dental Settings:** Given its ease of use and safety, policy-makers should support programs that allow trained non-dental professionals (such as pediatricians and nurses) to apply fluoride varnish in schools and community health centers to reduce the overall economic burden of ECC.

4. Future Research Directives

- **Addressing the "Very High-Risk" Gap:** Future randomized clinical trials must prioritize comparing the long-term effectiveness of various intensive FV application protocols (e.g., quarterly vs. biannual application) specifically within the Very High-Risk pediatric demographic.
- **Economic and Combination Analysis:** Research should investigate the cost-effectiveness of nationwide varnish programs and evaluate the comparative efficacy of combining fluoride varnish with other potent anti-caries agents, such as Silver Diamine Fluoride (SDF).

Author Contributions: Conceptualization, B.A.A.; methodology, B.A.A.; formal analysis, B.A.A.; investigation, B.A.A.; writing—original draft preparation, B.A.A.; writing—review and editing, B.A.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

 doi:10.20944/preprints202512.1697.v1

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available within the article and its references.

Conflicts of Interest: The author declares no conflict of interest.

Abbreviations: ECC: Early Childhood Caries; **FV:** Fluoride Varnish; **FG:** Fluoride Gel; **RCTs:** Randomized Controlled Trials; **SDF:** Silver Diamine Fluoride.

References

1. Zou, J., Du, Q., Ge, L., Wang, J., Wang, X., Li, Y., ... & Zhou, X. (2022). Expert consensus on early childhood caries management. *International journal of oral science*, *14*(1), 35..
2. Blanco-Victorio, D. J., López-Luján, N. A., Bernaola-Silva, W., Vicuña-Huaqui, L. A., Cacñahuaray-Palomino, R., Diaz-Campos, J. S., ... & López-Ramos, R. P. (2025). Sociodemographic and clinical factors associated with early childhood caries in Peruvian pre-schoolers. *BMC Oral Health*, 25(1), 125.
3. Patel, N. S., Miral, M., Yihan, F., Vishnu, D., Lala, H. S., Het, P., ... & Thakor, U. B. (2025). A review of early childhood caries: Risk factors, management, and policy recommendations. *Cureus*, 17(5).
4. Casamassimo, P. S., Thikkurissy, S., Edelstein, B. L., & Maiorini, E. (2009). Beyond the dmft: the human and economic cost of early childhood caries. *The Journal of the American Dental Association*, 140(6), 650-657.
5. Tinanoff, N., Baez, R. J., Diaz Guillory, C., Donly, K. J., Feldens, C. A., McGrath, C., ... & Twetman, S. (2019). Early childhood caries epidemiology, aetiology, risk assessment, societal burden, management, education, and policy: Global perspective. *International journal of paediatric dentistry*, 29(3), 238-248.
6. Manchanda, S., Sardana, D., Liu, P., Lee, G. H., Li, K. Y., Lo, E. C., & Yiu, C. K. (2022). Topical fluoride to prevent early childhood caries: Systematic review with network meta-analysis. *Journal of dentistry*, 116, 103885.
7. Marinho, V. C., Higgins, J. P., Logan, S., Sheiham, A., & Cochrane Oral Health Group. (1996). Topical fluoride (toothpastes, mouthrinses, gels or varnishes) for preventing dental caries in children and adolescents. *Cochrane Database of Systematic Reviews*, 2010(1).
8. Beltrán-Aguilar, E. D., Goldstein, J. W., & Lockwood, S. A. (2000). Fluoride varnishes: a review of their clinical use, cariostatic mechanism, efficacy and safety. *The Journal of the American Dental Association*, 131(5), 589-596.
9. Seppä, L. (2004). Fluoride varnishes in caries prevention. *Medical principles and practice*, 13(6), 307-311.
10. Miller, E. K., & Vann Jr, W. F. (2008). The use of fluoride varnish in children: a critical review with treatment recommendations. *Journal of Clinical Pediatric Dentistry*, 32(4).
11. Maldupa, I., Innes, N., Viduskalne, I., Brinkmane, A., Senakola, E., Krumina, K., & Uribe, S. E. (2024). Clinical effectiveness/child-patient and parent satisfaction of two topical fluoride treatments for caries: a randomised clinical trial. *Scientific Reports*, 14(1), 8123.
12. Sousa, G. P. D., Lima, C. C. B., Braga, M. M., Moura, L. D. F. A. D. D., Lima, M. D. D. M. D., & Moura, M. S. D. (2022). Early childhood caries management using fluoride varnish and neutral fluoride gel: a randomized clinical trial. *Brazilian Oral Research*, 36, e099.
13. Jiang, M., Xie, Q. Y., Wong, M. C. M., Chu, C. H., & Lo, E. C. M. (2021). Association between dental conditions, sliver diamine fluoride application, parental satisfaction, and oral health-related quality of life of preschool children. *Clinical Oral Investigations*, 25(2), 653-662.
14. Gucyetmez Topal, B., Falay Civelek, S. B., Tiras, M., & Yigit, T. (2023). The prevalence and influencing factors of gag reflex in children aged 7–14 years in the dental setting. *Journal of Oral Rehabilitation*, 50(5), 376-382.
15. Mehdizadeh, M., Mohammadbeigi, A., & Sharifinejad, A. (2023). An overview about New methods in Management of Gag Reflex during Dental Treatment: a systematic review. *Journal of Dentistry*, 24(4), 372.
16. Featherstone, J. D., Crystal, Y. O., Alston, P., Chaffee, B. W., Doméjean, S., Rechmann, P., ... & Ramos-Gomez, F. (2021). Evidence-based caries management for all ages-practical guidelines. *Frontiers in Oral Health*, 2, 657518.
17. Lygidakis, N. A., Garot, E., Somani, C., Taylor, G. D., Rouas, P., & Wong, F. S. L. (2022). Best clinical practice guidance for clinicians dealing with children presenting with molar-incisor-hypomineralisation (MIH): an

 doi:10.20944/preprints202512.1697.v1

updated European Academy of Paediatric Dentistry policy document. *European Archives of Paediatric Dentistry*, 23(1), 3-21.

18. Weyant, R. J., Tracy, S. L., Anselmo, T. (T.), Beltrán-Aguilar, E. D., Donly, K. J., Hujoel, P. P., Iafolla, T., Kohn, W., Kumar, J., Levy, S. M., Madden, T., Stegeman, C., Tinanoff, N., Wright, J. T., & Zero, D. (2013). Topical fluoride for caries prevention: Executive summary of the updated clinical recommendations and supporting systematic review. *J Am Dent Assoc*, 144(11), 1279–1291.
19. Jamal, D., AlMushayt, A., Abujamel, T., Bamashmous, S., Bamashmous, N., & Alamoudi, N. (2025). Silver diamine fluoride: the science behind the action–a narrative review. *BMC Oral Health*, 25(1), 1195.
20. Almalki, A. S., Alshahrani, O. S., Aljoaid, F. A., Alrwiali, M. A., Alrais, R. A., Alfuhigi, A. B., ... & Daghriri Sr, R. M. (2025). Effectiveness of Various Fluoride Varnishes in Preventing Dental Caries in Children and Adolescents: A Systematic Review of Evidence From Educational Settings. *Cureus*, 17(11).
21. Xia, L., Zhou, C., Mei, P., Jin, Z., He, H., Wang, L., ... & Fang, B. (2025). Expert consensus on the prevention and treatment of enamel demineralization in orthodontic treatment. *International Journal of Oral Science*, 17(1), 13.
22. Nagarajan, L. T., Pasha Mohammed, I., Atique, S., Bahammam, D. H. A., Moothedath, M., Habibullah, M. A., & Kolarkodi, S. H. (2025). Global policy approaches to combat early childhood caries: a scoping review with evidence map. *Frontiers in Oral Health*, 6, 1664019.