

# Screening, Referral, Behavioral Counseling, and Preventive Interventions for Oral Health in Adults

## A Systematic Review for the US Preventive Services Task Force

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**IMPORTANCE** Dental caries and periodontal disease are common adult oral health conditions and potentially amenable to primary care screening and prevention.

**OBJECTIVE** To systematically review the evidence on primary care screening and prevention of dental caries and periodontal disease in adults to inform the US Preventive Services Task Force.

**DATA SOURCES** MEDLINE, Cochrane Central Register of Controlled Trials, and Cochrane Database of Systematic Reviews (to October 3, 2022); surveillance through July 21, 2023.

**STUDY SELECTION** Diagnostic accuracy studies of primary care screening instruments and oral examination; randomized and nonrandomized trials of screening and preventive interventions; cohort studies on primary care oral health screening and preventive intervention harms.

**DATA EXTRACTION AND SYNTHESIS** One investigator abstracted data; a second checked accuracy. Two investigators independently rated study quality. Diagnostic accuracy data were pooled using a bivariate mixed-effects binary regression model.

**MAIN OUTCOMES AND MEASURES** Dental caries, periodontal disease, morbidity, quality of life, harms; and diagnostic test accuracy.

**RESULTS** Five randomized clinical trials, 5 nonrandomized trials, and 6 observational studies (total 3300 participants) were included. One poor-quality trial (n = 477) found no difference between oral health screening during pregnancy vs no screening in caries, periodontal disease, or birth outcomes. One study (n = 86) found oral health examination by 2 primary care clinicians associated with low sensitivity (0.42 and 0.56) and high specificity (0.84 and 0.87) for periodontal disease and with variable sensitivity (0.33 and 0.83) and high specificity (0.80 and 0.93) for dental caries. Four studies (n = 965) found screening questionnaires associated with a pooled sensitivity of 0.72 (95% CI, 0.57-0.83) and specificity of 0.74 (95% CI, 0.66-0.82) for periodontal disease. For preventive interventions no study evaluated primary care counseling or dental referral, and evidence from 2 poor-quality trials (n = 178) of sealants, and 1 fair-quality and 4 poor-quality trials (n = 971) of topical fluorides, was insufficient. Three fair-quality trials (n = 590) of persons with mean age 72 to 80 years found silver diamine fluoride solution associated with fewer new root caries lesions or fillings vs placebo (mean reduction, -0.33 to -1.3) and decreased likelihood of new root caries lesion (2 trials; adjusted odds ratio, 0.4 [95% CI, 0.3-0.7]). No trial evaluated primary care-administered preventive interventions.

**CONCLUSIONS AND RELEVANCE** Screening questionnaires were associated with moderate diagnostic accuracy for periodontal disease. Research is needed to determine benefits and harms of oral health primary care screening and preventive interventions.

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Oral health issues in adults are common, are often untreated, and can lead to tooth loss or irreversible damage and other adverse health outcomes.<sup>1-5</sup> For patients who lack access to dental services, oral health screening and preventive interventions for dental caries and periodontal disease, the most common oral health conditions in adults, could potentially be provided in primary care settings and reduce associated negative health consequences and observed disparities related to race and ethnicity, socioeconomic status, or other factors.<sup>6-10</sup> This evidence report was conducted to inform the US Preventive Services Task Force (USPSTF) for a new recommendation on primary care screening, dental referral, behavioral counseling, and preventive interventions for oral health in adults. A complementary evidence report was conducted for the USPSTF on oral health screening and prevention in children and adolescents aged 5 to 17 years.<sup>11,12</sup> The USPSTF addressed oral cancer screening separately<sup>13</sup> and previously addressed screening and prevention of dental caries in children younger than 5 years.<sup>14</sup>

includes findings for contextual questions (not systematically reviewed) on the association between dental caries and long-term health outcomes, oral health disparities, and primary care interventions to reduce disparities.

**Search Strategies**

A research librarian searched MEDLINE, the Cochrane Central Register of Controlled Trials, and the Cochrane Database of Systematic Reviews from inception to October 3, 2022 (eMethods 1 in the Supplement). Searches were supplemented by reference list review of relevant articles. Since October 3, 2022, ongoing surveillance was conducted through article alerts and targeted searches of journals to identify major studies published in the interim that could affect the conclusions or understanding of the evidence and the related USPSTF recommendation. The last surveillance was conducted on July 21, 2023, and identified no eligible randomized trials.

**Study Selection**

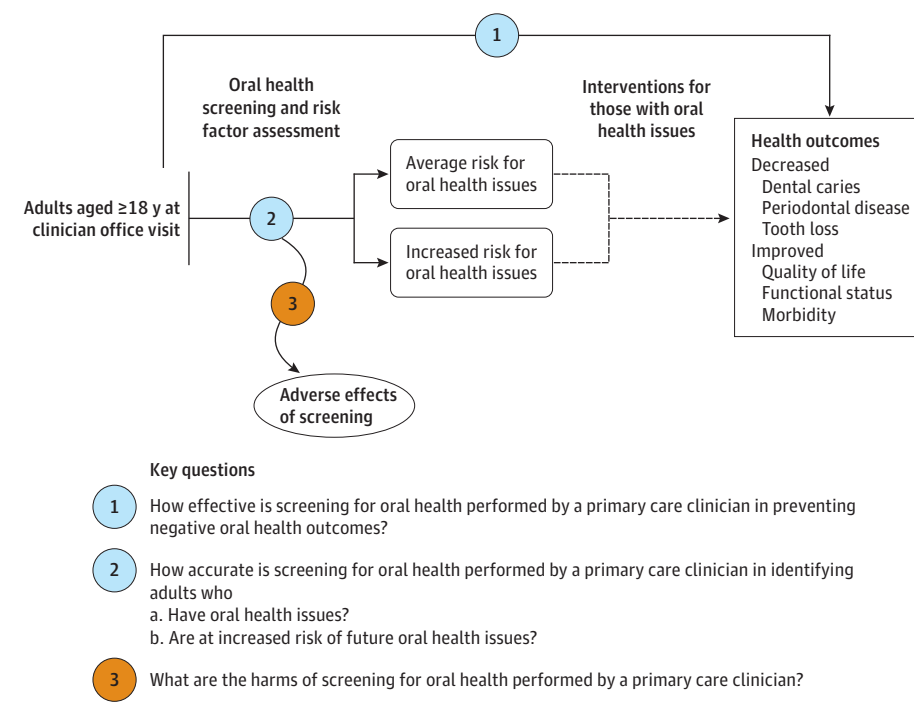
Two investigators independently reviewed titles, abstracts, and full-text articles using predefined eligibility criteria (eMethods 2 in the Supplement). The population was asymptomatic adults (≥18 years) who were not selected on the basis of having existing dental caries or periodontal disease. Screening and diagnostic accuracy studies conducted in primary care settings of oral health examination or risk assessment instruments were eligible. Studies of risk instruments that were not administered in primary care settings were also eligible if they were primary care relevant (did not involve a dental professional examination or specialty tests [eg, dental radiographs, cariogenic bacteria levels, salivary flow rates]).

**Methods**

**Scope of the Review**

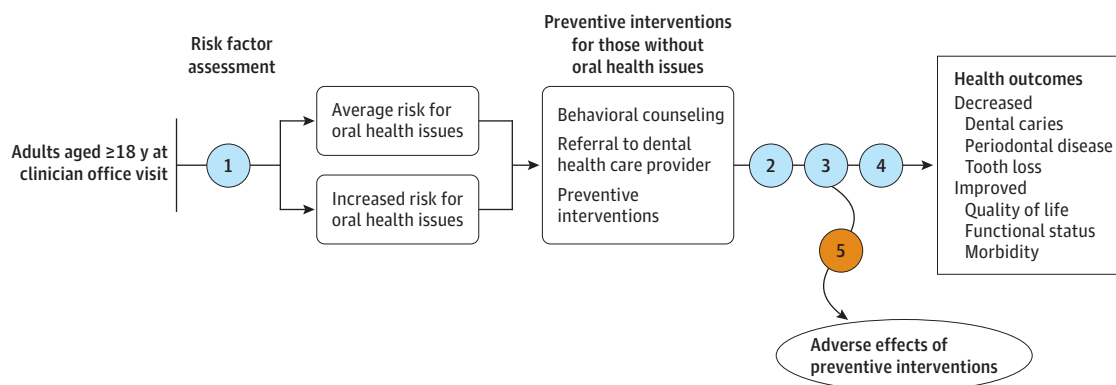
Detailed methods and evidence tables with additional study details are available in the full evidence report.<sup>15</sup> Figure 1 and Figure 2 show the analytic frameworks and key questions (KQs) that guided the review. Separate analytic frameworks were used to distinguish treatment of adults with existing dental caries or periodontal disease (screening) from treatment of adults without those conditions (preventive interventions). The full report<sup>15</sup>

Figure 1. Analytic Framework and Key Questions: Screening for Oral Health in Adults 18 Years or Older



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 depicts a health outcome that follows an intermediate outcome. For additional information, see the USPSTF Procedure Manual.<sup>16</sup>

Figure 2. Analytic Framework and Key Questions: Interventions to Prevent Oral Health Issues in Adults 18 Years or Older



**Key questions**

- 1 How accurate is screening performed by a primary care clinician in identifying adults who are at increased risk of future oral health issues?<sup>a</sup>
- 2 How effective is oral health behavioral counseling provided by a primary care clinician in preventing oral health issues?
- 3 How effective is referral by a primary care clinician to a dental health care provider in preventing oral health issues?
- 4 How effective are preventive interventions in preventing oral health issues?
- 5 What are the harms of specific interventions (behavioral counseling, referral, and preventive interventions) to prevent oral health issues?

<sup>a</sup> This is the same as key question 2b from the screening analytic framework (Figure 1).

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.<sup>16</sup>

Eligible preventive interventions were primary care oral health behavioral counseling, referral to a dental professional, and preventive medications potentially feasible for primary care administration (not requiring extensive dental training): topical fluoride (varnish, foam, or gel), silver diamine fluoride (SDF) topical solution, dental sealants, and xylitol. Comparisons were against placebo or no intervention. Outcomes were dental caries (incidence or caries burden, often measured as the number of decayed, missing, or filled permanent teeth [DMFT index] or surfaces [DMFS index]), periodontal disease presence and severity, morbidity, quality of life, functional status, and harms. Randomized or nonrandomized trials and diagnostic accuracy studies were eligible; cohort studies were also eligible for screening and preventive intervention harms.

**Data Abstraction and Quality Rating**

One investigator abstracted details about the study design, patient population, setting, interventions or screening instruments, 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 (eMethods 3 in the Supplement). Discrepancies were resolved by consensus. In accordance with the USPSTF Procedure Manual,<sup>16</sup> studies rated poor-quality were only included if higher-quality evidence was unavailable.

**Data Synthesis**

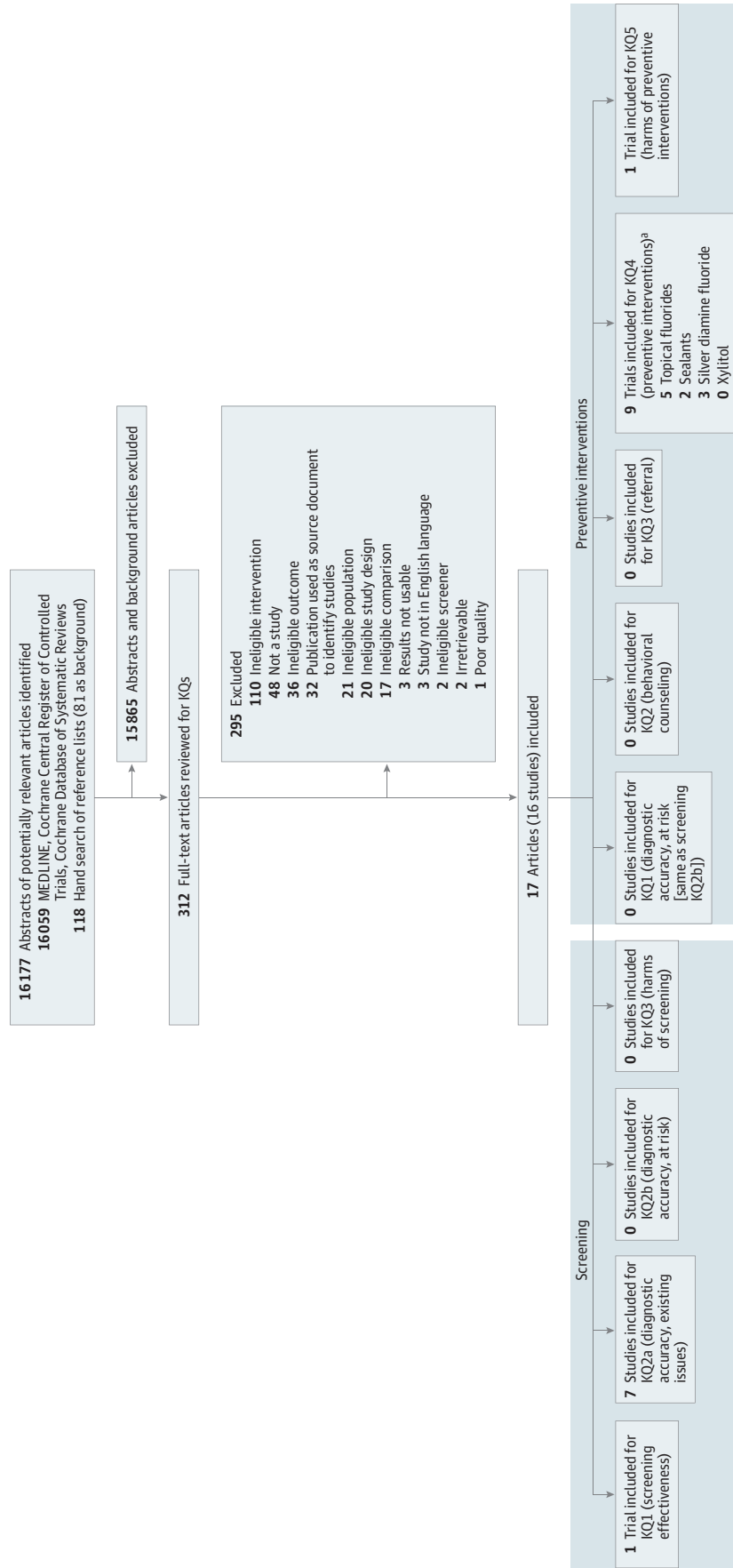
For all KQs, the overall quality of evidence was rated as “good,” “fair,” or “poor” based on study limitations, consistency, precision, reporting bias, and applicability, using the approach described in the USPSTF Procedure Manual.<sup>16</sup>

For diagnostic accuracy, a bivariate mixed-effects binary regression model with *x<sub>tm</sub>logit* in Stata version 14.2 (StataCorp) was used to summarize sensitivity and specificity of screening tests for periodontal disease or dental caries. The bivariate mixed-effects model was also used to create summary area under the receiver operating characteristic (AUROC) curves. Statistical heterogeneity was assessed using the *I*<sup>2</sup> statistic, and stratified analyses were conducted by setting (medical or dental) and risk of bias. All significance testing was 2-tailed; *P* values .05 or less were considered statistically significant. Meta-analysis was not conducted for preventive interventions, due to small numbers of studies with methodological limitations.

**Results**

Across all KQs, 16 studies (in 17 publications; total 3300 participants) were included (Figure 3).<sup>17-33</sup> One randomized clinical trial (RCT)<sup>17</sup> and 7 diagnostic accuracy studies addressed screening,<sup>18-24</sup> and 4 RCTs<sup>25-28</sup> and 5 nonrandomized trials<sup>29-33</sup> addressed

Figure 3. Literature Flow Diagram: Interventions to Prevent Oral Health Issues in Adults 18 Years or Older



The sum of the number of studies per key question (KQ) exceeds the total number of studies because some studies were applicable to multiple KQs or topic areas.

<sup>a</sup> One trial addressed both topical fluoride and silver diamine fluoride.

preventive interventions. The Table summarizes the evidence reviewed for this report.

## Screening

**Key Question 1.** How effective is screening for oral health performed by a primary care clinician in preventing negative oral health outcomes?

One poor-quality trial (n = 477) conducted in Australia in persons in the first trimester of pregnancy found no statistically significant differences between a midwife-led oral health screening intervention vs no screening in the mean number of third trimester decayed teeth (1.47 [SD, 2.51] vs 2.01 [SD, 2.55]) or filled teeth (3.06 [SD, 3.94] vs 2.09 [SD, 2.53]) (eTable 1 in the Supplement).<sup>17</sup> Periodontal disease and birth outcomes were very similar between groups. The screening intervention consisted of a 2-item questionnaire, midwife-performed oral health examination, and provision of oral health education and dental referral if indicated. Trial methodological limitations included open-label design, unclear allocation concealment methods, and high (44%) attrition (eTable 2 in the Supplement).

## Diagnostic Accuracy

**Key Question 2a.** How accurate is screening for oral health performed by a primary care clinician in identifying adults who have oral health issues?

### Screening Risk Instruments

Six fair-quality, primary care-relevant studies (in 7 publications; n = 1184; range, 88-408) assessed the diagnostic accuracy of oral health questionnaires for periodontal disease (eTable 3 in the Supplement).<sup>17-23</sup> Mean study age ranged from 40 to 58 years, except for 1 study of pregnant persons (mean age, 29 years). The prevalence of at least mild periodontitis ranged from 39% to 100%, and the prevalence of severe periodontitis ranged from 20% to 39%. Four studies were conducted in a dental setting<sup>19,20,22,23</sup> and 2 studies in an outpatient medical setting.<sup>17,18,21</sup> Three studies evaluated the same or a similar 8-item questionnaire on self-perceived dental health,<sup>19,21,23</sup> 1 study evaluated a more detailed 21-item questionnaire on self-perceived dental health,<sup>20</sup> 1 study evaluated a 7-item questionnaire that combined items on self-perceived dental health with patient demographics and smoking status,<sup>22</sup> and 1 study assessed a brief (2-item) questionnaire in pregnancy.<sup>18</sup> Methodological limitations included unclear blinding of screeners to the reference standard and use of nonpredefined thresholds for a positive screen result (eTable 4 in the Supplement). In addition, the questionnaires included items on prior treatment for periodontal disease, potentially reducing applicability to screening.

A pooled analysis of 4 studies (n = 965) found screening questionnaires of self-perceived dental health associated with sensitivity of 0.72 (95% CI, 0.57-0.83,  $I^2 = 91%$ ) and specificity of 0.74 (95% CI, 0.66-0.82,  $I^2 = 73%$ ) for periodontitis (defined as stage I through IV periodontitis, Community Periodontal Index of Treatment Needs [CPITN] scores 3 and 4, moderate and severe periodontitis, or  $\geq 2$  teeth with alveolar bone loss  $\geq 5$  mm) (Figure 4).<sup>19-21,23</sup> Statistical heterogeneity was high. One study<sup>21</sup> of an 8-item questionnaire administered in a medical setting reported lower sensitivity (0.49 [95% CI, 0.38-0.60]) compared with 3 studies conducted in dental settings (sensitivity ranged from 0.68

to 0.85), although its specificity (0.68 [95% CI, 0.56-0.79]) was within the range reported by the dental setting studies (range, 0.63-0.84). The summary AUROC value was 0.79 (95% CI, 0.75-0.83),<sup>19-21,23</sup> indicating fair discrimination (eFigure 1 in the Supplement).

When the analysis was limited to identification of more severe periodontitis (ie, stage III/IV periodontitis, CPITN score 4, severe periodontitis,  $\geq 3$  teeth with alveolar bone loss  $\geq 6$  mm), the pooled sensitivity was similar (0.68 [95% CI, 0.61-0.75];  $I^2 = 40%$ ) and specificity slightly higher (0.80 [95% CI, 0.71-0.87];  $I^2 = 90%$ ) than for any periodontitis, although confidence intervals overlapped (4 studies; n = 965) (eFigure 2 in the Supplement). The summary AUROC value was similar (0.76 [95% CI, 0.72-0.80]) (eFigure 3 in the Supplement).<sup>19-21,23</sup>

Two other studies evaluated questionnaires dissimilar to the other 4 studies and were not pooled. One study<sup>22</sup> (n = 88) used a 7-item questionnaire that included items on patient demographics and smoking status as well as self-reported oral health to generate a patient-reported Periodontitis Risk Score (pPRS; range, 0-20; higher scores indicate greater risk). A cutoff of 7 or greater on the pPRS was associated with a sensitivity of 0.87 (95% CI, 0.78-0.94), specificity of 0.84 (95% CI, 0.67-0.95), and odds ratio of 39.09 (95% CI, 9.82-132) for periodontal inflammation, and the pPRS was associated with good discrimination for periodontal inflammation (AUROC value, 0.86 [95% CI, 0.76-0.95]). The other study (n = 131) found a 2-item screener in pregnant women ("Do you have problems in your mouth?" and "Have you seen a dentist in the last 12 months?") associated with sensitivity of 0.88 (95% CI, 0.80-0.96) and specificity of 0.14 (95% CI, 0.05-0.23) for identifying those with a Periodontal Screening and Recording Index score 2 or greater (indicating early signs of periodontitis or presence of any tooth decay).<sup>17,18</sup>

## Oral Health Examination

One good-quality study evaluated the diagnostic accuracy of an oral health examination in primary care (eTables 3 and 4 in the Supplement).<sup>24</sup> Eighty-six patients (mean age, 66 years; 99% male) at a Veterans Affairs medical clinic were screened independently by 2 primary care clinicians. The reference standard was a same-day dentist examination. Primary care oral health examination was associated with high specificity (range, 0.80-0.93) for periodontal disease or caries. However, sensitivity was low for periodontal disease (0.56 [95% CI, 0.38-0.74] and 0.42 [95% CI, 0.24-0.56] for 2 examiners) and variable for caries (0.33 [95% CI, 0.12-0.62] and 0.83 [95% CI, 0.52-0.96]).

**Key Question 2b.** How accurate is screening for oral health performed by a primary care clinician in identifying adults who are at increased risk for future oral health issues?

No study addressed this KQ.

**Key Question 3.** What are the harms of screening for oral health performed by a primary care clinician?

One trial of oral health screening of pregnant persons vs no screening did not report harms.<sup>17</sup>

## Prevention

**Key Question 1.** How accurate is screening performed by a primary care clinician in identifying adults who are at increased risk of future oral health issues?

**Table. Summary of Evidence: Screening and Preventive Interventions for Oral Health in Adults 18 Years or Older**

Objective/intervention	No. of studies; study design (No. of participants)	Summary of findings by outcome	Consistency/precision; Reporting bias	Overall quality	Body of evidence limitations	Strength of evidence	Applicability
Screening KQ1: Screening effectiveness	1 (RCT (n = 477))	Decayed teeth: mean, 1.47 (SD, 2.51) vs 2.01 (SD, 2.55) Filled teeth: mean, 3.06 (SD, 3.04) vs 2.09 (SD, 2.53) Periodontal disease outcomes: no differences Birth outcomes: no differences	Consistency: Unable to assess Imprecise Reporting bias not suspected	Poor	Single trial with serious methodological limitations and imprecise estimates	Insufficient	Midwife-led intervention likely has generalizability to primary care; trial enrolled pregnant persons in first trimester in Australia
Screening KQ2: Screening accuracy	A. Questionnaires: 6 Studies (n = 1184) Oral health examination: 1 study (n = 86) B. No studies	Questionnaires: Pooled sensitivity, 0.72 (95% CI, 0.57-0.83) and pooled specificity, 0.74 (95% CI, 0.66-0.82) for periodontal disease, based on 4 studies of similar questionnaires; 2 other studies evaluated questionnaires that were not poolable (1 study reported an AUROC value of 0.86 [95% CI, 0.76-0.95] for a 7-item questionnaire and 1 study reported a sensitivity of 0.88 and specificity of 0.14 for a 2-item questionnaire) Oral health examination (1 study): For periodontal disease, sensitivity 0.42 and specificity 0.56 and 0.87; for dental caries, sensitivity 0.33 and specificity 0.83 and 0.93	Consistency: Serious inconsistency present (questionnaire) and low interrater reliability (oral health examination) Some imprecision present Reporting bias not suspected	Moderate	Most studies had methodological limitations; serious inconsistency or interrater reliability; variability in the questionnaires assessed; no studies on identification of persons at increased risk of future oral health issues and most studies focused on identification of periodontal disease	Low	Five of 6 studies on questionnaires were conducted in dental settings, but the questionnaires were self-administered and appeared relevant for primary care; high prevalence of periodontal disease in the studies; questionnaires included items on prior treatment for periodontal disease, potentially reducing applicability to screening
Screening KQ3: Screening harms	No studies	NA	NA	NA	NA	NA	NA
Prevention KQ1: Screening accuracy (identification of persons at increased risk of future caries) <sup>a</sup>	No studies	NA	NA	NA	NA	NA	NA

(continued)



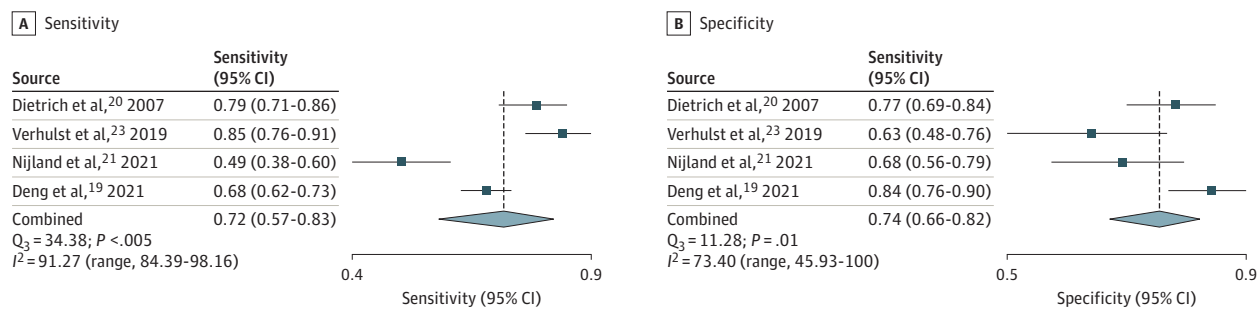
Table. Summary of Evidence: Screening and Preventive Interventions for Oral Health in Adults 18 Years or Older (continued)

Objective/intervention	No. of studies; study design (No. of participants)	Summary of findings by outcome	Consistency/precision; Reporting bias	Overall quality	Body of evidence limitations	Strength of evidence	Applicability
Prevention KQ2: Behavioral counseling	No studies	NA	NA	NA	NA	NA	NA
Prevention KQ3: Referral	No studies	NA	NA	NA	NA	NA	NA
Prevention KQ4: Preventive interventions	5 Studies (1 RCT and 4 nonrandomized [or randomized unclear] trials) (n = 971)	Inconsistent effects on caries burden for fluoride varnish (2 trials) and fluoride gels/solutions (3 trials)	Serious inconsistency Reasonably precise Reporting bias not suspected	Poor	Serious methodological limitations; serious inconsistency	Insufficient	Three trials focused on older adults (in residential or nursing homes in 2 trials and in the community in 1 trial) and 2 trials focused on young adults; 2 trials were conducted prior to 1980; topical fluorides were not administered by primary care clinicians in any trial (either administered by dental professionals or person administering not reported)
Sealants	2 Studies (1 RCT and 1 nonrandomized trial) (n = 178)	Sealants associated with decreased likelihood of caries (RR, 0.63 [95% CI, 0.31-1.29]) or proportion of teeth with caries (RR, 0.23 [95% CI, 0.10-0.49]) in young adults	No inconsistency Some imprecision Reporting bias not suspected	Poor	Serious methodological limitations	Insufficient	Both trials focused on young adults (students); 1 trial published in 1979; sealants administered by dental professionals
Silver diamine fluoride	3 RCTs (n = 590)	Silver diamine fluoride associated with decreased new root caries lesions or fillings vs placebo (3 trials; mean reduction, -0.33 to -1.8 at 24 to 30 mo)	Some inconsistency in magnitude of benefit (no inconsistency in direction of benefit) Reasonably precise Reporting bias not suspected	Fair	Some inconsistency in magnitude of benefit	Moderate	All trials conducted in older adults in China (2 trials of community-dwelling persons and 1 trial in persons living in community or nursing homes); silver diamine fluoride administered by dental professionals
Xylitol	No studies	NA	NA	NA	NA	NA	NA
KQ5: Harms of preventive interventions	1 RCT (n = 235)	Study states "No major side effects or discomfort were reported"	Unable to assess inconsistency (1 trial) Imprecise Potential reporting bias (1/9 trials of preventive interventions reported harms)	Poor	Suboptimal reporting of harms in 1 of 9 trials of preventive interventions	Insufficient	The only trial that reported harms evaluated fluoride varnish and silver diamine fluoride

Abbreviations: AUROC, area under the receiver operating characteristic curve; KQ, key question; NA, not applicable; RCT, randomized clinical trial; RR, relative risk.

<sup>a</sup> This is the same as KQ2b from the screening framework.

Figure 4. Sensitivity and Specificity of Questionnaire for Periodontitis



No study addressed this KQ.

**Key Question 2.** How effective is oral health behavioral counseling provided by a primary care clinician in preventing oral health issues?

No study addressed this KQ.

**Key Question 3.** How effective is referral by a primary care clinician to a dental health care provider in preventing oral health issues?

No study addressed this KQ.

**Key Question 4.** How effective are preventive interventions in preventing oral health issues?

#### Topical Fluorides

One fair-quality<sup>25</sup> and 4 poor-quality trials<sup>29-32</sup> evaluated topical fluorides (varnish or gels/solutions) vs placebo or no topical fluoride for prevention of dental caries in adults (eTables 5 and 6 in the Supplement). In all trials, topical fluorides were applied by dental professionals. Sample sizes ranged from 104 to 318 ( $n = 971$ ). Two trials were conducted in Europe, 2 trials in the US, and 1 trial in Hong Kong. One US trial described water fluoridation status as "optimal,"<sup>32</sup> and the water fluoridation level in Hong Kong is 0.5 ppm F<sup>25</sup>; water fluoridation status was otherwise not reported. Three studies were published between 1993 to 2021 and two between 1955 to 1979; the older trials may have reduced generalizability to current practice due to marked decreases in caries burden in US adults since the 1970s.<sup>34</sup> Only 1 trial was randomized<sup>25</sup>; the other trials were nonrandomized or use of randomization was unclear. Methodological limitations in the randomized trial included unclear allocation concealment methods, open-label design, and failure to report attrition or use of intention-to-treat analysis. The nonrandomized trials also had high or unclear attrition and open-label design and unclear baseline similarity of groups; all but 2 trials<sup>30,32</sup> did not adjust for potential confounders.

The RCT<sup>25</sup> and 1 nonrandomized trial<sup>30</sup> evaluated sodium fluoride varnish (22 600 ppm F). The other trials evaluated sodium fluoride (2%) solution,<sup>29</sup> stannous fluoride (30%) paste followed by a stannous fluoride (10%) aqueous solution,<sup>31</sup> and acidulated phosphate fluoride (1.2%).<sup>32</sup>

**Fluoride Varnish** | Two trials evaluated sodium fluoride varnish (22 600 ppm F) in older adults and reported inconsistent results.<sup>25,30</sup> One RCT ( $n = 104$ )<sup>25</sup> performed in Hong Kong enrolled older adults (mean age, 79 years) in residential and nursing homes. It found fluoride varnish every 3 months associated with a small, statistically nonsignificant reduction in dental caries burden at 1 year (mean difference in new active caries or fillings, 0.7;  $P > .05$ ), although differences

were larger and statistically significant at 3 years (mean difference, 1.6;  $P < .001$ ). Varnish was also associated with decreased risk of developing new caries (relative risk [RR], 0.25 [95% CI, 0.10-0.63]). A nonrandomized cluster trial ( $n = 232$ )<sup>30</sup> of older adults in long-term care facilities (mean age, 84 years) found sodium fluoride varnish (22 600 ppm F) applied every 6 months associated with no difference in caries burden based on DMFT index at 1 year (adjusted mean difference, -0.04 [95% CI, -0.10 to 0.03]).

**Other Topical Fluorides** | Three trials evaluated other topical fluorides.<sup>29,31,32</sup> All were nonrandomized or had unclear randomization methods. Two trials evaluated younger adults. One nonrandomized trial<sup>31</sup> ( $n = 169$ ) conducted in male college students in Poland (aged 19-20 years) found stannous fluoride (30%) paste followed by stannous fluoride (10%) aqueous solution applied every 6 months associated with lower increase in DMFS index relative to baseline, compared with no treatment at 3 years (6.10 vs 10.54,  $P < .01$ ). A nonrandomized trial ( $n = 148$ ) conducted in women at a military training center in the US (mean age, 22 years; baseline caries status not reported) found sodium fluoride (2%) solution applied semiweekly for 36 months associated with no difference vs placebo (sodium chloride [0.9%]) in number of newly decayed teeth (0.95 vs 1.08,  $P = .48$ ) or likelihood of experiencing 1 or more new carious teeth (60% vs 68%; RR, 0.88 [95% CI, 0.68-1.13]) at 8 to 14 months.<sup>29</sup>

A US trial (randomization unclear) of adults 60 years or older (mean age not reported;  $n = 318$ ) living in the community found topical acidulated phosphate fluoride (1.2%) gel applied every 3 months associated with fewer new root caries surface lesions (mean, 1.36 vs 1.99;  $P < .05$ ) and lower increase in DMFS index relative to baseline, compared with placebo (mean, 0.27 vs 0.91;  $P < .05$ ) at 48 months.<sup>32</sup>

#### Sealants

Two poor-quality trials ( $n = 178$ ) evaluated sealants vs no sealants in adults (eTables 7 and 8 in the Supplement).<sup>26,33</sup> The trials evaluated fluoride-containing or non-fluoride-containing light-cured resin-based sealants applied by dental professionals to premolars and molars in young adults. One trial<sup>26</sup> was randomized but did not report allocation concealment methods, and the other trial<sup>33</sup> was nonrandomized. Other methodological limitations included open-label design and failure to report attrition; additionally, the nonrandomized trial did not control for confounders.

A randomized trial ( $n = 119$ ; 719 tooth pairs) conducted in the US among military recruits (mean age, 22 years) found non-fluoride-



containing sealants associated with a statistically nonsignificant reduction in the percentage of teeth with caries, with a low caries rate in both groups (1.7% vs 2.6%; RR, 0.63 [95% CI, 0.31-1.29]).<sup>26</sup> The nonrandomized trial (n = 59; 122 tooth pairs) was conducted in Turkey among dental students.<sup>33</sup> Sealants (fluoride-containing or non-fluoride-containing) were associated with a reduction in the proportion of teeth with caries at 24 months (5.7% vs 25.4%; RR, 0.23 [95% CI, 0.10-0.49]).

#### Silver Diamine Fluoride

Three fair-quality RCTs evaluated SDF topical solution vs placebo for caries prevention (eTable 9 in the Supplement).<sup>25,27,28</sup> Sample sizes ranged from 106 to 257 (total n = 590). The trials were conducted among older adults (mean age, 72-80 years) in Hong Kong (water fluoridation level, 0.5 ppm F) and focused on root caries outcomes. Two trials<sup>27,28</sup> were restricted to community-dwelling persons and 1 trial<sup>25</sup> included community-dwelling persons and those living in nursing homes. In all trials, 38% SDF solution was administered by a dentist annually. Methodological limitations included unclear allocation concealment, unclear or no masking of clinicians or patients, and high attrition (eTable 10 in the Supplement).

At 2 to 3 years, SDF use was associated with a decrease in the number of new root caries lesions or fillings vs placebo, with a mean reduction at 24 to 30 months of -0.33 to -0.48 in 2 RCTs<sup>27,28</sup> and -1.3 in the other RCT.<sup>25</sup> In the latter trial, the mean difference in new root caries lesions or fillings was -1.8 at 36 months.<sup>25</sup> Two trials also found SDF associated with decreased likelihood of a new root caries lesion (adjusted odds ratio, 0.4 [95% CI, 0.3-0.7]<sup>27</sup> and RR, 0.19 [95% CI, 0.07-0.46]<sup>25</sup>).

#### Xylitol

No study evaluated xylitol for prevention.

**Key Question 5.** What are the harms of specific interventions (behavioral counseling, referral, and preventive interventions) to prevent oral health issues?

Reporting of harms of oral health preventive interventions was very limited. Of 9 trials included for KQ4, 1 trial (n = 235) evaluated fluoride varnish or SDF vs placebo and stated that "no major side effects or discomfort was reported."<sup>25</sup> Harms were unreported in the other 8 trials.

## Discussion

Evidence on screening was very limited. One randomized trial evaluated a midwife-led oral health screening intervention in pregnant persons but had serious methodological limitations and found no differences in caries outcomes, periodontal disease outcomes, or birth outcomes.<sup>17</sup> Studies on questionnaires for assessing presence of periodontal disease reported moderate diagnostic accuracy but had methodological limitations and included items on prior treatment for periodontal disease (which could limit applicability to screening); in addition, most studies were conducted in non-primary care settings.<sup>17-23</sup> No study evaluated the accuracy of primary care relevant questionnaires for identification of dental caries or the accuracy of questionnaires or oral health examination for identifying persons at increased risk for future caries or development of periodontal disease. Evidence on the accuracy of the pri-

mary care oral health examination was limited to 1 study that reported high specificity for periodontal disease or dental caries but variable or low sensitivity.<sup>24</sup>

Evidence on preventive interventions was also limited. There were no eligible trials of primary care counseling or referral to a dental professional. Regarding preventive interventions, SDF solution was associated with a small decrease in the number of new root caries lesions or fillings vs placebo in older adults, but all studies were conducted in Hong Kong.<sup>25,27,28</sup> Evidence for sealants (2 trials)<sup>26,33</sup> and topical fluorides (5 trials)<sup>25,29-32</sup> was insufficient, as all trials had serious methodological limitations, with inconsistency in the topical fluoride trials. The trials of preventive interventions did not evaluate periodontal or health outcomes (quality of life, function, or tooth loss) or impact on conditions associated with poor oral health, such as cardiovascular disease.<sup>35</sup> In addition, factors that could potentially affect the effectiveness of oral health preventive interventions, such as water fluoridation levels, provision of oral health education, and oral health behaviors, were not consistently reported. There were no trials of xylitol for prevention and harms of preventive interventions were poorly reported, although serious harms were not described. When used as a treatment to arrest existing caries, SDF is associated with staining of active caries lesions.<sup>36</sup>

#### Limitations

This review had several limitations. First, non-English-language articles were excluded. However, non-English-language articles likely to affect conclusions were not 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 for small sample effects, due to small numbers of studies with serious methodological limitations.<sup>37</sup> Third, meta-analysis of preventive interventions was not performed, also due to small numbers of studies with serious methodological limitations. Fourth, the review did not evaluate the effectiveness of tooth brushing or flossing, as these are routinely recommended and performed outside the primary care setting. Rather, the review addressed the effectiveness of oral health counseling, which includes counseling on tooth brushing, flossing, and diet. Fifth, the review included poor-quality trials of preventive interventions, due to the lack of higher-quality evidence. The evidence for preventive interventions addressed only in poor-quality trials was assessed as insufficient. Sixth, some trials of preventive interventions were published more than 25 years ago and all trials of SDF were conducted in China, potentially reducing applicability to current US practice. Importantly, all trials evaluated oral health preventive interventions administered by dental health professionals, with unknown effectiveness and feasibility in primary care. Barriers to provision of oral health preventive interventions in primary care include uncertain acceptability and uptake; potential need for additional training and equipment, particularly for sealants; and uncertain reimbursement.<sup>38,39</sup>

## Conclusions

Screening questionnaires were associated with moderate diagnostic accuracy for periodontal disease. Research is needed to determine benefits and harms of primary care screening and oral health preventive interventions.

## ARTICLE INFORMATION

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*Concept and design:* Chou.

*Acquisition, analysis, or interpretation of data:* All authors.

*Drafting of the manuscript:* Chou, Selph, Bougatso, Ahmed, Schwarz.

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