



# The Effectiveness of Fluoride Varnish and Fissure Sealant in Elementary School Children: A Systematic Review and Meta-Analysis

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## Abstract

**Background:** Highly necessary to evaluate the effectiveness of preventive interventions to prioritize them at the community level. We aimed to systematically investigate the related studies on the effects of fluoride varnish and fissure sealant on dental caries in 6-12 children.

**Methods:** We searched PubMed, EMBASE, Web of Science, Cochrane Library and Scopus databases using Fluoride Varnish, Fissure Sealant, Caries, and Oral Health keywords. The timeframe selected to search for articles is from 2000 to Dec 2020. CMA software: 2 (Comprehensive Meta-Analysis) was used to perform the meta-analysis. The intervention groups in this study were fluoride varnish and fissure sealants, each of them compared to the control groups.

**Results:** We included nine studies. In the intervention group 84,380 and control group 11,254 individuals were studied. Eight of the studies were Randomized Clinical Trial (RCT) and Field RCT, and two was non-RCT. In the overall Fluoride Varnish efficacy study, 4 were fully effective, 1 was ineffective, and all 4 were completely effective for Fissure Sealant. There was a significant difference between decayed, missing, and filled permanent teeth (DMFT) and decayed, missing, and filled primary teeth (dmft) indices in both interventions and comparison groups. Moreover, the mean difference of DMFT for Fluoride Varnish and Fissure Sealant in the intervention and control groups were -0.55 and -0.29, respectively ( $P=0.00$ ).

**Conclusion:** Due to the efficacy of fissure sealant and fluoride varnish in preventing dental caries in children aged 6-12 yr, these interventions can be considered as health priorities of societies and health systems interventions in countries.

**Keywords:** Fluoride varnish; Fissure sealant; Systematic review; Meta-analysis; Oral health



## Introduction

Dental caries is one of the most prevalent diseases in the world, especially, in children and adolescents. These diseases are one of the main multifactorial health problems in developing countries and are one of the main causes of tooth loss (1, 2).

Teeth are at risk of decay as soon as they appear in the mouth and the sensitivity of each to caries is different. Many factors affect the process of tooth caries in children. Effective factors include child nutrition, dental health, socioeconomic status of parents, consumption of sweet foods and sweets, and number of visits to the dentist and fluoride treatment (3, 4). At present, the severity and prevalence of dental caries in children and adolescents in different regions of the countries are between 60%-90%, and the incidence of dental caries in children varies from child to child and can be significantly different (5, 6).

Dental caries are damage to a tooth's surface that affects the health of teeth of all races and genders at all economic and social levels. Ignoring nutritional factors such as consumption of sweets, fizzy soft beverages and Lack of oral hygiene can increase DMFT. In a study of 300 students, most of them were familiar with the preventive interventions of fluoride varnish and their level of knowledge of oral health is one of the important factors in preventing caries. In addition, even the treatment of dental diseases promotes the proper growth of the body in children (7-11). Therefore, one of the goals of pediatric dentistry is to prevent dental caries. According to proven results and scientific documentation, dentists get benefit from fissure sealant and fluoride therapy as one of the main options for dental caries prevention (12, 13). Sealants prevent tooth decay from pits and fissures of the teeth by blocking these surfaces and stopping food and bacteria from entering and being stuck there (14).

Moreover, the use of fluoride has been one of the most effective methods to prevent dental caries. For more than 6 decades, laboratory, clinical and social studies on the efficacy and mechanism of

fluoride activity in preventing dental caries have proven that the use of fluoride is a safe, effective, efficient, and appropriate method. Fluoride is utilized in various forms; community water or milk fluoridation, or, using fluoride tablets and drops, toothpastes, mouthwashes, and fluoride therapy (15, 16).

In comprehensive oral health programs, the use of fluoride varnish and fissure sealant in high-risk caries samples was approved as effective preventive interventions; however, there was a big difference in their effectiveness over the period of 3 years (17). In general, these two preventive interventions (fissure sealant and fluoride varnish) have been accepted as effective measures in reducing dental caries; however, they remain unknown as superior clinical interventions (18). The lack of expression of the effects level of these substances in the prevention of tooth decay, as well as the difference between their values in related studies, prompted the authors to conduct a study that reported these cases.

Therefore, we aimed to evaluate accurately the effectiveness of two preventive dental interventions (fluoride varnish and fissure sealant) from the perspective of the health system in primary school children.

## Methods

The systematic review and meta-analysis method in 2020 were performed based on "Systematic reviews to support evidence-based medicine" book" (19).

### *Ethical approval*

This article does not contain any studies with human participants or animals intervention by any of the authors.

### *Search strategy*

The required information was collected using the keywords Fluoride Varnish, Fissure Sealant, Caries, Oral Health (Appendix 1, sample search

strategy) (Appendices are available in case of contacting with the corresponding author only) in databases of MEDLINE-PubMed, Scopus, Web of Science, Cochrane Library and EMBASE. The timeframe selected for searching the articles was from 2000 to Dec 2020.

### *Inclusion and exclusion criteria*

**Table 1:** Inclusion and exclusion criteria based on PICO model

| <i>PICO</i>  | <i>Inclusion Criteria</i>  | <i>Exclusion Criteria</i>  |
|--------------|--|--|
| population   | Children and adolescents between the ages of 6 and 12 yr, regardless of gender   | People with underlying and chronic diseases such as diabetes, heart disease, genetics, as well as people who were not in the age group of 6–12 yr. |
| Intervention | Fissure sealant and Fluoride varnish preventive dental interventions   | Dental interventions aimed at improving other problems (Nutritional, Respiratory, etc.) in the target group were performed.                        |
| Comparison   | No intervention or any of the available strategies (different fluoride therapy, such as taking pills, milk, etc.) in the studies.  | People with underlying and chronic diseases such as diabetes, heart disease and the like.  |
| Outcome      | Report of caries through DMFT, DMFS(decayed, missing, and filled permanent teeth or surfaces), dmft and dmfs(decayed, missing, and filled primary teeth or surfaces) indices | Outputs not related to oral health such as nutrition status, quality of life, etc.   |
| Other cases  | every article published in English Journal   | Pilot studies, other language studies, and pre-2000 studies  |

### *Quality Assessment*

The quality of reporting all articles after extraction from the target databases using the mentioned keywords was evaluated by two evaluators using checklists (CONSORT: 2010 and TREND) (Appendix 2). The CONSORT and TREND checklists were used to evaluate randomized and non-randomized clinical trial studies, respectively. The latest version of the Consort checklist, (Consort, 2010) contains 37 items to evaluate the 6 main sections of clinical trial studies. The TREND statement has a 22-item (57 sub-item) checklist specifically developed to guide standardized reporting of nonrandomized-controlled trials. In these reviews, studies from different dimensions such as Sequence generation, allocation concealment, blinding, incomplete outcome data, and selective outcome reporting and other sources of bias were examined (20-24).

PICO is used in systematic studies to define the inclusion and exclusion criteria of research so that it can be used to screen the obtained articles. Titles and abstracts were evaluated using the PICO (population, intervention, comparison and outcomes) model according to inclusion and exclusion criteria (Table 1).

Based on the framework of the above tools, studies that obtained less than one-third of the score were classified as weak, and studies that gained more than two-thirds of the checklist were categorized as high-level articles. Appropriate tools were used to determine the amount of bias in the remaining ten studies by two evaluators; if there were disagreements in the surveys (by two main individuals), the paper was judged by a third rater. Evaluation results were also divided into three different levels of low, medium and high based on the type of intervention.

### *Data Extraction*

The whole process of extracting data from studies by two people (independently) was systematically studied using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-

Analyses)2015 framework and the flow diagram 2009 (25-27). To do this, an Excel page was created specifically for the study, which included variables such as authors, date of release, country, study design, study indicators, type of intervention, tracking period (reported end of course), number of people. The study included the intervention and control groups as well as the comparison group and the results of each study, score scale and risk bias were investigated.

### *Data Analysis Methods*

At the first, the data were synthesized by presenting a descriptive summary of the existing studies; this was done through presenting the studies in tables, with details of study characteristics such as type of study, interventions, number of participants, a summary of their characteristics, outcomes and quality of presentations. Therefore, after extracting the data, the effectiveness of the interventions was evaluated in terms of the impact on each of the indicators. Afterward, the criteria for evaluating the effectiveness, reducing DMFT in the intervention group with different sealants were analyzed. According to the reports of the articles about the effectiveness of each intervention, the significance level was defined and their significance as a result of the interventions was presented.

To calculate the mean difference between the DMFT index between the intervention groups and the comparison after the follow-up period, meta-analytic statistical methods were utilized. Using Comprehensive Meta-Analysis software, the meta-analysis was performed. Forest plot charts were used to report the results, in which the size of each square indicates the sample size

and the lines drawn on each side of the square indicate the confidence interval of about 95% for each study. To measure the heterogeneity of the study results, Q statistics and  $I^2$  index were implemented. In this study,  $I^2$  was determined above 50% of the heterogeneous criteria of the articles. Other extracted data were analyzed and reported manually with descriptive statistics (percentage, frequency, mean, etc.).

### **Results**

In the initial search, five thousand two hundred and sixty-nine (5269) studies were obtained. After studying the titles and abstracts, 5201 studies were deleted and as a result, 68 studies remained for full-text study. According to inclusion and exclusion criteria, 58 other studies were excluded at this stage and 10 cases remained for inclusion in the study, and 6 articles for meta-analysis (28-42) (Fig. 1). The specifications of the reviewed articles as well as the information on interventions are presented in Tables 2 and 3. The reviewed articles were conducted in seven different countries; Germany (3 studies), Netherlands (2 studies), Turkey (1 study), India (1 study), France (1 study), Albania (1 study) and China (1 study). Seven out of the ten reviewed articles were RCT's. Overall, 84,380 and 11,254 individuals in the intervention and control groups, respectively, aged 6 to 12 yr were studied in different follow-up periods (7 to 48 months). Three of the studies examined DMFT and DMFS indices; one related to FS (Fissure sealant) interventions and two to FV (Fluoride Varnish).

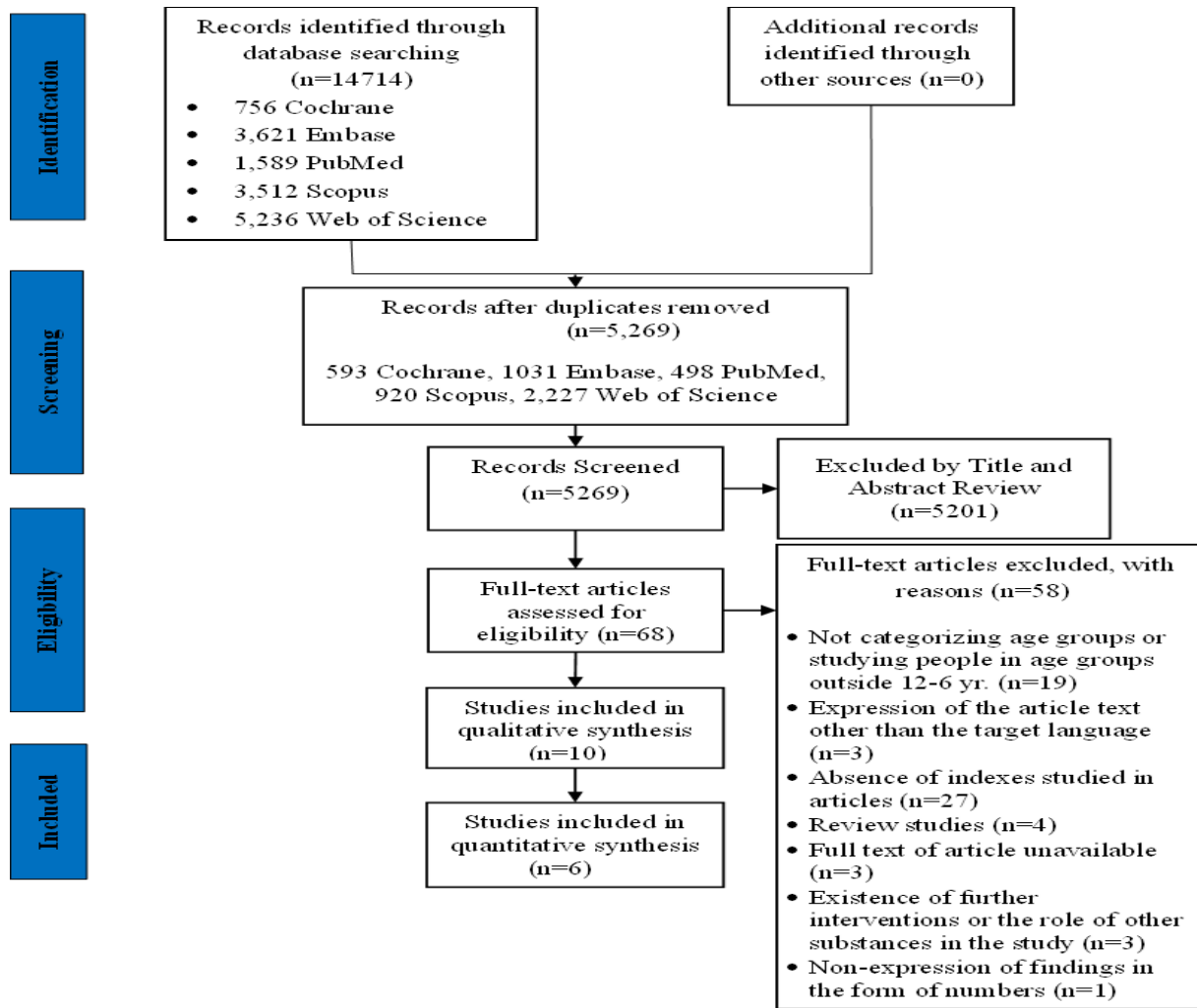


Fig. 1: Flow chart of the screening and study selection process

Table 2: Characteristics of the included studies (for FV interventions)

| Country (Reference No.) | Participants |         | Follow-up (M) | Type of Index | Comparison  | Results  |   | Overall   |
|-------------------------|--------------|---------|---------------|---------------|-------------|--|---|-----------|
|                         | Intervention | Control |               |               |             | Before   | After   |           |
| Albania (28)            | 40           | 52      | 7             | DMFT and DMFS | None / N=52 | IG: DMFT= 2.55 ± 1.98<br>DMFS=3.07 ± 2.41<br>CG: DMFT= 2.82 ± 2.04<br>DMFS=3.3 ± 2.23    | IG: DMFT= 2.77 ± 1.96<br>DMFS=3.31 ± 2.38<br>CG: DMFT= 3.46 ± 2.22<br>DMFS=4.02 ± 2.54    | Effective |
| India (29)              | 100          | 100     | 12            | DMFT and DMFS | None/ N=100 | IG: DMFT= 0.35 ± 0.04<br>DMFS= 0.68 ± 0.05<br>CG: DMFT= 0.26 ± 0.07<br>DMFS= 0.44 ± 0.09 | IG: DMFT= 0.32 ± 0.06<br>DMFS= 0.59 ± 0.05<br>CG: DMFT= 0.31 ± 0.05<br>DMFT= (0.18, 0.41, | Effective |
| Germany                 | 80589        | 7748    | 48            | DMFT          | None        | DMFT= (0.11, 0.35,   | DMFT= (0.11, 0.35,  | Effective |

|                  |     |     |    |      |                                   |  |  |              |
|------------------|-----|-----|----|------|-----------------------------------|--|--|--------------|
| (43)             |     |     |    |      |                                   | 0.75, 1.09, 1.52, 1.93 and 2.77)         | 0.65, 1.0, 1.32, 1.76 and 2.49) & (0.12, 0.32, 0.6, 0.97, 1.36, 1.68 and 2.22) & (0.1, 0.24, 0.45, 0.77, 1.16, 1.55 and 2.04) & (0.08, 0.23, 0.4, 0.63, 0.89, 1.33 and 1.64) |              |
| Netherlands (44) | 305 | 289 | 48 | DMFS | placebo gel group/<br>N=261       | IG: DMFS=3.4±2.7<br>CG: DMFS=3.4±2.7     | IG: DMFS=3.74±2.7<br>CG: DMFS=3.78±2.7   | In-effective |
| Germany (45)     | 259 | 160 | 24 | DMFS | oral hygiene instruction<br>N=160 | IG: DMFS=2.13±2.76<br>CG: DMFS=2.08±2.74 | IG: DMFS=4.35±3.87<br>CG: DMFS=4.69±4.51   | Effective    |

**Table 3:** Characteristics of the included studies (for FS interventions)

| Country          | Participants |         | Follow-up (M) | Type of Index | Comparison  | results  |   | Overall   |
|------------------|--------------|---------|---------------|---------------|---|--|---|-----------|
|                  | Intervention | Control |               |               |   | Before   | After   |           |
| France (39)      | 276          | 276     | 36            | dmft and DMFT | No treatment group<br>N=276, n=457  | dmft: (2.8 ±3.3)<br>DMFT: (0.2±0.5)  | dmft: (2.7±2.8 and 2.5±2.4 and 2.2±2.1);<br>DMFT: (0.4±0.8 and 0.8±1.1 and 1.1±1.3)   | Effective |
| Netherlands (35) | 407          | 407     | 24            | dmft and DMFT | G1: High-viscosity glass-ionomer; G2: High-viscosity glass-ionomer + LED; G3: Glass car-bomer | dmft: G1: (6.2± 2.8), G2 (6.3±2.9), G3 (6.3±2.8) and G4 (6.4±2.7)<br>DMFT: G1 (0.9±1.3), G2 (0.9±1.4), G3 (0.8±1.2) and G4 (0.7±1.2) | dmft*: G1 (4.7±2.6), G2 (4.9±2.5), G3 (4.9±2.6) and G4 (4.8±2.7)<br>DMFT*: G1 (0.8±1.2), G2 (0.6±0.9), G3 (0.9±1.3) and G4 (0.5±1.0)<br>*After 2 yr | Effective |
| Turkey (34)      | 322          | 174     | 36            | DMFT/dmft     | No sealant<br>n =174  | IG: dmft= 2.53<br>DMFT= 1.68   | IG: dmft=2.70 ±0.62, 2.86±1.07, 3.02±1.42;<br>DMFT=1.85±0.62, 2.01±1.07, 2.17 ±1.42   | Effective |
| Germany (46)     | 434          | 723     | 36            | DMFT/DMFS     | None  | DMFT=1.78±2.15<br>DMFS=2.79±4.07   | DMFT=3.97±3.68<br>DMFS= 6.94±8.34   | Effective |
| China (47)       | 1648         | 1325    | 36            | DMFT          | No sealant<br>n =1325   | DMFT= 0.05±0.30, 0.15±0.56, 0.27±0.70, 0.37±0.85   | DMFT= 0.03±0.22, 0.09±0.36, 0.16±0.51, 0.25±0.65  | Effective |

Among the indicators reported in the study, two types of DMFT index (obtained from fluoride varnish), DMFT (obtained from fissure sealant) and dmft (obtained from fissure sealant) were

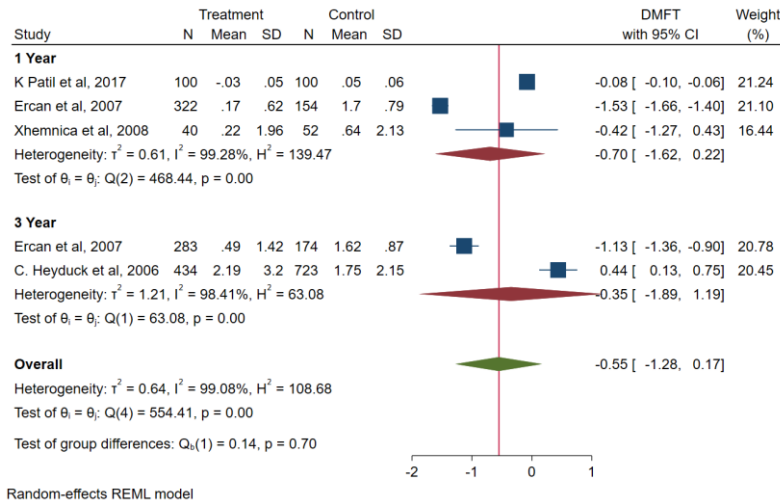
reported in different studies, hence, the average values of these indexes in the intervention and comparison group were extracted and entered into meta-analysis (Table 4).

**Table 4:** Summary of the values of the two types of FV and FS indices after meta-analysis

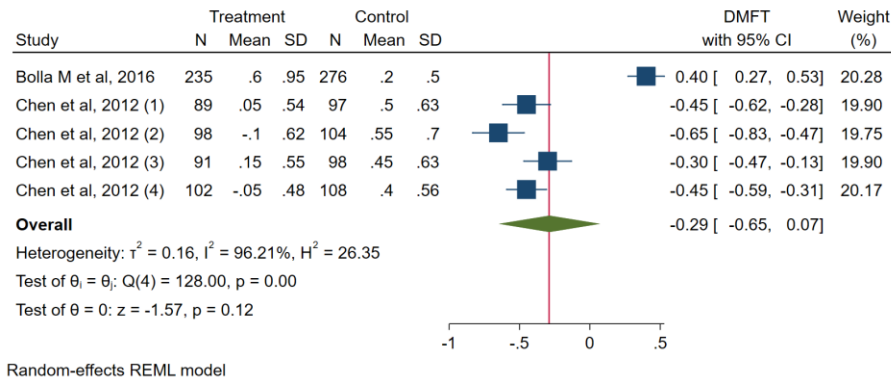
| Intervention | Outcomes | N (studies, Control, Intervention) | Mean difference (95%CI) | P-value | I <sup>2</sup> % |
|--------------|----------|------------------------------------|-------------------------|---------|------------------|
| FV           | DMFT     | 5, 1179, 1223                      | -0.55(-1.28 to .17)     | 0.001   | 99.08            |
| FS           | DMFT     | 5, 615, 683                        | -0.29(-.65 to 0.07)     | 0.001   | 96.21            |
| FS           | dmft     | 4, 615, 683                        | -6.66 (-6.91 to -6.42)  | 0.001   | 99.18            |

The results of meta-analysis showed that the difference between the mean DMFT between the two groups of intervention and comparison for FV (-0.55, Q=554, df=4 P=0.00, I<sup>2</sup>=99.08), the difference between the mean DMFT for FS (-0.29, Q=128, df = 4, P=0.00, I<sup>2</sup> =96.21) as well as the mean difference between the dmft for FS

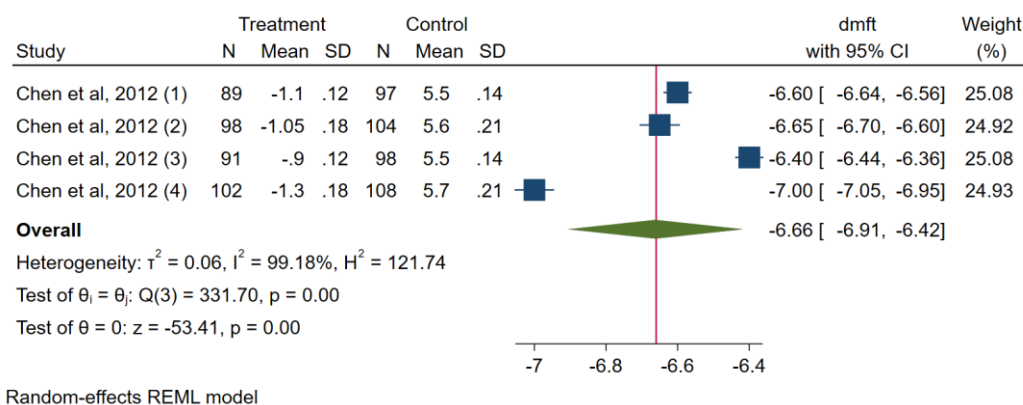
(-6.66, Q=331, df=4, P=0.00, I<sup>2</sup> =99.18). In all three indicators, the intervention has shown a significant effect. FV intervention reduced the DMFT index by 0.55 and FS intervention reduced the DMFT index by 0.29. FS intervention also reduced the dmft index to 6.66. (Fig. 2-4).



**Fig. 2:** Mean difference of DMFT index between intervention group and post-intervention comparison of fluoride varnish in children based on random model with 95% confidence factor



**Fig. 3:** Mean difference of DMFT index between intervention group and comparison after fissure sealant intervention in children based on random model with 95% confidence factor



**Fig. 4:** Mean difference of dmft index between intervention group and comparison after fissure sealant intervention in children based on random model with 95% confidence factor

### Characteristics of Studies

Among remaining studies, five articles examined the effects of fluoride varnish and five articles focused on cases of fissure sealants aimed at examining caries indexes (DMFT, DMFS, DMFS, dmfs).

### The effects of interventions

#### Effects of fluoride varnish

The level of evidence is according to the studies attached. Fluoride varnish is an effective therapeutic approach to prevent further progression of enamel lesions and is a safe, accepted and appropriate intervention for patients. Varnish was used every three months for a period of seven months (28). In the second study, after regular use of fluoride (three sessions per week) and after 12 months of follow-up, significant changes in caries were observed in the age group of 6 to 7 years (29).

In a similar vein, over a 4-year program (annual follow-up), the fluoride varnish program could be an effective public health measure for children 6 to 12 yr of age with high caries prevalence. DMFT declines were observed in all age groups and school years (43).

Fluoride gel did not show a statistically significant effect on the mean DMFS score in individuals with low caries levels in the 9.5 to 11.5 yr old group (44). In another study, using the described program could not prevent pits in children at risk

of decay (45). With the increasing age of the subjects, the average values of caries indices increase in control and intervention groups. Therefore, it is better for this intervention to start from younger age groups and continue regularly.

#### Effects of Sealants

A school-based dental sealant program can effectively reduce more than 60% of caries lesions in the first permanent molars over three years (annual follow-up) among vulnerable children (HR = 0.33, 95% CI: 0.24–0.46) (39). In a subsequent study, after two years of dental caries intervention (according to dental caries indices such as dmft and DMFT) in glass carbomer is more than other groups. There was also no significant difference in the cumulative survival of the sealants in the presence of energy ( $P=0.13$ ) (40).

Follow-up surveys conducted during the first, second, and third years indicated that ART-GIS could be used as a preventive approach in rural or suburban areas, which other preventive approaches are not available or economical. Caries incidence was lower in the intervention group than in the control group ( $P<0.001$ )(34).

A study aimed at investigating the efficacy of sealants in adolescents with high and low caries experiences, showing that sealants are effective on the occlusal surface of teeth with low and medium caries. However, in adolescents with high levels of decay, other measures are needed (46).



During a three-stage (annual) follow-up, the results of the use of sealants showed that fissure sealant intervention is an effective public program in the prevention of caries ( $P=0.001$ )(47). Since according to the indicators, all 5 studies (in 24- and 36-month follow-up intervals) were reported to be effective. It is best to check the sealants on the teeth at regular intervals (for example, every six months) to keep the sealants on the teeth and retain the ability to prevent caries for a long time.

## Discussion

This study is a comprehensive systematic study to evaluate the effectiveness of fluoride varnish and fissure sealant in children aged 6-12 years. In the present systematic study, we investigated the efficacy of two fluoride varnishes and fissure sealants using caries indices (DMFT, DMFS, dmft and dmfs). In the survey of 14,714 articles found from databases and other sources, ten articles were ultimately included. Among these, six were reviewed in a meta-analysis. Interventions and follow-up intervals ranged from seven to 48 months. In total, they were conducted in seven different countries. Sixteen indicators were reported, of which 15 cases were effective. In the study of the overall effectiveness of the studies, 9 effective studies and 1 ineffective study were determined. The aim was to design a study with the highest quality and based on available scientific documentation to achieve valid results.

The meta-analysis included studies with identical follow-up courses that had similar interventions. The researchers of the current study included follow-up periods ranging from six months to one year in the CMA data entry. The reason for the failure of meta-analysis for the DMFS index was due to dissimilarity of the follow-up periods of different studies. In the remaining articles, the dmfs index was not available for reporting. From six studies reported by DMFT because of fluoride varnish intervention at different follow-up periods, three were reported in meta-analyses at 1 and 3-year follow-up periods. In expressing the

results related to the dmft index that were meta-analytically included in the 2-year follow-up periods, the results of the sealant materials intervention were also reported in two studies and as a result of different interventions.

Use of fluoride varnishes against non-use of these substances Based on DMFT and DMFS indices, during 7-48 months follow-up according to the results of four studies out of five (80,988 participants), showed effectiveness. Moreover, dmft in the follow-up periods of 12 and 36 months were -.70,-0.35, and -0.55 units of change, respectively in the control groups.

Use of sealants during the 24-36 months follow-up period in five separate interventions (615 intervention participants) versus no use of these materials showed a higher incidence of decay compared to participants who did not receive the sealants. Concerning DMFT and dmft index in the 24-month follow-up period, they were -0.29 and -6.66 units, respectively.

The results of a study confirm the use of this type of intervention (48). Findings of another study recommended the implementation of dental health promotion programs in schools (49).

Briefly, interventions to improve dental caries in children aged 6-12 yr were effective in both intervention groups, and this finding was consistent with the DMFT index of meta-analysis in both intervention models.

Many studies on the efficacy of fissure sealants and fluoride therapies were conducted to evaluate sealant retention rates and caries rates, and some studies have investigated the effect of both, using a dental caries index (DMFT, DMFS, dmft and dmfs) approach investigations indicate failure to establish intervention and control groups in periodic surveys of the consequences of interventions as caries indices (39, 40) as well as failure to report general caries indices of all study participants (35) and failure to maintain sealant materials in different ways (Complete, partial or complete disappearance of sealants) (32, 36, 41, 42). The results of the present study confirm the general findings of related research in confirming the effectiveness of both types of interventions (FV and FS) (50, 51). It shows the effectiveness of

these materials in preventing the occurrence of dental caries and the need for its implementation in this age group.

## Conclusion

The use of interventional methods is effective in the prevention of dental caries in children aged 6-12 yr and the use of these types of interventions is an appropriate approach in the prevention of dental caries. Therefore, health policymakers and planners initiate interventions designed to reduce dental caries. In addition, they would rather prioritize this type of intervention in countries' health system programs and interventions.

## Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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## Conflict of interest

The authors declare that they have no conflict of interest.

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