

## Systematic Review Article

# Role of fluoride varnish in preventing early childhood caries: A systematic review

Poulami Mishra<sup>1</sup>, Nusrath Fareed<sup>1</sup>, Hemant Battur<sup>1</sup>, Sanjeev Khanagar<sup>1</sup>, Manohar A. Bhat<sup>1</sup>, Jagan Palaniswamy<sup>1</sup>

<sup>1</sup>Department of Public Health Dentistry, KVG Dental College and Hospital, Sullia, Karnataka, India

## ABSTRACT

**Background:** Early childhood caries is a public health problem that continues to affect babies and preschool children worldwide. This untreated caries process results in progressive destruction of the crowns of the teeth, often accompanied by severe pain and suffering, affecting the quality of life. Fluoride varnish which is one of the most important materials to prevent ECC is easy to apply and well tolerated by children. This study aimed to evaluate the scientific evidence regarding the role of fluoride varnish in preventing early childhood caries.

**Materials and Methods:** Records were searched from various databases such as PubMed/Medline, Cochrane, and EMBASE. Articles published over the past 36 years (1979-2015) were identified using the key search terms. A total of 190 records were identified by title/abstracts/full text articles and were retrieved. Potentially relevant reports identified from the reference lists of relevant studies, review articles and chapters were hand-searched, which yielded an additional 10 articles. The main outcome of our investigation was prevention of early childhood caries following application of fluoride varnish and unavoidable fluoride exposure. Out of 190 articles originally identified, 30 records were considered potentially eligible and sought for further assessment. 17 articles met the inclusion criteria and these studies were assessed independently for methodology and performance.

**Results:** Analysis of literature revealed that basically two concentrations of fluoride varnishes have been used: 1% and 5%, with a caries preventive fraction ranges of 6.4-30% and 5-63%, respectively.

**Conclusion:** The results showed that fluoride varnishes have been used at concentrations of 1% and 5% in the prevention of ECC. The preventive fraction was influenced by the frequency of application, the duration of study and sample size. The evidence level of the studies was of moderate to limited value.

**Key Words:** Early childhood caries, fluoride varnish, prevention

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### Address for correspondence:

Dr. Poulami Mishra,  
Department of Public Health  
Dentistry, KVG Dental  
College and Hospital,  
Sullia, Karnataka, India.  
E-mail: poulamimishra92@  
gmail.com

## INTRODUCTION

Early childhood caries (ECC) is a complex disease involving the maxillary primary incisors within months after eruption, spreading rapidly to involve other primary teeth. It is a serious socio-behavioral and dental problem that afflicts infants and toddlers

worldwide. In 2003, the American Academy of Pediatric Dentistry (AAPD) defined ECC as the presence of one or more decayed, missing, or filled tooth surfaces in any primary tooth in a child up to 71 months of age or younger. The academy also

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specified that in children younger than three years of age any sign of smooth surface caries is indicative of severe ECC.<sup>[1]</sup>

ECC is a public health problem that continues to affect infants and preschool children worldwide. Comprehensive reviews of the epidemiology reveal that caries levels have increased among toddlers and preschoolers, especially in maxillary anterior teeth, with the highest reported prevalence in Africa and South-East Asia.<sup>[2]</sup> Investigations in Europe, England, Sweden and Finland have reported the prevalence of ECC ranging from 1% to 32%. The prevalence is as high as 56% in some Eastern European countries.<sup>[3,4]</sup> In the US, the reported prevalence is about 17%; native American populations, however, have shown a prevalence ranging from 4% to more than 90%.<sup>[5-9]</sup> Latin America has a reported prevalence of 46%, whereas the reported prevalence in Canada is 67%.<sup>[10,11]</sup> Far Eastern regions of Asia seem to have the highest prevalence and severity for the disease, with reports ranging from 36% to 85%.<sup>[12-17]</sup> In the Middle East, the prevalence of ECC has been reported to be between 22% and 61% and in Africa, between 38% and 45%.<sup>[18-21]</sup> In India, a prevalence rate of 44% has been reported,<sup>[22]</sup> with a study reporting a prevalence of 52.87%,<sup>[23]</sup> and 54.1% in the preschool children of Hubli and Dharwad.<sup>[24]</sup>

Untreated caries causes progressive destruction of the crowns of the teeth, often accompanied by severe pain and suffering, affecting the quality of life. The repair and replacement of carious primary teeth is excessively time-consuming, costly and challenging, even in developed countries. Considering the magnitude of this problem and the effect of ECC on the quality of life of children, prevention of ECC should be the top most priority of the dental profession. Judicious fluoride therapy has been the centerpiece of caries preventive strategies since the introduction of water fluoridation schemes nearly seven decades ago.<sup>[25]</sup> A substantial decline in dental caries rates, especially of permanent dentition in many countries, an increase in dental fluorosis levels in some countries, and intensive research on the mechanism of action of fluoride highlighting the primary importance of its topical effect have led to a greater attention being paid to the appropriate use of topical fluoride-based interventions.

By definition, the term “topical fluoride” is used to describe those delivery systems which provide

fluoride to exposed surfaces of the dentition, at elevated concentrations, for a local protective effect, and are therefore not intended for ingestion. Fluoride-containing toothpastes (dentifrices), mouth rinses, gels, and varnishes are the modalities most commonly used at present.

Fluoride varnishes were developed during the late 1960s in an effort to further improve the effects of topical fluoride agents by prolonging contact time between tooth enamel and fluoride. Fluoride varnishes have been described as the most convenient means of having preschoolers use professionally applied topical fluoride, based on the premise that they are easy to apply and well tolerated.<sup>[26,27]</sup> In recent decades, the use of fluoride varnish is much more concentrated than any other sources of fluoride; the reason might be the thickness and rapid setting of fluoride varnish, which reduces the amount of fluoride ingested, its ease of application, higher fluoride concentration and the fluoride adherence to tooth structures. It is critical that dentists and health services planners be familiar with the true range of benefits that fluoride varnishes offer specifically toward the prevention of ECC.

The evidence on the effect of fluoride varnish on the prevention of dental caries in children and adolescent has been reviewed in traditional narrative reviews and systematic reviews/meta-analyses. However, they have failed to report the factors that may influence their effectiveness in the preschool population, specifically among those with ECC. A Cochrane systematic review, conducted by *Marinho et al.*, focused both on children and adolescents besides the studies on ECC included in the review until 2008.<sup>[25]</sup> A systematic review focusing on sodium fluoride varnish specifically on ECC was published in 2010, which included articles published up to 2006.<sup>[26]</sup> Thus, the aim of this systematic review was to assess the role of fluoride varnish in preventing ECC.

## MATERIALS AND METHODS

This systematic review was conducted independently based on the Joanna Briggs Institute (JBI) guidelines for conducting systematic reviews.<sup>[28]</sup> At the first level, electronic searches were carried out in various databases such as PubMed/Medline (until the year 2015) search strategy – (“FV” or “DV” or “FPV” or “varnish” or “paint” or “lacquer” or “coating” or “silane”) AND (“caries” or “ECC” or “def” or “decay”

or “white spot” or “cavit”), Cochrane (1979–2015), EMBASE (1982–2015) and IRIS database WHO, (until 2015). All the published literature irrespective of study designs available over the past 36 years (1979–2015) were identified using the key search terms such as fluoride varnishes, fluoride varnishes and ECC, fluoride varnish in the prevention of dental caries in primary teeth, efficacy of fluoride varnish in the reduction of dental caries in children.

A total of 190 records were identified by title/abstracts/full-text articles and were retrieved. Potentially relevant reports identified from the reference lists of relevant studies, review articles, and chapters were hand-searched, which yielded an additional ten articles, yielding a total of 200 records. The records selected for retrieval were assessed by the first three authors (selectors and extractors) for methodological validity before inclusion in the review. Studies published in languages other than English were not included because of their virtual absence. Gray literature was consulted and the decision to include it was made through mutual discussion of all the three authors. The decision to include the articles was almost unanimous, and in case of a tie-breaker situation, the opinion of an external reviewer (a professor in the Department of Conservative Dentistry and Endodontics) was sought and considered to be final.

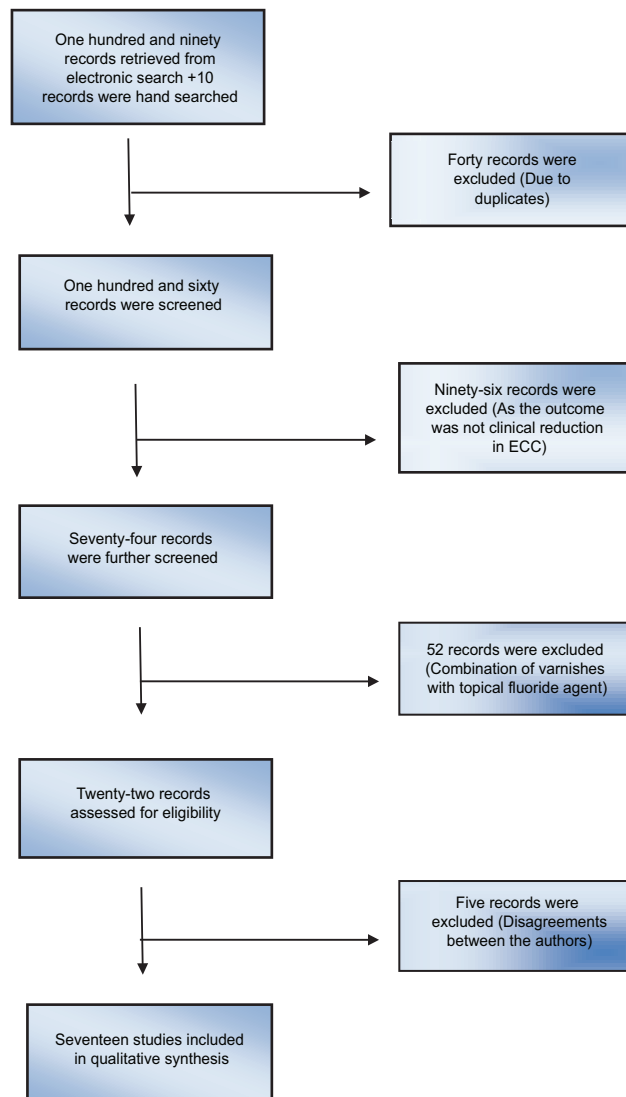
At the second level, since multiple databases were searched, a total of 40 articles were identified as duplicates and excluded from the study. The main outcome of our investigation was the prevention of ECC following application of fluoride varnish with unavoidable fluoride exposure (fluoridated tablet, fluoridated water, and fluoridated toothpaste). Therefore, in the next level, 96 records were eliminated as the outcome in those studies was not clinical reduction in ECC. Furthermore, 52 records were excluded as they were studies which included a combination of varnishes with a topical fluoride agent.

Eventually, 22 articles which were considered potentially eligible for this review were critically appraised by the entire team based on JBI critical appraisal checklist for systematic reviews. The journal name and the authors’ names were masked, and the manuscripts were circulated. Five studies had disagreements with regards to inclusion; the studies were further re-evaluated and discussed by the entire group, and it was decided to exclude them. Thus, 17 manuscripts were included in qualitative synthesis in

this systematic review, as shown in the flow chart 1. The primary measure of the effect was the prevented fraction, calculated as the difference in mean caries increment between the treatment and control groups expressed as the percentage of the increment in the control group.<sup>[29]</sup> The level of evidence was determined according to the protocol of JBI levels of evidence for effectiveness, as shown in Table 1.

## RESULTS

Analysis of the studies revealed that they were conducted in Sweden, Poland, Hannover, China, United States, Canada, Australia, Brazil, Hong Kong, and Iran. Studies conducted during the last 36 years were included and the most recent one was published in 2015.<sup>[30-46]</sup> In these studies, approximately 13,583



**Flow Chart 1:** Screening of manuscripts.

children, aged 1–5 years were assigned to the test groups (fluoride varnish) and placebo (control groups). The follow-up periods were different in different studies.

Analysis of literature revealed that basically two concentrations of fluoride varnishes have been used 1% and 5% with a caries preventive fraction ranges of 6.4–30% to 5–63%, respectively, as shown in Table 2.

Analysis of the benefits of fluoride varnish in relation to severity of caries at baseline revealed that the participants in thirteen studies had mean baseline dmfs in the range of 0–8, where the preventive fraction ranged from 6.4% to 63%, whereas participants in three studies had mean baseline dmfs in the range of 8–16, the preventive fraction ranging from 5% to 24.48%, and the participants of one study had mean baseline dmfs more than 16, the preventive fraction being 35%, as shown in Table 2.

The preventive fraction varied with the sample size in various studies, a highest preventive fraction of 63% for studies with sample size of <500 whereas a wide range of 6.4–30% reduction was observed in studies with a sample size of more than 1000. Wide variations in preventive fractions were observed when analysis of studies was performed in relation to randomization and blinding among various studies as shown in Table 2.

Analysis of the preventive fraction in relation to concomitant exposure revealed that participants in three studies were exposed to other sources of fluoride (fluoridated toothpaste, fluoridated tablet, fluoridated water) had a preventive fraction ranging from 24% to 30.06% compared to 14 studies, without concomitant fluoride exposure and a preventive fraction ranging from 5% to 63%. Analysis of studies in relation to the number of times of application revealed that fluoride varnishes have been applied one, two, three, four, and five times annually. However, more consistent preventive fraction was reported for twice and thrice annual applications (5–63% and 48.3–55%). Sodium fluoride at 5% was the most common ingredient in all the brands (Duraphat, Cavity shield, Clinpro, Durashield); difluorosilane at 1% was the only alternative used in the literature. Sodium fluoride varnish at 5%, irrespective of the brand yielded similar results. Difluorosilane at 1% yielded preventive fraction ranging from 6.4% to 30%.

Analysis of literature in relation to funding revealed that two (approx. 11%) of the studies were funded by

companies; 10 (58%) were funded by regional research grants and 5 (29%) studies were self-financed with a preventive fraction ranges of 24–56%, 6.4–59%, and 5–63%, respectively, as shown in Table 2.

The studies were analyzed for levels of evidence according to JBI criteria. It was revealed that 15 (88%) studies had evidence level of 1-C, and two (11.7%) studies had evidence level of 3-E, as shown in Table 1.

The results of all these 17 studies are compiled in Table 3.

## DISCUSSION

The systematic search for literature, data extraction, and subsequent qualitative synthesis of the included literature is now a well-established measure for evidence-based medicine. However, the precise methods for the process and the methodology used differ between various organizations. The present systematic review was conducted according to the guidelines of the JBI. The nature of systematic reviews has changed over the years, and significant progress has been made regarding appropriate evidence for inclusion in a systematic review. Increasingly, these reviews are used to answer a broad range of questions for health professionals. Traditionally, the evidence-based practice movement has focused on the results of quantitative evidence (considering the randomized controlled trial as the gold standard) to answer questions of effectiveness. However, the JBI has its central focus

**Table 1: Joanna Briggs Institute levels of evidence (2013)**

Levels of evidence	Study designs
Level 1: Experimental designs	
Level 1a	Systematic review of RCTs
Level 1b	Systematic review of RCTs and other study designs
Level 1c	RCT
Level 1d	Pseudo-RCTs
Level 3: Observational-analytical designs	
Level 3a	Systematic review of comparable cohort studies
Level 3b	Systematic review of comparable cohort and other lower study designs
Level 3c	Cohort study with control group
Level 3d	Case-controlled study
Level 3e	Observational study without a control group

RCTs: Randomized controlled trials

on not only effectiveness but also on appropriateness, meaningfulness, and feasibility of health practices and delivery methods.<sup>[28]</sup> The central question addressed in this systematic review is the effectiveness of fluoride varnish in the prevention of ECC. Articles published from 1979 to 2015, with a total of 13,583 children with varying study designs, were included.

Fluoride varnish has been described as the most convenient means of professionally applied topical fluoride agent in the management of ECC. This is based on the premise that they are easy to apply and

**Table 2: Preventive fraction of the studies included in this review**

Parameter	Number of studies	PF (%)
Concentration of varnish		
1%	2	6.4-30
5%	15	5-63
Baseline caries experience		
0-8	13	6.4-63
8-16	3	5-24.48
>16	1	35
Sample size		
<500	12	5-63
500-1000	2	24
>1000	3	6.4-30
Randomization		
Randomization	9	5-63
Nonrandomized trials	6	24-55
Observational study	2	30-35
Blinding		
Single	6	12-63
Double	3	5-56.25
Nonblind	8	24-55
Concomitant exposure		
Exposure	3	24-30.06
No exposure	14	5-63
Frequency of application		
Once	1	56.25
Twice	13	5-63
Thrice	3	48.3-55
Four	3	37-59
Less than four	1	35
Brand of varnish		
Duraphat (ICN pharma)	9	5-63
Fluor protector (Vivacave)	2	6.4-30
Cavity shield (OMNII)	2	24-40
Durafluor (Montreal)	2	18.3-35
Durashield (Sultan healthcare)	1	59
Clinpro (3M ESPE)	1	41
Funding on the study		
Grants	10	6.4-59
Company	2	24-56
None	5	5-63

PF: Preventive fraction

**Table 3: An overall analysis of the included studies**

Author (year)	Country	Age	Sample	Blinding	Randomization	Varnish	Control	Exposure	Frequency	Duration (years)	Attrition	Dmfs	PF (%)	Funding	Evidence
Holm (1979)	Sweden	3	275	Single	Yes	NaF	Nil	Nil	Twice	2	10	1.05	44	Grants	1c
Grodzka (1982)	Poland	3.5	401	Double	Yes	NaF	Nil	Nil	Twice	2	23	9.9	5	Nil	1c
Frostell (1991)	Sweden	4	393	Single	Yes	NaF	Nil	Nil	Twice	2	0	2.75	35.40	Grants	1c
Twetman (1996)	Sweden	5	1044	No	No	Difluorosilane	Nil	Yes	Twice	2	2	1	30	Nil	3e
Petersson (1998)	Sweden	5	5137	Single	Yes	Difluorosilane	Preventive strategies	Nil	Twice	2	18.9	1.13	6.40	Grants	1c
Zimmer (1999)	Germany	5	269	No	No	NaF	Nil	Nil	Four	4	5.9	1.36	37	Nil	1c
Lo (2001)	China	4	375	No	No	NaF	Placebo	Nil	Three	1.5	9	4.71	48.30	Grants	1c
Gold (2001)	USA	5	222	Single	Yes	NaF	Nil	Nil	Twice	0.75	22	2.51	63	Nil	1c
Chu (2002)	China	5	375	No	No	NaF	Nil	Nil	Three	2.5	16	4.71	55	Grants	1c
Weintraub (2006)	China	5	384	Double	Yes	NaF	Nil	Nil	Twice	2	46	0	56.30	Co.	1c
Lawrence (2008)	Canada	5	1793	Single	Yes	NaF	Nil	Nil	Twice	2	28.8	12.89	18.30	Grants	1c
Holve (2008)	USA	4.4	368	No	No	NaF	Nil	Nil	Five or six	2.5	2.9	23.66	35	Nil	3e
Weinstein (2009)	USA	4	787	No	No	NaF	Placebo	Nil	Twice	3	34.5	11.6	24.50	Grants	1c
Slade (2011)	Australia	4	666	No	No	NaF	Nil	Yes	Twice	2	18	7.7	24	Co.	1c
Arruda (2014)	Brazil	5	424	No	No	NaF	Placebo	Yes	Twice	2	4	6.2	27.30	Grants	1c
Jiang (2014)	Hong Kong	2	450	Double	Yes	NaF	OHI	Nil	Twice	1	7.7	0.3	41	Grants	1c
Mermapr (2015)	Iran	3	220	Single	Yes	NaF	OHI	Nil	Four	1	36	0.14	59	Grants	1c

PF: Preventive fraction; OHI: Oral health instructions

well tolerated. The time required to apply the varnish varies from 1 to 4 min per child, depending on the number of teeth present, and immediately following application the child can close his/her mouth because the varnish hardens on contact with saliva and forms a film that adheres to tooth surfaces. It is, however, recommended that children avoid eating for 2 h following application of the varnish and not brush their teeth that same day. This allows the varnish to remain in contact with the dental enamel for several hours. Evidence suggests that though there are currently various commercial formulations, 5% NaF and 1% difluorosilane are the two products of fluoride varnishes that have been used for the prevention of ECC. A total of 190 articles were retrieved, and 173 were excluded at various level of screening; therefore, 17 articles were sorted for qualitative synthesis. Analysis of these records revealed preventive fraction ranging from as low as 5% to as high as 63%. This is consistent with the findings of a systematic review conducted by Carvalho *et al.*<sup>[26]</sup> However, a preventive fraction of 44% and 30–63% was reported in primary and young permanent dentitions, respectively, in another systematic review conducted by Petersson *et al.*<sup>[27]</sup> Rozier reported an overall preventive effect of professionally applied topical fluoride agents in the range of 22–46% in young permanent teeth.<sup>[47]</sup> A Cochrane systematic review of ten trials conducted by Marinho *et al.* has reported a preventive fraction of 37% in primary dentition; in contrast to these findings our review revealed a preventive fraction range of 5–63% from analysis of seventeen articles, including trials and observational studies.

It is difficult to determine whether fluoride concentration in the varnish affects its prophylactic capacity since only two studies used a fluoride concentration of 1%, whereas fifteen studies have reported having used a fluoride concentration of 5%, with preventive fractions of 6.4–30% and 5–63%, respectively, similar to the findings of Carvalho *et al.* It is also difficult to conclude the ideal interval time of varnish application. In our analysis, we found thirteen studies having biannual application with a preventive fraction ranging from 5% to 63%. Two studies have reported <6 months interval and one study has reported an annual application. The preventive fraction in these studies is almost similar. Hence, we suggest that the conclusion should be evaluated with caution.

The caries experience of children at baseline was reported to be as low as 0.00 mean dmfs to as high

as 23.66 mean dmfs. The effect of the past caries experience showed an inverse relation. Children with dmfs of 0–8 showed a preventive fraction of 6–63%, whereas those with dmfs score of 8–16 had a preventive fraction of 5–24%. A similar trend was reported by Carvalho *et al.* However, one study has reported a baseline mean dmfs of 23.66 with a preventive fraction of 35%.

Factors concerned with study design such as sample size, randomization, blinding, concomitant fluoride exposure, placebo, and attrition revealed great variations in the methodology. Sample size revealed an inverse relation to a preventive fraction in our analysis; such a trend was not reported in the literature. Nearly 50% of the studies employed the process of randomization in our analysis contrary to the findings of Carvalho *et al.*, who reported one study of random assignment of subjects to the test and control groups. The preventive fraction in studies with randomization was 5–63% versus 24–55% in nonrandomized studies. These findings have to be interpreted with caution as various other factors such as concentration, and frequency of application could be possible confounders.

In our analysis, we found a higher number of non-blind studies, i.e., eight compared to six single-blind and 3 double-blind studies, yielding a preventive fraction of 24–55%, 12–63%, and 5–56.25%, respectively. Such trends have not been reported in the literature. Hence, interpretation of the effect of blinding on preventive fraction of varnishes on ECC has to be carried out cautiously.

Dropout rate in our analysis ranged from 0% to as high as 46%; interestingly, the study duration of both studies was 2 years. Factors pertaining to such a high difference were not clearly mentioned. Nevertheless, it is difficult to evaluate the effect of dropouts on the preventive benefits of fluoride varnish on ECC.

Concomitant fluoride exposure among children and its effect on the preventive fraction of fluoride varnish was also a focus of our analysis. It was revealed that three studies reported exposure of children to fluoridated water and/or use of fluoridated toothpaste and fluoride tablets having a preventive fraction range of 24–30.06% compared to 5–63% among those without concomitant exposure.

In our analysis, the evidence levels for effectiveness were based on the JBI criteria. Most of the studies had an evidence level of 1C, whereas two studies had an evidence level of 3E, which can be considered as

overall limited evidence, consistent with Carvalho *et al.* report, who calculated on the basis of Jadad's criteria and Petersson *et al.*, who calculated on the recommendation by Britton<sup>[48]</sup> and Rozier, who categorized evidence-based on Brader *et al.*<sup>[49]</sup>

## CONCLUSION

Based on our review, we concluded that a significantly small number of publications on the effect of fluoride varnish on ECC are available. These publications widely vary in methodological issues. Though the AAPD recommends the use of fluoride varnishes to prevent or reverse the demineralization of dental enamel in children with moderate to high risk of dental caries, this systematic review showed the evidence of studies supporting it to be of limited value. It is noteworthy to mention that possible side effects of fluoride varnishes have not been reported in any of the trials/studies. Fluoride varnishes have been used at concentrations of 1% and 5% for the prevention of ECC. The preventive fraction for 1% fluoride varnish ranged from 6.4% to 30% (on the basis of two studies only) and for 5% fluoride varnish it ranged from 5% to 63%. The preventive fraction was influenced by the frequency of application, the duration of study and sample size. It is recommended to conduct further studies on the effect of fluoride varnish on ECC, with improvised methodology in terms of sample size determination, randomization, blinding, the duration of the study, the use of placebos, accountability for dropouts, etc.

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## Conflicts of interest

The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or nonfinancial in this article.

## REFERENCES

- American Academy of Paediatric Dentistry. Policy on early childhood caries (ECC): Classifications, consequences, and preventive strategies. Oral health policies. Vol. 37. United States: APD; 2014. p. 15-6.
- Milnes AR. Description and epidemiology of nursing caries. *J Public Health Dent* 1996;56:38-50.
- Douglass JM, Douglass AB, Silk HJ. A practical guide to infant oral health. *Am Fam Physician* 2004;70:2113-20.
- Szatko F, Wierzbicka M, Dybizbanska E, Struzycka I, Iwanicka-Frankowska E. Oral health of Polish three-year-olds and mothers' oral health-related knowledge. *Community Dent Health* 2004;21:175-80.
- Berkowitz RJ. Causes, treatment and prevention of early childhood caries: A microbiologic perspective. *J Can Dent Assoc* 2003;69:304-7.
- Douglass JM, Tinanoff N, Tang JM, Altman DS. Dental caries patterns and oral health behaviors in Arizona infants and toddlers. *Community Dent Oral Epidemiol* 2001;29:14-22.
- Reisine S, Douglass JM. Psychosocial and behavioral issues in early childhood caries. *Community Dent Oral Epidemiol* 1998;26 1 Suppl:32-44.
- Tang JM, Altman DS, Robertson DC, O'Sullivan DM, Douglass JM, Tinanoff N. Dental caries prevalence and treatment levels in Arizona preschool children. *Public Health Rep* 1997;112:319-29.
- O'Sullivan DM, Douglass JM, Champany R, Eberling S, Tetre S, Tinanoff N. Dental caries prevalence and treatment among Navajo preschool children. *J Public Health Dent* 1994;54:139-44.
- Rosenblatt A, Zarzar P. The prevalence of early childhood caries in 12- to 36-month-old children in Recife, Brazil. *ASDC J Dent Child* 2002;69:319-24, 236.
- Peressini S, Leake JL, Mayhall JT, Maar M, Trudeau R. Prevalence of early childhood caries among First Nations children, District of Manitoulin, Ontario. *Int J Paediatr Dent* 2004;14:101-10.
- Tsai AI, Chen CY, Li LA, Hsiang CL, Hsu KH. Risk indicators for early childhood caries in Taiwan. *Community Dent Oral Epidemiol* 2006;34:437-45.
- Cariño KM, Shinada K, Kawaguchi Y. Early childhood caries in Northern Philippines. *Community Dent Oral Epidemiol* 2003;31:81-9.
- Jin BH, Ma DS, Moon HS, Paik DI, Hahn SH, Horowitz AM. Early childhood caries: Prevalence and risk factors in Seoul, Korea. *J Public Health Dent* 2003;63:183-8.
- Douglass JM, Wei Y, Zhang BX, Tinanoff N. Caries prevalence and patterns in 3-6-year-old Beijing children. *Community Dent Oral Epidemiol* 1995;23:340-3.
- Mayanagi H, Saito T, Kamiyama K. Cross-sectional comparisons of caries time trends in nursery school children in Sendai, Japan. *Community Dent Oral Epidemiol* 1995;23:344-9.
- Fujiwara T, Sasada E, Mima N, Ooshima T. Caries prevalence and salivary mutans streptococci in 0-2-year-old children of Japan. *Community Dent Oral Epidemiol* 1991;19:151-4.
- Rajab LD, Hamdan MA. Early childhood caries and risk factors in Jordan. *Community Dent Health* 2002;19:224-9.
- Al-Malik MI, Holt RD, Bedi R. The relationship between erosion, caries and rampant caries and dietary habits in preschool children in Saudi Arabia. *Int J Paediatr Dent* 2001;11:430-9.
- Al-Hosani E, Rugg-Gunn A. Combination of low parental educational attainment and high parental income related to high caries experience in pre-school children in Abu Dhabi. *Community Dent Oral Epidemiol* 1998;26:31-6.

21. Masiga MA, Holt RD. The prevalence of dental caries and gingivitis and their relationship to social class amongst nursery-school children in Nairobi, Kenya. *Int J Paediatr Dent* 1993;3:135-40.
22. Jose B, King NM. Early childhood caries lesions in preschool children in Kerala, India. *Pediatr Dent* 2003;25:594-600.
23. Simratvir M, Moghe GA, Thomas AM, Singh N, Chopra S. Evaluation of caries experience in 3-6-year-old children, and dental attitudes amongst the caregivers in the Ludhiana city. *J Indian Soc Pedod Prev Dent* 2009;27:164-9.
24. Mahejabeen R, Sudha P, Kulkarni SS, Anegundi R. Dental caries prevalence among preschool children of Hubli: Dharwad city. *J Indian Soc Pedod Prev Dent* 2006;24:19-22.
25. Marinho VC, Worthington HV, Walsh T, Clarkson JE. Fluoride varnishes for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev* 2013;7:CD002279.
26. Carvalho DM, Salazar M, Oliveira BH, Coutinho ES. Fluoride varnishes and decrease in caries incidence in preschool children: A systematic review. *Rev Bras Epidemiol* 2010;13:139-49.
27. Petersson LG, Twetman S, Dahlgren H, Norlund A, Holm AK, Nordenram G, *et al.* Professional fluoride varnish treatment for caries control: A systematic review of clinical trials. *Acta Odontol Scand* 2004;62:170-6.
28. Available from: [http://www.joannabriggs.org/assets/docs/sumari/ReviewersManual\\_2014-The-Systematic-Review-of-Prevalence-and-Incidence-Data\\_v2.pdf](http://www.joannabriggs.org/assets/docs/sumari/ReviewersManual_2014-The-Systematic-Review-of-Prevalence-and-Incidence-Data_v2.pdf). [ Last accessed on 2016 Apr 28].
29. Koch G, Poulsen S, editors. *Pediatric Dentistry: A Clinical Approach*. Sweden: John Wiley and Sons; 2009.
30. Holm AK. Effect of a fluoride varnish (Duraphat®) in preschool children. *Community Dent Oral Epidemiol* 1979;7:241-5.
31. Grodzka K, Augustyniak L, Budny J, Czarnocka K, Janicha J, Mlosek K, *et al.* Caries increment in primary teeth after application of Duraphat® fluoride varnish. *Community Dent Oral Epidemiol* 1982;10:55-9.
32. Frostell G, Birkhed D, Edwardsson S, Goldberg P, Petersson LG, Priwe C, *et al.* Effect of partial substitution of invert sugar for sucrose in combination with Duraphat® treatment on caries development in preschool children: The Malmö study. *Caries Res* 1991;25:304-10.
33. Twetman S, Petersson LG, Pakhomov GN. Caries incidence in relation to salivary mutans streptococci and fluoride varnish applications in preschool children from low- and optimal-fluoride areas. *Caries Res* 1996;30:347-53.
34. Petersson LG, Twetman S, Pakhomov GN. The efficiency of semiannual silane fluoride varnish applications: A two-year clinical study in preschool children. *J Public Health Dent* 1998;58:57-60.
35. Zimmer S, Robke FJ, Roulet JF. Caries prevention with fluoride varnish in a socially deprived community. *Community Dent Oral Epidemiol* 1999;27:103-8.
36. Lo EC, Chu CH, Lin HC. A community-based caries control program for pre-school children using topical fluorides: 18-month results. *J Dent Res* 2001;80:2071-4.
37. Autio-Gold JT, Courts F. Assessing the effect of fluoride varnish on early enamel carious lesions in the primary dentition. *J Am Dent Assoc* 2001;132:1247-53.
38. Chu CH, Lo EC, Lin HC. Effectiveness of silver diamine fluoride and sodium fluoride varnish in arresting dentin caries in Chinese pre-school children. *J Dent Res* 2002;81:767-70.
39. Weintraub JA, Ramos-Gomez F, Jue B, Shain S, Hoover CI, Featherstone JD, *et al.* Fluoride varnish efficacy in preventing early childhood caries. *J Dent Res* 2006;85:172-6.
40. Lawrence HP, Binguis D, Douglas J, McKeown L, Switzer B, Figueiredo R, *et al.* A 2-year community-randomized controlled trial of fluoride varnish to prevent early childhood caries in Aboriginal children. *Community Dent Oral Epidemiol* 2008;36:503-16.
41. Holve S. An observational study of the association of fluoride varnish applied during well child visits and the prevention of early childhood caries in American Indian children. *Matern Child Health J* 2008;12 Suppl 1:64-7.
42. Weinstein P, Spiekerman C, Milgrom P. Randomized equivalence trial of intensive and semiannual applications of fluoride varnish in the primary dentition. *Caries Res* 2009;43:484-90.
43. Slade GD, Bailie RS, Roberts-Thomson K, Leach AJ, Raye I, Endean C, *et al.* Effect of health promotion and fluoride varnish on dental caries among Australian Aboriginal children: Results from a community-randomized controlled trial. *Community Dent Oral Epidemiol* 2011;39:29-43.
44. Arruda AO, Senthamarai Kannan R, Inglehart MR, Rezende CT, Sohn W. Effect of 5% fluoride varnish application on caries among school children in rural Brazil: A randomized controlled trial. *Community Dent Oral Epidemiol* 2012;40:267-76.
45. Jiang EM, Lo EC, Chu CH, Wong MC. Prevention of early childhood caries (ECC) through parental toothbrushing training and fluoride varnish application: A 24-month randomized controlled trial. *J Dent* 2014;42:1543-50.
46. Memarpour M, Fakhraei E, Dadaein S, Vossoughi M. Efficacy of fluoride varnish and casein phosphopeptide-amorphous calcium phosphate for remineralization of primary teeth: A randomized clinical trial. *Med Princ Pract* 2015;24:231-7.
47. Rozier RG. Effectiveness of methods used by dental professionals for the primary prevention of dental caries. *J Dent Educ* 2001;65:1063-72.
48. Britton M. Evidence-based medicine. Grading the scientific values and strength of conclusions in clinical trials. *Lakartidningen* 2000;97:4414-5.
49. Bader JD, Shugars DA., Bonito AJ. *Diagnosis and Management of Dental Caries: Evidence Report*. Vol. 1 and 2. Research Triangle Park, North Carolina: Research Triangle Institute; 2000.