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Screening, Referral, Behavioral Counseling, and Preventive Interventions for Oral Health in Adults: A Systematic Review for the U.S. Preventive Services Task Force

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The information in this report is intended to help healthcare decision makers—patients and clinicians, health system leaders, and policymakers, among others—make well-informed decisions and thereby improve the quality of healthcare services. This report is not intended to be a substitute for the application of clinical judgment. Anyone who makes decisions concerning the provision of clinical care should consider this report in the same way as any medical reference and in conjunction with all other pertinent information (i.e., in the context of available resources and circumstances presented by individual patients).

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Structured Abstract

Background: Dental caries and periodontal disease are common oral health conditions in adults. In 1996, the U.S. Preventive Services Task Force (USPSTF) recommended that clinicians counsel patients to prevent dental and periodontal disease; however, the USPSTF noted insufficient evidence on the effectiveness of counseling for changing oral health behaviors.

Purpose: To systematically review the evidence on primary care screening for and prevention of dental caries and periodontal disease in adults.

Data Sources: We searched the Cochrane Central Register of Controlled Trials and Cochrane Database of Systematic Reviews, and MEDLINE through September 2022, and manually reviewed reference lists; with surveillance through January 20, 2023. Additional surveillance for new literature will be conducted on an ongoing basis.

Study Selection: Studies on diagnostic accuracy of primary care screening instruments and oral examination; randomized controlled trials **(**RCTs) and non-randomized trials of screening and preventive interventions; cohort studies on risk of fluorosis with fluoride preventive interventions; and cohort studies of oral health screening in primary care.

Data Extraction: One investigator abstracted data and a second investigator checked data abstraction for accuracy. Two investigators independently assessed study quality using methods developed by the USPSTF.

Data Synthesis (Results): Sixteen studies (reported in 17 publications) were included in this update (five RCTs, five non-randomized trials, and six observational studies). One poor-quality trial found no difference between oral health screening of pregnant persons versus no screening on caries burden, severity of periodontal disease, or birth outcomes. One study (N=86) found primary care oral health exam associated with low sensitivity (0.42 and 0.56, based on two examiners) and high specificity (0.84 and 0.87) for periodontal disease, and variable sensitivity (0.33 and 0.83) and high specificity (0.80 and 0.93) for dental caries. Four studies (N=965) found a screening questionnaire associated with a pooled sensitivity of 0.72 (95% confidence interval [CI] 0.57 to 0.83) and specificity of 0.74 (95% CI 0.66 to 0.82) for periodontal disease. No trial evaluated the effectiveness of primary care oral health behavioral counseling versus no counseling or referral by a primary care clinician to a dental health provider versus no referral. Evidence from two poor-quality trials (N=178) of sealants and five poor-quality trials (N=971) of topical fluorides (varnish or gels/solution) was insufficient to determine preventive effectiveness of these interventions. Three fair-quality trials of silver diamine fluoride (SDF) in older adults (mean age 72 to 80 years) found SDF associated with decreased risk of new root caries lesions or fillings versus placebo (mean reduction ranged from -0.33 to -1.3) and decreased likelihood of having a new root caries lesions (two trials, adjusted odds ratio 0.4, 95% confidence interval (CI) 0.3 to 0.7 and relative risk 0.19, 95% CI 0.07 to 0.46). Evidence on harms of screening, counseling, or referral was not available; reporting of harms of preventive interventions was very poor, though serious harms were not reported.
Limitations: Oral health preventive interventions were administered by dental professionals with uncertain applicability and feasibility in primary care; only English-language articles were

included; sparse or no evidence on screening and preventive interventions; most studies of preventive interventions had serious methodological limitations; screening questionnaires included items on prior periodontal disease, potentially reducing applicability to screening; uncertain generalizability of older studies or studies conducted in resource-poor settings to current U.S. practice.

Conclusions: SDF improved root caries outcomes in older adults when administered by dental professionals. Screening questionnaires were associated with moderate diagnostic accuracy for periodontal disease; evidence on the accuracy of the primary care oral health exam was limited and estimates varied. Research is needed to determine benefits and harms of screening, primary care counseling, dental referral, and oral health preventive interventions administered in primary care settings.

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Chapter 1. Introduction and Background

Purpose

Screening, referral, behavioral counseling, and preventive interventions for oral health in adults is a new topic for the U.S. Preventive Services Task Force (USPSTF). However, the USPSTF previously addressed the related topics of counseling to prevent dental and periodontal disease (1996),[1] screening and prevention of dental caries in children younger than 5 years of age (2021),[2] and oral cancer screening (2013);[3] a concurrent topic addresses oral health screening and preventive interventions in children and adolescents 5 to 17 years of age.

In 1996, the USPSTF issued several recommendations relevant to adults on counseling to prevent dental and periodontal disease (note: the grading system used for the 1996 recommendations differed from current USPSTF definitions and are defined below).[1] The USPSTF recommended counseling patients to visit a dental care provider on a regular basis, floss daily, brush their teeth daily with a fluoride-containing toothpaste, and appropriately use fluoride for caries prevention and chemotherapeutic mouth rinses for plaque prevention ("B" recommendation ["fair evidence to support the recommendation that the condition be specifically considered in a periodic health examination"]). However, the USPSTF found that effectiveness of clinician counseling to change any of these behaviors had not been adequately evaluated ("C" recommendation ["insufficient evidence to recommend for or against the inclusion of the condition in a periodic health examination"]). Additionally, the USPSTF suggested that clinicians examine the oral cavity and be alert for obvious signs of oral disease (ungraded statement); screening for oral cancer was addressed separately ("C" [insufficient] recommendation in 1996; most recently, in 2013, the USPSTF issued an I [insufficient] statement on oral cancer screening).[3]

In 2006, the USPSTF inactivated the topic of counseling to prevent dental and periodontal disease, based on the lack of new evidence on the role of the primary care clinician in counseling for dental services to inform updated recommendations. In 2016, the USPSTF received a nomination on the topic of risks and benefits of dental x-rays for screening; oral health was selected as a topic for further refinement. Through the topic refinement process, the scope was broadened to address screening, referral, behavioral counseling, and preventive interventions for oral health conditions (dental caries and periodontal disease) in adults. Given current interest in primary care and oral health,[4-6] evidence of gaps in provision of oral health services,[7] and potential new evidence to inform recommendations, the USPSTF commissioned a systematic review to address oral health in adults. For this topic, screening was defined as risk assessment or oral cavity examination; dental x-rays were excluded during topic refinement because of limited relevance to primary care. The new oral health topic was scoped to not overlap with currently active related topics (dental caries in children from birth to age 5 years[8] and oral cancer screening[9]); a concurrent systematic review was commissioned on screening and preventive services for oral health in children.[10] This review will be used by the USPSTF to inform the development of new recommendations on screening and prevention for oral health in adults.

Condition Background

Condition Definition

In 2000, the U.S. Surgeon General published the first Oral Health in America report,[11] which emphasized that "oral health means much more than healthy teeth. It means being free of chronic oral-facial pain conditions, oral and pharyngeal (throat) cancers, oral soft tissue lesions, birth defects such as cleft lip and palate, and scores of other diseases and disorders that affect the oral, dental, and craniofacial tissues, collectively known as the craniofacial complex." An Oral Health in America follow-up report from the National Institutes of Health was published in 2021.[7] It noted that "…in adulthood, the relationship between oral health and overall health becomes much more apparent and manifests in a variety of ways." The 2021 report noted a lack of progress in improving oral health in adults: "Overall, U.S. adults' oral health has not improved—and in some respects has worsened—since publication of the 2000 Surgeon General's report on oral health." In adults, common oral health conditions include dental caries, periodontal (gum) disease, and oral cancer.[12,13] This report focuses on dental caries and periodontal disease. As previously noted, oral cancer screening is covered as a separate USPSTF topic;[3] other topics that may impact oral health (e.g., tobacco smoking cessation,[14] unhealthy alcohol use,[15] healthy diet[16]) are also addressed elsewhere by the USPSTF, although recommendations do not specifically address impacts on oral health. Oral health conditions that are associated with symptoms (e.g., orofacial pain or temporomandibular joint disorders) and treatment of existing oral health conditions or management of oral health conditions that may occur due to other treatments or medications are outside the scope of the USPSTF.

Prevalence and Burden of Disease/Illness

Dental caries and gum disease, the most common oral health conditions in adults, can lead to pain, disability, and decreased wellbeing for millions of Americans.[12,17-19] In addition, infections and tooth loss may lead to problems with eating and speaking and negatively impact quality of life and social interactions.[20] Caries is common in adulthood, with over 90 percent of adults affected;[7,21] according to the Global Burden of Disease Study, untreated dental caries is the most common health condition worldwide.[22] The prevalence of oral health conditions increases with age. In 2011 to 2014, the overall prevalence of caries among persons 20 to 64 years of age was estimated at 92 percent; the prevalence increased from 82 percent among those 20 to 34 years of age to 97 percent among those 50 to 64 years of age.[7] In 2015 to 2018, the prevalence of untreated caries was estimated at 25.9 percent in persons 20 to 44 years of age.[23] Although the overall prevalence of oral health conditions increases with age, the prevalence of untreated oral health conditions is lower in older adults, due to better access to dental care or other factors. Based on 2011 to 2016 data, the prevalence of untreated caries was 15 percent among those 65 to 74 years of age and 17 percent among those 75 years of age or older.[7] Over 40 percent of U.S. adults have some form of periodontal disease, with at least 60 percent of adults age 65 years and older having this condition.[21,24] Although the prevalence of complete tooth loss (edentulism) has declined,[7,21] the prevalence of edentulism in 2011 to 2012 was 26 percent in adults 75 years of age or older and 13 percent in those 65 to 74 years of age (in 1960 to 1962, the proportion of persons 65 to 74 years of age with edentulism was 59 percent).[7,25] In addition to pain and

wellbeing, untreated dental caries and gum disease have been associated with other health problems, including diabetes, and heart disease.[7,11,20,26-28]

Etiology and Natural History

Dental caries is a multifactorial disease process that occurs when various strains of bacteria colonize the tooth surface and metabolize dietary carbohydrates (especially refined sugars) to produce lactic and other acids, resulting in demineralization of teeth.[29,30] Dental caries first manifests as white spot lesions, which are small areas of demineralization under the enamel surface. At this stage, the caries lesion is usually reversible, if appropriate preventive action is taken (e.g., change in dietary behaviors or application of fluoride varnish). If oral health conditions do not improve, demineralization progresses, and eventually results in irreversible cavities, with a loss of the normal tooth shape and contour. Continued progression of the caries process leads to pulpitis and tooth loss, and can be associated with complications such as facial cellulitis and systemic infections.[30,31]

Periodontitis refers to inflammation of the gingival tissues. Gradual build-up of dental plaque (consisting of colonies of mixed oral bacteria) on the teeth at the margin of the gums may induce gingival inflammation and bleeding, which usually precedes development of periodontitis.[32] Left untreated, periodontitis can progress to destroy the tissues that support the teeth (the bone and periodontal ligaments) and cause the gums to pull away from the teeth, leading to exposure of tooth roots. Exposed tooth roots can cause sensitivity or pain and are more susceptible to caries (root caries). Severe periodontitis is the leading cause of tooth loss in older adults.[33]

Risk Factors

Risk factors for dental caries and periodontal disease include poor oral hygiene, tobacco use, excessive alcohol use, methamphetamine use, and inappropriate dietary practices, and may be influenced by genetics. As discussed earlier, older age is also associated with increased risk of poor oral health.[7,34,35] Certain conditions (e.g., diabetes), comorbidities (e.g., xerostomia), and medications (e.g., those that cause xerostomia) also increase risk of dental caries and periodontal disease.[36-38]

Rationale for Screening/Screening Strategies

Oral health issues in adults are common, are often untreated, and can lead to tooth loss or irreversible damage and other adverse health outcomes. Patients may be asymptomatic or be aware of their condition but not seek treatment because oral health conditions can progress slowly over time. In addition, patients may have inadequate access to dental services due to insurance status or other socioeconomic factors, or not utilize dental services for other reasons.[39] In 2015, approximately 40 percent of adults aged 21 to 64 years reported having a dental visit in the last year.[7] For patients who lack access to dental services, interventions and treatments that could prevent and treat early dental caries and periodontal disease could potentially be provided in primary care settings. Therefore, identifying and treating oral health issues early in primary care could help prevent adverse health outcomes.

Screening for oral health conditions and provision of interventions for oral health in primary care also provide an opportunity to potentially reduce disparities in detection and treatment of oral health conditions among socioeconomic and racial/ethnic groups (see subsequent section on Disparities). In most communities, dental care is the most common unmet health need.[40] Screening in primary care would reach patients who do not have access to dental care; 35 percent of the population (108 million people) who see a doctor, do not see a dentist.[41] Forty percent of the population lacks dental insurance and a similar proportion do not have an annual visit with a dentist.[42,43] Forty-five million Americans live in areas with a shortage of dental health professionals (defined as >5,000 persons per dentist).[42]

Interventions/Treatment

Screening for oral health conditions may include risk assessment, health history, visual/tactile examination, and imaging (dental x-rays)[44] to identify persons with early untreated dental caries or periodontal disease, or those at high risk for developing these conditions. Interventions to prevent development of caries focus on reducing the burden of bacteria, reducing the intake of refined sugars, and increasing the resistance of teeth to caries development.[29,45] Counseling interventions include those that address oral hygiene (e.g., brushing twice daily with fluoride toothpaste, flossing daily), diet, tobacco use, or alcohol use, as well as counseling to visit a dentist. Preventive interventions include fluoride, dental sealants, varnish, xylitol, medication adjustment (e.g., to reduce dry mouth), and referral to a dentist.

Use of fluorides primarily focuses on promoting remineralization of the enamel. Fluoride can be topical (fluoride dentifrices, rinses, gels, foams, varnishes) or systemic (dietary fluoride supplements).[29,45] Fluoride is incorporated into the biofilm (dental plaque), saliva and tooth enamel and increases tooth resistance to acid decay, acts as a reservoir for remineralization of caries lesions, and inhibits cariogenic bacteria.[29,31] A potential harm of excessive systemic fluoride exposure is enamel fluorosis, a visible change in enamel opacity due to altered mineralization during teeth formation. The severity of enamel fluorosis depends on the dose, duration and timing of fluoride intake, and is most strongly associated with cumulative intake during enamel development in early childhood; children are most susceptible between 15 to 30 months of age.[46,47] Mild fluorosis manifests as small opaque white streaks or specks in the tooth enamel.[48] Severe fluorosis results in discoloration and pitted or rough enamel.[31] In 1999 to 2004, the prevalence of severe enamel fluorosis in the United States was estimated at less than 1 percent.[48,49]

Topical fluoride is typically applied as a varnish with a small brush (more commonly used in younger children) or as a gel or foam (more commonly used in older, school-aged children).[50] Fluoride varnish application does not require specialized dental devices or equipment and can be applied quickly by both dental professionals and non-dental health professionals in a variety of settings; topical gels and foams typically require special suction. Systemic exposure to fluoride is lower following application of fluoride varnish compared to a gel or foam because smaller amounts are swallowed.[29,50-52] Fluoride varnish results in prolonged contact time between the fluoride and the tooth surface, which maintains a higher level of the calcium fluoride in the biofilm; later the released fluoride promotes remineralization. Fluoride varnish is typically available in the United States as 5 percent sodium fluoride (2.26% F). Fluoride varnish is cleared

for marketing by the U.S. Food and Drug Administration (FDA) as a cavity liner and tooth desensitizer; its use for prevention of caries is off-label.[53] Fluoride gel is typically available as sodium fluoride and acidulated phosphate fluoride.

Silver diamine fluoride (SDF) is a topical medication that is noninvasive, relatively inexpensive, and easy to apply.[54] Its mechanism of action is related to the antibacterial properties of silver in addition to the effects of fluoride. The most common concentration is 38 percent, though it has been evaluated in 10 to 38 percent formulations. SDF was cleared for marketing by the FDA in 2014 as a desensitizing agent in adults, similar to fluoride varnish 20 years earlier[55]; it has long been used outside the United States to arrest progression of existing caries lesions and avoid the need for restorative treatment. SDF works by the combined effects of silver and fluoride on promoting remineralization, as a short-term germicide, and by inhibiting enzymes involved in collagen degradation, all of which result in an arrest of the carious process;[54,56] SDF is also being evaluated for preventing future caries.[57] A potential disadvantage of SDF is cosmetic concern due to the permanent dark discoloration of active caries lesions by the silver component. However, SDF will not discolor healthy enamel, and caries lesions themselves may be discolored. Based on its potential as a caries treatment, SDF has been granted "breakthrough therapy" designation by the FDA, providing the opportunity for expedited approval for this indication, and a number of clinical trials of SDF for treating or preventing caries are in progress.

Xylitol is a naturally occurring sugar alcohol that cannot be metabolized by the oral microflora and thus has the potential to reduce levels of caries-forming mutans streptococci in the plaque and saliva.[58] Xylitol can be administered topically (e.g., wipes) or via gum, lozenges, or snack foods. FDA allows foods (including chewing gums) that contain xylitol to make the following statement: "Xylitol may reduce the risk of tooth decay."[59] Other topical antimicrobials such as chlorhexidine varnish or gel and povidone-iodine rinses are not commonly used in the United States. Neither chlorhexidine nor povidone iodine has been approved by FDA for caries reduction or prevention.

Dental sealants are a thin coating applied to the chewing and other surfaces of the premolars and molars, providing a physical barrier with the ability to prevent cavities over a prolonged period of time. A variety of sealant materials are available, though the main materials are resins/composites and glass ionomers. Sealants are applied as a paste; following application sealants can be activated (cured) using light or chemicals; resulting in polymerization of the sealant material and hardening on the tooth surface (some sealants are autopolymerized [not requiring light or chemicals]). Resin-based sealants are classified into four generations, based on the method of polymerizations. First generation sealants utilized ultraviolet light for polymerization and are no longer used; second generation sealants are auto-polymerizing or chemically cured; third generation sealants are activated using visible light; and fourth generation sealants contain fluoride-releasing particles.[60] Glass ionomer sealants contain fluoride and can be classified as low or high viscosity; high viscosity sealants may have better retention on the tooth. Dental sealants are typically applied by dental health professionals in their office or in community settings such as schools.[61] Other interventions typically performed by dental health professionals to prevent dental caries or periodontal disease or to treat disease identified on screening which are considered beyond the scope of primary care practice include teeth

cleaning, plaque removal, and treatments for caries (fillings, crowns, root canals, tooth extractions) and periodontal disease (surgery and grafts).

A potential barrier to provision of oral health services in primary care settings is unfamiliarity with interventions, need for additional training or equipment (e.g., fluoride varnish, dental sealants, or silver diamine fluoride), and non-reimbursement; in addition, there are barriers to dental referrals from primary care.[62] However, some data in non-adult populations suggest that increased provision of an oral health intervention (fluoride varnish) in non-adult (children younger than 5 years of age) primary care settings is feasible.[63,64] For some interventions, state laws or regulations currently restrict administration to certain dental professionals (e.g., dental sealants can be placed by dentists, dental hygienists, and dental assistants [in certain states]), though such regulations do not apply to medical professionals.

Current Clinical Practice/Recommendations of Other Groups

The 2000 U.S. Surgeon General's report, *Oral Health in America,*[11] and 2021 update[7] highlight the importance of integrating oral health into primary care medical settings, primarily focusing on counseling, coordination, and referral. Reports from the Institute of Medicine in 2011 (*Advancing Oral Health in America*,[65] and *Improving Access to Oral Health Care for Vulnerable and Underserved Populations*[66]) and from the Health Resources and Services Administration in 2014 (*Integration of Oral Health and Primary Care Practice*[67]), also emphasized the importance of integrating oral health services in primary care medicine.

In 2013, the American Dental Association (ADA) recommended professionally applied 2.26 percent fluoride varnish or 1.23 percent fluoride (acidulated phosphate fluoride) gel in adults at elevated risk of developing caries, based on expert opinion.[68] In 2018, the American Academy of Family Physicians (AAFP) recommended physician education in oral condition screening and management, as well as the consequences of poor oral hygiene on overall health.[69] The AAFP also encouraged collaboration of family physicians with dental health practitioners to provide comprehensive medical care. The AAFP did not provide recommendations on specific oral health preventive interventions. In 2013, the American College of Obstetricians and Gynecologists (ACOG) recommended that women be routinely counseled about maintaining good oral health habits throughout their lives as well as the safety and importance of oral health care during pregnancy.[70] Other groups, such as Smiles for Life and Qualis Health, have also issued educational resources and recommendations on provision of oral health services in primary medical care settings.[42,71]

Disparities

Oral health disparities have been described with regard to race/ethnicity (Black, Hispanic, American Indian, and Alaska Native persons are disproportionately impacted), socioeconomic status,[72] insurance status, health literacy,[73] immigration status,[74] and educational level.[21,75] Populations with higher prevalence of dental caries and periodontal disease include pregnant persons, people with special needs, older adults, individuals living in rural and urban underserved areas, individuals without insurance, individuals with public insurance, and individuals experiencing homelessness.[66] In 2011 to 2016, the prevalence of untreated dental

caries among adults 20 to 64 years of age was approximately 28 percent in men and 24 percent in women, and 45 percent among those at less than 100 percent below the federal poverty threshold and 18 percent among those at greater than or equal to 200 percent of the federal poverty threshold.[21] The percentage of untreated dental caries among adults 20 to 64 years of age was approximately 22 percent in non-Hispanic White persons, compared with 40 percent in non-Hispanic Black persons and 37 percent among Mexican Americans. Periodontal disease is also more common in men than women (50% vs 35%), persons living below the federal poverty level (60%), and current smokers (62%).[76] (Additional details on oral health disparities are discussed in Contextual Question 2.)

Chapter 2. Methods

Key Questions and Analytic Framework

Using the methods developed by the USPSTF,[77] the USPSTF and the Agency for Healthcare Research and Quality (AHRQ) determined the scope and key questions for this review. Investigators created an analytic framework with the Key Questions and the patient populations, interventions, and outcomes reviewed for both screening (**Figure 1**) and prevention (**Figure 2**).

Screening Key Questions

1. How effective is screening for oral health performed by a primary care clinician in preventing negative oral health outcomes?
2. How accurate is screening for oral health performed by a primary care clinician in identifying adults who: a. Have oral health issues? b. Are at increased risk for future oral health issues?
3. What are the harms of screening for oral health performed by a primary care clinician?

Prevention 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?*
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?

*This is the same as Key Question 2b from the screening Key Questions.

Contextual Questions

Three Contextual Question were also requested by the USPSTF to help inform the report. Contextual Questions are not reviewed using systematic review methodology.

1. What is the association between presence or severity of dental caries in adults and pain, quality of life, function, and tooth loss/edentulism?
2. What factors (e.g., race/ethnicity, age, socioeconomic status, cultural factors, educational attainment, or health literacy) are associated with oral health care disparities in adults?
3. What is the effectiveness of primary care interventions to reduce oral health care disparities in adults?

Search Strategies

We searched the Cochrane Central Register of Controlled Trials and Cochrane Database of Systematic Reviews, and Ovid MEDLINE from database conception through September 2022 for relevant studies and systematic reviews. Search strategies are available in **Appendix A1.** We also reviewed reference lists of relevant articles. Ongoing surveillance was conducted to identify major studies published since September 2022 that may affect the conclusions or understanding of the evidence and the related USPSTF recommendation. The last surveillance was conducted on January 20, 2023 and identified no studies affecting review conclusions. Additional surveillance for new literature will be conducted on an ongoing basis.

Study Selection

At least two reviewers independently evaluated each study to determine inclusion eligibility. We selected studies on the basis of inclusion and exclusion criteria developed for each key question (**Appendix A2**). Disagreements were resolved by consensus. The selection of literature is summarized in the literature flow diagram (**Appendix A3**). **Appendix A4** lists included studies, and **Appendix A5** lists excluded studies with reasons for exclusion.

This review addresses screening, risk assessment, and preventive interventions for oral health in adults. Separate Analytic Frameworks address *screening* for oral health conditions and *prevention* of oral health conditions, to more clearly distinguish treatment of adults with existing dental caries identified by screening (Screening Analytic Framework) from treatment of those without dental caries to prevent the development of future caries (Prevention Analytic Framework).

For both Analytic Frameworks, the population was asymptomatic adults (≥18 years of age), including pregnant persons. Groups of interest were defined by age (<65 vs. ≥65 years), sex, gender, socioeconomic status, race/ethnicity, educational attainment, and health literacy. Studies that selected patients based on presence of caries were ineligible; however, given the very high prevalence of caries in U.S. adults, we did not exclude studies based on high baseline mean caries prevalence, if patients were not required to have caries to be enrolled. Screening interventions were oral examination or clinical assessment by a primary care provider, or risk assessment for dental caries or periodontal disease using a standardized risk assessment instrument. Risk assessment instruments that utilized findings from a dental professional oral exam or that utilized tests not commonly utilized in primary care (dental x-rays, salivary flow rates, levels of cariogenic bacteria) were excluded. Preventive interventions were oral health behavioral counseling, preventive medications (topical fluoride [varnish, foam, or gel], SDF, dental sealants, or xylitol), or referral of persons deemed at high risk for oral disease by a primary care provider to a dental professional. Comparisons were against placebo or no screening/treatment/referral. Dental X-rays were not addressed because they are not typically obtained in primary care settings or ordered by primary care clinicians. Outcomes were presence of and severity of caries (likelihood of developing caries [dichotomous outcome] or caries burden [continuous outcome, often measured based on the number of decayed, missing, or filled teeth [DMFT] or surfaces [DMFS]; the capital letters indicate permanent teeth or tooth surfaces), presence and severity of periodontal disease, morbidity, quality of life, functional status, and

harms of screening and treatment. Settings were primary care or primary care applicable; the preventive interventions selected for review were assessed as potentially primary care feasible (defined as not requiring extensive training to administer); studies of such interventions were considered potentially primary care applicable even if the intervention was administered in a dental care setting or by a dental health professional. Randomized trials were included for screening and preventive interventions; we also included cohort studies of screening and large cohort studies for dental fluorosis and studies on diagnostic accuracy of oral examination/clinical assessment and risk assessment instruments. In accordance with USPSTF procedures,[77] poor quality studies were excluded unless higher quality evidence was unavailable.

Data Abstraction and Quality Rating

For studies meeting inclusion criteria, we created data abstraction forms to summarize characteristics of study populations, interventions (including the specific drug, formulation or material used; dose; frequency; duration; and professional background or training of persons administering the intervention), comparators, outcomes, study designs, settings (including clinical setting, geographic status, and fluoridation status, if available), and methods. One investigator conducted data abstraction, which was reviewed for completeness and accuracy by another team member.

Predefined criteria were used to assess the quality of individual controlled trials, systematic reviews, and observational studies by using criteria developed by the USPSTF; studies were rated as "good," "fair," or "poor" per USPSTF criteria, depending on the seriousness of the methodological shortcomings (**Appendix A6**).[77] For each study, quality assessment was performed by two team members. Disagreements were resolved by consensus.

Data Synthesis

For all Key Questions, the overall quality of evidence was determined using the approach described in the USPSTF Procedure Manual.[77] Evidence was rated "good", "fair", or "poor" based on study quality, consistency of results between studies, precision of estimates, study limitations, risk of reporting bias, and applicability.[77]

For diagnostic accuracy, a bivariate mixed-effects binary regression model with xtmelogit in Stata 14.2 was used to summarize sensitivity and specificity of screening tests for simultaneously identifying those with periodontitis, severe periodontitis and caries from those without periodontitis, severe periodontitis and caries. This model produced summary values for sensitivity and specificity with corresponding 95 percent confidence intervals (CIs) and required at least four studies to pool. Meta-analyses were limited to studies that screened with a self-reported questionnaire on dental health due to sparse evidence for other forms of screening. The bivariate mixed-effects model was also used to create summary area under the receiver operator characteristic (AUROCs) curves with 95 percent CIs for both confidence and prediction contours using hierarchical methods. Statistical heterogeneity was assessed using the I^2, which does not depend on the number of the studies in the meta-analysis. However, due to few studies available for diagnostic accuracy meta-analyses, statistical heterogeneity was explored qualitatively.

Meta-analysis was not conducted for preventive interventions, due to small numbers of studies and methodological limitations in the available studies.

USPSTF and AHRQ Involvement

The authors worked with USPSTF members at key points throughout the review process to develop and refine the Analytic Frameworks and Key Questions and to resolve issues around scope for the final evidence synthesis.

AHRQ staff provided oversight for the project, coordinated the systematic review, reviewed the draft report, and assisted in an external review of the draft evidence synthesis.

Expert Review and Public Comment

We obtained input to inform the draft work plan from Key Informants to identify important subpopulations and inform the development of the scope and Key Questions. In addition, the draft Research Plan was posted on the USPSTF website for public comment from March 18, 2021, to April 14, 2021. In response, the USPSTF revised the inclusion criteria to clarify that screening is performed by a primary care provider and that preventive interventions are administered by a primary care provider or are feasible to be administered by a primary care provider. The USPSTF made no other changes.

The draft report was reviewed by content experts and collaborative partners (**Appendix A7**) and minor clarifications were made to the report. The report will also be posted for public comment and revised in response to comments before finalization.

Chapter 3. Results

A total of 16,177 references from electronic database searches and manual searches of recently published studies were reviewed and 312 full-text papers were evaluated for inclusion. We included a total of 16 studies (reported in 17 publications). Included studies and quality ratings are described in **Appendix B**.

Screening Key Questions

Key Question 1. How Effective Is Screening for Oral Health Performed by a Primary Care Clinician in Preventing Negative Oral Health Outcomes?

Summary

- Evidence from one poor-quality randomized controlled trial (RCT) was insufficient to determine effects of oral health screening of pregnant women by midwives versus no screening.

Evidence

Evidence on the effects of oral health screening versus no screening is very limited. We identified one RCT of screening versus no screening (**Appendix B Table 1**).[78] It was conducted in Australia (water fluoridation status not described; however, the study was conducted in Sydney, which is fluoridated) among pregnant persons in the first trimester and evaluated a midwife-led dental screening intervention versus no intervention (mean age 29 years, n=427, excluding participants randomized to a third [dental intervention] arm). For the screening intervention, midwives administered the maternal oral health screening instrument (consisting of two questions and an optional visual inspection of the oral cavity) and provided oral health education, with dental referrals for persons identified as being at high risk. Baseline caries status was not reported. At followup in the third trimester, there were no statistically significant differences between the midwife screening intervention versus no intervention in the mean number of decayed teeth (1.47 [standard deviation (SD) 2.51] vs. 2.01 [SD 2.55]) or filled teeth (3.06 [SD 3.94] vs. 2.09 [SD 2.53]). Measures of periodontal disease (clinical attachment loss or sulcus bleeding index) and birth outcomes (birth weight, preterm, or low birth weight) were very similar between groups. The trial was rated poor-quality; methodological limitations included open-label design, unclear allocation concealment methods, and high attrition (oral health outcomes assessed in 44% of participants randomized) (**Appendix B Table 2**).

Key Question 2a. How Accurate Is Screening for Oral Health Performed by a Primary Care Clinician in Identifying Adults Who Have Oral Health Issues?

Summary

- Self-reported questionnaires on perceived dental health were associated with a pooled sensitivity of 0.72 (95% CI 0.57 to 0.83, I^2=91%) and a specificity of 0.74 (95% CI 0.66 to 0.82, I^2=73%) for periodontitis (four studies, N=965), though statistical heterogeneity was substantial. The questionnaires were associated with fair discrimination (area under summary receiver operating characteristic [sROC] 0.79, 95% CI 0.75 to 0.83).
- One study (n=86) found primary care examination associated with high specificity for dental caries and periodontal disease, with low sensitivity for periodontal disease and variable sensitivity for caries.

Evidence

Screening Risk Instruments

Six studies (N=1,281, range 88 to 408) reported in seven publications assessed the diagnostic accuracy of a self-reported oral health questionnaire for periodontal disease in adults (**Appendix B Table 3**).[78-84] The reference standard was a dental exam,[79,81,83,84] intra-oral screening using the Community Periodontal Index of Treatment Needs (CPITN) by a dentist,[82] or radiographic evidence of periodontal disease.[80] Studies were conducted in a dental setting (e.g., dental hospital, clinic, or school)[79,80,83,84] or an outpatient medical setting.[78,81,82] Two studies were conducted in Germany,[80,83] two in the Netherlands,[82,84] one in Australia,[78,81] and one in China.[79] Three studies used the same or a similar 8-item questionnaire on self-perceived dental health,[79,82,84] one study used a more detailed 21-item questionnaire that also focused on self-perceived dental health,[80] one combined items on self-perceived dental health with patient demographics and smoking status,[83] and one assessed a brief (2-item) questionnaire in pregnancy.[81] In the studies, the prevalence of at least mild periodontitis ranged from 39 percent to 100 percent and severe periodontitis ranged from 20 percent to 39 percent. Mean study age ranged from 40 to 58 years, except for one study of pregnant persons in which the mean age was 29 years. All studies were rated fair-quality; common methodological limitations included unclear blinding of screeners to the reference standard and use of non-predefined thresholds for a positive screen (**Appendix B Table 4**). One study evaluated a non-representative spectrum (patients referred for endodontic surgery),[80] one study reported that a high proportion of patients did not undergo the reference standard,[78,81] and in two studies it was unclear if reference standard assessment was blinded to screening results.[83,84]

The questionnaire used by two studies (N=311)[82,84] consisted of eight self-reported items on dental health (**Table 1**); another study (n=408) used a similar but slightly modified questionnaire ("Do not know" added as a response; coronal scaling separated from root planing, and days per week not specified for questions 7 and 8).[79] A fourth study (N=246) used a 21-item questionnaire that also focused on self-reported dental health, but was more detailed.[80] There were some

differences in the issues addressed: while questions on flossing and mouthwash were not included in the 21-item questionnaire, it had additional items on malodor or bad taste in mouth, gum recession, gaps between teeth, and swollen gums. In each study, a logistic regression model was developed to predict the probability of periodontal disease based on the responses to the questionnaires; diagnostic accuracy was based on the optimum probability threshold (the probability providing the best combination of sensitivity and specificity). An issue that could reduce applicability of the questionnaires for screening is that they included items on prior treatment for periodontal disease.

A pooled analysis of 4 studies (N=965) found the screening questionnaires that focused on self-perceived dental health associated with a sensitivity of 0.72 (95% CI 0.57 to 0.83, I^2=91%) and a specificity of 0.74 (95% CI 0.66 to 0.82, I^2=73%) for periodontitis (defined as stage I through IV periodontitis, CPITN scores 3 and 4, moderate and severe periodontitis, or ≥2 teeth with Alveolar Bone Loss (ABL) ≥5 mm)[79,80,82,84] (**Figure 3**). The probability threshold ranged from 0.34 to 0.68 in three studies; the fourth study[80] did not report the probability threshold utilized. Statistical heterogeneity was substantial, particularly for sensitivity. Stratified and sensitivity analyses to evaluate potential sources of heterogeneity were limited by the small number of studies. One study[82] of an 8-item questionnaire administered in a medical setting reported lower sensitivity (0.49, 95% CI 0.38 to 0.60) compared to three studies conducted in dental settings (sensitivity ranged from 0.68 to 0.85), though its specificity (0.68, 95% CI 0.56 to 0.79) was within the range reported by the dental setting studies (range 0.63 to 0.84). A dental clinic setting study that used the identical 8-item questionnaire resulted reported similar specificity (0.63, 95% CI 0.48 to 0.76) but higher sensitivity (0.85, 95% CI 0.76 to 0.91).[84] The good-quality study, which evaluated a modified version of the 8-item questionnaire and was conducted in a dental setting, reported a sensitivity of 0.68 (95% CI 0.62 to 0.73) and specificity of 0.84 (95% CI 0.76 to 0.90).[79]

The questionnaires were associated with fair discrimination for distinguishing between persons with and without periodontitis (area under sROC 0.79, 95% CI 0.75 to 0.83)[79,80,82,84] (**Figure 4**).

When the analysis was limited to identification of more severe periodontitis (i.e., stage III/IV periodontitis, CPITN score 4, severe periodontitis, ≥3 teeth with ABL ≥6 mm) pooled sensitivity was somewhat lower and specificity somewhat higher than for any periodontitis, though confidence intervals overlapped (four studies, N=965, 0.68, 95% CI 0.61 to 0.75, I^2=40%; 0.80, 95% CI 0.71 to 0.87, I^2=90%, respectively; **Figure 5**). Focusing on the outcome of more severe periodontitis reduced statistical heterogeneity for sensitivity, although heterogeneity remained high for specificity. The probability threshold ranged from 0.16 to 0.30 in three studies; the fourth study[80] did not report the probability threshold.

Discrimination of the questionnaires for distinguishing persons with from those without severe periodontitis was similar to discrimination for any periodontitis (area under sROC 0.76, 95% CI 0.72 to 0.80) (**Figure 6**).[79,80,82,84]

One study (N=88) used a 7-item questionnaire that differed from the instruments in the meta-analysis;[83] therefore, it was not pooled with them. This questionnaire included items about gum bleeding and tooth mobility and five items on patient characteristics (age, gender, current and

past smoking, and education); the seven items in the questionnaire were used to generate a patient-reported Periodontitis Risk Score (pPRS, range 0 to 20). A cutoff of ≥7 on the pPRS was associated with an odds ratio for periodontal inflammation of 39.09 (95% CI 9.82 to 132), using the ADA's Periodontal Screening and Recording (PSR) by a dentist as the reference standard. The pPRS was associated with good discrimination for detecting periodontal inflammation (AUROC 0.86, 95% CI 0.76 to 0.95).

The sixth study (n=133) screened pregnant women during an antenatal visit and evaluated the Maternal Oral Screening tool, which consisted of two items: "Do you have problems in your mouth?" and "Have you seen a dentist in the last 12 months?;" it was also not included in the pooled analyses of the more detailed questionnaires on self-perceived dental health.[78,81] The 2-item screener was associated with sensitivity of 0.88 (95% CI 0.80 to 0.96) and specificity of 0.14 (95% CI 0.05 to 0.23) for a positive dental exam (defined as a PSR rating of at least 2, indicating early signs of periodontitis or presence of any tooth decay).[81]

Oral Health Exam

One good-quality study evaluated the diagnostic accuracy of an oral health exam in primary care (**Appendix B Tables 3 and 4**).[85] Eighty-six patients (mean age 66 years, 99% male) at a Veterans Affairs medical clinic were screened independently by two primary care providers (a physician internist and a physician, resident, or physician assistant). The reference standard was a same-day exam by a dentist. The prevalence of periodontal disease and caries was 37 percent and 18 percent, respectively. A primary care oral health exam was associated with high specificity (range, 0.80 to 0.93) for periodontal disease or caries; however, sensitivity was low for periodontal disease (0.56, 95% CI 0.38 to 0.74 and 0.42, 95% CI 0.24 to 0.56 for two examiners) and variable for caries (0.33, 95% CI 0.12 to 0.62 and 0.83, 95% CI 0.52 to 0.96) (**Table 2**).

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 studies addressed this Key Question that met inclusion criteria (examined screening for oral health accuracy performed by a primary care clinician in identifying adults at increased risk for future oral health issues).

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 versus no screening did not report harms.[78]

Prevention Key Questions

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?

As noted for Key Question 2b in the Screening Analytic Framework, no studies addressed this Key Question that met inclusion criteria.

Key Question 2. How Effective Is Oral Health Behavioral Counseling Provided by a Primary Care Clinician in Preventing Oral Health Issues?

No studies addressed this Key Question that met inclusion criteria.

Key Question 3. How Effective Is Referral by a Primary Care Clinician to a Dental Health Care Provider in Preventing Oral Health Issues?

No studies addressed this Key Question that met inclusion criteria.

Key Question 4. How Effective Are Preventive Interventions in Preventing Oral Health Issues?

Summary

- There was insufficient evidence from five poor-quality trials (N=971) with inconsistent results to determine effects of topical fluorides (varnish or gel/solution) in adults.
- Evidence from two poor-quality trials (one randomized and one non-randomized) was insufficient to determine effects of sealants in adults.
- SDF was more effective than placebo in reducing the number of new root caries lesions or fillings in older adults (mean difference -0.33 to -1.3 at 24 to 30 months in 3 RCTs, N=744) and reducing the likelihood of developing new root caries (adjusted OR 0.4, 95% CI 0.3 to 0.7 and RR 0.19, 95% CI 0.07 to 0.46 in 2 RCTs, N=478); all trials were conducted in Hong Kong.
- No study evaluated effects of xylitol for prevention.

Evidence

Topical Fluorides

Five trials evaluated topical fluorides (varnish or gels/solutions) versus placebo or no topical fluoride for prevention of dental caries in adults (**Appendix B Table 5**).[86-90] 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, two trials in the United States, and one trial in Hong Kong. The water fluoridation level was 0.5 parts per million (ppm) fluoride in the trial conducted in Hong Kong; water fluoridation status was not reported in the other trials. Three studies were published between 1993 to 2021 and two between 1955 to 1979. All five trials were rated poor-quality (**Appendix B Table 6**), but were included because higher quality evidence was unavailable. Only one trial was randomized;[86] the other trials were non-randomized 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. In addition to not being randomized, the other trials had high or unclear attrition and open-label design, with unclear baseline similarity of groups; in addition, all but two[87,88] of the trials did not adjust for potential confounders.

The randomized control trial[86] and one non-randomized trial[87] evaluated sodium fluoride varnish (22,600 ppm). The other trials evaluated sodium fluoride (2%) solution,[89] stannous fluoride (30%) paste followed by a stannous fluoride (10%) aqueous solution,[90] and acidulated phosphate fluoride (1.2%).[88] Three trials[86-88] focused on older adults; two trials[86,87] focused on older adults (mean ages 79 to 84 years) in residential or nursing homes and one trial[88] focused on older adults (60 years or older; mean age not reported) in the community. Two trials[89,90] focused on young adults (means ages 20 to 22 years) enrolled at college or a military training center. None of the studies reported race or ethnicity. In three trials[86,87,89] the proportion of women ranged from 61 percent to 100 percent; one trial[90] only enrolled men and one trial[88] did not report sex or gender. Water fluoridation status was described as "optimal" in one trial (set in the United States)[88] and not reported in the other trials. All patients in one trial[88] reported use of fluoridated dentifrices in addition to the study interventions; oral health behaviors were not reported in the other trials.

Fluoride Varnish

Two trials evaluated 22,600 ppm sodium fluoride varnish in older adults and reported inconsistent results. One randomized controlled trial (n=104)[86] performed in Hong Kong enrolled older adults in residential and nursing homes (mean age 79 years; mean decayed and filled surfaces (DFS)-root at baseline 2.2). It found application of sodium fluoride (22,600 ppm) varnish every three months associated with a non-statistically significant reduction in dental caries burden at 1 year (mean difference in new active caries or fillings of 0.7, $p>0.05$), though differences were larger and statistically significant at two (mean difference 1.8, $p<0.001$) and three (mean difference 1.6, $p<0.001$) years. Varnish was also associated with decreased risk of developing new caries (relative risk [RR] 0.25, 95% CI 0.10 to 0.63; number needed to treat [NNT] 3.1, 95% CI 2.1 to 7.7). One non-randomized cluster trial (n=232)[87] of older adults in long-term care facilities (mean age 84 years; mean DMFT of 21.5 in the intervention group and 21.87 in the control group) found sodium fluoride varnish (22,600 ppm) associated with no

difference in caries burden based on DMFT score at 1 year (adjusted mean difference -0.04, 95% CI -0.10 to 0.03).

Other Topical Fluorides

Three trials evaluated other topical fluorides. All were non-randomized or randomization was unclear. One non-randomized trial[90] (n=169) conducted in male college students in Poland (age 19 to 20; DMFS at baseline 18.83 and 20.06) found application of stannous fluoride (30%) paste followed by stannous fluoride (10%) aqueous solution every six months associated with decreased DMFS increment versus no treatment at 3 years (6.10 vs. 10.54, p<0.01). A non-randomized trial (n=148) conducted in women at a military training center in the United States (mean age 22 years; baseline caries status not reported) found application of sodium fluoride (2%) solution semi-weekly for 36 months associated with no difference versus placebo (sodium chloride 0.9%) in number of newly decayed teeth (0.95 vs 1.08, p=0.48) or likelihood of experiencing ≥1 new carious teeth (60% vs. 68%, RR 0.88, 95% CI 0.68 to 1.13) at 8 to 14 months.

One U.S. trial (randomization unclear) of adults 60 years and older (mean age not reported; n=318)[88] living in the community and with at least 15 remaining teeth (mean decayed root surfaces 1.3 vs. 1.3 at baseline; mean filled root surfaces 1.6 vs. 2.3 at baseline) found topical acidulated phosphate fluoride (1.2%) gel applied every three months associated with decreased caries burden, based on new root caries surface lesions (mean 1.36 vs. 1.99, p<0.05) and incremental DMFS (mean 0.27 vs. 0.91, p<0.05) at 48 months.[88]

Sealants

Two trials evaluated sealants versus no sealants in adults (**Appendix B Table 7**).[91,92] Both trials were rated poor-quality (**Appendix B Table 8**), but were included because higher quality evidence was unavailable. One trial was conducted in the United States and one trial in Europe. The trials evaluated fluoride or non-fluoride containing light-cured resin-based sealants applied by dental professionals to premolars and molars in young adults. Each used a split mouth design (paired teeth on different sides of the mouth allocated to different treatments). One trial[91] was randomized but did not report allocation concealment methods, and the other trial[92] was non-randomized. Other methodological limitations in the trials included open label design and failure to report attrition with no intention-to-treat analysis; additionally, the non-randomized trial did not adjust for confounders. Although the trials both found sealants associated with reduced risk of caries, the estimate was imprecise in one of the trials. Due to poor quality and imprecision, the evidence was insufficient to determine effects of sealants in adults.

The randomized trial (n=119; 719 tooth pairs) was conducted in the United States among military (submarine school) recruits (mean age 22 years, mean baseline DMFT 7.2).[91] It found non-fluoride-containing sealants associated with a non-statistically significant reduction in the proportion of teeth with caries, with a low rate of caries in both groups (1.7% vs. 2.6%, RR 0.63, 95% CI 0.31 to 1.29). In this trial, the sealant was either a commercially available sealant (Nuvaseal) or a non-commercially available tinted sealant (results were similar for both sealants). The non-randomized trial (n=59; 122 tooth pairs) was conducted in Turkey among dental students without clinically detectable caries.[92] Although participants who received

sealants received either fluoride-containing (Helioseal F) or non-fluoride containing (Concise Light Cure White Sealant) sealants, results were only reported for the sealant groups combined. Sealants were associated with a reduction in the proportion of teeth with caries (5.7% vs. 25.4% at 24 months, RR 0.23, 95% CI 0.10 to 0.49).

Silver Diamine Fluoride

Three RCTs evaluated SDF versus placebo for prevention of caries (**Appendix B Table 9**).[86,93,94] Sample sizes for the SDF versus placebo comparisons ranged from 155 to 323 (total N=744). The trials were all conducted among older adults (mean age 72 to 80 years) in Hong Kong (fluoridation 0.5 ppm) and focused on effects of SDF on root caries. At baseline, the mean number of decayed and filled root surfaces ranged from 0.8 to 2.0. Two trials[93,94] were restricted to community dwelling persons and one trial[86] included community dwelling persons and those living in nursing homes. In each of the trials, 38 percent SDF solution was administered by a dentist annually. One trial[94] reported that 88 percent of participants reported brushing twice or more daily and 87 percent used additional aids to clean teeth daily; in the other trials, oral health behaviors at baseline were not reported. In all of the trials, oral health education was provided to all participants. All trials were rated fair-quality; methodological limitations included unclear allocation concealment, unclear or no masking of care providers or patients, and high attrition with no analysis of patients with missing data (**Appendix B Table 10**).

At 2 to 3 years, SDF was associated with a decrease in the number of new root caries lesions or fillings versus placebo, with a mean reduction at 24 to 30 months of -0.33 to -0.48 in two RCTs[93,94] and -1.3 in the other RCT.[86] In the latter trial, the mean difference in new root caries lesions or fillings was -1.8 at 36 months.[86] Two trials also found SDF associated with decreased likelihood of a new root caries (adjusted odd ratio [OR] 0.4, 95% CI 0.3 to 0.7[93] and RR 0.19, 95% CI 0.07 to 0.46).[86] Two trials evaluated additional interventions used in addition to SDF.[93,94] One trial reported similar results for SDF and SDF plus topical potassium iodine (which may prevent staining).[93] Another trial found SDF plus an oral health intervention associated with slightly fewer new root caries surfaces than SDF without the oral health intervention (mean number of new root caries surfaces at 24 months 0.70 [standard error (SE) 0.11] vs. 1.00 [SE 0.16]).[94]

Xylitol

No study evaluated xylitol for prevention. One trial of xylitol versus placebo was excluded because it restricted enrollment to patients with caries at baseline (n=691).[95] It found a very small, non-statistically significant difference between xylitol lozenges versus placebo in D_2FS increment (annualized mean difference -0.32; incidence rate ratio 0.89, 95% CI 0.80 to 1.01).

Key Question 5. What Are the Harms of Specific Interventions (Behavioral Counseling, Referral, and Preventive Interventions) to Prevent Oral Health Issues?

Summary

- One trial (n=235) of fluoride varnish or SDF versus placebo reported no harms; eight other trials of oral health preventive interventions did not report harms.

Evidence

Reporting of harms of oral health preventive interventions was very limited. Of nine trials of oral health preventive interventions (topical fluorides [varnish or gels/solutions], sealants, and SDF) that met inclusion criteria for Key Question 4, only one trial reported harms. This trial (n=235) evaluated fluoride varnish or SDF versus placebo and stated "no major side effects or discomfort was reported."[86] Harms were unreported in the other eight trials of oral health preventive interventions. There were no trials of counseling versus no counseling or referral versus no referral and no cohort studies on risk of fluorosis following use of preventive interventions in adults.

Contextual Questions

Contextual Question 1. What Is the Association Between Presence or Severity of Dental Caries in Adults and Pain, Quality of Life, Function, and Tooth Loss/Edentulism?

No longitudinal studies evaluated the association between improvements in measures of dental caries or periodontal disease and health outcomes such as pain, quality of life, function, or tooth loss/edentulism. However, cross-sectional evidence indicates a negative association between dental caries and quality of life or function; evidence on periodontal disease is more mixed. Data also indicate an association between presence of dental caries and dental pain and dental caries or periodontal disease and tooth loss.

A systematic review of observational studies included three studies (N=15,326) of dental caries and seven studies (N=17,021) of periodontal disease.[96] Dental caries was negatively associated with health-related quality of life (HRQoL) after adjustment for key confounding factors in all three studies. The largest study (N=14,231) included in the systematic review, which accounted for 93 percent of patients, was conducted in South Korea and utilized the EuroQol-5D (EQ-5D) questionnaire.[97] It found a high DMFT index (≥7) associated with increased likelihood of self-reported problems with mobility (adjusted OR 1.18, $p<0.001$), usual activity (adjusted OR 1.19, $p<0.01$), and pain/discomfort (adjusted OR 1.16, $p<0.001$) domains on the EQ-5D, with no differences in self-care or anxiety/depression. The systematic review found presence of periodontitis (defined as a community periodontal index >3) associated with increased likelihood of self-reported problems with usual activity (adjusted OR 1.19, $p<0.001$), with no differences in

other EQ-5D domains. Another systematic review of 19 observational studies (15 studies on DMFT) in elderly populations (age 75 years and older) conducted in upper-middle income and higher-income countries found an association between higher DMFT scores and worse oral health related quality of life (OHQoL) (15 studies, OR 0.91, 95% CI 0.87 to 0.96, I^2=99%) and presence of periodontal disease and worse OHQoL (three studies, OR 1.38, 95% CI 1.15 to 1.62, I^2=2%).[98] A positive caries history was also associated with worse OHQoL, though the estimate was imprecise (five studies, OR 1.35, 95% CI 0.6 to 2.11, I^2=82%).[98] Another systematic review of 11 observational studies in pregnant persons (primarily conducted in low and middle income countries) found an association between higher DMFT and increased likelihood of poor quality of life (four studies, OR 1.40, 95% CI 1.24 to 1.55, I^2=41.4%).[99] In this review, periodontal disease was not associated with increased likelihood of poor quality of life (four studies, OR 0.83, 95% CI 0.28 to 1.38, I^2=72.9%).

Evidence also indicates an association between dental caries and pain. A large survey of adults (mean age 39 years) in Colombia (n=34,843) found presence of dental caries associated with a very large increase in likelihood of dental pain (OR 56.2, 95% CI 49.5 to 63.9).[100] Other, smaller studies also found an association between dental caries and dental pain, though the magnitude of increased risk was substantially smaller. A cross-sectional study of adult males in the Brazilian army (n=414) found presence of one or more untreated caries associated with increased likelihood of dental pain (adjusted OR 3.2, 95% CI 1.7 to 5.8).[101] A cross-sectional study of young adults in Mexico (n=638) found an association between DMFT index (OR 1.05, 95% CI 1.01 to 1.09) and number of decayed teeth (OR 1.09, 95% CI 1.02 to 1.16) and presence of dental pain; there was no association between number of filled teeth and presence of dental pain (OR 1.01, 95% CI .97 to 1.0).[102]

Dental caries and periodontal diseases are the most common causes of tooth loss. In U.S. studies (168 extractions, 389 extractions, or 839 patients) the proportion of tooth extractions due to dental caries ranged from 37 to 63 percent and the proportion due to periodontal disease ranged from 29 to 51 percent.[103-105] A large study conducted in France (14,621 extractions) found dental caries to be the most common reason for tooth extractions overall (49%), followed by periodontal disease (32%).[106] However, among persons >50 years of age, periodontal disease was the most common reason for extraction. Similar results were reported in a study conducted in Scotland.[107]

Contextual Question 2. What Factors (e.g., Race/Ethnicity, Age, Socioeconomic Status, Cultural Factors, Educational Attainment, or Health Literacy) Are Associated With Oral Health Care Disparities in Adults?

A number of factors have been associated with oral health care disparities in U.S. adults; these factors likely relate to decreased access to dental care and presence of other negative social determinants of health. Based on National Health and Nutrition Examination Survey (NHANES) 2011 to 2016 data,[21] the prevalence of untreated tooth decay was highest in persons 20 to 34 years of age (29.3%), non-Hispanic Black persons (40.2% in those 20 to 64 years of age and 29.1% in those >65 years of age), and Mexican American persons (37.1% in those 20 to 64 years

of age and 35.9% in those >65 years of age); by comparison, the prevalence of untreated tooth decay in non-Hispanic White persons was 22.2 percent among those 20 to 64 years of age and 13.4 percent among those >65 years of age. There was also an association between older age and higher caries burden (mean DMFT increasing from 6.7 for those 20 to 34 years of age to 17.8 for those ages 75 years and older) and edentulism (1.6% for those 35 to 49 years of age to 22.5% for those 75 years and older). Among persons >65 years of age, the group with the highest prevalence of edentulism was non-Hispanic Black Americans (30.7%); in non-Hispanic White and Mexican Americans the prevalence was 15.2 percent and 16.7 percent, respectively. There was also an association between socioeconomic status and likelihood of edentulism, with higher prevalence among those at less than 100 percent of the Federal poverty level (FPL) or 100 to 199 percent of the FPL (34.1% and 26.1%, respectively) than those at 200 percent or greater of the FPL (10.7%).

Similar factors were associated with disparities in periodontal disease. Based on NHANES 2009 to 2014 data,[76] periodontitis was present in 42.2 percent of Americans ages 30 years and older (7.8% had severe periodontitis) (**Table 3**). The prevalence of periodontitis increased with age (29.5% for those age 30 to 44 years, 46.0% for those age 45 to 64 years, and 59.8% for those age 65 years and older), was higher for males than females (50.2% versus 34.6%, respectively), was lower for non-Hispanic White persons (37.0%) compared to those of other races and ethnicities (non-Hispanic Black 56.6%, Mexican American 59.7%, other race including multiracial 46.2%), and increased with lower socioeconomic status (<100% FPL 60.4%, 100 to 199% FPL 53.6%, 200 to 399% FPL 44.6%, >400% FPL 28.6%).

Evidence on the association between social determinants of health other than socioeconomic status and oral health disparities in adults is limited. A systematic review of 25 observational studies (17 conducted in the U.S.) found no association between oral health literacy and oral health behaviors, oral health perception, or dental treatment outcomes; however, most studies in the review were rated as having a high risk of bias.[108] A systematic review of 42 observational studies examined the impact of acculturation on oral health among immigrants and ethnic minorities and found a positive association between higher acculturation and better oral health outcomes, oral health behaviors, dental care utilization, and dental knowledge.[109] The most commonly used indicators of acculturation were language spoken and length of stay in the host country.

Contextual Question 3. What Is the Effectiveness of Primary Care Interventions to Reduce Oral Health Care Disparities in Adults?

Evidence on the effectiveness of primary care interventions to reduce oral health care disparities in adults was very limited. One U.S. trial found that an oral health education intervention to improve oral health in low-income pregnant women increased likelihood of attending a dental visit, but did not report dental caries or other health outcomes.[110] No other study evaluated interventions in U.S. primary care settings to reduce oral health care disparities.

Chapter 4. Discussion

Summary of Review Findings

Table 4 summarizes the evidence reviewed for this report. Dental caries and periodontal disease are common in U.S. adults and often remain untreated, potentially resulting in adverse oral and other health outcomes. Disparities in oral health, related in part to social determinants including inadequate access to dental services, suggest a potential role for primary care providers in oral health screening and prevention. This report updates and expands upon a 1996 USPSTF recommendation on oral health counseling by addressing oral health screening and prevention in adults. It complements other USPSTF reviews on oral health topics, including a concurrent review on oral health screening and prevention in children and adolescents 5 to 18 years of age[10] and prior USPSTF reviews on dental caries screening and prevention in children less than 5 years of age[8] and on screening for oral cancer.[9]

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.[78] Six studies evaluated questionnaires for assessing presence of periodontal disease. The questionnaires were based on self-report and appeared feasible for use in primary care settings; however, four of the six studies were conducted in dental care settings and prevalence of periodontal disease was high. In four studies that evaluated questionnaires similar enough to pool, diagnostic accuracy was moderate (pooled sensitivity 0.72, 95% CI 0.57 to 0.83 and pooled specificity 0.74, 95% CI 0.66 to 0.82).[79,80,82,84] The questionnaires included items on prior treatment for periodontal disease, which could limit applicability to screening. Two other studies evaluated questionnaires that included items not addressed in the pooled questionnaires (age, gender, smoking status, and educational level; AUROC 0.86, 95% CI 0.76 to 0.95)[83] or only included two items evaluated in pregnant persons (sensitivity 0.88 and specificity 0.14).[78,81] Evidence on accuracy of the primary care oral health examination was limited to one study that reported low specificity (0.56 and 0.68, based on two primary care examiners) for periodontal disease and high specificity (0.83 and 0.81) for dental caries, with variable sensitivity (range 0.33 to 0.93).[85] No study evaluated the accuracy of questionnaires for identification of dental caries or the accuracy of questionnaires or oral health examination for identifying persons at high risk for future development of caries or periodontal disease. Although caries risk prediction instruments exist, they did not meet inclusion criteria because they utilized dental examination and tests not administered in primary care (x-rays, cariogenic bacteria levels, salivary flow rates); furthermore, most instruments were primarily designed for assessment of young children.[111,112]

Evidence on preventive interventions was also limited. There were no trials of primary care counseling versus no counseling or primary care referral to a dental professional versus no referral. Regarding preventive interventions, three RCTs conducted in China found SDF associated with lower number of new root caries lesions or filling versus placebo in older adults (mean difference -0.33 to -1.3 at 24 to 30 months).[86,93,94] Evidence for sealants (two trials)[91,92] and topical fluorides (varnish or gels/solutions; 5 trials)[86-90] was insufficient, as all trials had serious methodological limitations (including non-randomized design, open-label design, and high attrition), with inconsistency in the topical fluoride trials. There were no trials of xylitol for

prevention (one randomized trial of adults with existing caries that did not meet inclusion criteria found no beneficial effects of xylitol)[95] and harms were poorly reported (one trial of fluoride varnish or SDF reported no harms[86] and eight other trials of topical fluorides, sealants, and SDF did not report harms). No study reported harms of exposure to a fluoride preventive intervention in adults versus no exposure and risk of fluorosis.

Limitations

There were important limitations in the evidence available to address the benefits and harms of primary care oral health screening and prevention. The greatest issue was the overall paucity of evidence. The only primary care relevant study of oral health screening versus no screening was conducted in pregnant persons, there was only one study on the accuracy of the primary care oral health examination, there were no studies on accuracy of questionnaires for identification of persons with dental caries or on identification of persons at risk for future oral health issues, and there were no studies of primary care counseling versus no counseling or primary care referral to a dental professional versus no referral. Trials of oral health primary care intervention focused on caries outcomes, with no trials evaluating effects on periodontal or health outcomes (quality of life, tooth loss/edentulism) and studies were not designed to evaluate effects on clinical conditions associated with poor oral health such as adverse cardiovascular or cognitive outcomes. In addition, studies of topical fluorides and sealants had serious methodological limitations, and reporting of harms in the trials was very poor. Importantly, several factors may also reduce applicability of the available evidence to U.S. primary care practice. First, the preventive interventions were administered by dental professionals in all trials, with unknown effectiveness and feasibility in primary care settings. Second, all three trials of fluoride gels and solutions and one of two trials of sealants were published between 1993 and 1995, when the prevalence of dental caries and periodontal disease was higher. Third, all trials of SDF were conducted in older adults in China, where oral health behaviors and dental care may differ from the United States, in an area with suboptimal water fluoridation (0.5 mg/L; the U.S. Public Health Service recommends an optimal concentration of 0.7 mg/L).[113] Fourth, water fluoridation levels, provision of oral health education, and oral health behaviors were not consistently reported by the trials, although these factors could impact the effectiveness of oral health preventive interventions.

There were also potential limitations in the review methods. First, we excluded non-English language articles, which could result in language bias. However, we did not identify non-English language articles that appeared likely to impact conclusions. Second, we did not search for studies published only as abstracts. Third, we were unable to assess for publication bias with graphical or statistical methods for small sample effects, due to small numbers of studies with serious methodological limitations.[114] Fourth, we did not perform meta-analysis for preventive interventions, also because of small numbers of studies with serious methodological limitations. Fifth, we did not evaluate the effectiveness of tooth brushing or flossing, as these are performed outside the primary care setting and routinely recommended. Rather, the review addressed the effectiveness of counseling on oral health, including counseling on tooth brushing, flossing and diet.

Emerging Issues/Next Steps

SDF was cleared for U.S. marketing by the FDA in 2014 as a desensitizing agent in adults.[55] Although it has been used to arrest existing caries, this use is off-label. Similarly, use of SDF for prevention of caries is also off-label. In 2022, the American Medical Association approved a Current Procedural Terminology (CPT) code for provision of SDF by non-dental healthcare professionals, which may facilitate reimbursement in primary care settings.[115] A potential disadvantage of SDF is permanent dark discoloration of active caries lesions by the silver component, which may impact acceptability. However, active caries lesions themselves may be discolored, and may result in other cosmetic consequences.

There are also barriers to administration of oral health preventive interventions such as varnish, sealants, or SDF in primary care settings, including the need for additional training and equipment. Even if such interventions are effective in dental settings, the effectiveness, feasibility, acceptability and uptake (by clinicians and patients) in adult primary care settings is unknown. There is some evidence of increased uptake of primary care administration of fluoride varnish by primary care clinicians in young (<5 years) children,[116] suggesting feasibility in other (e.g., adult) primary care settings. Applying SDF is considered similar in terms of technical difficulty to applying varnish.[117] However, sealant application is more technically challenging than varnish application and evidence on implementation by non-dental professionals in primary care settings is lacking. Prior to implementation, it would also be important to clarify reimbursement of primary care clinicians for provision of oral health preventive interventions.

Relevance for Priority Populations

Disparities among adults in oral health have been described with regard to age, race/ethnicity, socioeconomic status, insurance status, health literacy, immigration status, educational level, pregnancy status, and living in rural and urban underserved areas.[21,66,75] The relevance of evidence on primary care oral health screening and prevention to priority populations defined by age, race/ethnicity, socioeconomic status, pregnancy status, and other social determinants is limited. Although the only trial of screening was conducted in pregnant persons, it was poor quality.[78] All trials of SDF for prevention focused on older adults and root caries.[86,93,94] However, there was no evidence on how effectiveness of oral health screening or preventive interventions varied according to age, race/ethnicity, socioeconomic status, or other social determinants.

Future Research

Research is needed on benefits and harms of primary care screening versus no screening, primary care counseling versus no counseling, and primary care referral to a dental professional versus no referral. Research is also needed to clarify benefits and harms of oral health preventive interventions including topical fluorides, sealants, and SDF, particularly when they are administered in primary care settings. Importantly, studies of oral health preventive interventions should describe the training and equipment utilized when they are administered in primary care settings and studies on primary care referral should describe approaches to facilitate coordination between primary care and dentistry, in order to inform future implementation efforts. Trials

should report water fluoridation levels, oral health behaviors (e.g., tooth brushing), provision of oral health education, and baseline oral health status, so that the context in which effective interventions are delivered are better understood. Studies should enroll representative populations including those disproportionately impacted by poor oral health, and should be conducted in high prevalence settings (e.g., low socioeconomic status, high oral health burden, rural and urban underserved settings). Research is needed on the accuracy of questionnaires that can be used for screening in primary care settings to identify persons more likely to have dental caries or periodontal disease. For questionnaires to be most useful for screening, they should not include items on prior diagnosis or treatment of oral health issues. For preventive interventions, studies on factors for predicting future oral health issues would be helpful for identifying those who may benefit more from preventive interventions. In addition to outcomes related to oral health such as caries burden, trials should assess and report outcomes related to quality of life, tooth loss/edentulism, and function as well as harms; research is also needed to determine effectiveness of screening or prevention of periodontal disease.

Conclusions

SDF improved root caries outcomes in older adults when administered by dental professionals. Screening questionnaires were associated with moderate diagnostic accuracy for periodontal disease; evidence on the accuracy of the primary care oral health exam was limited and estimates varied. Research is needed to determine benefits and harms of screening, primary care counseling, dental referral, and oral health preventive interventions administered in primary care settings.

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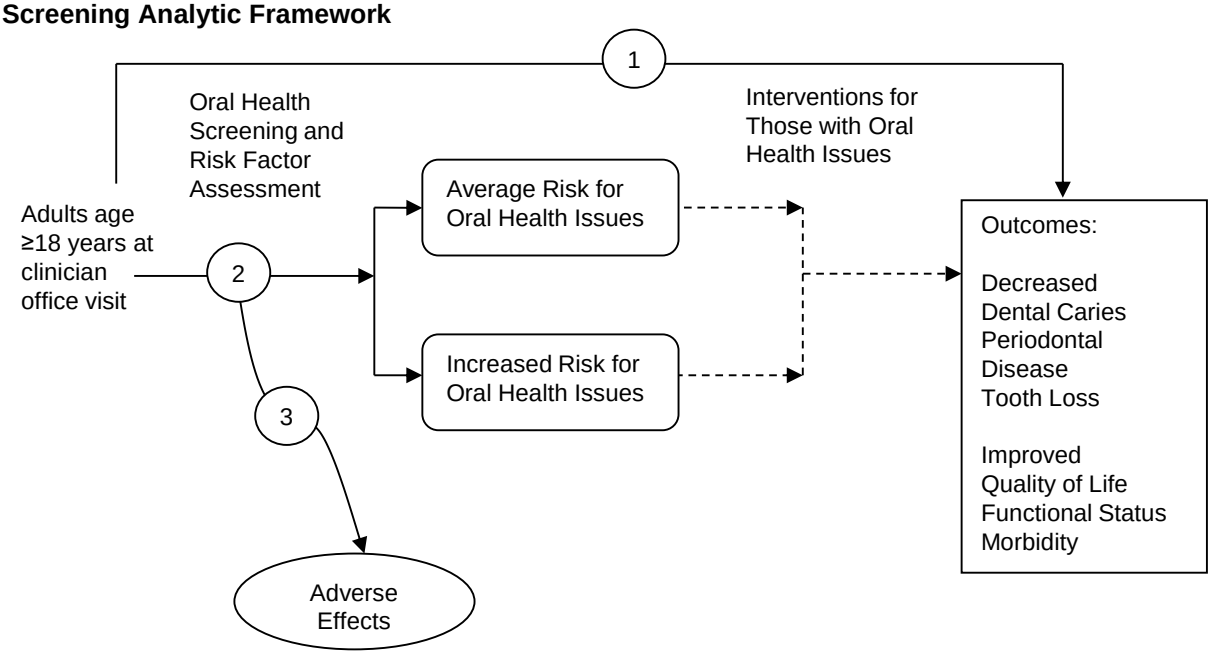
Figure 1. Analytic Framework and Key Questions: Screening for Oral Health in Adults Age 18 Years and Older

Screening Analytic Framework

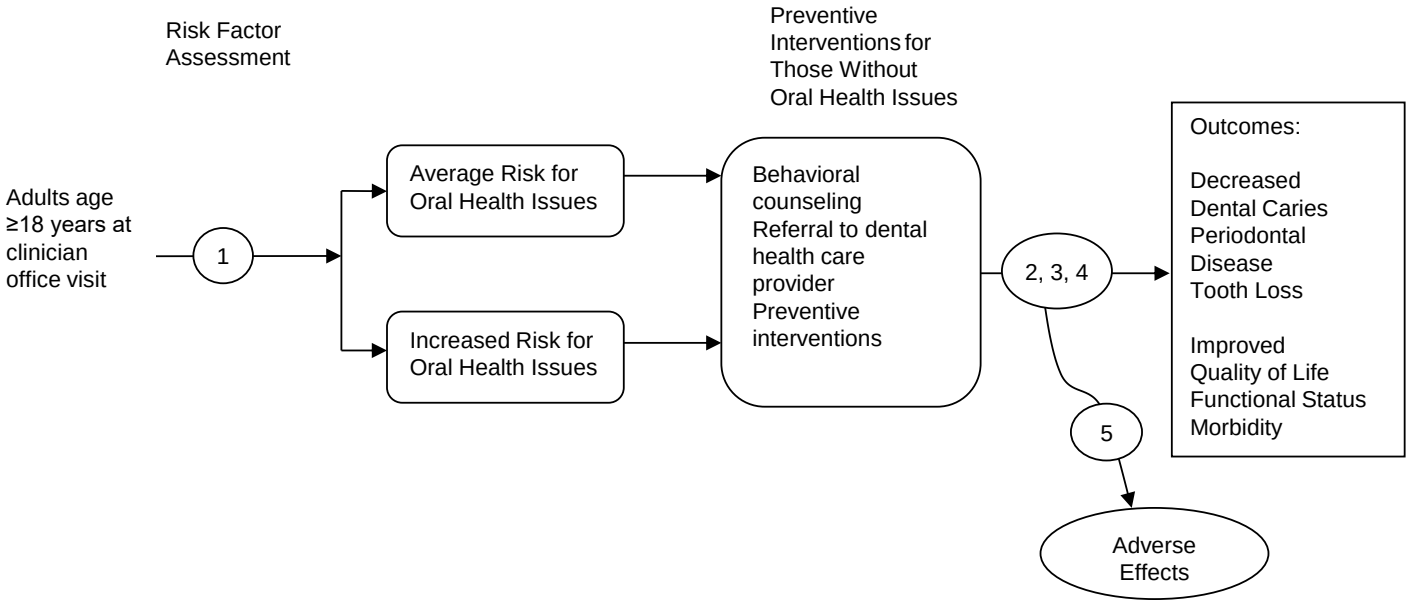


Screening Key Questions:

1. How effective is screening for oral health performed by a primary care clinician in preventing negative oral health outcomes?
2. How accurate is screening for oral health performed by a primary care clinician in identifying adults who:
   a. Have oral health issues?
   b. Are at increased risk for future oral health issues?
3. What are the harms of screening for oral health performed by a primary care clinician?

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

Prevention Analytic Framework

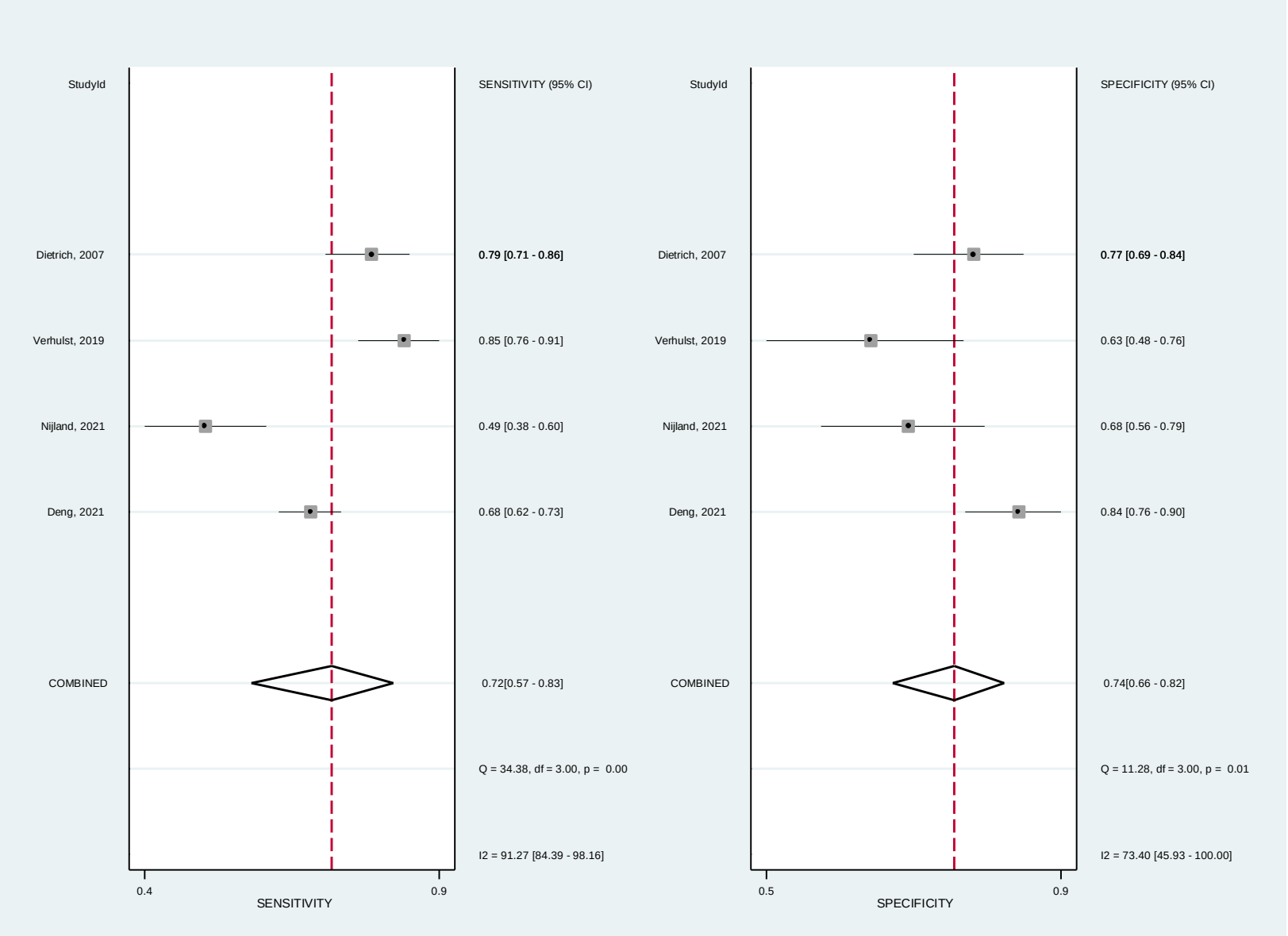


Prevention Key Questions:

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

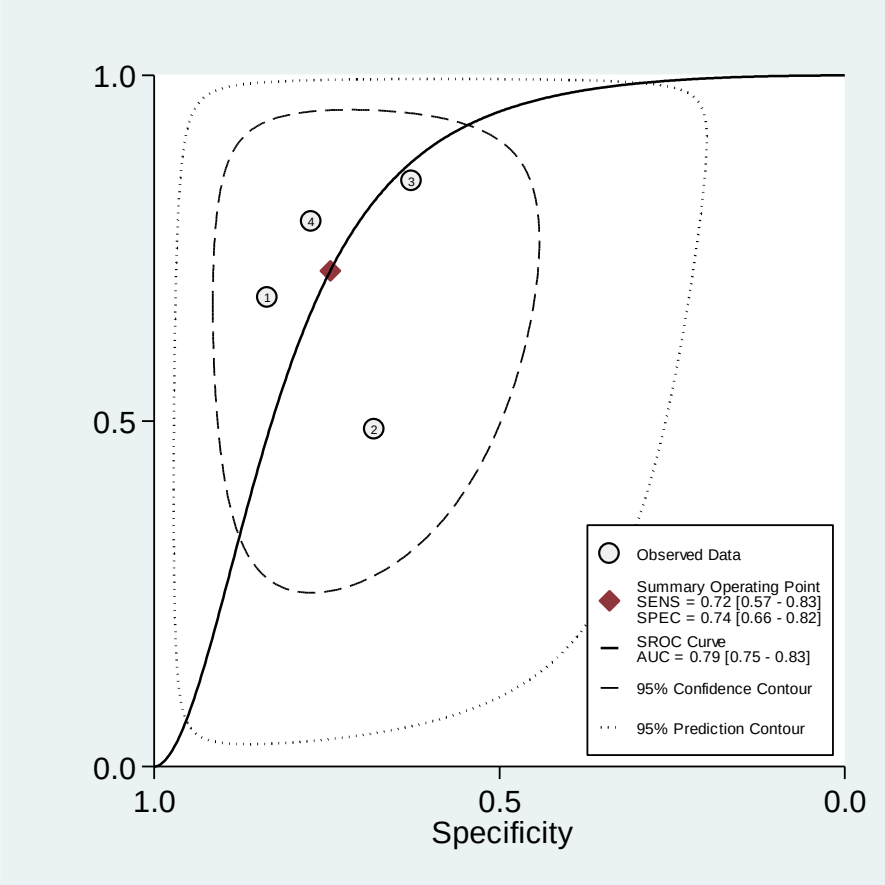
*This is the same as Key Question 2b from the previous Analytic Framework.

Figure 3. Sensitivity and Specificity of Questionnaire for Periodontitis



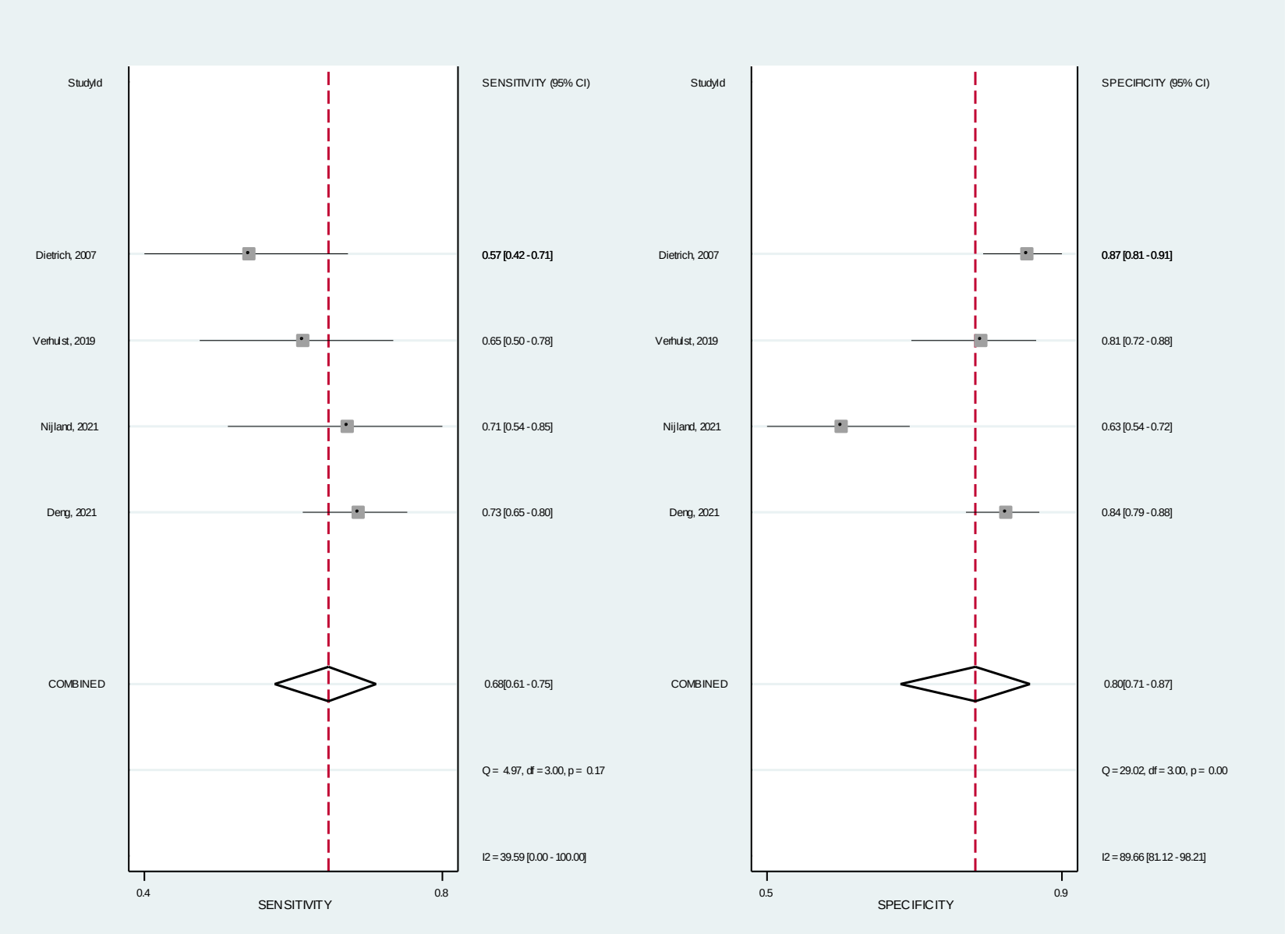
Abbreviations: CI = confidence interval; df = degrees of freedom.

Figure 4. sROC for Periodontitis vs. No Periodontitis



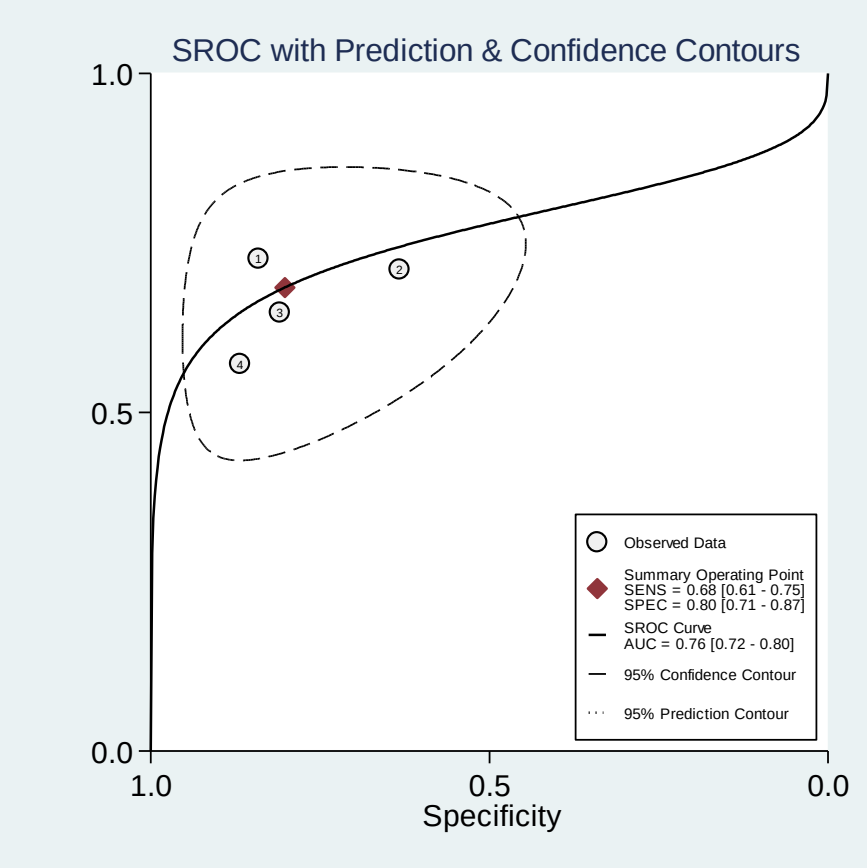
Abbreviations: AUC = area under curve; SENS = sensitivity; SPEC = specificity; sROC=summary receiver operating characteristic.

Figure 5. Sensitivity and Specificity of Questionnaire for Severe Periodontitis



Abbreviations: CI = confidence interval; df = degrees of freedom.

Figure 6. sROC Curve for Severe Periodontitis vs. No Severe Periodontitis



Abbreviations: AUC = area under curve; SENS = sensitivity; SPEC = specificity; sROC=summary receiver operating characteristic.

Table 1. Self-Reported Oral Health Questionnaire

Item #	Question	Possible Responses
1	Do you think you might have gum disease?	Yes No
2	Overall, how would you rate the health of your teeth and gums?	Poor Fair Good Very good Excellent
3	Have you ever had treatment for gum disease such as scaling and root planning, sometimes called “deep cleaning”?	Yes No
4	Have you ever had any teeth become loose on their own, without an injury?	Yes No
5	Have you ever been told by a dental professional that you lost bone around your teeth?	Yes No
6	During the past three months, have you ever noticed a tooth that doesn’t look right?	Yes No
7	Aside from brushing your teeth with a toothbrush, in the last seven days, how many times did you use dental floss or any other device to clean between your teeth?	1-7 days/week Never
8	Aside from brushing your teeth with a toothbrush, in the last seven days, how many times did you use mouthwash or other dental rinse product that you use to treat dental disease or dental problems?	1-7 days/week Never

Source: Nijland 2021[82] and Verhulst 2019[84]

Table 2. Sensitivity and Specificity for Periodontal Disease and Caries

Disease	Screener	Sensitivity (95% CI)	Specificity (95% CI)
Periodontal Disease	Clinician 1	0.56 (0.38 to 0.74)	0.87 (0.75 to 0.95)
	Clinician 2	0.42 (0.24 to 0.56)	0.84 (0.71 to 0.92)
Caries	Clinician 1	0.33 (0.12 to 0.62)	0.93 (0.84 to 0.98)
	Clinician 2	0.83 (0.52 to 0.96)	0.80 (0.69 to 0.89)

Source: Westman 1994[85]

Table 3. NHANES Data for Oral Health

Outcome	Results
Dental Caries Years 2011-2016[118]	Prevalence of adults ages 20-64 with dental caries: By age: 20-34 vs 35-49 vs 50-64: 82.0% vs 92.5%* vs 96.4%* By gender: male vs female: 88.2% vs 91.5%* By race and ethnicity: Non-Hispanic White vs Non-Hispanic Black vs Mexican American: 91.5% vs 86.1%* vs 86.6%* By poverty status (federal poverty level): <100% FPL vs 100-199% FPL vs >or=200% FPL: 88.0%* vs 89.3% vs 90.2% Prevalence of adults ages >65 years with dental caries: By age: 65-74 vs >or=75: 96.4% vs 96.0% By gender: male vs female: 96.1% vs 96.3% By race and ethnicity: Non-Hispanic White vs Non-Hispanic Black vs Mexican American: 98.2% vs 85.7%* vs 85.3%* By poverty status (federal poverty level): <100% FPL vs 100-199% FPL vs >or=200% FPL: 88.1%* vs 94.0%* vs 98.2%
Untreated Tooth Decay Years 2011-2016[118]	Prevalence with untreated tooth decay: By age: 20-34 vs 35-49 vs 50-64: 29.3% vs 26.4%* vs 21.5%* By gender: male vs female: 28.0% vs 24.3%* By race and ethnicity: Non-Hispanic White vs Non-Hispanic Black vs Mexican American: 22.2% vs 40.2%* vs 37.1%* By poverty status (federal poverty level): <100% FPL vs 100-199% FPL vs >or=200% FPL: 45.3%* vs 37.0%* vs 17.7% Prevalence of adults >65 years with untreated tooth decay: By age: 65-74 vs >or=75: 15.4% vs 16.5% By gender: male vs female: 18.0% vs 14.2%* By race and ethnicity: Non-Hispanic White vs Non-Hispanic Black vs Mexican American: 13.4% vs 29.1%* vs 35.9%* By poverty status (federal poverty level): <100% FPL vs 100-199% FPL vs >or=200% FPL: 33.1%*26.9%* vs 9.9%
DMFT Years 2011-2016[118]	DMFT, mean (SE) of adults ages 20-64: By age: 20-34 vs 35-49 vs 50-64: 6.7 (0.12) vs 9.4 (0.15)* vs 12.7 (0.13)* By gender: male vs female: 9.0 (0.12 vs 9.6 (0.11)* By race and ethnicity: Non-Hispanic White vs Non-Hispanic Black vs Mexican American: 9.4 (0.13) vs 9.1 (0.17) vs 8.7 (0.20)* By poverty status (federal poverty level): <100% FPL vs 100-199% FPL vs >or=200% FPL: 10.0 (0.17)* vs 9.9 (0.15)* vs 9.0 (0.11) DMFT, mean (SE) of adults >65 years: By age: 65-74 vs >or=75: 15.9 (0.21) vs 17.8 (0.21)* By gender: male vs female: 16.6 (0.22) vs 16.9 (0.17) By race and ethnicity: Non-Hispanic White vs Non-Hispanic Black vs Mexican American: 16.8 (0.17) vs 16.2 (0.40) vs 14.6 (0.60)* By poverty status (federal poverty level): <100% FPL vs 100-199% FPL vs >or=200% FPL: 16.5 (0.42) vs 17.0 (0.29) vs 16.8 (0.19)
Edentulism Years 2011-2016[118]	Percentage of adults aged 20–64 years who have lost all their natural teeth: By age: 20-34 vs 35-49 vs 50-64: NR vs 1.6% vs 5.6% By gender: male vs female: 2.2% vs 2.1% By race and ethnicity: Non-Hispanic White vs Non-Hispanic Black vs Mexican American: 2.4% vs 2.3% vs 0.7%* By poverty status (federal poverty level): <100% FPL vs 100-199% FPL vs >or=200% FPL: 6.1%* vs 3.7%* vs 1.1% Percentage of adults >65 years who have lost all their natural teeth: By age: 65-74 vs >or=75: 13.0% vs 22.5%* By gender: male vs female: 17.7% vs 16.9% By race and ethnicity: Non-Hispanic White vs Non-Hispanic Black vs Mexican American: 15.2% vs 30.7%* vs 16.7% By poverty status (federal poverty level): <100% FPL vs 100-199% FPL vs >or=200% FPL: 34.1%* vs 26.1%* vs 10.7%

Table 3. NHANES Data for Oral Health

Outcome	Results
Periodontitis Years 2009-2014 [76]	Periodontitis: Adults ages >or=30 years: 42.2% By severity: Mild or moderate vs severe periodontitis: 34.4% vs 7.8% By age: 30-44 vs 45-64 vs >or=65: 29.5% vs 46.0%† vs 59.8%† By gender: male vs female: 50.2%† vs 34.6% By race and ethnicity: Non-Hispanic White vs Non-Hispanic Black vs Mexican American vs other Hispanic vs other race including multiracial: 37.0% vs 56.6%† vs 59.7%† vs 48.5%† vs 46.2%‡ By poverty status (federal poverty level): <100% FPL vs 100-199% FPL vs 200-399% FPL vs >400% FPL: 60.4%† vs 53.6%† vs 44.6%† vs 28.6%

Abbreviations: DMFT = decayed, missing, and filled teeth; FPL = federal poverty level; NR = not reported; SE = standard error.
* $p<0.05$; † $p<0.001$; ‡ $p<0.01$.

Table 4. Summary of Evidence: Oral Health in Adults Age 18 Years and Older

Analytic Framework	Key question	Number of studies (k) Number of participants (n) Study design	Summary of findings by outcome	Consistency/ precision Reporting bias	Overall quality	Body of evidence limitations	Strength of evidence	Applicability
Screening	KQ 1 Screening effectiveness	k=1 N=427 RCT	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
	KQ 2 Screening accuracy a. Identification of existing oral health issues b. Identification of persons at increased risk for future oral health issues	a. Questionnaires: k=6 N=1,281 Oral health exam: k=1 N=86 b. No studies	Questionnaires: Pooled sensitivity 0.72 (95% CI 0.57 to 0.83) and pooled specificity 0.74 (95% CI 0.66 to 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 of 0.86 [95% 0.76 to 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 exam (1 study): For periodontal disease, sensitivity 0.42 and 0.56 and specificity 0.84 and 0.87; for dental caries, sensitivity 0.33 and 0.83 and specificity 0.80 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	5 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
	KQ 3 Screening harms	No studies	--	--	--	--	--	--

Table 4. Summary of Evidence: Oral Health in Adults Age 18 Years and Older

Analytic Framework	Key question	Number of studies (k) Number of participants (n) Study design	Summary of findings by outcome	Consistency/ precision Reporting bias	Overall quality	Body of evidence limitations	Strength of evidence	Applicability
Prevention	KQ 1 Screening accuracy* (Identification of persons at increased risk of future caries)	No studies	--	--	--	--	--	--
	KQ 2 Behavioral counseling	No studies	--	--	--	--	--	--
	KQ 3 Referral	No studies	--	--	--	--	--	--
	KQ 4 Preventive interventions - *Topical fluorides (varnish or gel/solution)*	k=5 N=971 1 RCT and 4 non-randomized (or randomization unclear) trials	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 two trials focused on young adults; two 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)

Table 4. Summary of Evidence: Oral Health in Adults Age 18 Years and Older

Analytic Framework	Key question	Number of studies (k) Number of participants (n) Study design	Summary of findings by outcome	Consistency/ precision Reporting bias	Overall quality	Body of evidence limitations	Strength of evidence	Applicability
Prevention	KQ 4 Preventive interventions - *Sealants*	k=2 N=178 1 RCT and 1 non-randomized trial	Sealants associated with decreased likelihood of caries (RR 0.63, 95% CI 0.31 to 1.29) or proportion of teeth with caries (RR 0.23, 95% CI 0.10 to 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); one trial published in 1979; sealants administered by dental professionals
	KQ 4 Preventive interventions - *SDF*	k=3 N=744 RCTs	SDF associated with decreased new root caries lesions or fillings versus placebo (3 trials, mean reduction -0.33 to -1.8 at 24 to 30 months)	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 one trial in persons living in community or nursing homes); SDF administered by dental professionals
	KQ 4 Preventive interventions - *Xylitol*	No studies	--	--	--	--	--	--

Table 4. Summary of Evidence: Oral Health in Adults Age 18 Years and Older

Analytic Framework	Key question	Number of studies (k) Number of participants (n) Study design	Summary of findings by outcome	Consistency/ precision Reporting bias	Overall quality	Body of evidence limitations	Strength of evidence	Applicability
Prevention	KQ 5 Harms of preventive interventions	k=1 N=235 RCT	Study states, "No major side effects or discomfort were reported"	Unable to assess inconsistency (1 trial) Imprecise Potential reporting bias (1 of 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 SDF

*This is the same as KQ 2b from the screening framework.
Abbreviations: AUROC = area under the receiver operating characteristic; CI = confidence interval; KQ = key question; RCT = randomized controlled trial; RR = relative risk; SD = standard deviation; SDF = silver diamine fluoride.

Oral Health Overall

Database: EBM Reviews - Cochrane Database of Systematic Reviews

1 ("oral health" or "oral disease*" or "dental caries" or "tooth decay" or "periodontal disease" or periodontitis or gingivitis or "gum disease").ti.
2 limit 1 to full systematic reviews
3 (child* or pediatric* or youth or teen* or adolescen* or "school age*").ti.
4 2 and 3
5 2 not 4

Oral Health Screening

Database: Ovid MEDLINE(R) ALL (Systematic Reviews)

1 Oral Health/
2 Mouth Diseases/
3 exp Periodontal Diseases/
4 exp Tooth Diseases/
5 ("oral health" or "oral disease*" or "dental caries" or "tooth decay" or "periodontal disease" or periodontitis or gingivitis or "gum disease").ti,ab,kf.
6 or/1-5
7 Mass Screening/
8 screen*.ti,ab,kf.
9 Risk Assessment/
10 Risk Factors/
11 risk.ti,ab,kf.
12 or/7-11
13 6 and 12
14 limit 13 to (meta analysis or "systematic review")
15 (child* or pediatric* or youth or teen* or adolescen* or "school age*").ti,ab,kf,sh.
16 14 and 15
17 limit 16 to english language
18 14 not 15
19 limit 18 to english language

Database: EBM Reviews - Cochrane Central Register of Controlled Trials

1 Oral Health/
2 Mouth Diseases/
3 exp Periodontal Diseases/
4 exp Tooth Diseases/
5 ("oral health" or "oral disease*" or "dental caries" or "tooth decay" or "periodontal disease" or periodontitis or gingivitis or "gum disease").ti,ab.
6 or/1-5
7 Mass Screening
8 screen*.ti,ab.
9 Risk Assessment/
10 Risk Factors/

11 risk.ti,ab.
12 or/7-11
13 6 and 12
14 conference abstract.pt.
15 "journal: conference abstract".pt.
16 "journal: conference review".pt.
17 "http://.www.who.int/trialsearch*".so.
18 "https://clinicaltrials.gov*".so.
19 14 or 15 or 16 or 17 or 18
20 13 not 19
21 (child* or pediatric* or youth or teen* or adolescen* or "school age*").ti,ab,sh.
22 20 and 21
23 20 not 22

Database: Ovid MEDLINE(R) ALL

1 Oral Health/
2 Mouth Diseases/
3 exp Periodontal Diseases/
4 exp Tooth Diseases/
5 ("oral health" or "oral disease*" or "dental caries" or "tooth decay" or "periodontal disease" or periodontitis or gingivitis or "gum disease").ti,ab,kf.
6 or/1-5
7 Mass Screening/
8 screen*.ti,ab,kf.
9 Risk Assessment/
10 Risk Factors/
11 risk.ti,ab,kf.
12 or/7-11
13 Primary Health Care/
14 ("primary care" or "general practic*" or "family medicine" or "family practic*").ti,ab,kf.
15 13 or 14
16 6 and 12 and 15
17 (child* or pediatric* or youth or teen* or adolescen* or "school age*").ti,ab,kf,sh.
18 16 and 17
19 16 not 18

Database: Ovid MEDLINE(R) ALL

1 Oral Health/
2 Mouth Diseases/
3 exp Periodontal Diseases/
4 exp Tooth Diseases/
5 ("oral health" or "oral disease*" or "dental caries" or "tooth decay" or "periodontal disease" or periodontitis or gingivitis or "gum disease").ti,ab,kf.
6 or/1-5
7 Mass Screening/
8 screen*.ti,ab,kf.

9 Risk Assessment/
10 Risk Factors/
11 risk.ti,ab,kf.
12 or/7-11
13 6 and 12
14 (child* or pediatric* or youth or teen* or adolescen* or "school age*").ti,ab,kf,sh.
15 13 not 14
16 exp "Sensitivity and Specificity"/
17 (diagnos* adj2 accura*).ti,ab,kf.
18 16 or 17
19 15 and 18
20 limit 15 to randomized controlled trial
21 (random* or control* or trial or cohort).ti,ab.
22 15 and 21
23 19 or 20 or 22

Oral Health Interventions

Database: Ovid MEDLINE(R) ALL

1 Oral Health/
2 Mouth Diseases/
3 exp Periodontal Diseases/
4 exp Tooth Diseases/
5 ("oral health" or "oral disease*" or "dental caries" or "tooth decay" or "periodontal disease" or periodontitis or gingivitis or "gum disease").ti,ab,kf.
6 or/1-5
7 Counseling/
8 health education/ or health education, dental/ or health promotion/ or patient education as topic/
9 exp Cariostatic Agents/
10 "Pit and Fissure Sealants"/
11 exp Dentifrices/
12 Xylitol/
13 "Referral and Consultation"/
14 (counsel* or education or fluoride or "silver diamine" or sealant* or xylitol or referral).ti,ab,kf.
15 or/7-14
16 6 and 15
17 limit 16 to (meta analysis or "systematic review")
18 (child* or pediatric* or youth or teen* or adolescen* or "school age*").ti,ab,kf,sh.
19 17 and 18
20 17 not 19
21 limit 20 to english language

Database: EBM Reviews - Cochrane Central Register of Controlled Trials

1 Oral Health/
2 Mouth Diseases/
3 exp Periodontal Diseases/
4 exp Tooth Diseases/
5 ("oral health" or "oral disease*" or "dental caries" or "tooth decay" or "periodontal disease" or periodontitis or gingivitis or "gum disease").ti,ab.
6 or/1-5
7 Counseling/
8 health education/ or health education, dental/ or health promotion/ or patient education as topic/
9 exp Cariostatic Agents/
10 "Pit and Fissure Sealants"/
11 exp Dentifrices/
12 Xylitol/
13 "Referral and Consultation"/
14 (counsel* or education or fluoride or "silver diamine" or sealant* or xylitol or referral).ti,ab.
15 or/7-14
16 6 and 15
17 limit 16 to english language
18 conference abstract.pt.
19 "journal: conference abstract".pt.
20 "journal: conference review".pt.
21 "http://.www.who.int/trialsearch*".so.
22 "https://clinicaltrials.gov*".so.
23 18 or 19 or 20 or 21 or 22
24 17 not 23
25 (child* or pediatric* or youth or teen* or adolescen* or "school age*").ti,ab,sh.
26 24 and 25
27 24 not 26

Database: Ovid MEDLINE(R) ALL

1 Oral Health/
2 Mouth Diseases/
3 exp Periodontal Diseases/
4 exp Tooth Diseases/
5 ("oral health" or "oral disease*" or "dental caries" or "tooth decay" or "periodontal disease" or periodontitis or gingivitis or "gum disease").ti,ab,kf.
6 or/1-5
7 Counseling/
8 health education/ or health education, dental/ or health promotion/ or patient education as topic/
9 exp Cariostatic Agents/
10 "Pit and Fissure Sealants"/
11 exp Dentifrices/

12 Xylitol/
13 "Referral and Consultation"/
14 (counsel* or education or fluoride or "silver diamine" or sealant* or xylitol or referral).ti,ab,kf.
15 or/7-14
16 Primary Health Care/
17 ("primary care" or "general practic*" or "family medicine" or "family practic*").ti,ab,kf.
18 16 or 17
19 6 and 15 and 18
20 (child* or pediatric* or youth or teen* or adolescen* or "school age*").ti,ab,kf,sh.
21 19 and 20
22 19 not 21
23 limit 22 to english language

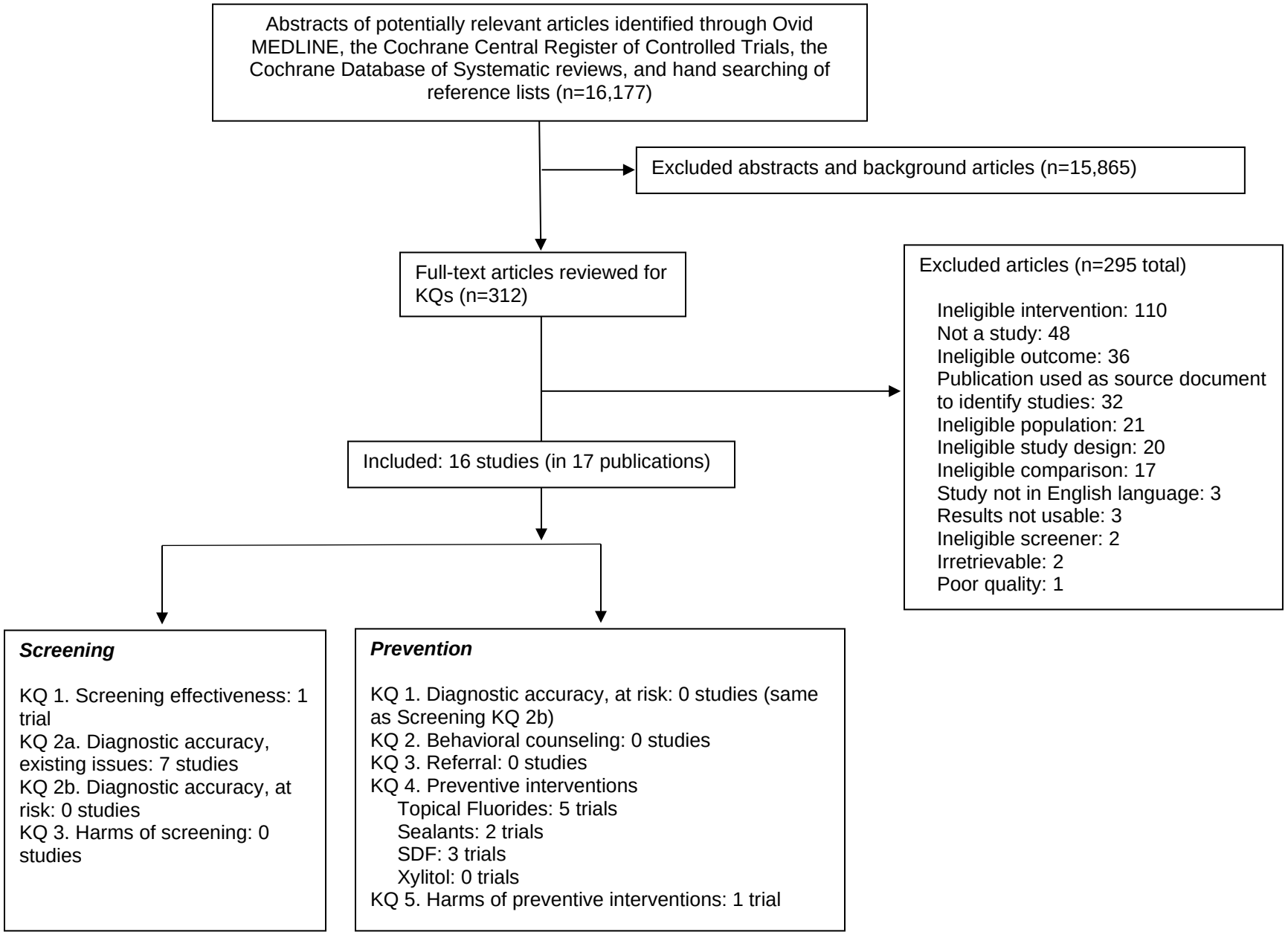
Database: Ovid MEDLINE(R) ALL

1 Oral Health/
2 Mouth Diseases/
3 exp Periodontal Diseases/
4 exp Tooth Diseases/
5 ("oral health" or "oral disease*" or "dental caries" or "tooth decay" or "periodontal disease" or periodontitis or gingivitis or "gum disease").ti,ab,kf.
6 or/1-5
7 Counseling/
8 health education/ or health education, dental/ or health promotion/ or patient education as topic/ (220967)
9 exp Cariostatic Agents/
10 "Pit and Fissure Sealants"/
11 exp Dentifrices/
12 Xylitol/
13 "Referral and Consultation"/
14 (counsel* or education or fluoride or "silver diamine" or sealant* or xylitol or referral).ti,ab,kf.
15 or/7-14
16 6 and 15
17 (child* or pediatric* or youth or teen* or adolescen* or "school age*").ti,ab,kf,sh.
18 16 not 17
19 limit 18 to randomized controlled trial
20 (random* or control* or trial or cohort).ti,ab,kf.
21 18 and 20
22 19 or 21

Appendix A2. Inclusion and Exclusion Criteria

Category	Included	Excluded
Populations	Asymptomatic adults, including pregnant persons Populations of interest were groups defined by: age (<65 vs. ≥65 years), sex, gender, socioeconomic status, race/ethnicity, educational attainment, and health literacy	Children and adolescents less than 18 years (addressed in separate USPSTF recommendations)
Interventions	Screening: • Oral examination/clinical assessment by a primary care provider • Risk assessment by a primary care provider for dental caries or periodontitis based on history, examination, standardized risk-assessment instrument, or some combination thereof Preventive interventions: • Behavioral counseling/education by a primary care provider • Preventive medications (topical fluoride [varnish, foam, or gel], silver diamine fluoride, dental sealants, and xylitol-containing products) that are feasible to be administered by a primary care provider • Referral of persons deemed at high risk for oral diseases by a primary care provider to a dental care health provider	Treatment for existing oral health issues
Comparisons	No intervention or placebo	Active treatment
Outcomes	Dental caries (incidence and severity) Periodontal disease in adults (incidence and severity) Tooth loss Morbidity Quality of life Functional status Harms of screening and treatment (e.g., dental fluorosis, tooth staining, bone effects, and neurological effects)	Cost effectiveness
Setting	Primary care or applicable to U.S. primary care practice (e.g., screening or preventive interventions do not require specialized dental training or equipment and are feasible for implementation in primary care); includes tele-dentistry approaches based in primary care settings	Dental clinics providing interventions not available in primary care settings
Study Design	Screening: Trials and cohort studies Preventive interventions: Trials; large cohort studies for selected harms (e.g., dental fluorosis) Risk assessment: Studies of diagnostic accuracy or risk prediction	Case-control studies or uncontrolled studies
Study Quality	Good or fair quality	Poor quality

Appendix A3. Literature Flow Diagram



Note: The included studies do not total because some studies apply to more than one Key Question.
Abbreviation: KQ = Key Question.

Appendix A4. List of Included Studies

1. Carter WJ, Jay P, Shklair IL, et al. The effect of topical fluoride on dental caries experience in adult females of a military population. J Dent Res. 1955 Feb;34(1):73-6. doi: 10.1177/00220345550340011801. PMID: 13233389.
2. Deng K, Pelekos G, Jin L, et al. Diagnostic accuracy of self-reported measures of periodontal disease: A clinical validation study using the 2017 case definitions. J Clin Periodontol. 2021 08;48(8):1037-50. doi: 10.1111/jcpe.13484. PMID: 33998009.
3. Dietrich T, Stosch U, Dietrich D, et al. Prediction of periodontal disease from multiple self-reported items in a German practice-based sample. J Periodontol. 2007 Jul;78(7 Suppl):1421-8. doi: 10.1902/jop.2007.060212. PMID: 17608613.
4. Eden GT. Clinical evaluation of a pit and fissure sealant for young adults. J Prosthet Dent. 1976 Jul;36(1):51-7. doi: 10.1016/0022-3913(76)90233-x. PMID: 1067415.
5. George A, Dahlen HG, Blinkhorn A, et al. Evaluation of a midwifery initiated oral health-dental service program to improve oral health and birth outcomes for pregnant women: a multi-centre randomised controlled trial. Int J Nurs Stud. 2018;82:49-57. doi: 10.1016/j.ijnurstu.2018.03.006. PMID: 29605753.
6. George A, Dahlen HG, Blinkhorn A, et al. Measuring oral health during pregnancy: sensitivity and specificity of a maternal oral screening (MOS) tool. BMC Pregnancy Childbirth. 2017;16(347) PMID: 27829388.
7. Jabir E, McGrade C, Quinn G, et al. Evaluating the effectiveness of fluoride varnish in preventing caries amongst Long-Term Care Facility Residents. Gerodontology. 2021 May 24;24:24. doi: 10.1111/ger.12563. PMID: 34028089.
8. Li R, Lo ECM, Liu BY, et al. Randomized Clinical Trial on Preventing Root Caries among Community-Dwelling Elders. JDR Clin Trans Res. 2017 Jan;2(1):66-72. doi: 10.1177/2380084416668491. PMID: 30938645.
9. Nijland N, Overtoom F, Gerdes VEA, et al. External validation of a rapid, non-invasive tool for periodontitis screening in a medical care setting. Clin Oral Investig. 2021 May 12;12:12. doi: 10.1007/s00784-021-03952-2. PMID: 33978832.
10. Obersztyn A, Kolwinski K, Trykowski J, et al. Effects of stannous fluoride and amine fluorides on caries incidence and enamel solubility in adults. Aust Dent J. 1979 Dec;24(6):395-7. doi: 10.1111/j.1834-7819.1979.tb03633.x. PMID: 295205.
11. Sekundo C, Bolk T, Kalmus O, et al. Accuracy of a 7-Item Patient-Reported Stand-Alone Tool for Periodontitis Screening. J Clin Med. 2021 Jan 14;10(2):14. doi: 10.3390/jcm10020287. PMID: 33466797.
12. Tan HP, Lo EC, Dyson JE, et al. A randomized trial on root caries prevention in elders. J Dent Res. 2010;89(10):1086-90. doi: 10.1177/0022034510375825. PMID: 20671206.
13. Verhulst MJL, Teeuw WJ, Bizzarro S, et al. A rapid, non-invasive tool for periodontitis screening in a medical care setting. BMC Oral Health. 2019 05 23;19(1):87. doi: 10.1186/s12903-019-0784-7. PMID: 31122214.
14. Wallace MC, Retief DH, Bradley EL. The 48-month increment of root caries in an urban population of older adults participating in a preventive dental program. J Public Health Dent. 1993;53(3):133-7. doi: 10.1111/j.1752-7325.1993.tb02691.x. PMID: 8371190.
15. Westman EC, Duffy MB, Simel DL. Should physicians screen for oral disease? A physical examination study of the oral cavity. J Gen Intern Med. 1994 Oct;9(10):558-62. doi: 10.1007/BF02599281. PMID: 7823227.

16. Yildiz E, Dorter C, Efes B, et al. A comparative study of two fissure sealants: a 2-year clinical follow-up. J Oral Rehabil. 2004 Oct;31(10):979-84. doi: 10.1111/j.1365-2842.2004.01334.x. PMID: 15387838.

17. Zhang W, McGrath C, Lo EC, et al. Silver diamine fluoride and education to prevent and arrest root caries among community-dwelling elders. Caries Res. 2013;47(4):284-90. doi: 10.1159/000346620. PMID: 23392087.

Appendix A5. List of Excluded Studies

1. Alsarraf, AH, Kujan O, Farah CS. The utility of oral brush cytology in the early detection of oral cancer and oral potentially malignant disorders: A systematic review. J Oral Pathol Med. 2018 Feb;47(2):104-16. doi: 10.1111/jop.12660. PMID: 29130527. **Exclusion reason:** Ineligible outcome
2. Ab Malik N, Zhang J, Lam OL, et al. Effectiveness of computer-aided learning in oral health among patients and caregivers: a systematic review. J Am Med Inform Assoc. 2017 01;24(1):209-17. doi: 10.1093/jamia/ocw045. PMID: 27274013. **Exclusion reason:** Used as source document
3. Adel-Khattab D, Montero E, Herrera D, et al. Evaluation of the FDI Chairside Guide for Assessment of Periodontal Conditions: A Multicentre Observational Study. Int Dent J. 2021 Oct;71(5):390-8. doi: 10.1016/j.identj.2020.12.024. PMID: 33531146. **Exclusion reason:** Ineligible intervention
4. Akuno MH, Nocella G, Milia EP, et al. Factors influencing the relationship between fluoride in drinking water and dental fluorosis: a ten-year systematic review and meta-analysis. J Water Health. 2019 Dec;17(6):845-62. doi: 10.2166/wh.2019.300. PMID: 31850893. **Exclusion reason:** Ineligible intervention
5. Al Khamis S, Asimakopoulou K, Newton T, et al. The effect of dental health education on pregnant women's adherence with toothbrushing and flossing - A randomized control trial. Community Dent Oral Epidemiol. 2017;45(5):469-77. doi: 10.1111/cdoe.12311. PMID: 28612363. **Exclusion reason:** Ineligible intervention
6. Al-Ak'hali MS, Halboub ES, Asiri YM, et al. WhatsApp-assisted Oral Health Education and Motivation: a Preliminary Randomized Clinical Trial. J Contemp Dent Pract. 2020;21(8):922-5. PMID: 33568616. **Exclusion reason:** Ineligible outcome
7. Alabdullah JH, Daniel SJ. A Systematic Review on the Validity of Teledentistry. Telemedicine Journal and e-Health. 2018 Aug;24(8):639-48. doi: 10.1089/tmj.2017.0132. PMID: 29303678. **Exclusion reason:** Used as source document
8. Albrecht M, Kupfer R, Reissmann DR, et al. Oral health educational interventions for nursing home staff and residents. Cochrane Database Syst Rev. 2016(9)doi: 10.1002/14651858.CD010535.pub2. PMID: 27689868. **Exclusion reason:** Ineligible intervention
9. Alirezaei M, Bagherian A, Sarraf Shirazi A. Glass ionomer cements as fissure sealing materials: yes or no?: A systematic review and meta-analysis. J Am Dent Assoc. 2018 Jul;149(7):640-9.e9. doi: 10.1016/j.adaj.2018.02.001. PMID: 29735163. **Exclusion reason:** Ineligible comparison
10. Alrashdi M, Hameed A, Cervantes Mendez MJ, et al. Education intervention with respect to the oral health knowledge, attitude, and behaviors of refugee families: a randomized clinical trial of effectiveness. J Public Health Dent. 2021;81(2):90-9. doi: 10.1111/jphd.12415. PMID: 33084019. **Exclusion reason:** Ineligible outcome
11. Amarasena N, Haag D, Peres KG. A scoping review of caries risk management protocols in Australia and New Zealand. Australian Dental Journal. 2019 03;64(1):19-26. doi: 10.1111/adj.12653. PMID: 30242843. **Exclusion reason:** Ineligible intervention
12. American Dental Association Council on Scientific A. Professionally applied topical fluoride: evidence-based clinical recommendations. J Dent Educ. 2007 Mar;71(3):393-402. doi: 10.1002/j.0022-0337.2007.71.3.tb04289.x. PMID: 17389574. **Exclusion reason:** Not a study
13. American Dental Association Council on Scientific Affairs. Professionally applied topical fluoride: evidence-based clinical recommendations. J Am Dent Assoc. 2006 Aug;137(8):1151-9. doi: 10.14219/jada.archive.2006.0356. PMID: 16873333. **Exclusion reason:** Not a study

14. Anders PL, Davis EL. Oral health of patients with intellectual disabilities: a systematic review. Spec Care Dentist. 2010 May-Jun;30(3):110-7. doi: 10.1111/j.1754-4505.2010.00136.x. PMID: 20500706. **Exclusion reason:** Ineligible intervention

15. Anonymous. Educators and Clinicians Create New Assessment Tool to Improve Oral-Systemic Health. Dentistry Today. 2015 Mar;34(3):48, 50. PMID: 26351724. **Exclusion reason:** Ineligible study design

16. Anter E, Zayet MK, El-Dessouky SH. Accuracy and precision of cone beam computed tomography in periodontal defects measurement (systematic review). J Indian Soc Periodontol. 2016 May-Jun;20(3):235-43. doi: 10.4103/0972-124X.176389. PMID: 27563194. **Exclusion reason:** Ineligible intervention

17. Antonio AG, Pierro VS, Maia LC. Caries preventive effects of xylitol-based candies and lozenges: a systematic review. J Public Health Dent. 2011;71(2):117-24. doi: 10.1111/j.1752-7325.2010.00208.x. PMID: 21774134. **Exclusion reason:** Used as source document

18. Armstrong S, Dermont M. Does prevention-focused dental care provision during recruit training reduce adverse dental outcomes in UK Armed Forces personnel? A retrospective cohort analysis. Br Dent J. 2021 04;230(7):400-6. doi: 10.1038/s41415-021-2741-5. PMID: 33837335. **Exclusion reason:** Ineligible intervention

19. Asimakopoulou K, Newton JT, Daly B, et al. The effects of providing periodontal disease risk information on psychological outcomes - a randomized controlled trial. J Clin Periodontol. 2015;42(4):350-5. doi: 10.1111/jcpe.12377. PMID: 25682859. **Exclusion reason:** Ineligible population

20. Asimakopoulou K, Nolan M, McCarthy C, et al. The effect of risk communication on periodontal treatment outcomes: a randomized controlled trial. J Periodontol. 2019. doi: 10.1002/JPER.18-0385. PMID: 30997690. **Exclusion reason:** Ineligible intervention

21. Astvaldsdottir A, Bostrom AM, Davidson T, et al. Oral health and dental care of older persons-A systematic map of systematic reviews. Gerodontology. 2018 Dec;35(4):290-304. doi: 10.1111/ger.12368. PMID: 30129220. **Exclusion reason:** Used as source document

22. Atara AGMRSVJVDB. Clinical evaluation of Krimidanta Pratishedha (anti-caries) activity of Triphaladi Gandusha in high risk dental caries patients. Ayu. 2014;35(1):42-5. doi: 10.4103/0974-8520.141916. PMID: 25364198. **Exclusion reason:** Ineligible intervention

23. Axelsson S, Soder B, Nordenram G, et al. Effect of combined caries-preventive methods: a systematic review of controlled clinical trials. Acta Odontol Scand. 2004 Jun;62(3):163-9. doi: 10.1080/00016350410006842. PMID: 15370637. **Exclusion reason:** Ineligible outcome

24. Azarpazhooh A, Main PA. Efficacy of dental prophylaxis (rubber cup) for the prevention of caries and gingivitis: a systematic review of literature. Br Dent J. 2009 Oct 10;207(7):E14; discussion 328-9. doi: 10.1038/sj.bdj.2009.899. PMID: 19816459. **Exclusion reason:** Ineligible intervention

25. Bader JD, Perrin NA, Maupome G, et al. Validation of a simple approach to caries risk assessment. J Public Health Dent. 2005;65(2):76-81. doi: 10.1111/j.1752-7325.2005.tb02790.x. PMID: 15929544. **Exclusion reason:** Ineligible intervention

26. Bader JD, Shugars DA, Bonito AJ. Systematic reviews of selected dental caries diagnostic and management methods. J Dent Educ. 2001 Oct;65(10):960-8. doi: 10.1002/j.0022-0337.2001.65.10.tb03470.x. PMID: 11699997. **Exclusion reason:** Used as source document

27. Bader JD, Shugars DA, Vollmer WM, et al. Design of the xylitol for adult caries trial (X-ACT). BMC Oral Health. 2010;10(22)doi: 10.1186/1472-6831-10-22. PMID: 20920261. **Exclusion reason:** Not usable

28. Bader JD, Vollmer WM, Shugars DA, et al. Results from the Xylitol for Adult Caries Trial (X-ACT). J Am Dent Assoc. 2013;144(1):21-30. doi: 10.14219/jada.archive.2013.0010. PMID: 23283923. **Exclusion reason:** Ineligible population

29. Bahri N, Tohidinik HR, Bahri N, et al. Educational intervention to improve oral health beliefs and behaviors during pregnancy: a randomized-controlled trial. J Egypt Public Health Assoc. 2015;90(2):41-5. doi: 10.1097/01.EPX.0000464139.06374.a4. PMID: 26154829. **Exclusion reason:** Ineligible outcome

30. Bakhtiar K, Gharouni K, Gharouni B, et al. The effect of training interventions on the psychological factors of oral health in pregnant women. Electron Physician. 2017 Oct;9(10):5506-15. doi: 10.19082/5506. PMID: 29238491. **Exclusion reason:** Ineligible intervention

31. Bansal A, Ingle NA, Kaur N, et al. Recent advancements in fluoride: A systematic review. Journal of International Society of Preventive & Community Dentistry. 2015 Sep-Oct;5(5):341-6. doi: 10.4103/2231-0762.165927. PMID: 26539383. **Exclusion reason:** Not usable

32. Banting DW, Papas A, Clark DC, et al. The effectiveness of 10% chlorhexidine varnish treatment on dental caries incidence in adults with dry mouth. Gerodontology. 2000;17(2):67-76. doi: 10.1111/j.1741-2358.2000.00067.x. PMID: 11808057. **Exclusion reason:** Ineligible intervention

33. Beauchamp J, Caufield PW, Crall JJ, et al. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. J Am Dent Assoc. 2008 Mar;139(3):257-68. doi: 10.14219/jada.archive.2008.0155. PMID: 18310730. **Exclusion reason:** Not a study

34. Beauchamp J, Caufield PW, Crall JJ, et al. Evidence-based clinical recommendations for the use of pit-and-fissure sealants: a report of the American Dental Association Council on Scientific Affairs. Dent Clin North Am. 2009 Jan;53(1):131-47, x. doi: 10.1016/j.cden.2008.09.003. PMID: 19215748. **Exclusion reason:** Not a study

35. Beier G, Riethe P. Effect of periodontal sprays on uncalcified deposition, infectious periodontal diseases and enamel. Deutsche zahnarztliche Zeitschrift. 1971;26(5):600-3. PMID: 5280922. **Exclusion reason:** Not in English

36. Beiruti N, Frencken JE, van 't Hof MA, et al. Caries-preventive effect of resin-based and glass ionomer sealants over time: a systematic review. Community Dent Oral Epidemiol. 2006 Dec;34(6):403-9. doi: 10.1111/j.1600-0528.2006.00321.x. PMID: 17092268. **Exclusion reason:** Ineligible comparison

37. Beltran-Aguilar ED. Silver diamine fluoride (SDF) may be better than fluoride varnish and no treatment in arresting and preventing cavitated carious lesions. J Evid Based Dent Prac. 2010 Jun;10(2):122-4. doi: 10.1016/j.jebdp.2010.02.014. PMID: 20466328. **Exclusion reason:** Ineligible intervention

38. Berg JH. Dental caries detection and caries management by risk assessment. J Esthet Restor Dent. 2007;19(1):49-55. doi: 10.1111/j.1708-8240.2006.00059.x. PMID: 17244151. **Exclusion reason:** Not a study

39. Bijle MNA, Yiu CKY, Ekambaram M. Calcium-Based Caries Preventive Agents: A Meta-evaluation of Systematic Reviews and Meta-analysis. J Evid Based Dent Prac. 2018

09;18(3):203-17.e4. doi: 10.1016/j.jebdp.2017.09.003. PMID: 30077374. **Exclusion reason:** Ineligible intervention

40. Bizarra MF, Ribeiro Graca S. Short-term impact of an oral health program for adults with cerebral palsy. Spec Care Dentist. 2020 Jan;40(1):26-34. doi: 10.1111/scd.12431. PMID: 31697453. **Exclusion reason:** Ineligible outcome

41. Bonetti D, Clarkson JE. Fluoride Varnish for Caries Prevention: Efficacy and Implementation. Caries Res. 2016;50 Suppl 1:45-9. doi: 10.1159/000444268. PMID: 27100219. **Exclusion reason:** Not a study

42. Bonetti D, Hampson V, Queen K, et al. Improving oral hygiene for patients. Nurs Stand. 2015 Jan 13;29(19):44-50. doi: 10.7748/ns.29.19.44.e9383. PMID: 25563127. **Exclusion reason:** Ineligible outcome

43. Botelho J, Machado V, Mendes JJ, et al. Causal Association between Periodontitis and Parkinson's Disease: A Bidirectional Mendelian Randomization Study. Genes (Basel). 2021 05 19;12(5):19. doi: 10.3390/genes12050772. PMID: 34069479. **Exclusion reason:** Ineligible study design

44. Boyle S, Duke A. Are adjunctive therapies effective in reducing gingivitis and plaque? Evid Based Dent. 2021 01;22(3):98-9. doi: 10.1038/s41432-021-0204-0. PMID: 34561658. **Exclusion reason:** Not a study

45. Brady EP. Dental caries and topically applied fluorides. The Journal of the Missouri State Dental Association. 1948 May;28(5):159-65. PMID: 18865692. **Exclusion reason:** Not a study

46. Brennan MT, Runyon MS, Batts JJ, et al. Odontogenic signs and symptoms as predictors of odontogenic infection: a clinical trial. J Am Dent Asoc. 2006;137(1):62-6. doi: 10.14219/jada.archive.2006.0022. PMID: 16457000. **Exclusion reason:** Ineligible outcome

47. Brocklehurst P, Kujan O, O'Malley LA, et al. Screening programmes for the early detection and prevention of oral cancer. Cochrane Database Syst Rev. 2013 Nov 19(11):CD004150. doi: 10.1002/14651858.CD004150.pub4. PMID: 24254989. **Exclusion reason:** Ineligible outcome

48. Brown JB, Rosenstein D, Mullooly J, et al. Impact of intensified dental care on outcomes in human immunodeficiency virus infection. AIDS Patient Care STDs. 2002;16(10):479-86. doi: 10.1089/10872910260351258. PMID: 12437859. **Exclusion reason:** Ineligible population

49. Cagetti MG, Bonta G, Cocco F, et al. Are standardized caries risk assessment models effective in assessing actual caries status and future caries increment? A systematic review. BMC Oral Health. 2018 07 16;18(1):123. doi: 10.1186/s12903-018-0585-4. PMID: 30012136. **Exclusion reason:** Ineligible intervention

50. Carra MC, Detzen L, Kitzmann J, et al. Promoting behavioural changes to improve oral hygiene in patients with periodontal diseases: A systematic review. J Clin Periodontol. 2020 Jul;47 Suppl 22:72-89. doi: 10.1111/jcpe.13234. PMID: 31912530. **Exclusion reason:** Ineligible population

51. Carson SJ. Limited evidence for existing caries assessment systems. Evid Based Dent. 2013 Mar;14(1):10-1. doi: 10.1038/sj.ebd.6400911. PMID: 23579298. **Exclusion reason:** Not a study

52. Carta G, Cagetti MG, Cocco F, et al. Caries-risk profiles in Italian adults using computer caries assessment system and ICDAS. Pesqui Odontol Bras. 2015;29(1):S1806-83242015000100306. doi: 10.1590/1807-3107BOR-2015.vol29.0126. PMID: 26892361. **Exclusion reason:** Ineligible intervention

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Systematic Reviews

Criteria:

- Comprehensiveness of sources considered/search strategy used
- Standard appraisal of included studies
- Validity of conclusions
- Recency and relevance (especially important for systematic reviews)

Definition of ratings based on above criteria:
Good: Recent, relevant review with comprehensive sources and search strategies; explicit and relevant selection criteria; standard appraisal of included studies; and valid conclusions
Fair: Recent, relevant review that is not clearly biased but lacks comprehensive sources and search strategies
Poor: Outdated, irrelevant, or biased review without systematic search for studies, explicit selection criteria, or standard appraisal of studies

RCTs and Cohort Studies

Criteria:

- Initial assembly of comparable groups:
  - For RCTs: Adequate randomization, including first concealment and whether potential confounders were distributed equally among groups
  - For cohort studies: Consideration of potential confounders, with either restriction or measurement for adjustment in the analysis; consideration of inception cohorts
- Maintenance of comparable groups (includes attrition, cross-overs, adherence, contamination)
- Important differential loss to followup or overall high loss to followup
- Measurements: equal, reliable, and valid (includes masking of outcome assessment)
- Clear definition of interventions
- All important outcomes considered
- Analysis: adjustment for potential confounders for cohort studies or intention-to treat analysis for RCTs

Definition of ratings based on above criteria:
Good: Meets all criteria: Comparable groups are assembled initially and maintained throughout the study (followup ≥80%); reliable and valid measurement instruments are used and applied equally to all groups; interventions are spelled out clearly; all important outcomes are considered; and appropriate attention to confounders in analysis. In addition, intention-to-treat analysis is used for RCTs.
Fair: Studies are graded "fair" if any or all of the following problems occur, without the fatal flaws noted in the "poor" category below: Generally comparable groups are assembled initially, but some question remains whether some (although not major) differences occurred with followup; measurement instruments are acceptable (although not the best) and generally applied equally; some but not all important outcomes are considered; and some but not all potential confounders are accounted for. Intention-to-treat analysis is used for RCTs.

Poor: Studies are graded "poor" if any of the following fatal flaws exists: Groups assembled initially are not close to being comparable or maintained throughout the study; unreliable or invalid measurement instruments are used or not applied equally among groups (including not masking outcome assessment); and key confounders are given little or no attention. Intention-to-treat analysis is lacking for RCTs.

Diagnostic Accuracy Studies

Criteria:

- Screening test relevant, available for primary care, and adequately described
- Credible reference standard, performed regardless of test results
- Reference standard interpreted independently of screening test
- Indeterminate results handled in a reasonable manner
- Spectrum of patients included in study
- Sample size
- Reliable screening test

Definition of ratings based on above criteria:
Good: Evaluates relevant available screening test; uses a credible reference standard; interprets reference standard independently of screening test; assesses reliability of test; has few or handles indeterminate results in a reasonable manner; includes large number (>100) of broad-spectrum patients with and without disease
Fair: Evaluates relevant available screening test; uses reasonable although not best standard; interprets reference standard independent of screening test; has moderate sample size (50 to 100 subjects) and a "medium" spectrum of patients
Poor: Has a fatal flaw, such as: Uses inappropriate reference standard; improperly administers screening test; biased ascertainment of reference standard; has very small sample size or very narrow selected spectrum of patients

Source: U.S. Preventive Services Task Force. Procedure Manual. Accessed at https://www.uspreventiveservicestaskforce.org/uspstf/about-uspstf/methods-and-processes/procedure-manual/procedure-manual-appendix-vi-criteria-assessing-internal-validity-individual-studies

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Federal Partners

- The Centers for Disease Control and Prevention (1 reviewer)
- The National Institute of Dental and Craniofacial Research (3 reviewers)

Appendix B Table 1. Data Abstraction of Screening Trial

Author, year	Study design	Intervention A	Intervention B	Intervention C	Other notes about intervention	Interventionist	Baseline age	Baseline, % female	Baseline race/ ethnicity	Baseline oral health information	Eligibility criteria
George, 2018[78]	RCT	A. Midwifery-Initiated Oral Health Dental Service program: Oral health education from midwives, including advice to consult a dentist for a checkup; oral health screening to identify women at risk of poor oral health; dental referrals for pregnant women at risk of poor oral health	B. Same as intervention A + study dentists providing pregnant women priority access to free dental services in one of three public dental clinics	C. Control (received oral health promotional material at time of recruitment)	NR	Trained midwifes (interventions A and B) and dentists (intervention B)	29 years	100%	NR	Current problems with teeth, gums, or mouth: 57.6% vs. 61.4% vs. 60.3% Seen dentist in previous 12 months?: 32.2% vs. 31.6% vs. 34.1% Oral health behaviors: Not reported	Pregnant women ≥18, between 12 and 20 weeks of gestational age attending their first antenatal appointment Excluded: women with pregnancies with fetal anomalies or other risk factors that would make the pregnancy higher risk

Appendix B Table 1. Data Abstraction of Screening Trial

Author, year	No. approached, eligible	No. enrolled	No. analyzed (arms A vs. B)	Attrition	Country Setting	Duration of followup	Outcomes	Adverse events/ harms	Quality rating	Sponsor
George, 2018[78]	1091 868	639 A. 212 B. 212 C. 215	477 completed final questionnaire A. 152 B. 156 C. 169 285 received final dental assessment A. 87 B. 102 C. 96	Final questionnaire: 28% (60/212) vs. 26% (56/211) vs. 21% (46/215) Final dental assessment: 59% (125/212) vs. 52% (110/212) vs. 55% (119/215)	Sydney, Australia Three large metropolitan public hospitals November 2012 to October 2015 Water fluoridation status: Not reported (Sydney is fluoridated)	Until the final trimester (28-38 weeks)	A vs. B vs. C Oral health outcomes Clinical attachment loss (based on periodontal pocket depth and gingival recession and presence of calculus), mean mm (SD): 2.24 (0.85) vs. 1.51 (0.77) vs. 2.24 (0.72), p<0.001 Decayed teeth, mean (SD): 1.47 (2.51) vs. 0.48 (1.17) vs. 2.01 (2.55), p<0.001 Filled teeth, mean (SD): 3.06 (3.94) vs. 4.96 (4.34) vs. 2.09 (2.53), p<0.001 DMFT: p>0.05, data otherwise not provided Use of dental services: Did you seek advice from a dental professional for your problem/concern? Yes 28.3% (43/152) vs. 87.2% (136/156) vs. 20.2% (34/168), p<0.001 Pregnancy outcomes Preterm: 4.4% (8/180) vs. 5.3% (10/189) vs. 3.7% (7/189); p=0.96 Birth weight <2500 kg: 3.9% (7/180) vs. 4.2% (8/189) vs. 3.7% (7/189); p=0.97	NR	Fair	National Health and Medical Research Council

Abbreviations: DMFT = Decayed, Missing and Filled Teeth; NR = not reported; RCT = randomized controlled trial; SD = standard deviation.

Appendix B Table 2. Quality Assessment of Screening Trial

Author, year	Random-ization adequate?	Allocation conceal-ment adequate?	Groups similar at baseline?	Outcome assessors masked?	Care provider masked?	Patient masked?	Intention-to-treat (ITT) analysis	Patients with missing data analyzed?	Acceptable levels of overall attrition (<20%) and between-group differences (<10%) in attrition?	Post-random-ization exclus-ions?	Avoidance of selective outcomes reporting?	Adjusted for cluster correl-ation?	Quality rating
George, 2018[78]	Yes	Yes	Yes	Yes	No	No	No	No	No (>20% for final question-naire; >50% for final dental assessment) No	Yes (4, 3, and 3 preg-nancy comp-lications)	Yes	NA	Fair, but very high attrition for oral health out-comes

Abbreviations: ITT = intention-to-treat; NA=not applicable; NR=not reported.

Appendix B Table 3. Data Abstraction of Diagnostic Accuracy Studies

Author, year	Screening test	Reference standard	Country Setting	Population	Sample size	Proportion with condition	Definition of a positive screening exam	Proportion unexaminable by screening test	Analysis of screening failures	Proportion who underwent reference standard and included in analysis
Deng, 2021[79]	CDC/AAP Questionnaire in Cantonese	Single calibrated examiner	China Dental hospital	Adults age 18 and above	408	Periodontitis: 68.6% Stage I/II periodontitis: 31.8% Stage III/IV periodontitis: 36.8%	NR	Appears to be none	NR	Appears to be all
Dietrich, 2007[80]	Questionnaire	Periodontal disease determine by radiographs	Germany 2 oral and maxillofacial surgery private practices	Adults: age 20 to 80	246	≥3 teeth with ABL > 5 mm: 39% ≥3 teeth with ABL > 6 mm: 20% ≥2 teeth with ABL ≥ 5 mm: 50% ≥2 teeth with ABL ≥ 7 mm: 15%	NR	Appears to be none	NR	Appears to be all
George, 2017[81] George, 2018[78]	Questionnaire	Dental exam	Australia Screening at prenatal visit; reference standard at dental clinic	Pregnant women mean age 29 years	207; 131 analyzed	56% had poor oral health defined as any tooth decay and a PSR rating ≥ 2	At risk of "poor oral health" defined as a positive response to 2/2 questions	Appears to be none	NR	131/207 (63%)
Nijland, 2021[82]	ACTA questionnaire	Community Periodontal Index of Treatment Needs	The Netherlands Outpatient medical setting	Adults aged 18 to 80	155	CPITN score 0-2: 44.5% CPITN score 3: 31.0% CPITN score 4: 24.5%	NR	Appears to be none	NR	Appears to be all
Sekundo, 2021[83]	DG PARO (PSR) questionnaire	Academic dentist's exam	Germany Dental school	Adults age 18 and above	88	Periodontal Screening and Recording 2: 28.4% Periodontal Screening and Recording 3: 33.0% Periodontal Screening and Recording 4: 38.6%	Periodontitis Risk Score < 7 vs. ≥ 7 best predictor	Appears to be none	NR	Appears to be all

Appendix B Table 3. Data Abstraction of Diagnostic Accuracy Studies

Author, year	Screening test	Reference standard	Country Setting	Population	Sample size	Proportion with condition	Definition of a positive screening exam	Proportion unexaminable by screening test	Analysis of screening failures	Proportion who underwent reference standard and included in analysis
Verhulst, 2019[84]	ACTA questionnaire	Periodontal exam by calibrated periodontists	The Netherlands Dental clinic	Adults age 18 and above	156	Severe periodontitis: 32.7% Moderate periodontitis: 34.6% Mild or no periodontitis: 32.7%	NR	Appears to be none	NR	Appears to be all
Westman, 1994[85]	Dental exam by 2 primary care clinicians	Dental exam	United States VA Medical Center	Adults	86	Clinical impression of pre-malignancy: 23% Periodontal disease: 37% Calculus: 54% Caries:18%	NR	Appears to be none	NR	Appears to be all

Appendix B Table 3. Data Abstraction of Diagnostic Accuracy Studies

Author, year	Sensitivity	Specificity	Positive predictive value	Negative predictive value	AUC (95% CI)	Quality rating
Deng, 2021[79]	Periodontal disease: 61.4 Periodontitis: 67.9 Stage I/II periodontitis: 86.8 Stage III/IV periodontitis: 72.8	Periodontal disease: 91.1 Periodontitis: 83.5 Stage I/II periodontitis: 35.3 Stage III/IV periodontitis: 84.1	Periodontitis: 90.0 Stage I/II periodontitis: 38.6 Stage III/IV periodontitis: 72.7	Periodontitis: 54.3 Stage I/II periodontitis: 85.2 Stage III/IV periodontitis: 84.1	Periodontal disease: 0.837 (0.783, 0.891) Periodontitis: 0.803 (0.758, 0.849) Stage I/II periodontitis: 0.608 (0.550, 0.0665) Stage III/IV periodontitis: 0.870 (0.830, 0.910)	Good
Dietrich, 2007[80]	≥3 teeth with ABL > 5 mm: 73 (63, 81) ≥3 teeth with ABL > 6 mm: 57 (42, 71) ≥2 teeth with ABL ≥ 5 mm: 79 (70, 86) ≥2 teeth with ABL ≥ 7 mm: 53 (36, 69) Age 40 years: ≥3 teeth with ABL > 5 mm: 75 (64, 84) ≥3 teeth with ABL > 6 mm: 57 (41, 72) ≥2 teeth with ABL ≥ 5 mm: 82 (72, 89) ≥2 teeth with ABL ≥ 7 mm: 52 (33, 70)	≥3 teeth with ABL > 5 mm: 81 (74, 97) ≥3 teeth with ABL > 6 mm: 87 (82, 92) ≥2 teeth with ABL ≥ 5 mm: 77 (68, 84) ≥2 teeth with ABL ≥ 7 mm: 90 (85, 94) Age 40 years: ≥3 teeth with ABL > 5 mm: 57 (42, 72) ≥3 teeth with ABL > 6 mm: 74 (63, 83) ≥2 teeth with ABL ≥ 5 mm: 51 (34, 69) ≥2 teeth with ABL ≥ 7 mm: 81 (71, 88)	≥3 teeth with ABL > 5 mm: 71 ≥3 teeth with ABL > 6 mm: 52 ≥2 teeth with ABL ≥ 5 mm: 78 ≥2 teeth with ABL ≥ 7 mm: 49	≥3 teeth with ABL > 5 mm: 82 ≥3 teeth with ABL > 6 mm: 89 ≥2 teeth with ABL ≥ 5 mm: 79 ≥2 teeth with ABL ≥ 7 mm: 92	NR	Fair
George 2017[81] George, 2018[78]	Question 1 only: 70.3% (59.9% to 82.1%) Question 2 only: 41.9% (30.7% to 54.7%) Both questions: 87.8% (50.4% to 96.3%)	Question 1 only: 29.8% (17.9% to 41.7%) Question 2 only: 68.4% (56.4% to 80.5%) Both questions: 14.0% (5.0% to 23.1%)	Question 1 only: 56.5% (46.4% to 66.7%) Question 2 only: 63.3% (49.8% to 76.8%) Both questions: 57.0% (47.9% to 66.1%)	Question 1 only: 43.6% (28.0% to 59.2%) Question 2 only: 47.6% (36.8% to 58.4%) Both questions: 47.1% (23.3% to 70.8%)	NR	Fair
Nijland, 2021[82]	CPITN 3-4: 49 CPITN 4: 71	CPITN 3-4: 68 CPITN 4: 63	CPITN 3-4: 57 CPITN 4: 39	CPITN 3-4: 55 CPITN 4: 87	CPITN 3-4: AUROC 0.59 (0.50, 0.68) CPITN 4: AUROC 0.73 (0.65, 0.82)	Fair
Sekundo, 2021[83]	pPRS <4 vs. ≥ 4: 93.7 (85.9, 98.0) pPRS <5 vs. ≥ 5: 92.1 (83.5, 97.1) pPRS <6 vs. ≥ 6: 92.1 (83.7, 97.1) pPRS <7 vs. ≥ 7: 87.3 (77.7, 94.0) pPRS <8 vs. ≥ 8: 79.4 (68.3, 88.1)	pPRS <4 vs. ≥ 4: 60.0 (40.5, 77.5) pPRS <5 vs. ≥ 5: 68.0 (48.6, 83.9) pPRS <6 vs. ≥ 6: 72.0 (52.8, 86.9) pPRS <7 vs. ≥ 7: 84.0 (66.6, 94.7) pPRS <8 vs. ≥ 8: 84.0 (66.6, 94.7)	pPRS <4 vs. ≥ 4: 85.5 (76.0, 92.5) pPRS <5 vs. ≥ 5: 87.5 (78.6, 94.3) pPRS <6 vs. ≥ 6: 89.2 (80.2, 95.2) pPRS <7 vs. ≥ 7: 93.2 (84.9, 97.8) pPRS <8 vs. ≥ 8: 92.6 (83.6, 97.6)	pPRS <4 vs. ≥ 4: 78.9 (57.6, 92.9) pPRS <5 vs. ≥ 5: 77.3 (57.4, 91.2) pPRS <6 vs. ≥ 6: 78.3 (59.0, 91.6) pPRS <7 vs. ≥ 7: 72.4 (54.7, 86.3) pPRS <8 vs. ≥ 8: 61.8 (45.0, 76.8)	pPRS <4 vs. ≥ 4: 0.77 (0.64. 0.89) pPRS <5 vs. ≥ 5: 0.80 (0.68. 0.92) pPRS <6 vs. ≥ 6: 0.82 (0.71, 0.93) pPRS <7 vs. ≥ 7: 0.86 (0.76, 0.95) pPRS <8 vs. ≥ 8: 0.82 (0.72, 0.92)	Fair

Appendix B Table 3. Data Abstraction of Diagnostic Accuracy Studies

Author, year	Sensitivity	Specificity	Positive predictive value	Negative predictive value	AUC (95% CI)	Quality rating
	pPRS <9 vs. ≥ 9: 63.5 (51.2, 74.7)	pPRS <9 vs. ≥ 9: 84.0 (66.6, 94.7)	pPRS <9 vs. ≥ 9: 90.9 (80.1, 97.1)	pPRS <9 vs. ≥ 9: 47.7 (33.4, 62.3)	pPRS <9 vs. ≥ 9: 0.74 (0.63, 0.85)	
Verhulst, 2019[84]	Moderate and severe periodontitis: Questionnaire only: 85 (78, 92) Questionnaire + demographic data (age, gender, smoking): 78 (69, 86) Severe periodontitis: Questionnaire only: 65 (52, 79) Questionnaire + demographic data (age, gender, smoking): 80 (66, 90)	Moderate and severe periodontitis: Questionnaire only: 63 (49, 76) Questionnaire + demographic data (age, gender, smoking): 84 (71, 93) Severe periodontitis: Questionnaire only: 81 (73, 88) Questionnaire + demographic data (age, gender, smoking): 70 (60, 79)	Moderate and severe periodontitis: Questionnaire only: 82 (75, 89) Questionnaire + demographic data (age, gender, smoking): 91 (84, 95) Severe periodontitis: Questionnaire only: 62 (48, 75) Questionnaire + demographic data (age, gender, smoking): 56 (48, 64)	Moderate and severe periodontitis: Questionnaire only: 68 (55, 81) Questionnaire + demographic data (age, gender, smoking): 66 (57, 74) Severe periodontitis: Questionnaire only: 83 (76, 90) Questionnaire + demographic data (age, gender, smoking): 88 (81, 93)	Moderate and severe periodontitis: Questionnaire only: AUROC 0.81 (0.74, 0.88) Questionnaire + demographic data (age, gender, smoking): AUROC 0.88 (0.82, 0.93) Severe periodontitis: Questionnaire only: 0.78 (0.71, 0.86) Questionnaire + demographic data (age, gender, smoking): 0.82 (0.75, 0.89)	Fair
Westman, 1994[85]	Clinical impression of pre-malignancy: 1st clinician: 30 2nd clinician: 26 Periodontal disease: 1st clinician: 56 2nd clinician: 42 Calculus: 1st clinician: 37 2nd clinician: 71 Caries: 1st clinician: 33 2nd clinician: 83	Clinical impression of pre-malignancy: 1st clinician: 95 2nd clinician: 90 Periodontal disease: 1st clinician: 87 2nd clinician: 84 Calculus: 1st clinician: 94 2nd clinician: 80 Caries: 1st clinician: 93 2nd clinician: 80	Clinical impression of pre-malignancy **LR+**: 1st clinician: 6.6 (1.8, 24.0) 2nd clinician: 2.7 (0.9, 7.9) Periodontal disease **LR+**: 1st clinician: 4.3 (2.0, 9.3) 2nd clinician: (2.7 (1.3, 5.7) Calculus **LR+**: 1st clinician: 5.8 (1.8, 18.6) 2nd clinician: 3.6 (1.9, 6.6) Caries **LR+**: 1st clinician: 4.6 (1.5, 13.9) 2nd clinician: 4.2 (2.4, 7.3)	Clinical impression of pre-malignancy **LR-**: 1st clinician: 0.7 (0.5, 1.0) 2nd clinician: 0.8 (0.6, 1.0) Periodontal disease **LR**: 1st clinician: 0.5 (0.3, 0.8) 2nd clinician: 0.7 (0.5, 1.0) Calculus **LR-**: 1st clinician: 0.7 (0.5, 0.9) 2nd clinician: 0.4 (0.2, 0.6) Caries **LR-**: 1st clinician: 0.7 (0.5, 1.0) 2nd clinician: 0.2 (0.1, 0.7)	Clinical impression of pre-malignancy: 1st clinician: 0.8 2nd clinician: 0.75 Periodontal disease: 1st clinician: 0.76 2nd clinician: 0.68 Calculus: 1st clinician: 0.68 2nd clinician: 0.76 Caries: 1st clinician: 0.82 2nd clinician: 0.81	Fair

Abbreviations: AAP = American Academy of Pediatrics; ABL = alveolar bone loss; ACTA = Academic Center of Dentistry Amsterdam; AUC = area under the curve; AUROC = area under the receiver operating characteristic curve; CDC = Centers for Disease Control; CI = confidence interval; CPITN = Community Periodontal Index of Treatment Needs; DG PARO = German Society for Periodontology; LR+ = likelihood ratio (sensitivity / 1- specificity); LR- = likelihood ratio (1- sensitivity / specificity); NR = not reported; pPRS = patient-reported Periodontitis Risk Score; PSR = Periodontal Screening and Recording; VA = Veterans Affairs.

Appendix B Table 4. Quality Assessment of Diagnostic Accuracy Studies

Author, year	Represent-ative spectrum	Random or con-secutive sample	Screening test adequately described	Screen-ing cutoffs pre-defined	Credible reference standard	Reference standard applied to all screened patients	Same reference standard applied to all patients	Reference standard and screening exam-ination interpreted independ-ently	Reference standard assessed by blinded assessor	Screening test assessed by blinded assessor	High rate of uninter-pretable results, non-compliance with screening test, or attrition	Analysis includes patients with uninter-pretable results or non-compl-iance	Quality rating
Deng, 2021[79]	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	No No No	NA NA	Fair
Dietrich, 2007[80]	No; patients were referred for endodontic surgery	Unclear	Yes	No	Yes	Yes	Yes	Yes	Yes	Unclear	No No No	NA NA	Fair
George, 2017,[81] George 2018[78]	Yes	Yes	Yes	Yes	Yes	No, many screened did not undergo reference standard	Yes	Yes	Unclear	Yes	No No No	No	Fair
Nijland, 2021[82]	Yes	Yes	Yes	No	Yes but not full exam	Yes	Yes	Yes	Yes	Yes	No No No	NA NA	Fair
Sekundo, 2021[83]	Unclear	Yes	Yes	No	Yes	Yes	Yes	Yes	Unclear	Yes	No No No	NA NA	Fair
Verhulst, 2019[84]	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Unclear	Yes	No No No	NA NA	Fair
Westman, 1994[85]	Yes	Yes	Yes	NA	Yes	Yes	Yes	Yes	Yes	Yes	No No No	NA NA	Good

Abbreviation: NA = not applicable.

Appendix B Table 5. Data Abstraction of Topical Fluoride Trials

Author, year	Study design	Interventions	Interventionist	Baseline population characteristics	Eligibility criteria	No. approached, eligible	No. enrolled	No. analyzed (arms)	Country Setting
Carter, 1955[89]	Non-randomized controlled clinical trial	A: Sodium fluoride 2% solution semi-weekly (>50% received >4 successive treatments; mean number of treatments not reported B: Sodium chloride 0.9% solution semi-weekly (control) Oral health counseling/ education NR	NR	Age, mean years: 22 (ranged 19 to 39) % Female: 100% Race/ethnicity: NR Baseline caries: Not reported Oral health behaviors: Not reported	Enlisted women at military training center	270 NR	NR	148 A: 60 B: 88	North Chicago, Illinois, USA Clinical setting NR Water fluoridation status not reported
Jabir, 2021[87]	Non-randomized cluster controlled trial	A: Sodium fluoride varnish (22,600 ppm) every 6 months + training of long term care staff on oral hygiene and oral health screeningB: No intervention	Dentists	Age, mean years (SD): 83.77 (6.87) and 84.41 (6.37) % female: 68.9% and 55% Race/ethnicity: NR Number of teeth, mean (SD): 6.14 (1.43) and 6.53 (1.47) Plaque score, mean (SD): 88.97 (13.97) and 91.17 (10.78) DMFT, mean (SD): 21.49 (3.62) and 21.87 (3.04) Number carious teeth, mean (SD): 4.65 (1.27) and 4.48 (1.37) Oral health behaviors: Not reported	Dentate residents in long-term care facilities Excluded: Edentulous, unable to cooperate, unable to consent and no registered power of attorney, presence of facial or oral infections, medical history precluding application of fluoride products	A: 356 B: 426 NR	A: 190 B: 217	A: 101 (complete case analysis)/190 (last outcome carried forward analysis)B: 131 (complete case analysis)/217 (last outcome carried forward analysis)	Northern Ireland Long-term care facilitiesWater fluoridation status not reported

Appendix B Table 5. Data Abstraction of Topical Fluoride Trials

Author, year	Study design	Interventions	Interventionist	Baseline population characteristics	Eligibility criteria	No. approached, eligible	No. enrolled	No. analyzed (arms)	Country Setting
Obersztyn, 1979[90]	Non-randomized controlled clinical trial	A: Stannous fluoride 30% paste followed by stannous fluoride 10% aqueous solution every 6 months B: Supervised tooth brushing with 297 and 335 amine fluorides an sodium fluoride gel under supervision by a dentist (40-45 times annually) C: No treatment Oral health counseling/ education not reported	NR	A vs. B. vs. C Age: NR (19 to 20 years by inclusion criteria) % Female: 0% Race/ethnicity: Not reported DMFS, mean (SE): 18.83 (1.07) vs. 20.19 (1.15) vs. 20.06 (1.15) Oral health behaviors: NR	19 to 20 year old men enrolled at a college	NR NR	300A: 100B: 100C: 100	248A: 85B: 79C: 84	Warsaw, Poland Clinical setting NR Water fluoridation status not reported

Appendix B Table 5. Data Abstraction of Topical Fluoride Trials

Author, year	Study design	Interventions	Interventionist	Baseline population characteristics	Eligibility criteria	No. approached, eligible	No. enrolled	No. analyzed (arms)	Country Setting
Tan, 2010[86]	RCT	A: Sodium fluoride varnish (22,600 ppm) every 3 months B: Silver diamine fluoride solution (380 mg/ml) every 12 months C: Chlorhexidine varnish (1% chlorhexidine/1% thymol) every 3 months D: Placebo (water) applied every 12 months All groups received oral hygiene instruction, including effective brushing with manual toothbrush and recommendation to use fluoride toothpaste	Assessments performed by trained dentist; intervent-ionalist performing treatments; providing education NR	Age, mean years (SD): 79.5 vs. 78.9 vs. 78.4 vs. 78.5% female: 76% (all groups) Race/ethnicity: NR Number of teeth, mean (SD): 14.3 (6.5) (all groups) Number of sound surfaces, mean (SD): 52.1 (3.2) vs. 56.0 (3.1) vs. 57.5 (3.2) vs. 54.7 (3.0) DS-root (carious root surfaces), mean (SD): 1.3 (0.2) vs. 1.3 (0.2) vs. 1.1 (0.2) vs. 1.3 (0.2) FS-root (filled root surfaces), mean (SD): 0.9 (0.2) vs. 0.8 (0.2) vs. 0.9 (0.3) vs. 0.8 (0.2) DFS-root (decayed or filled root surfaces), mean (SD): 2.2 (0.3) vs. 2.1 (0.3) vs. 2.0 (0.3) vs. 2.1 (0.3) Oral health behaviors: NR	Elders in residential and nursing homes, at least 5 teeth with exposed sound root surfaces, no serious medical problems, self-care ability	1546 NR	306 A: 80 B: 72 C: 71 D: 83	203 A: 49 B: 51 C: 48 D: 55	Hong Kong, People's Republic of China Residential and nursing homes Water fluoridation status not reported

Appendix B Table 5. Data Abstraction of Topical Fluoride Trials

Author, year	Study design	Interventions	Interventionist	Baseline population characteristics	Eligibility criteria	No. approached, eligible	No. enrolled	No. analyzed (arms)	Country Setting
Wallace, 1993[88]	Controlled clinical trial (unclear if randomized)	A: Topical acidulated phosphate fluoride (APF) gel (1.2% F) every 6 months + placebo mouth rinse daily B: Fluoridated mouth rinse (0.05% F) daily C: Placebo mouth rinse daily Oral health counseling/education NR	Dentist	A vs. B vs. C (information provided only for those not lost to follow up) Age, sex, race/ethnicity: NR Surfaces at risk, mean (SD): 45.7 (19.6) vs. 48.4 (18.1) vs. 46.1 (18.2) DS-root (decayed root surfaces), mean (SD): 1.3 (2.4) vs. 2.1 (3.5) vs. 1.3 (2.3) FS-root (filled root surfaces), mean (SD): 1.6 (2.4) vs. 1.9 (3.0) vs. 2.3 (3.5) Oral health behaviors: All patients reported use of fluoridated dentifrices	60 years and older, noninstitutionalized, at least 15 remaining teeth	NR 603	591 A: 187 B: 179 C: 225	466 A: 147 B: 148 C: 171	Birmingham, Alabama, USA Dental clinics Water fluoridation "optimal"

Appendix B Table 5. Data Abstraction of Topical Fluoride Trials

Author, year	Duration of followup	Outcomes	Adverse events/ harms	Attrition	Quality rating	Sponsor
Carter, 1955[89]	8 to 14 months	A vs. B Newly decayed teeth, mean (SD): 0.950 (1.064) vs. 1.079 (1.046), p=0.48 ≥1 new carious teeth: 60% (36/60) vs. 68% (60/88), RR 0.88 (95% CI 0.68 to 1.13)	NR	Total 45% (122/270)	Poor	NR
Jabir, 2021[87]	12 months	A and B at 12 months (complete case analysis, n=101 vs. 131) Number of carious teeth, mean change from baseline: -0.85 (95% CI -1.12 to -0.58) vs. 0.21 (95% CI 0.05 to 0.37); mean difference (ANCOVA) -0.93 (95% CI -1.15 to -0.71) DMFT score, mean change from baseline: 0.10 (95% CI 0.03 to 0.17) vs. 0.13 (95% CI 0.04 to 0.22); mean difference (ANCOVA) -0.06 (95% CI -0.18 to 0.06) Plaque score, mean change from baseline: -0.06 (95% CI -1.13 to 1.01) vs. 1.16 (95% CI 0.28 to 2.04); mean difference (ANCOVA) -1.80 (95% CI -3.00 to -0.60) A vs B at 12 months (complete case analysis, n=190 vs. 217) Number of carious teeth, mean change from baseline: -0.45 (95% CI -0.61 to -0.30) vs. 0.12 (95% CI 0.03 to 0.22); mean difference (ANCOVA) -0.48 (95% CI -0.63 to -0.32) DMFT score, mean change from baseline: 0.05 (95% CI 0.01 to 0.09) vs. 0.08 (95% CI 0.03 to 0.13); mean difference (ANCOVA) -0.04 (95% CI -0.10 to 0.03) Plaque score, mean change from baseline: -0.03 (95% CI -0.60 to 0.53) vs. 0.70 (95% CI 1.12); mean difference (ANCOVA) -1.03 (95% CI -1.75 to -0.36) Reduction in carious teeth: 40% (40/101) vs. 12% (15/131); adjusted OR 14.74 (95% CI 5.89 to 36.91)	NR	A vs. B: 46.8% (89/190) vs. 39.6% (86/217)	Poor	NR
Obersztyn, 1979[90]	36 months	A vs. B vs. C DMFS, mean (SE): 21.98 (1.15) vs. 22.85 (1.18) vs. 24.81 (1.26) at 1 year; 21.98 (1.22) vs. 23.94 (1.33) vs. 28.34 (1.36) at 2 years; 24.93 (1.23) vs. 25.63 (1.29) vs. 30.60) at 3 years DMFS increment (mean, SE NR): 6.10 vs. 5.44 vs. 10.54 at 3 years (p<0.01 for A and B vs. C)	NR	A vs. B vs. C21% (21/100) vs. 16% (16/100) vs. 15% (15/100)	Poor	NR
Tan, 2010[86]	3 years	A vs. B vs C and D New decayed or filled root surfaces, mean (SE): 0.8 (0.2) vs. 0.4 (0.1) vs. 1.0 (0.2) vs. 1.5 (0.2) at 1 year (p<0.001 for B and C vs. D); 0.9 (0.2) vs. 0.7 (0.2) vs. 1.0 (0.3) vs. 2.0 (0.3) at 2 years (p<0.001 for A, B, and C vs. D); 0.9 (0.3) vs. 0.7 (0.2) vs. 1.1 (0.2) vs. 2.5 (0.5) at 3 years (p<0.001 for A, B, and C vs. D) Development of new root caries: RR 0.26 (95% CI 0.10 to 0.63) for A vs. D, NNT 3.1 (95% CI 2.1 to 7.7); RR 0.19 (95% CI 0.07 to 0.46) for B vs. D, NNT 2.5 (95% CI 1.8 to 4.8); RR 0.27 (95% CI 0.11 to 0.66) for C vs. D, NNT 3.2 (95% CI 2.1 to 8.3)	"No major side effect or discomfort reported"	A vs. B vs. C vs. D: 39% (31/80) vs. 29% (21/72) vs. 32% (23/71) vs. 34% (28/83); overall 34% (103/306)	Poor	NR

Appendix B Table 5. Data Abstraction of Topical Fluoride Trials

Author, year	Duration of followup	Outcomes	Adverse events/ harms	Attrition	Quality rating	Sponsor
Wallace, 1993[88]	48 months	A vs. B vs C at 48 months New root caries surface lesions (mean, SD): 1.36 (2.00) vs. 1.72 (2.42) vs. 1.99 (2.65); p<0.05 for A vs. C Reversed root caries surface lesions (mean, SD): 1.01 (1.86) vs. 1.53 (2.03) vs. 1.11 (1.74); p<0.05 for B vs. C Incremental DMFS (mean, SD): 0.27 (271) vs. 0.26 (2.72) vs. 0.91 (2.99); p<005 for A and B vs. C	NR	Baseline number for each group NR Overall, 23% (466/603)	Poor	National Institute of Dental Research, mouth rinses supplied by Johnson & Johnson

Abbreviations: ANCOVA = analysis of covariance; APF = acidulated phosphate fluoride; CI = confidence interval; DFS-root = decayed or filled root surfaces; DMFS = Decayed, Missing, and Filled Surfaces; DMFT = Decayed, Missing, and Filled Teeth; DS-root =carious root surfaces; FS-root = filled root surfaces; NA = not applicable; NNT = number needed to treat; NR =not reported; OR = odds ratio; ppm = parts per million; RR = relative risk; SD = standard deviation; SE = standard error; USA = United States of America.

Appendix B Table 6. Quality Assessment of Topical Fluoride Trials

Author, year	Random-ization adequate?	Allocation conceal-ment adequate?	Groups similar at baseline?	Outcome assessors masked?	Care provider masked?	Patient masked?	Intention-to-treat (ITT) analysis	Patients with missing data analyzed?	Acceptable levels of overall attrition and between-group differences in attrition?	Post random-ization exclus-ions	Avoidance of selective outcomes reporting	Adjusted for cluster correlate-ion?	Quality rating
Carter, 1955[89]	No	No	Unclear	Unclear	No	No	No	No	No	Unclear	Unclear	NA	Poor
Jabir, 2021[87]	No	No	No	No	No	No	No	Yes (LOCF)	No	Unclear	Unclear	No	Poor
Obersztyn, 1979[90]	No	No	Unclear	Unclear	No	No	No	No	Yes	Unclear	Unclear	NA	Poor
Tan, 2010[86]	Yes	Unclear	Yes	Yes	Unclear	Unclear	No	Unclear	No	Unclear	Unclear	NA	Poor
Wallace, 1993[88]	Unclear	Unclear	No	Yes	Unclear	Unclear	No	No	No	Unclear	Unclear	NA	Poor

Abbreviations: ITT = intention-to-treat; LOCF = last observation carried forward; NA=not applicable.

Appendix B Table 7. Data Abstraction of Sealant Trials

Author, year	Study design	Interventions	Interventionist	Baseline population characteristics	Eligibility criteria	No. approached, eligible	No. enrolled	No. analyzed (arms)	Country Setting
Eden, 1976[91]	RCT	A: Resin-based non-fluoride-containing sealant applied to noncarious premolars and molars (clear [NuvaSeal] or tinted sealant; both require ultraviolet light for polymerization) B: No sealant applied to paired premolars and molars Oral health counseling/education NR	NR	Age, mean (SD): 21.63 (1.79) (overall) % female: NR Race/ethnicity: Not reported DMFS, mean (SD NR): 7.2 (overall) DMFT, mean: 5.6 (overall) Oral health behaviors: Not reported	Enrollment in submarine school and at least one caries-free pair of first or second molars	NR 299	119	119 (719 tooth pairs)	United States Clinical setting NR Water fluoridation status NR
Yildiz, 2004[92]	Non-randomized controlled clinical trial	A: Resin-based fluoride-containing sealant (Helioseal F) applied to first and second molars on the right side of the mouth, followed by exposure to dental curing light B: Resin-based, non-fluoride containing sealant (Concise Light Cure White Sealant) applied to the first and second molars on the right side of the mouth, followed by exposure to dental curing light C: No sealant applied to corresponding teeth on the left side of the mouth Oral health counseling/education NR	Dentists	Age: 18-20 % female: NR Race/ethnicity: NR DMFS, mean (SE): NR Oral health behaviors: Not reported	18-20 year old students enrolled in a dental program with clinically non-detectable caries (radiographic examination was not used) or no restorations or sealants present on first and second molar fissures	NR 200	59	59 (122 tooth pairs)	Istanbul, Turkey Department of Operative Dentistry Water fluoridation status NR

Appendix B Table 7. Data Abstraction of Sealant Trials

Author, year	Duration of followup	Outcomes	Adverse events/ harms	Attrition	Quality rating	Sponsor
Eden, 1976[91]	24 months	A vs. B Proportion of teeth with caries: 1.7% (12/719) vs. 2.6% (19/719)	NR	60% (180/299)	Poor	NR
Yildiz, 2004[92]	24 months	A and B vs. C Proportion with caries: 5.7% (7/122) vs. 15.6% (19/122) at 12 months (p=0.02); 5.7% (7/122) vs. 25.4% (31/122) at 24 months (p=0.005)	NR	NR	Poor	NR

Abbreviations: DMFS = Decayed, Missing, and Filled Surfaces; DMFT = Decayed, Missing, and Filled Teeth; NR=not reported; RCT=randomized controlled trial; SD=standard deviation; SE=standard error; USA = United States of America.

Appendix B Table 8. Quality Assessment of Sealant Trials

Author, year	Random-ization adequate?	Allocation conceal-ment adequate?	Groups similar at baseline?	Outcome assessors masked?	Care provider masked?	Patient masked?	Intention-to-treat (ITT) analysis	Patients with missing data analyzed?	Acceptable levels of overall attrition and between-group differences in attrition?	Post-random-ization exclus-ions?	Avoidance of selective outcomes reporting	Adjusted for cluster correlat-ion?	Quality rating
Eden, 1976[91]	Yes	Unclear	Yes	Unclear	No	No	No	No	Unclear	Unclear	Unclear	NA	Poor
Yildiz, 2004[92]	No	No	Yes	No	No	No	Unclear	Unclear	Unclear	Unclear	Unclear	NA	Poor

Abbreviations: ITT = intention-to-treat; NA=not applicable.

Appendix B Table 9. Data Abstraction of Silver Diamine Fluoride Trials

Author, year	Study design	Intervention A	Intervention B	Intervention C	Intervention D	Other notes about intervention	Interventionist	Baseline population characteristics	Eligibility criteria
Li, 2017[93]	RCT	A. 38% SDF solution to exposed tooth root surfaces at 12 and 24 months	B. 38% SDF solution to exposed tooth root surface followed by saturated potassium iodide solution (2.36 mol/l), which may prevent staining, at 12 and 24 months	C. Placebo (tonic water) to exposed tooth root surfaces at 12 and 24 months	NA	All participants received oral hygiene instructions for brushing teeth and cleaning their dentures; and a toothbrush and toothpaste	Dentist	Age, mean 72.1 (6.3 SD) years % female: 78% Race/ ethnicity: NR All subjects Exposed sound root surfaces, mean (SE): 41.7 (1.6) vs. 41.6 (1.6) vs. 40.2 (1.6) Decayed root surfaces, mean (SE): 0.6 (0.1) vs. 0.7 (0.1) vs. 0.6 (0.1) Filled root surfaces, mean (SE): 0.4 (0.1) vs. 0.6 (0.1) vs. 0.4 (0.1) Root caries experience, mean (SE): 1.0 (0.2) vs. 1.3 (0.2) vs. 1.0 (0.1) Visible plaque index, mean (SE): 26.6 (2.4) vs. 28.0 (2.7) vs. 28.6 (2.5) Oral health behaviors: 86% brushed teeth at least twice daily	Community dwelling adults aged >55 years; ≥5 teeth with exposed root surfaces not indicated for extraction; no serious health problems; no cognitive problems in communication; self-care ability for normal daily activities Excluded: salivary gland function affected by disease, medication, or treatment

Appendix B Table 9. Data Abstraction of Silver Diamine Fluoride Trials

Author, year	Study design	Intervention A	Intervention B	Intervention C	Intervention D	Other notes about intervention	Interventionist	Baseline population characteristics	Eligibility criteria
Tan, 2010[86]	RCT	A: Silver diamine fluoride solution (380 mg/ml) every 12 months	B: Sodium fluoride varnish (22,600 ppm) every 3 months	C: Chlor-hexidine varnish (1% chlor-hexidine/ 1% thymol) every 3 months	D: Placebo (water) applied every 12 months	All groups received oral hygiene instruction, including effective brushing with manual toothbrush and recommendation to use fluoride toothpaste	Assessments performed by trained dentist; interventionist performing treatments and providing education not reported	Age, mean (SD): 78.9 vs. 79.5 vs. 78.4 vs. 78.5 years % female: 76% Race/ ethnicity: NR Number of teeth, mean (SD): 14.3 (6.5) (all groups) Number of sound surfaces, mean (SD): 56.0 (3.1) vs. 52.1 (2.7) vs. 57.5 (3.2) vs. 54.7 (3.0) DS-root (carious root surfaces), mean (SD): 1.3 (0.2) vs. 1.3 (0.2) vs. 1.1 (0.2) vs. 1.3 (0.2) FS-root (filled root surfaces), mean (SD): 0.8 (0.2) vs. 0.9 (0.2) vs. 0.9 (0.3) vs. 0.8 (0.2) DFS-root (decayed or filled root surfaces), mean (SD): 2.1 (0.3) vs. 2.2 (0.3) vs. 2.0 (0.3) vs. 2.1 (0.3) Oral health behaviors: NR	Elders in residential and nursing homes, at least 5 teeth with exposed sound root surfaces, no serious medical problems, self-care ability
Zhang, 2013[94]	RCT	A. 38% SDF solution at 12 and 24 months	B. 38% SDF at 12 and 24 months + oral health education program (prevent snacking, tooth brushing methods, use additional cleaning aids) for 30 minutes every 6 months	C. Placebo (water) at 12 and 24 months	NA	All groups received oral hygiene instructions tailored to the individual's condition, including how to clean the teeth by the use of a manual toothbrush The subjects were also asked to brush their teeth twice a day and to use fluoridated toothpaste during brushing, but no toothpaste was provided	Dentist for SDF and trained dental hygienist for oral health education	Age, mean: 72.5 (5.7 SD) % female: 74% Race/ ethnicity: NR Mean exposed sound root surfaces, (SE): 16.48 (0.51) Decayed and filled root surfaces: 1.97 (0.15) Decayed root surfaces: 1.02 (0.10) Arrested root surfaces: 0.47 (0.06) Oral health behaviors: 88% brushed twice or more daily; 87% used additional aids to clean teeth daily	Elders aged 60-89 years able to perform daily self-care activities, who had at least 5 teeth with exposed root surfaces and do not have serious life-threatening medical diseases

Appendix B Table 9. Data Abstraction of Silver Diamine Fluoride Trials

Author, year	No. approached, eligible	No. enrolled	No. analyzed (arms A vs. B)	Attrition	Country Setting	Duration of followup	Outcomes	Adverse events/ harms	Quality rating	Sponsor
Li, 2017[93]	544 NR	323 A. 107 B. 108 C. 108	257 at 30 months A. 95 B. 82 C. 80	A vs. B vs. C: 11% (95/107) vs. 24% (26/108) vs. 26% (28/108)	Hong Kong, China Community centers Community dwelling elders recruited at local elder centers in Hong Kong Water optimally fluoridated at 0.5 ppm April 2012 to March 2015	30 months	A vs. B vs. C Number of root surfaces with new caries lesions or fillings, mean (SE) 12 months (n=297) 0.2 (0.1) vs. 0.2 (0.1) vs. 0.5 (0.1), p=0.004 24 months (n=258) 0.4 (0.1) vs. 0.4 (0.1) vs. 0.9 (0.1), p=0.004 30 months (n=257) 0.4 (0.1) vs. 0.5 (0.1) vs. 1.1 (0.2), p<0.001; mean difference (ANCOVA) -0.394 (SE 0.134) for A vs. C (p=0.001) and -0.475 (SE 0.139) for B vs. C (p=0.001) New root caries at 30 months: Adjusted OR 0.4 (0.3 to 0.7) for A vs. C, adjusted OR 0.5 (95% CI 0.3 to 0.8) for B vs. C	No adverse side effects	Fair	Research Grants Council of Hong Kong
Tan, 2010[86]	1546 NR	306A: 72B: 80C: 71D: 83	203A: 51B: 49C: 48D: 55	A vs. B vs. C vs. D: 29% (21/72) vs. 39% (31/80) vs. 32% (23/71) vs. 34% (28/83); overall 34% (103/306)	Hong Kong, People's Republic of China Residential and nursing homes Water fluoridation status NR	3 years	A vs. B vs C and D New decayed or filled root surfaces, mean (SE): 1 year: 0.4 (0.1) vs. 0.8 (0.2) vs. 1.0 (0.2) vs. 1.5 (0.2) (p<0.001 for A and C vs. D); 2 years: 0.7 (0.2) vs. 0.9 (0.2) vs. 1.0 (0.3) vs. 2.0 (0.3) (p<0.001 for A, B, and C vs. D) 3 years: 0.7 (0.2) vs. 0.9 (0.3) vs. 1.1 (0.2) vs. 2.5 (0.5) (p<0.001 for A, B, and C vs. D) Development of new root caries: RR 0.19 (95% CI 0.07 to 0.46) for A vs. D, NNT 2.5 (95% CI 1.8 to 4.8) RR 0.26 (95% CI 0.10 to 0.63) for B vs. D, NNT 3.1 (95% CI 2.1 to 7.7) RR 0.27 (95% CI 0.11 to 0.66) for C vs. D, NNT 3.2 (95% CI 2.1 to 8.3)	"No major side effect or discomfort reported"	Fair	NR

Appendix B Table 9. Data Abstraction of Silver Diamine Fluoride Trials

Author, year	No. approached, eligible	No. enrolled	No. analyzed (arms A vs. B)	Attrition	Country Setting	Duration of followup	Outcomes	Adverse events/ harms	Quality rating	Sponsor
Zhang, 2013[94]	717 277	266 A. 98 B.84 C. 84	227 A. 83 B. 69 C. 75	A vs. B vs. C: 15% (15/98) vs. 18% (15/84) vs. 11% (9/84)	Hong Kong, China Unclear setting Community dwelling elders recruited from 11 community elderly centers in Hong Kong Water optimally fluoridated at 0.5 ppm	24 months	A vs. B vs. C Mean number of new root caries surfaces at 24 months (SE): 1.00 (0.16) vs. 0.70 (0.11) vs. 1.33 (0.21); mean difference (ANCOVA) -0.27 (SE 0.22) for A vs. C and -0.68 (SE 0.23) for B vs. C Mean number of arrested root caries surfaces at 24 months (SE): 0.28 (0.06) vs. 0.33 (0.10) vs. 0.04 (0.02); mean difference (ANCOVA) 0.25 (SE 0.09) for A vs. C and 0.28 (0.09) for B vs. C	NR	Fair	NR

Abbreviations: ANCOVA = analysis of covariance; CI = confidence interval; DFS-root = decayed or filled root surfaces; DS-root =carious root surfaces; FS-root = filled root surfaces; NA = not applicable; NNT = number needed to treat; NR = not reported; OR = odds ratio; RCT = randomized controlled trial; RR = relative risk; SD = standard deviation; SDF = silver diamine fluoride; SE = standard error.

Appendix B Table 10. Quality Assessment of Silver Diamine Fluoride Trials

Author, year	Random-ization adequate?	Allocation conceal-ment adequate?	Groups similar at baseline?	Outcome assessors masked?	Care provider masked?	Patient masked?	Intention-to-treat analysis	Patients with missing data analyzed?	Acceptable levels of overall attrition (<20%) and between-group differences (<10%) in attrition?	Post-random-ization exclusions	Avoidance of selective outcomes reporting	Adjusted for cluster correlat-ion?	Quality rating
Li, 2017[93]	Yes	Yes	Yes	Yes	No	Unclear	No	No	Yes No (At 30 months, SDF only group dropout rate was lower than other 2 groups (11% vs. 25%, p=0.014)	No	Yes	NA	Fair
Tan, 2010[86]	Yes	Unclear	Yes	Yes	Unclear	Unclear	No	Unclear	No	Unclear	Unclear	NA	Fair
Zhang, 2013[94]	Yes	Unclear	Yes	Yes	Unclear	Yes	No	No	Yes No	No	Yes	NA	Fair

Abbreviations: ITT = intention to treat analysis; NA=not applicable; SDF = silver diamine fluoride.