JAMA | US Preventive Services Task Force | EVIDENCE REPORT

Screening and Interventions to Prevent Dental Caries in Children Younger Than 5 Years

Updated Evidence Report and Systematic Review for the US Preventive Services Task Force

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IMPORTANCE A 2014 review for the US Preventive Services Task Force (USPSTF) found that oral fluoride supplementation and topical fluoride use were associated with reduced caries incidence in children younger than 5 years.

OBJECTIVE To update the 2014 review on dental caries screening and preventive interventions to inform the USPSTF.

DATA SOURCES Ovid MEDLINE, the Cochrane Central Register of Controlled Trials, and the Cochrane Database of Systematic Reviews (to September 2020); surveillance through July 23, 2021.

STUDY SELECTION Randomized clinical trials (RCTs) on screening, preventive interventions, referral to dental care; cohort studies on screening and referral; studies on diagnostic accuracy of primary care oral examination or risk assessment; and a systematic review on risk of fluorosis included in prior USPSTF reviews.

DATA EXTRACTION AND SYNTHESIS One investigator abstracted data; a second checked accuracy. Two investigators independently rated study quality.

RESULTS Thirty-two studies (19 trials, 9 observational studies, and 4 nonrandomized clinical intervention studies [total 106 694 participants] and 1 systematic review [19 studies]) were included. No study evaluated effects of primary care screening on clinical outcomes. One study (n = 258) found primary care pediatrician examination associated with a sensitivity of 0.76 (95% CI, 0.55 to 0.91) and specificity of 0.95 (95% CI, 0.92 to 0.98) for identifying a child with cavities, and 1 study found a risk assessment tool associated with sensitivity of 0.53 and specificity of 0.77 (n = 697, CIs not reported) for a child with future caries. No new trials of dietary fluoride supplementation were identified. For prevention, topical fluoride compared with placebo or no topical fluoride was associated with decreased caries burden (13 trials, n = 5733; mean caries increment [difference in decayed, missing, and filled teeth or surfaces], −0.94 [95% CI, −1.74 to −0.34]) and likelihood of incident caries (12 trials, n = 8177; RR, 0.80 [95% CI, 0.66 to 0.95]; absolute risk difference, −7%) in higher-risk populations or settings, with no increased fluorosis risk. Evidence on other preventive interventions was limited (education, xylitol) or unavailable (silver diamine fluoride), and no study directly evaluated primary care dentistry referral vs no referral.

CONCLUSIONS AND RELEVANCE There was no direct evidence on benefits and harms of primary care oral health screening or referral to dentist. Dietary fluoride supplementation and fluoride varnish were associated with improved caries outcomes in higher-risk children and settings.

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Dental caries is a common chronic disease that can cause pain and diminish function and quality of life.[1] Dental caries is the most common chronic disease of children in the US and disproportionately affects vulnerable and underserved children.[1,2] Children who lack access to a dentist often have encounters with a primary care clinician. Therefore, provision of oral care in primary care settings may improve access and facilitate provision of treatments to prevent or treat caries and improve outcomes.[3-5]

In 2014, the US Preventive Services Task Force (USPSTF) recommended that primary care clinicians prescribe oral fluoride supplementation starting at age 6 months for children whose water supply is deficient in fluoride and apply fluoride varnish starting at the age of primary tooth eruption for all children (B recommendations).[6] The USPSTF found insufficient evidence to assess the benefits and harms of dental caries screening by primary care clinicians in children younger than 5 years (I statement). This evidence report was conducted to update the 2014 USPSTF review on dental caries screening and preventive interventions in children younger than 5 years,[7,8] to inform the USPSTF for an updated recommendation statement.

Methods

Scope of Review

Detailed methods and study details are available in the full evidence report.[9] **Figure 1** (screening) and **Figure 2** (preventive interventions) show the analytic frameworks and key questions (KQs) that guided the review. Separate analytic frameworks were used to distinguish treatment of children with existing caries (screening) from treatment of children without caries (preventive interventions).

Data Sources and Searches

Ovid MEDLINE, the Cochrane Central Register of Controlled Trials, and the Cochrane Database of Systematic Reviews were searched from 2013 through September 2020 (see the Supplement for search strategies). Searches were supplemented by reference list review of relevant systematic reviews; studies from the prior USPSTF review[7,8] that met inclusion criteria were carried forward. Ongoing surveillance was conducted to identify major studies published since September 2020 that may affect the conclusions or understanding of the evidence and the related USPSTF recommendation. The last surveillance was conducted on July 23, 2021, and identified no studies affecting review conclusions.

Study Selection

Two investigators independently reviewed titles, abstracts, and full-text articles using predefined eligibility criteria. The population was children younger than 5 years. Screening and diagnostic accuracy studies conducted in primary care settings were eligible. Eligible preventive interventions were primary care feasible (not requiring extensive dental training): parental or caregiver education, referral to a dentist, dietary fluoride supplementation, topical fluoride application (varnish, foam, or gel), xylitol, and silver diamine fluoride. Comparisons were against placebo or no intervention. Outcomes were dental caries (incidence or caries burden, measured based on the number of decayed, missing, or filled teeth [dmft] or decayed, missing, or filled surfaces), morbidity, quality of life, and harms (including fluorosis).

Data Extraction and Quality Assessment

One investigator abstracted details about the study design, patient population, setting, interventions, analysis, follow-up, and results from each study. A second investigator reviewed abstracted data for accuracy. Two independent investigators assessed the quality of each study as good, fair, or poor using predefined criteria developed by the USPSTF (see the Supplement for quality rating criteria).[10] Discrepancies were resolved through consensus. In accordance with the USPSTF Procedure Manual,[10] studies rated poor quality owing to critical methodological limitations were excluded.

Data Synthesis and Analysis

For all KQs, the overall quality of evidence was rated "good," "fair," or "poor" based on study limitations, consistency, precision, reporting bias, and applicability, using the approach described in the USPSTF Procedure Manual.[10]

Meta-analysis was conducted only for topical fluoride, because of small numbers of trials of other preventive interventions with clinical and methodological heterogeneity. For topical fluoride, random-effects meta-analysis was performed to summarize the likelihood of incident caries or caries increment (difference in mean caries burden) vs placebo or no topical fluoride using a profile likelihood model in Stata/SE 16.1 (StataCorp). Statistical heterogeneity was assessed using the I^2 statistic.[11] Analyses were stratified by community fluoridation status (adequate [≥0.7 parts fluoride per million parts water {ppm F} vs nonadequate) and topical fluoride type (varnish vs foam or gel). Additional subgroup analyses were conducted on use of cluster randomization, follow-up duration, varnish frequency, use of additional oral health measures, very high Human Development Index (HDI) setting (based on a United Nations Development Programme HDI score of 0.800 or higher for the country or geographic setting),[12] conducted in preschool or daycare setting, conducted in high-risk population, and inclusion of children with caries at baseline. A random-effects meta-regression model was used to test subgroup differences. All significance testing was 2-tailed; *P* values of .05 or less were considered statistically significant.

Results

Across all KQs, 32 studies (reported in 35 publications, total 106 694 participants)[13-48] and 1 systematic review (19 studies)[49] were included (**Figure 3**). Seventeen studies[15,16,18-22,34-45,48] were new for this update and 16 studies (including the systematic review)[13,14,17,23-33,46,47,49] were carried forward from the previous USPSTF review.

Screening

Benefits of Screening

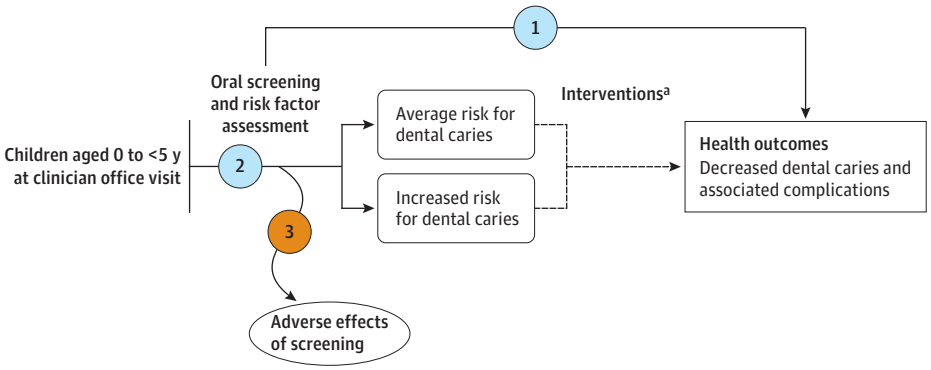
Key Question 1. How effective is oral screening (including risk assessment) performed by a primary care clinician in preventing dental caries in children younger than 5 years?

No study met inclusion criteria for this KQ.

Accuracy of Screening

Key Question 2a. How accurate is screening performed by a primary care clinician in identifying children younger than 5 years who have cavitated or noncavitated caries lesions?

Figure 1. Analytic Framework: Screening for Dental Caries in Children Younger Than 5 Years



Key questions

1 How effective is oral screening (including risk assessment) performed by a primary care clinician in preventing dental caries in children younger than 5 years?

2 How accurate is screening performed by a primary care clinician in identifying children younger than 5 years who
a. Have cavitated or noncavitated caries lesions?
b. Are at increased risk for future dental caries?

3 What are the harms of oral health screening performed by a primary care clinician in children younger than 5 years?

Evidence reviews for the US Preventive Services Task Force (USPSTF) use an analytic framework to visually display the key questions that the review will address to allow the USPSTF to evaluate the effectiveness and safety of a preventive service. The questions are depicted by linkages that relate interventions and outcomes. A dashed line indicates a health outcome that immediately follows an intermediate outcome. For additional information see the USPSTF Procedure Manual.[10]

[a] Interventions are provided to children found to have caries on screening.

No new study met inclusion criteria for this KQ. Two studies in the prior USPSTF review compared a pediatrician vs pediatric dentist oral examination (eTables 1 and 2 in the Supplement). One good-quality study of children younger than 36 months (n = 258) reported a sensitivity of 0.76 (95% CI, 0.55 to 0.91) and specificity of 0.95 (95% CI, 0.92 to 0.98) for identifying a child with 1 or more cavities and a sensitivity of 0.49 (95% CI, 0.37 to 0.60) and specificity of 0.99 (95% CI, 0.99 to 0.99) for identifying a tooth with a cavity.[13] A fair-quality study of children aged 18 to 36 months reported a sensitivity of 1.0 and specificity of 0.87 for identifying nursing caries (n = 61, CIs not reported).[14]

Key Question 2b. How accurate is screening performed by a primary care clinician in identifying children younger than 5 years who are at increased risk for future dental caries?

One new fair-quality study (n = 1681) found a caries risk assessment tool administered by health visitor nurses in children aged 1 year associated with sensitivity of 0.53 and specificity of 0.77 (n = 697, CIs not reported) for predicting any $d_3$mft lesion (d_3 indicates dentin caries lesion) at age 4 years and sensitivity of 0.65 and specificity of 0.69 (n = 784, CIs not reported) for predicting presence of 3 or more $d_3$mft lesions (eTables 2 and 3 in the Supplement).[15]

Harms of Screening

Key Question 3. What are the harms of oral health screening performed by a primary care clinician in children younger than 5 years?

No study met inclusion criteria for this KQ.

Preventive Interventions

Accuracy of Screening

Key Question 1. How accurate is screening performed by a primary care clinician in identifying children younger than 5 years who are at increased risk of future dental caries?

See KQ2b for screening, which addresses the same question.

Benefits of Intervention

Key Question 2. How effective is parental or caregiver/guardian oral health education provided by a primary care clinician in preventing dental caries in children younger than 5 years?

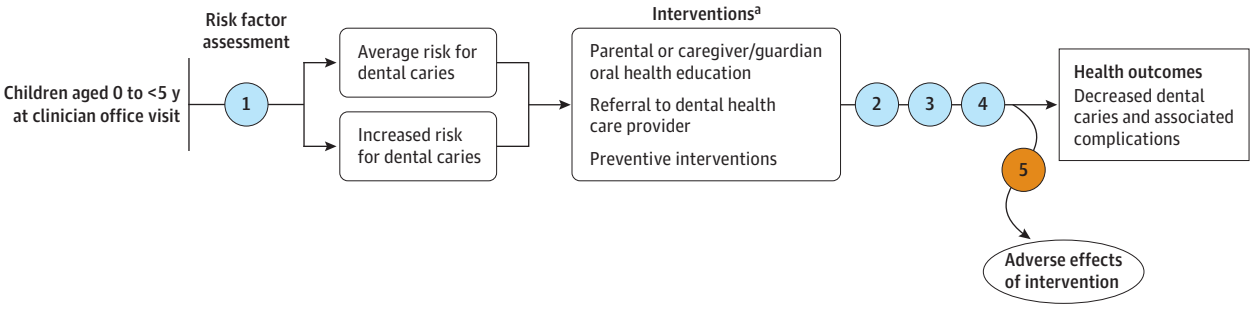
One new fair-quality trial (n = 104) found oral health education for mothers of caries-free children aged 12 to 36 months was associated with reduced risk of incident dental caries at 6 months vs usual care (13.5% vs 34.7%; relative risk [RR], 0.39 [95% CI, 0.18 to 0.85) (eTables 4 and 5 in the Supplement).[16]

Key Question 3. How effective is referral by a primary care clinician to a dental health care professional in preventing dental caries in children younger than 5 years?

No study directly evaluated the effects of referral by a primary care clinician to a dental care professional on caries incidence. Although 6 observational studies (n = 92 476) (1 included in the prior USPSTF review[17] and 5 new[18-22]) of children enrolled in Medicaid compared receiving a preventive dental visit from a dentist vs primary care clinician or earlier vs later first preventive dental visit, the studies were not designed to determine the referral source or effects of dental referral from primary care vs no referral (eTables 6 and 7 in the Supplement). In addition, results in some studies indicating an association between a dentist or earlier preventive visit and increased likelihood of subsequent caries-related treatment or caries burden are susceptible to confounding by indication related to the need for dental services.

Key Question 4. How effective are preventive interventions (dietary fluoride supplementation, topical fluoride application, silver diamine fluoride, or xylitol) in preventing dental caries in children younger than 5 years?

Figure 2. Analytic Framework: Interventions to Prevent Dental Caries in Children Younger Than 5 Years



Key questions

1. How accurate is screening performed by a primary care clinician in identifying children younger than 5 years who are at increased risk of future dental caries?[b]
2. How effective is parental or caregiver/guardian oral health education provided by a primary care clinician in preventing dental caries in children younger than 5 years?
3. How effective is referral by a primary care clinician to a dental health care professional in preventing dental caries in children younger than 5 years?
4. How effective are preventive interventions (dietary fluoride supplementation, topical fluoride application, silver diamine fluoride, or xylitol) in preventing dental caries in children younger than 5 years?
5. What are the harms of specific oral health interventions to prevent dental caries in children younger than 5 years (parental or caregiver/guardian oral health education, referral to a dental health care professional, and preventive interventions)?

Evidence reviews for the US Preventive Services Task Force (USPSTF) use an analytic framework to visually display the key questions that the review will address to allow the USPSTF to evaluate the effectiveness and safety of a preventive service. The questions are depicted by linkages that relate interventions and outcomes. For additional information see the USPSTF Procedure Manual.[10]

[a] Interventions are provided to children without caries.

[b] This is the same question as screening key question 2b.

Dietary Fluoride Supplementation

We identified no new trials published since the 2004 or 2014 USPSTF reviews.[8,50] One randomized trial of Taiwanese 2-year old children with cleft lip (n = 140, fluoridation <0.1 ppm F) found 0.25-mg fluoride drops or chews associated with significantly decreased caries increment vs no supplementation (mean dmft reduction, 72% [*P* = .001] and 52% [*P* = .01], respectively).[23] Four nonrandomized controlled intervention studies (n = 2273) included in the prior USPSTF review[8] also found dietary fluoride supplementation in settings with water fluoridation levels below 0.6 ppm F associated with decreased caries incidence vs no fluoride supplementation (mean dmft reduction, 32% to 69%).[24-28]

Topical Fluoride Application

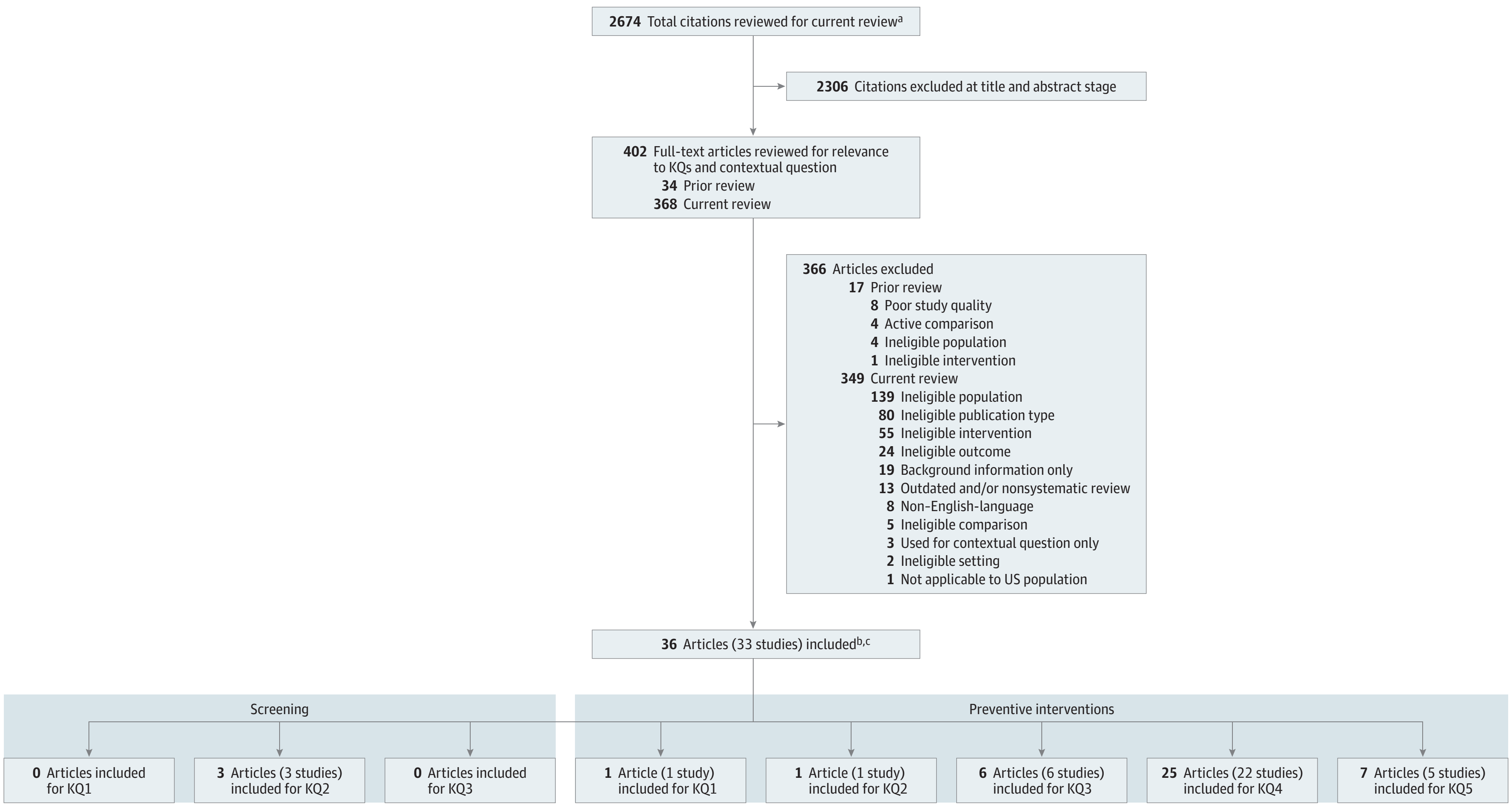
Fifteen trials (5 trials[29-33] in the prior USPSTF review and 10 new trials[34-45]) evaluated topical fluoride (eTables 8 and 9 in the Supplement). Sample sizes ranged from 123 to 2536 (total 9541 participants). Two trials[33,44,45] (n = 1376) were conducted in communities with adequate drinking water fluoridation, defined as 0.7 ppm F or greater. The mean age of enrolled children was 1 year to younger than 2 years in 6 trials and 2 to 5 years in 9 trials (1 trial[31] did not report mean age). Five trials[30,34,38,39,42] were conducted in preschool or daycare settings and the others were conducted in clinics. Eight trials (including 6 of the new trials) were conducted in very high HDI countries or settings. All trials except for 1[44,45] evaluated children classified as being at higher risk, based on low socioeconomic status, high community prevalence of caries, high baseline caries burden, or low rates of oral health behaviors.

One trial[38] evaluated acidulated phosphate fluoride foam and the others evaluated fluoride varnish. Fluoride varnish was most commonly administered as 5% sodium fluoride every 6 months. Topical fluoride was administered by a dental health professional in all trials in which this information was reported. In all trials except for 3,[29,30,38] oral health education was provided in addition to the randomized intervention. The duration of follow-up ranged from 1 to 3 years.

Three trials were rated good quality[37,39,43] and the rest fair quality (eTable 5 in the Supplement). Methodological limitations in the fair-quality trials included unclear randomization or allocation concealment methods, open-label design, or high attrition.

Topical fluoride was associated with significant decreased caries increment (13 trials, n = 5733; mean difference, −0.94 [95% CI, −1.74 to −0.34]; I^2 = 86%) (**Figure 4**) and decreased likelihood of incident caries (12 trials, n = 8177; RR, 0.80 [95% CI, 0.66 to 0.95]; I^2 = 79%; absolute risk difference, −7% [95% CI, −12% to −2%]) (**Figure 5**) vs placebo or no varnish, with a number needed to treat to prevent 1 child with incident caries of 14 (95% CI, 8 to 50). Although statistical heterogeneity was present, results consistently favored topical fluoride in analyses stratified by use of cluster design, very high HDI setting, application frequency, preschool, baseline caries status, adequate community fluoridation, provision of additional oral health measures, risk of bias, or duration of follow-up, and

Figure 3. Literature Search Flow Diagram: Screening for Dental Caries in Children Younger Than 5 Years



KQ indicates key question.

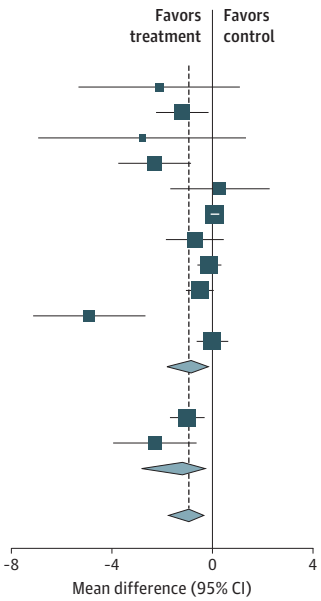
[a] Identified from reference lists, hand searching, suggested by experts, etc.

[b] Studies that provided data and contributed to the body of evidence were considered included.

[c] Studies may have contributed data for more than 1 KQ.

Figure 4. Pooled Analysis of Topical Fluoride vs Placebo or No Topical Fluoride on Mean Change in Number of Caries at Follow-up, by Fluoridation Status

Source	Mean age, y	Follow-up duration, y	Baseline caries	Continuous caries measure[a]	Treatment No.	Treatment Mean (SD)	Control No.	Control Mean (SD)	Mean difference (95% CI)
No adequate fluoridation									
Frostell et al,[29] 1991	4	2	Mean $dmfs_1$: 4.79	$dmfs_1$	93	6.6 (11.2)	113	8.7 (12.3)	-2.12 (-5.33 to 1.09)
Jiang et al,[30] 2005[b]	3.5	2	Mean dmft 1.6-1.7	dmfs	167	3.8 (0.9)	151	5.0 (1.0)	-1.20 (-2.24 to -0.16)
Lawrence et al,[31] 2008[b]	0.5-5	2	dmft >0: 72%	dmfs	832	11.0 (14.4)	328	13.5 (16.3)	-2.80 (-6.94 to 1.34)
Slade et al,[32] 2011[b]	2.8	2	≥1 Carious surface	dm_3fs	344	7.3 (10.4)	322	9.6 (10.1)	-2.30 (-3.75 to -0.85)
Agouropoulos et al,[34] 2014	3.4	2	dmfs1 >0: 38%	dmfs	175	5.8 (9.5)	154	5.5 (8.8)	0.30 (-1.68 to 2.28)
Jiang et al,[37] 2014	1.3	2	Mean dmft: 0.03	Cavitated dmft	137	0.2 (0.9)	144	0.1 (0.5)	0.10 (-0.07 to 0.27)
Oliveira et al,[43] 2014	2.4	2	Dentine caries: 24%	d_3mfs	89	1.8 (3.9)	92	2.5 (4.0)	-0.70 (-1.85 to 0.45)
Memarpour et al,[41] 2015	1.8	1	0	dmft	29	0.3 (0.9)	31	0.4 (1.0)	-0.12 (-0.60 to 0.36)
Muñoz-Millán et al,[42] 2018	2.7	2	0	dmft	131	1.6 (2.0)	144	2.1 (2.6)	-0.50 (-1.05 to 0.05)
Latifi-Xhemajli et al,[38] 2019	1.8	2	Mean dmfs: 1	dmfs	218	5.2 (10.5)	209	10.1 (12.9)	-4.90 (-7.14 to -2.66)
McMahon et al,[39] 2020	3.5	2	Caries: 17%	d_3mfs	577	3.5 (5.9)	573	3.5 (4.9)	0.00 (-0.63 to 0.63)
Subgroup: $I^2 = 87.2\%$; $P < .001$									-0.85 (-1.81 to -0.16)
Adequate fluoridation									
Weintraub et al,[33] 2006	1.8	2	0	$d_{2+}mfs$	187	0.7 (1.9)	93	1.7 (3.1)	-1.00 (-1.69 to -0.31)
Tickle et al,[45] 2017[b]	3.1	3	0	d_3mfs	187	7.2 (8.0)	213	9.6 (8.8)	-2.29 (-3.95 to -0.63)
Subgroup: $I^2 = 0.0\%$; $P = .16$ Heterogeneity between groups: $P = .54$									-1.19 (-2.81 to -0.29)
Overall: $I^2 = 85.7\%$; $P < .001$									-0.94 (-1.74 to -0.34)



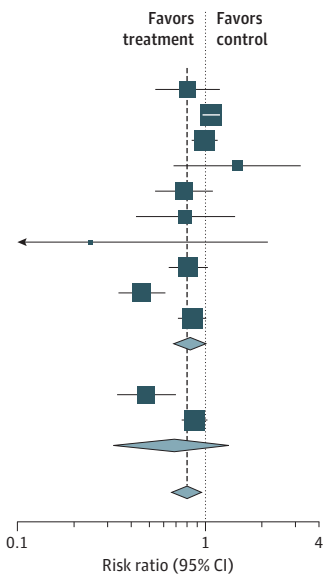
The size of the data markers indicates the weight of each study in the analysis. dmfs indicates decayed, missing, or filled surfaces; dmft, decayed, missing, or filled teeth.

[a] Subscripts indicate the extent of the caries lesion (eg, d_1 indicates noncavitated enamel lesion; d_2, cavitated enamel lesion; d_3, dentin lesion; d_4, lesion extending into pulp).

[b] Study adjusted for clustering design or other confounding variables.

Figure 5. Pooled Analysis of Topical Fluoride vs Placebo or No Topical Fluoride on Caries Development at Follow-up, by Fluoridation Status

Source	Mean age, y	Follow-up duration, y	Baseline caries	Outcome definition[a]	Treatment No.	Treatment Mean (SD)	Control No.	Control Mean (SD)	Risk ratio (95% CI)
No adequate fluoridation									
Jiang et al,[30] 2005[b]	3.5	2	Mean dmft 1.6-1.7	dmfs increase ≥6	47	167	53	151	0.80 (0.54 to 1.19)
Lawrence et al,[31] 2008[b]	0.5-5	2	dmft >0: 72%	New dmfs ≥1	595	832	247	328	1.07 (0.96 to 1.19)
Agouropoulos et al,[34] 2014	3.4	2	dmfs >0: 38%	dmfs >0	113	174	101	154	0.99 (0.85 to 1.16)
Jiang et al,[37] 2014	1.3	2	Mean dmft: 0.03	Incident caries	14	137	10	144	1.47 (0.68 to 3.20)
Oliveira et al,[43] 2014	2.4	2	Dentine caries: 24%	New caries lesion	32	89	43	92	0.77 (0.54 to 1.09)
Anderson et al,[36] 2016[b]	1	3	ICDAS 5-6: 0.2%	ICDAS 5 to 6	75	1231	99	1305	0.78 (0.43 to 1.44)
Memarpour et al,[40] 2016	1.7	1	0	dmft >0	1	87	4	85	0.24 (0.03 to 2.14)
Muñoz-Millán et al,[42] 2018	2.7	2	0	Cavitated caries	59	131	80	144	0.81 (0.64 to 1.03)
Latifi-Xhemajli et al,[38] 2019	1.8	2	Mean dmfs: 1.1	ICDAS 5 or 6	48	218	100	209	0.46 (0.34 to 0.61)
McMahon et al,[39] 2020	3.5	2	Caries: 17%	$d_3$mfs increment >0	165	577	193	573	0.85 (0.71 to 1.01)
Subgroup: I^2 = 75.4%; P <.001									0.83 (0.68 to 1.00)
Adequate fluoridation									
Weintraub et al,[33] 2006	1.8	2	0	Incident caries	37	163	42	90	0.49 (0.34 to 0.70)
Tickle et al,[45] 2017	3.1	3	0	Became caries active	187	549	213	547	0.87 (0.75 to 1.02)
Subgroup: I^2 = 76.2%; P = .003 Heterogeneity between groups: P = .43									0.68 (0.33 to 1.33)
Overall: I^2 = 79.3%; P <.001									0.80 (0.66 to 0.95)



The size of the data markers indicates the weight of each study in the analysis. dmfs indicates decayed, missing, or filled surfaces; dmft, decayed, missing, or filled teeth; ICDAS, International Caries Detection and Assessment System.

[a] Subscripts indicate the extent of the caries lesion (eg, d_1 indicates noncavitated enamel lesion; d_2, cavitated enamel lesion; d_3, dentin lesion; d_4, lesion extending into pulp).

[b] Study adjusted for clustering design or other confounding variables.

Table 1. Pooled Analyses of Mean Change in Number of Caries at Follow-up, Topical Fluoride vs Placebo or No Topical Fluoride

	No. of trials	Mean difference (95% CI)	I^2, %	*P* value for interaction
All studies	13[29-34,37-39,41-43,45]	−0.94 (−1.74 to −0.34)	86	
Fluoride type				
Sodium fluoride (5%) varnish	10[29,31-33,37,39,41-43,45]	−0.62 (−1.35 to −0.16)	75	.57
Other varnish	2[34,38]	−2.24 (−8.56 to 3.98)	83	
Foam	1[30]	−1.20 (−2.24 to −0.16)	NA	
Study quality				
Good	3[37,39,43]	0.08 (−0.28 to 0.27)	0	.13
Fair	10[29-34,38,41,42,45]	−1.33 (−2.36 to −0.54)	78	
Fluoridation status				
Adequate	2[33,45]	−1.19 (−2.81 to −0.29)	0	.54
Not adequate	11[29-32,34,37-39,41-43]	−0.85 (−1.81 to −0.16)	87	
Cluster enrollment				
Yes	3[30-32]	−1.63 (−3.04 to −0.64)	0	.27
No	10[29,33,34,37-39,41-43,45]	−0.72 (−1.66 to −0.09)	86	
Setting				
Preschool	5[30,34,38,39,42]	−1.04 (−2.90 to 0.57)	88	.94
Other	8[29,31-33,37,41,43,45]	−0.89 (−1.86 to −0.21)	80	
Mean age, y				
<2	4[33,37,38,41]	−1.26 (−3.24 to 0.74)	98	.93
≥2	9[29-32,34,39,42,43,45]	−0.89 (−1.70 to −0.30)	50	
High risk of caries				
Yes	12[29-34,37-39,41-43]	−0.81 (−1.64 to −0.24)	84	.34
No	1[45]	−2.29 (−3.95 to −0.63)	NA	
Caries-free at baseline				
Yes	5[33,37,41,42,45]	−0.43 (−1.24 to 0.06)	74	.33
No	8[29-32,34,38,39,43]	−1.40 (−2.74 to −0.29)	74	
High Human Development Index rating				
Yes	7[29,33,34,37,39,42,45]	−0.43 (−1.16 to 0.06)	64	.22
No	6[30-32,38,41,43]	−1.62 (−3.26 to −0.33)	81	
Additional oral health measures used				
Yes	10[31-34,37,39,41-43,45]	−0.53 (−1.18 to −0.10)	71	.07
No	3[29,30,38]	−2.57 (−5.45 to 0.03)	62	
Duration of follow-up, y				
1	2[34,41]	−0.09 (−0.73 to 0.71)	0	.35
2	11[29-34,37-39,42,43]	−0.95 (−1.87 to −0.28)	84	
3	1[45]	−2.29 (−3.95 to −0.63)	NA	
Application frequency				
Every 3 mo	1[38]	−4.90 (−7.14 to −2.66)	NA	.06
Every 4 mo	1[41]	−0.12 (−0.60 to 0.36)	NA	
Every 6 mo	11[29-34,37,39,42,43,45]	−0.73 (−1.40 to −0.24)	70	
Every 12 mo	1[33]	−1.00 (−1.72 to −0.28)	NA	

Abbreviation: NA, not applicable.

there were no statistically significant interactions on these factors and caries outcomes (**Table 1** and **Table 2**). Results were also similar when the trial of fluoride foam or the trial conducted in a non–high-risk population was excluded from the analysis. There was a significant interaction between age and effects of fluoride varnish on likelihood of incident caries but not caries increment. In trials in which the mean age was younger than 2 years, fluoride varnish was associated with significant decreased likelihood of incident caries (5 trials, n = 3669; RR, 0.60 [95% CI, 0.39 to 1.03]; I^2 = 49%),[33,36-38,40] with no significant difference in trials in which the mean age was 2 years or older (7 trials, n = 4508; RR, 0.92 [95% CI, 0.81 to 1.01]; I^2 = 42%; *P* = .008 for interaction).[30,31,34,39,42,43,45]

No trial evaluated effects of topical fluoride on quality of life, function, or other noncaries outcomes.

Xylitol

No new trials of xylitol vs no xylitol were identified. Two fair-quality trials (n = 115 and n = 44) included in the prior USPSTF review found

Table 2. Pooled Analyses of Risk of Caries Development at Follow-up, Topical Fluoride vs Placebo or No Topical Fluoride

	No. of trials	Relative risk (95% CI)	I^2, %	*P* value for interaction
All studies	12[30,31,33,34,36-40,42,43,45]	0.80 (0.66 to 0.95)	79	
Fluoride type				
Sodium fluoride (5%) varnish	11[31,33,34,36-40,42,43,45]	0.84 (0.69 to 0.99)	65	.79
Other varnish	2[34,38]	0.69 (0.27 to 1.71)	90	
Foam	1[30]	0.80 (0.54 to 1.19)	NA	
Quality				
Good	3[37,39,43]	0.85 (0.71 to 1.08)	0	.49
Fair	9[30,31,33,34,36,38,40,42,45]	0.77 (0.60 to 0.96)	84	
Fluoridation status				
Adequate	2[33,45]	0.68 (0.33 to 1.33)	76	.43
Not adequate	10[30,31,34,36-40,42,43]	0.83 (0.68 to 1.00)	75	
Cluster enrollment				
Yes	3[30,31,36]	1.04 (0.74 to 1.17)	0	.37
No	9[33,34,37-40,42,43,45]	0.76 (0.60 to 0.95)	78	
Setting				
Preschool	5[30,34,38,39]	0.77 (0.58 to 1.01)	83	.63
Other	7[31,33,36,37,40,42,43,45]	0.83 (0.61 to 1.08)	74	
Mean age, y				
<2	5[33,36-38,40]	0.60 (0.39 to 1.03)	49	.008
≥2	7[30,31,34,39,42,43,45]	0.92 (0.81 to 1.01)	42	
High risk of caries				
Yes	11[30,31,33,34,36-40,42,43]	0.79 (0.64 to 0.96)	80	.73
No	1[45]	0.87 (0.75 to 1.02)	NA	
Caries-free at baseline				
Yes	6[33,36,37,40,42,45]	0.77 (0.57 to 1.04)	48	.77
No	6[30,31,34,38,39,43]	0.82 (0.62 to 1.05)	86	
High Human Development Index rating				
Yes	7[33,34,36,37,39,42,45]	0.84 (0.69 to 1.00)	48	.57
No	5[30,31,38,40,43]	0.74 (0.47 to 1.07)	79	
Additional oral health measures used				
Yes	10[31,33,34,36,37,39,40,42,43,45]	0.86 (0.73 to 1.00)	64	.11
No	2[30,38]	0.59 (0.31 to 1.18)	59	
Duration of follow-up, y				
1	3[33,34,40]	0.71 (0.27 to 1.29)	58	.68
2	9[30,31,33,34,37-39,42,43]	0.79 (0.63 to 0.99)	84	
3	2[36,45]	0.87 (0.67 to 1.07)	0	
Application frequency				
Every 3 mo	1[38]	0.46 (0.35 to 0.61)	NA	.07
Every 6 mo	11[30,31,33,34,36,37,39,40,42,43,45]	0.88 (0.74 to 0.98)	52	
Every 12 mo	1[33]	0.60 (0.40 to 0.91)	NA	

Abbreviation: NA, not applicable.

xylitol tablets or wipes associated with decreased caries increment or likelihood or incident caries, but estimates were imprecise.[46,47]

Silver Diamine Fluoride

No study of silver diamine fluoride met inclusion criteria.

Harms of Intervention

Key Question 5. What are the harms of specific oral health interventions to prevent dental caries in children younger than 5 years (parental or caregiver/guardian oral health education, referral to a dental health care professional, and preventive interventions)?

The prior USPSTF review included a systematic review of 19 studies that found an association between early childhood fluoride supplementation and risk of fluorosis of the permanent dentition. Studies were observational and had methodological shortcomings, including use of recall to determine exposures.[49] In studies that recorded supplement use at the time of exposure, odds ratios for dental fluorosis ranged from 4.2 to 15.6. No new

Table 3. Summary of Evidence

Objective/intervention	Studies (No. of observations), study design	Summary of findings	Consistency and precision	Other limitations	Strength of evidence	Applicability
Screening KQ1 and KQ3: Effectiveness and harms of screening by PCP						
	No studies	NA	NA	NA	NA	NA
Screening KQ2a: Accuracy of screening by PCP						
Identifying caries lesion	2 (n = 368) diagnostic accuracy studies (both in prior USPSTF review)	Sensitivity of 0.76 and specificity of 0.95 for identifying a child with ≥1 cavities and sensitivity of 0.63 and specificity of 0.98 for identifying a child in need of a dental referral (1 study) Sensitivity of 1.0 and specificity of 0.87 for identifying nursing caries (1 study)	Unable to assess consistency due to differences between studies Precision low to moderate	Nursing caries study rated fair quality	Low	Primary care examiners underwent 2 or 4 h of training; both studies conducted in the US
Screening KQ2b: Accuracy of screening by PCP						
Predicting future caries	1 (n = 1681) diagnostic accuracy study (new)	Dundee Caries Risk Assessment Model associated with sensitivity of 0.53 and specificity of 0.77 for predicting future dentin caries in children aged 1 y	Unable to assess consistency (single study), precise	Fair quality; factors selected for model not predefined; no validation available	Low	Administered by health visitor nurses in Scotland
Prevention KQ1: Accuracy of screening by PCP[a]						
	See screening KQ2b	See screening KQ2b	See screening KQ2b	See screening KQ2b	See screening KQ2b	See screening KQ2b
Prevention KQ2: Educational interventions						
	1 (n = 104) RCT (new)	1 RCT found oral health education for mothers of caries-free children aged 12 to 36 mo associated with reduced risk of incident dental caries vs usual care at 6 mo (RR, 0.39 [95% CI, 0.18 to 0.85])	Unable to assess consistency (1 study), precise	Fair quality; dental health behaviors not reported at baseline or follow-up	Low	Conducted in Iran in region with inadequate fluoridation of drinking water
Prevention KQ3: Referral to a dentist by a PCP						
	6 (n = 92 476) observational studies; 1 study in prior review and 5 new	No study directly compared referral by primary care clinician to a dentist vs no referral Receiving a dental visit from a dentist associated with increased likelihood of subsequent caries-related treatment vs a dental visit from a primary care clinician (4 studies) Earlier vs later first preventive dental visit associated with no difference in rate of subsequent dental procedures, higher subsequent caries burden, and lower rates of untreated caries	Consistent, precise	Observational studies; fair quality; studies not designed to determine referral source or compare effects of referral vs no referral; findings susceptible to confounding by indication	Low	All studies conducted in US children enrolled in Medicaid; some overlap in study populations conducted within the same state

(continued)

Table 3. Summary of Evidence (continued)

Objective/intervention	Studies (No. of observations), study design	Summary of findings	Consistency and precision	Other limitations	Strength of evidence	Applicability
Prevention KQ4: Preventive interventions						
Dietary fluoride supplementation	1 (n = 140) RCT and 4 (n = 3172) nonrandomized controlled intervention studies (all in prior USPSTF review)	Dietary fluoride supplementation in settings with water fluoridation levels below 0.6 ppm F associated with decreased caries incidence vs no fluoridation (percentage reduction ranged from 48% to 72% for primary teeth and from 51% to 81% for primary tooth surfaces)	Consistent, precise	4 of 5 studies were nonrandomized	Moderate	2 Trials conducted in Asia; 1 trial conducted in children with cleft lip; 3 trials conducted between 1967 and 1972
Topical fluoride	15 (n = 9541) RCTs (5 in prior USPSTF review and 10 new)	Topical fluoride associated with decreased caries increment (13 trials; mean difference, −0.94 [95% CI, −1.74 to −0.34]) and decreased likelihood of incident caries (12 trials; RR, 0.80 [95% CI, 0.66 to 0.95]) vs placebo or no varnish	Inconsistent (high statistical heterogeneity), precise	11 Trials rated fair quality (2 rated good quality); open-label design in some trials	Moderate	Almost all trials conducted in higher-risk children or settings; almost all trials evaluated fluoride varnish; varnish applied by persons with dental training; some trials conducted in preschool or daycare setting; some trials conducted in non-very high Human Development Index settings; some trials included children with high baseline caries burden
Xylitol	2 (n = 159) RCTs (both in prior USPSTF review)	Estimates imprecise from 2 trials, but favored xylitol over placebo for caries outcomes	Consistent, imprecise	Trials rated fair quality	Low	Trials conducted in US and Sweden; 1 trial conducted in low socioeconomic status setting; xylitol administered as tablet or wipe
Silver diamine fluoride	No studies	NA	NA	NA	NA	NA
Prevention KQ5: Harms of interventions						
Dietary fluoride supplements	1 Systematic review of 19 observational studies (in prior USPSTF review)	Intake of fluoride supplements before age 7 y (primarily before age 3 y) associated with increased risk of mild to moderate fluorosis; odds ratio ranged from 1.1 to 10.8 in the studies that relied on retrospective recall and from 4.2 to 15.6 in the studies that recorded supplement use at the time of exposure	Consistent, precise	Observational studies; most studies relied on retrospective recall to determine fluoride exposure	Low-moderate	Studies conducted in a variety of settings and countries, variability in recommended levels of fluoride supplementation and water fluoridation levels
	4 (n = 4141) RCTs (all new)	No difference in risk of fluorosis or esthetically objectionable fluorosis (1 trial); no difference in risk of adverse events (1 trial); reports of disagreeable odor	Consistency cannot be determined (single trials reported different adverse events), precise	Harms not reported or suboptimal reporting in most trials	Low-moderate	See KQ4
Xylitol	No studies	RCTs of xylitol vs placebo or no xylitol did not report harms	NA	NA	NA	NA

Abbreviations: KQ, key question; NA, not applicable; PCP, primary care physician; ppm F, parts fluoride per million parts water; RCT, randomized clinical trial; RR, relative risk; USPSTF, US Preventive Services Task Force.

[a] Same question as screening KQ2b.

study evaluated the association between fluoride supplementation and risk of fluorosis.

Four new trials (n = 4141) reported no significant differences between fluoride varnish vs placebo or no varnish in risk of fluorosis or the likelihood of any adverse event.[34-36,44,45,48] Two studies (n = 2864) reported that children did not like the smell of the fluoride varnish, and 1 study reported that a few children vomited due to the smell, texture, or taste.[34-36]

Discussion

Table 3 summarizes the evidence reviewed for this update. As in the prior USPSTF review,[7,8] there remained no direct evidence on screening vs no screening for dental caries in children younger than 5 years. Evidence on the accuracy of primary care clinician examination in identifying caries lesions or predicting caries incidence in this population remained very limited, with no new studies. One new study found a novel caries risk assessment tool in 1-year-old children associated with suboptimal diagnostic accuracy for predicting future caries.[15] Although other caries risk assessment instruments are available, they did not meet inclusion criteria because they were not administered by primary care clinicians or in primary care settings. These instruments often incorporate findings from an oral examination by a dental health professional and include tests not commonly obtained or available in primary care.[51,52]

Evidence on the effectiveness of parental or caregiver oral health education also remains very limited. One new trial found oral health education for mothers of caries-free children associated with reduced risk of incident dental caries vs usual care, but the study was relatively small and conducted in Iran, potentially reducing applicability to the US.[16] No study directly evaluated effects of referral by a primary care clinician to a dentist. Observational studies that compared children enrolled in Medicaid who received a preventive dental visit from a dentist vs a pediatrician are available but difficult to interpret due to confounding related to need for dental services.[19-22] In addition, these studies did not evaluate referral source and did not compare dental referral vs no referral.

No new trial evaluated fluoride supplementation. Prior USPSTF reviews found dietary fluoride supplementation associated with reduced caries incidence in children younger than 5 years in settings primarily with water fluoridation levels less than 0.6 ppm F, largely based on nonrandomized controlled intervention studies.[53] There was also no new evidence on the association between early childhood intake of dietary fluoride supplementation and risk of enamel fluorosis. A systematic review included in the prior USPSTF review found an association between early childhood ingestion of systemic fluoride and enamel fluorosis of the permanent dentition.[49] Severe fluorosis remains uncommon in the US (prevalence <2%).[54]

Findings regarding topical fluoride are strengthened by the inclusion of 10 new trials. In addition to increasing the precision of estimates, 6 new trials were conducted in very high HDI settings (compared with 2 of 5 prior trials), potentially increasing applicability to US primary care settings. Topical fluoride was associated with improved outcomes, with a number needed to treat to prevent 1 child with incident caries of about 14 (95% CI, 8 to 50). Topical fluoride was administered as a varnish in all trials except for 1,[30] which used acidulated phosphate fluoride foam. Results were consistent in stratified analyses on multiple factors, including community water fluoridation status. Although there was a significant interaction between younger age and larger reduction in likelihood of incident caries with topical fluoride, there was no significant interaction between age and effects on caries burden. Because almost all trials were conducted in higher-risk children, the applicability of findings to children not at increased risk is uncertain. In all trials the varnish was applied by dental personnel, although fluoride varnish can be successfully applied easily and with minimal training.[55,56] Limited evidence on harms associated with topical fluoride indicated no increased risk of fluorosis[48] or adverse events[44,45] vs placebo. Serious adverse events were not reported, though some children had difficulty tolerating the varnish application because of odor or taste.

Evidence on other preventive interventions was limited or unavailable. There were no new trials of xylitol in children younger than 5 years, and evidence in the prior USPSTF review was limited to 2 trials with imprecise estimates.[46,47] Silver diamine fluoride has primarily been used as a treatment for arresting existing cavitated caries, but is also being evaluated for caries prevention. No trial evaluated silver diamine fluoride for prevention of caries in children younger than 5 years, although trials in US school-aged children are expected to be completed in 2023.[57,58]

Limitations

This review has several limitations. First, non–English-language articles were excluded. However, no non–English-language articles that appeared likely to affect conclusions were identified. Second, the review did not search for studies published only as abstracts and did not formally assess for publication bias with graphical or statistical methods because of differences in study design, populations, and outcomes assessed, with substantial statistical heterogeneity. Third, statistical heterogeneity was substantial in meta-analyses of topical fluoride. However, results were consistent in prespecified stratified analyses based on factors related to study design, population characteristics, intervention characteristics, and setting, and meta-analysis used a random-effects model. Fourth, some trials were conducted in countries and settings in which oral health care and behaviors may differ substantially from typical US primary care settings, potentially reducing applicability. Fifth, most studies had methodological limitations, reducing certainty in findings, and some KQs and interventions were addressed by little or no evidence.

Conclusions

There was no direct evidence on benefits and harms of primary care oral health screening or referral to dentist. Dietary fluoride supplementation and fluoride varnish were associated with improved caries outcomes in higher-risk children and settings.

ARTICLE INFORMATION

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Concept and design: Chou, Dana.

Acquisition, analysis, or interpretation of data: All authors.
Drafting of the manuscript: Chou, Pappas, Dana, Selph, Hart, Fu.
Critical revision of the manuscript for important intellectual content: Chou, Schwarz.
Statistical analysis: Chou, Dana, Fu.
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Administrative, technical, or material support: Pappas, Dana, Hart, Schwarz.
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Editorial Disclaimer: This evidence report is presented as a document in support of the accompanying USPSTF Recommendation Statement. It did not undergo additional peer review after submission to *JAMA*.

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