

SYSTEMATIC REVIEW

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Every bite counts to achieve oral health: a scoping review on diet and oral health preventive practices

Steffany Chamut^{1,5,7*}, Mona Alhassan^{1,8}, Alhassan Hameedalddeen^{1,2}, Shivangi Kaplish¹, Adam H. Yang¹, Carrie G. Wade³, Sondos Alghamdi^{1,4}, Denisse Chamut⁵, Brian B. Novy^{1,9} and Tejasvita Chandel⁶

Abstract

Objective To examine the landscape of preventive strategies and interventions directed to achieve oral health equity, with particular emphasis on the interplay between dental caries prevention, individual behaviors, and population-level strategies across various demographic and geographic regions.

Methods This scoping review was guided by Peters et al.'s framework, which incorporates four key concepts aimed at reducing caries: education for individuals and healthcare providers, behavioral modifications, addressing broader social determinants of health, and extending oral health education programs beyond traditional dental settings. A systematic search was conducted across five databases, from 2011 to 2022.

Results This review identified 107 studies highlighting three main themes: behavioral practices ($N=33$), which focused on reducing the prevalence of caries, improving oral hygiene practices, and enhancing overall oral health knowledge; educational interventions ($N=39$), which explored strategies to integrate oral health with broader public health initiatives; and dietary interventions ($N=35$), which emphasized the critical relationship between diet and oral health.

Conclusion This SR highlights the critical need for comprehensive multilevel approaches that address the complex interplay between nutrition, oral health, and sociodemographic factors, while emphasizing the critical relationship between societal factors and individual health behaviors. Multifaceted interventions that include behavioral change, education, and dietary modifications are crucial for improving oral and overall health outcomes across diverse populations. Comprehensive strategies should prioritize medical-dental integration and data-driven approaches to effectively reduce oral health disparities for vulnerable populations, promoting long-term health equity.

Keywords Oral health, Diet, Nutrition, Micronutrient, Nutritional epidemiology, Food insecurity, Social determinants of health, Health disparities, Health equity, Public health interventions, Policy implications, Healthy aging

*Correspondence:

Steffany Chamut

steffany.chamut@cuanschutz.edu; Steffany_Chamut@hsdm.harvard.edu

Full list of author information is available at the end of the article



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Introduction

Oral health is a frequently overlooked yet essential aspect of overall well-being. Described as a “silent epidemic,” poor oral health impacts nearly 4 billion people worldwide, resulting in substantial economic losses [1–8]. In the United States (U.S.), oral diseases, including both inflammatory and degenerative conditions, lead to an annual financial impact of approximately \$136 billion, emphasizing the urgency of integrating oral health into broader health policy frameworks and enhancing accessible, cost-effective preventive measures, particularly among children, older adults, and underserved populations [1–12]. Oral diseases not only compromise masticatory function, which is essential for proper nutrition and quality of life (QoL), but are associated with increased risk for systemic conditions and noncommunicable chronic diseases (NCDs), such as diabetes and cardiovascular disease [4, 13–19]. Such systemic manifestations, often heightened by dietary deficiencies, further complicate the burden of oral diseases and potentially lead to severe and life-threatening health conditions [8, 12, 20–24].

A key objective for both public and private health entities in the U.S. is the reduction of health disparities, as underscored the 2000 Surgeon General’s report, which highlighted oral health as essential to overall well-being and pointed out disparities in dental care access. Later, the 2011 Institute of Medicine (IOM) report acknowledged that efforts to date have been insufficient in eliminating these disparities. Recently, the 2021 NIDCR’s “Oral Health in America: Advances and Challenges” report noted the minimal progress made, particularly for the most disadvantaged groups, reaffirming the urgent need for focused action [4, 6, 22, 23, 25, 26]. Whilst the World Health Organization (WHO) champions the concept of health as a holistic state encompassing physical, mental, and social well-being, wherein oral health is recognized as a crucial component [27, 28]. Building on this foundation, the WHO’s “Global Oral Health Action Plan 2023 – 2030” underscores the integration of oral health into overall health strategies [29–31]. Additionally, in 2022, the WHO, along with the Food and Agriculture Organization of the United Nations, the World Organization for Animal Health, and the United Nations Environment Programme, forged a collaborative agreement to propel the One Health initiative to the forefront of global health priorities, emphasizing the interconnectedness of human, animal, and environmental health [32]. Concurrently, the United Nations Agenda 2030 introduced the 17 Sustainable Development Goals (SDG) aimed at securing peace, prosperity, and well-being for all by 2030. Notably, SDG 3, which seeks to ensure good health and promote well-being for all ages, implicitly encompasses

oral health, despite not targeting it explicitly [30, 33, 34]. Oral health extends beyond the mere condition of one’s teeth, influencing and being influenced by broader social, environmental, and economic factors. These strategic partnerships and action plans highlight the upstream and downstream social determinants of health that impact oral health outcomes, addressing factors from global policy initiatives to individual behaviors, also mirrored in the US where significant socioeconomic impacts and health disparities persist [4, 35].

Good oral health ensures the dignity of performing daily activities without pain or discomfort, which is paramount for maintaining QoL [20, 21, 36–40]. Tooth loss and other oral health problems can directly compromise QoL, dietary intake and nutritional quality, leading to broader health consequences. Most oral diseases are preventable, and factors involved in caries are highly modifiable with the right support [3, 41, 42]. Sustained neglect of oral health not only diminishes QoL, but also poses risks to micronutrient deficiencies and overall systemic health, highlighting the critical need for integrated approaches such as the One Health initiative [12, 24, 30, 32]. The prevailing dental restorative approach proves unfeasible in many regions, especially in low-income countries where over 90% of caries remains untreated, highlighting the urgent need for accessible, affordable, and sustainable oral health solutions [43, 44]. Established links between chronic oral conditions and systemic diseases, including heart disease, diabetes, and neurodegenerative diseases such as Alzheimer’s and related dementias (AD/ADRDs), are likely due to inflammation caused by oral bacteria and occlusal dysfunction [9, 24, 45, 46]. Rethinking oral and planetary health can redefine global oral health strategies by fostering sustainable oral health outcomes, ensuring today’s needs for the most vulnerable and underserved are met without compromising future capabilities [30].

Socioeconomic factors and access to care are significant determinants of oral health, with vulnerable groups facing the greatest challenges [4, 25, 47–49]. The interplay of oral health with nutrition is pivotal; diets high in sugars and fermentable carbohydrates exacerbate the risk for dental caries and disease. However, dental caries a preventable condition characterized by long duration and slow progression, directly influences food choices and an individual’s ability to eat “chew” a balanced and healthy diet. Individuals often perceive foods rather than individual nutrients, highlighting the need for dietary considerations and modifiable risk factors in oral health promotion [1–7, 9, 24, 50, 51]. Approximately one in six children aged 6–11 have experienced caries, and a similar proportion of adolescents have untreated cavities, while a significant number of older adults have lost all their teeth due to caries [6, 52]. The impact of caries, tooth

loss, and oral function on the ability to follow the Dietary Guidelines for Americans (DGAs) is profound, with poor oral health limiting the intake of more healthful food choices, thereby influencing long-term health outcomes [5, 53]. This scoping review (SR) aims to bridge the gap between oral health and dietary guidelines by examining the landscape of preventive strategies and interventions to achieve oral health equity, with particular attention given to dental caries prevention, diet, and socioeconomic determinants across various demographic and geographic regions.

Methods

We conducted an SR according to the framework described by Peters et al. to identify relevant studies that center efforts on behavioral and educational programs/interventions to support effective preventive oral health practices in reducing caries and cariogenic bacteria [54]. This review has been reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses – Scoping Review extension (PRISMA-ScR).

Eligibility criteria

Inclusion criteria

- Population: Studies including pregnant women, young children, and older adults, with subgroup analysis where applicable;
- Study Design: Cross-sectional, case-control, cohort, and interventional studies, including randomized controlled trials and systematic reviews;
- Impact on Health: Studies reporting a clear, positive impact on individual and/or population-level oral health outcomes, behaviors, or health promotion with a focus on health equity.
- Relevance to DGAs: Evidence that can inform DGAs with actionable recommendations to address preventable oral diseases.
- Equity Focus: Research focused on health disparities and social determinants of health.
- Language and Publication Date: English-language articles published between 2011 and 2022.

Exclusion criteria

- Language Barriers: Non-English articles.
- Publication Type: Case reports/series, opinions, commentaries, editorials, abstracts, and other non-peer-reviewed materials.
- Irrelevant Results: Studies reporting nonsignificant findings that are not relevant to the research question or those with inadequate or small sample sizes.

- Methodological issues: Articles with reported methodological flaws.
- Generalizability: Studies with results that cannot be generalized to broader populations.
- Accessibility and Sustainability: Studies involving interventions or technologies (excluding mobile phones) are not feasible for implementation among marginalized or low socioeconomic communities (e.g., expensive dental equipment).

Search strategy and data abstraction

An electronic database search of the literature was conducted on October 7, 2022, by a librarian (CW). The search was developed in PubMed (National Library of Medicine) using controlled vocabulary and keywords for four concepts (Table 1). The searches were translated into four other databases using database-specific controlled vocabulary and keyword adjustments—Embase (Elsevier), Dentistry and Oral Sciences Source (EBSCO), ERIC (EBSCO), and the Cochrane Central Register of Trials (Wiley). (Appendix. 1) Results were deduplicated in EndNote before being screened for eligibility in Covidence. The SR was conducted by a team comprising six independent reviewers: Mona Alhassan (MA), Alhassan Hameedaldien (AH), Adam Yang (AY), Shivangi Kaplish (SK), Steffany Chamut (SC), and Tejasvita Chandel (TJ). The preliminary screening of titles and abstracts to determine the articles' eligibility for comprehensive review was performed by MA and AH. Once an agreement was reached on which abstracts and studies were suitable for full-text review, MA, AH, AY, and SK proceeded to evaluate the full texts according to the predefined eligibility criteria. In instances of discord, SC reviewed the abstracts and full text in each stage to reach a consensus [55]. An adapted Population, Intervention, Comparator/s, and Outcomes (PICO) framework was used to carry out the data extraction strategy and charting for this SR. MA, AH, AY, and SK generated the data from the chosen articles. TJ conducted a random verification of 10% of the collated data to confirm its precision. SC and TJ, who organized the information by author, publication year, country, type of publication, outcomes of the program, and key results, evaluated the full-text data according to the eligibility criteria and primary concepts (Tables 2, 3 and 4).

Results

A. Overview of included studies

The PRISMA flowchart illustrates the process of this SR, which initially identified a total of 9,114 articles through electronic databases, and after removing 1,129 duplicates, 1,940 articles remained for screening for full-text

Table 1 Key concepts guiding the search strategy for oral health impacting lifetime outcomes and caries reduction

Concept Number	Main Focus	Subcategories/Terminology
Concept 1	Education to Individuals and Healthcare Providers	<ul style="list-style-type: none"> • Effective methods for improving dental/oral health (OH) education across various audiences (public, specific patient groups, health providers) • Strategies for OH promotion and consumer health information • Resources on oral hygiene education, nutrition, literature, and patient handouts
Concept 2	Health behaviors	<ul style="list-style-type: none"> • Educational programs and training focused on enhancing health outcomes and behaviors • Diet management, toothbrushing, use of sugar-free gum • Identification and mitigation of negative behaviors contributing to caries and cariogenic bacteria
Concept 3	Oral Health Problems Leading to Broader Health Issues	<ul style="list-style-type: none"> • The impact of caries and oral bacteria on broader health conditions/diseases • Common oral health problems (e.g., caries, gum disease, tooth loss) and their implications for overall health, including nutrition-related challenges
Concept 4	Location of Oral Health Education Programs	<ul style="list-style-type: none"> • Oral health education in non-dental settings • Connections between oral health and serious health outcomes such as cardiovascular disease, stroke, vascular disorders, diabetes, Alzheimer's disease and related dementias, adverse pregnancy outcomes

Table 1 outlines the four primary concepts that guided the SR's search strategy. The detailed methodology and complete search strategy are documented in Appendix 1.

review (Fig. 1, Tables 2, 3 and 4). A total of 1,833 articles did not meet the inclusion criteria and were excluded. A total of 107 articles published between 2011 and 2022 were selected and included in the SR. The studies originated from Asia ($N=54$), Europe ($N=24$), North America ($N=10$), South America ($N=7$), Africa ($N=5$), Oceania ($N=4$), and others with multiple locations ($N=3$). Most of the articles ($N=36$) were cross-sectional studies, with a sample size range of 116–99,07. The remaining studies were case-control studies ($N=10$); cohort studies ($N=3$); clinical trials ($N=5$); cluster randomized studies ($N=1$); comparative studies ($N=1$); cost-effectiveness analyses ($N=1$); descriptive epidemiological studies ($N=1$); interventional studies ($N=4$); literature reviews ($N=1$); mixed methods investigations ($N=1$); narratives ($N=1$); pilot programs ($N=1$); prospective cohort studies ($N=1$); prospective observational studies ($N=1$); quasirandomized field studies ($N=1$); quasi-experimental studies ($N=2$); reviews ($N=7$); randomized controlled trials ($N=17$); randomized controlled trials ($N=1$); randomized cluster trials ($N=1$); and systematic reviews ($N=10$).

B. Types/themes of effective interventions

Tables 2, 3 and 4 describes the included articles that are categorized under the themes of effective interventions with the primary objective of addressing various facets of oral health, with a particular emphasis on reducing the prevalence of caries, enhancing oral hygiene practices, and enhancing overall oral health knowledge among the target populations. 1) Behavioral practices ($N=33$;

Table 2); 2) educational intervention ($N=39$; Table 3); 3) dietary best practices ($N=28$; Table 4), including sugar-free gums (SFGs) ($N=7$; Table 4).

Behavioral interventions were investigated in 33 studies (Table 2) [56–86]. Overall, these studies revealed various strategies implemented across diverse demographics and geographies. These interventions were primarily focused on reducing the prevalence of caries, improving oral hygiene practices, and enhancing overall dental health knowledge [56–86]. Studies in Tonga and Thailand revealed that school-based fluoride mouth-rinsing programs significantly improved children's oral health, with long-term participants showing fewer caries lesions [64, 65]. A family-centered oral health intervention targeting new parents significantly enhanced feeding and toothbrushing practices, reducing toddlers' risk of caries [66]. Additionally, motivational interviewing within healthcare environments has proven to be a successful strategy for preventing caries in children from lower-income families [76]. Oral health education in urban schools plays a pivotal role in recognizing key factors such as brushing duration and the oral hygiene index as critical predictors of caries [70]. Gao and Jain highlighted the importance of identifying key risk factors for early childhood caries (ECC) to prevent the progression of this condition [80, 81].

Educational interventions. Education interventions were a prominent focus in our SR, with 39 studies exploring their effects by highlighting a variety of effective strategies that have improved oral health outcomes [87–124]. These strategies target different groups, from

Table 2 Behavioral interventions

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/ Population	Focus of the Intervention/ Aim of Study	Outcome	Main Results/Key Findings
Caries Research (2013)	Ekstrand, Denmark	A randomized clinical trial of the anti-caries efficacy of 5,000 ppm fluoridated toothpaste on root caries lesions in elderly disabled nursing home residents	Randomized controlled trial	Elderly disabled nursing home residents in Denmark	Tooth brushing with 5,000 ppm fluoridated toothpaste	Comparison of effectiveness for controlling root caries between 5,000 ppm and 1,450 ppm F-toothpaste	5,000 ppm F-toothpaste significantly more effective than 1,450 ppm F-toothpaste for controlling root caries progression and promoting remineralization ($p < 0.001$)
Journal of the Indian Society of Pedodontics & Preventive Dentistry (2016)	Bhayade, India	Assessment of social, demographic determinants and oral hygiene practices in relation to dental caries among the children attending Anganwadis of Hingna, Nagpur	Cross-sectional study	Children age 5 and younger attending Anganwadis of Hingna, Nagpur	Main nutrition and oral hygiene practices	Prevalence and incidence of dental caries	Caries prevalence was higher in subjects who were cleaning their teeth using a tooth powder and finger compared to toothbrush and toothpaste. Also, malnutrition increase the risk for dental caries. Significant associations found among age, malnutrition, parents' educational status, oral hygiene practices, total number of siblings, and dental caries
Nutrients (2021)	Jouhar, Saudi Arabia	Association of BMI, diet, physical activity, and oral hygiene practices with DMFT index of male dental students at King Faisal university, Al-ahsa	Cross-sectional study	Male dental students at King Faisal University	Frequency of sweet consumption, tooth brushing, interdental cleaning, and use of fluoridated toothpaste	Association of BMI (body mass index) with DMFT (decayed, missing, and filled teeth), and association of diet, physical activity, and oral hygiene practices with DMFT	Higher parental education and income levels were significantly linked to higher BMI. Dietary factors, especially sugar consumption, and low physical activity were also associated with increased BMI. Oral hygiene practices, except for miswak and mouthwash, were linked to higher BMI. Overweight and obese individuals had more decayed and missing teeth. There was a strong association between decayed and missing teeth and higher BMI levels.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Canadian Journal of Dental Hygiene (2021)	Limeback, Canada	Biomimetic hydroxyapatite and caries prevention: a systematic review and meta-analysis	Systematic review and meta-analysis	Clients of all ages, with primary, mixed or permanent dentitions.	Biomimetic hydroxyapatite (HAP) as an active ingredient in toothpaste, mouthwash, or gel	Reduction of dental decay	3 RCTs showed HAP provided 17% protection against caries. Shown evidence that hydroxyapatite in oral care products, in the absence of fluoride, effectively reduces dental decay.
International Journal of Dental Hygiene (2022)	Mutluay, Turkey	Caries prevalence, oral health practices/behaviours and dental anxiety levels amongst dental hygiene students: A Cross-sectional study	Cross-sectional study	Dental hygiene students at Kirikkale University, Vocational School of Health Services, Department of Dental Hygiene	Fluoride toothpaste and junk-food consumption	Oral health practices/behaviors and dental anxiety levels	Junk-food consumption affected decayed teeth and missing teeth. Students demonstrated favorable oral health behaviors/practices and low caries prevalence. Emphasis should be placed on improving adherence to oral hygiene instructions, healthy dietary/lifestyle habits, and oral health education in the undergraduate curriculum.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Oral Health & Preventive Dentistry (2020)	Pereira Pinto, Brazil	Dental Caries Investigation in Children Controlled for an Educative and Preventive Oral Health Programme	Cross-sectional study	Children aged 4 to 6 years old who had appointments over the 9 months period at Pediatric Dentistry Specialties Center (PDSC)	Oral hygiene factors (toothbrushing, sucrose ingestion, and bottle feeding habit)	Association of dental caries with behavioral, socioeconomic, and cultural factors; Streptococcus mutans (SM) levels in saliva; and oral hygiene index	High SM levels associated with DMFT index, toothbrushing without parental assistance, deficient oral hygiene, and ingestion of sweet foods. Deficient oral hygiene found in children aged 4 years old and with three or more siblings. Dental caries associated with low family income, deficient oral hygiene, sucrose ingestion by children younger than three years old, bottle-feeding habit, and low parental compliance. High SM levels in saliva, deficient oral hygiene, and high frequency of sucrose ingestion associated with dental caries in children. Cultural, socioeconomic, and behavior factors indirectly influenced the onset of dental caries.
BMC Oral Health (2018)	Skeie, Multiple	Dental caries prevention strategies among children and adolescents with immigrant— or low socioeconomic backgrounds- do they work? A systematic review	Systematic review	Children and adolescents of immigrant or low socioeconomic backgrounds	Supervised toothbrushing. Child/mother approach, targeting nutrition and broad oral health education of mothers.	Effects of caries preventive strategies	Besides studies of water fluoridation and fluoride toothpaste, the other preventive intervention studies provide scientific evidence for caries reduction among children and adolescents with immigrant or low socioeconomic. back-grounds

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Community Dentistry & Oral Epidemiology (2022)	Kim, Korea	Effect of interdental cleaning devices on proximal caries	Cross-sectional study	Adults aged 19–64 years who participated in the Sixth Korea National Health and Nutrition Examination Survey (2013–2015)	Use of dental floss	Association between use of interdental cleaning devices (specifically dental floss) and proximal caries experience	Flossing at home along with toothbrushing is one of the easiest ways to prevent proximal caries. Dental floss should not be excluded from oral healthcare products.
Journal of Oral Science (2012)	Takeuchi, Kingdom of Tonga	Effect of school-based fluoride mouth-rinsing on dental caries incidence among school-children in the Kingdom of Tonga	Case control study	Children aged 10 years in the Kingdom of Tonga.	School-based fluoride mouth-rinsing (FMR) program	Effect of school-based FMR on dental caries incidence.	FMR program effectively decreased the number of dental caries. FMR group had significantly lower mean number of slight caries, mean number of treated teeth, and mean DMFT index in the posterior region and overall compared with control group.
Southeast Asian Journal of tropical medicine and public health (2015)	Arunakul, Thailand	Effectiveness of an Oral Hygiene Education Program Combined With Fluoride Mouth Rinse Among Visually Impaired Students in Bangkok, Thailand	Case control study	Visually impaired students (VIS) in Bangkok, Thailand aged 10–12 years.	Oral hygiene education kits (OHE kits) and 0.05% sodium fluoride mouth rinse	Improvement in plaque index (PI), gingival index (GI), and mutans streptococci (MS) salivary levels.	Group 1: OHE kits and NaF mouth rinse; Group 2: OHE kits only; Group 3 (Control): Brushing instructions only. Reduction observed in PI, GI, and MS levels in all groups. Group receiving OHE kits with or without sodium fluoride mouth rinse showed significantly lower GI and MS levels compared to the control group.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Journal of Dental Research (2022)	Yu, China	Effectiveness of Family-Centered Oral Health Promotion on Toddler Oral Health in Hong Kong	Review	Pregnant mothers and their husbands in Hong Kong, Toddlers aged 3 years old.	Test group: Individualized oral health education (OHE) via behavioral and educational counseling approach. Control group: OHE pamphlets only.	Proportions of toddlers with certain feeding habits and oral hygiene practices. Oral health status of toddlers, including visible plaque, Streptococcus mutans, white spot lesion, and cavitated lesion.	Toddlers in test group had better oral health status with lower levels of visible plaque, Streptococcus mutans, white spot lesion, and cavitated lesion compared to control ($P < 0.05$). Family-centered oral health promotion and individualized OHE for parents via behavioral and educational counseling approach are more effective in establishing good feeding habits and parental tooth-brushing practices, and in decreasing the caries risk of their toddlers, compared to distribution of OHE pamphlets alone.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Community Dental Health (2021)	Shakir, UK	Effectiveness of school-based behavioural interventions to improve children's oral health by reducing sugar intake and promoting oral hygiene: A rapid review of randomised controlled trials	Randomized controlled trial	Children aged 3–18 years	School-based behavioural interventions for oral health improvement	Caries increment, plaque levels, gingival health, reported frequency/amount of free sugars intake, oral hygiene behavior.	Three trials found significant reductions in plaque scores and improvements in gingival health with modest effects. Interventions delivered by peers or with parents' involvement showed significant reductions in plaque scores compared to those delivered by dentists or teachers only. Behavioural interventions did improve oral hygiene amongst primary and secondary school children. Most interventions showed significant improvements in self-reported behaviors. There is a need for well-designed trials of behavioural interventions that are theory-derived and include environmental elements.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
European Journal of Orthodontics (2019)	Enerbäck, Sweden	Effects of orthodontic treatment and different fluoride regimens on numbers of cariogenic bacteria and caries risk: a randomized controlled trial	Randomized controlled trial	Patients who were referred to the Specialist Clinic for Orthodontics, Public Dental Service, Mölndal Hospital, Sweden. Age 12–20.	Group I (Control): 1450 ppm fluoride (F) toothpaste Group II: 1450 ppm F toothpaste plus 0.2% sodium fluoride (NaF) mouth rinse Group III: 5000 ppm F toothpaste	Primary outcome variables: caries risk and numbers of cariogenic bacteria. Caries risk assessed using the Cariogram.	Caries risk increased significantly during orthodontic treatment in group I. All groups showed statistically significant increases in the numbers of cariogenic bacteria. Everyday use of high-fluoride toothpaste (5000 ppm F) or mouth rinse (0.2% NaF) in combination with ordinary toothpaste is recommended to avoid an increased risk of caries during orthodontic treatment.
Nutrients (2022)	Andrysiak-Karmińska, Poland	Factors Affecting Dental Caries Experience in 12-Year-Olds, Based on Data from Two Polish Provinces	Cross-sectional study	12-year-old adolescents of five primary schools in two western provinces of Poland (Lubusz Province and Greater Poland Province)	Questionnaire on socioeconomic characteristics of family, diet, and oral hygiene habits Assessment of dentition according to WHO recommendations Noting cavitated carious lesions and incipient caries lesions according to ICDASepiDMFT	Mean number of teeth with untreated caries, removed due to caries, and restored because of caries (DMFT). ICDASepiDMFT index. Odds of having ICDASepiDMFT > 0 based on oral hygiene behaviors. Association between daily consumption of sweet carbonated drinks and ICDASepiDMFT.	Children who did not brush every day had significantly higher odds of having ICDASepiDMFT > 0 compared to those brushing at least once daily. Adolescents who drank sweet carbonated drinks every day had significantly higher ICDASepiDMFT than those who drank them less frequently. Dental caries indices of 12-year-old adolescents depend mainly on oral hygiene behaviors. The only significant nutritional factor differentiating caries intensity was the daily consumption of sweet carbonated drinks.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Archives of Orofacial Science (2015)	Kaur, Malaysia	Factors associated with dental caries among selected urban school children in Kuala Lumpur, Malaysia	Cross-sectional study	School going children aged between 7 to 11 years, 2 public schools in Cheras, Kuala Lumpur	Structured questionnaire assessing socio-demographic characteristics, frequency of sugar consumption, and oral health behavior Dental caries examination conducted Oral hygiene index (OHI) classified into good, fair, and poor using the dmft	Prevalence of dental caries among children Mean dmft index Association between dental caries and weight status and distribution Factors associated with dental caries, including age, duration of teeth brushing, and oral hygiene index	Prevalence of dental caries was 44.6%. Mean dmft index was 1.27(1.84) Significant predictors of dental caries included age ($p < 0.001$), duration of teeth brushing ($p = 0.023$), and the oral hygiene index ($p = 0.002$) Younger children, longer time taken to brush teeth, and poorer oral hygiene index were predisposing factors for dental caries. Education on dental health is important to improve oral health behavior and oral hygiene practices to reduce dental caries incidences among young children.
ISRN Dentistry (2013)	Shrutha, India	Feeding Practices and Early Childhood Caries: A Cross-sectional study of Preschool Children in Kanpur District, India	Cross-sectional study	Preschool children aged 3–5 years of Kanpur city, India	Pretested questionnaire consisting of 9 questions was used for collecting personal data, mothers' practices regarding feeding, and oral hygiene practices. Children of those parents were clinically examined for dental caries using dentition status and treatment need.	Prevalence of early childhood caries (ECC), Mean dmft index, Relationship between feeding practices and ECC.	Caries prevalence was high and statistically significant ($p < 0.05$) among those who were breastfed for longer duration, during nighttime, those falling asleep with a bottle, and those fed with additional sugar in milk. Determining the role of feeding practices on early childhood caries can help in the development of appropriate oral health promotion strategies.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/ Population	Focus of the Intervention/ Aim of Study	Outcome	Main Results/Key Findings
Pakistan Journal of Medical and Health Sciences (2021)	Izhar, Pakistan	Impact of oral health educational intervention for reduction in new lesions of dental caries: Cross sectional study	Cross-sectional study	The study was conducted among children in 10 Rural Health Centers (RHCs) in Pakistan.	The intervention involved oral hygiene instruction, including the provision of toothbrushes with paste, aimed at motivating and treating individuals.	The impact of oral health education intervention on improving oral health practices and the formation of new carious lesions after 3 months of intervention.	The majority of respondents lacked access to fluoridated water supply. Only 23.5% of respondents had literate parents, with the majority having illiterate parents. All respondents were at moderate risk for caries. In comparison of risk associated with teeth missing due to caries in the past 36 months, 63.2% were at low risk, 25.3% at high risk, and 11.5% at moderate risk. The study concluded that oral hygiene instruction intervention significantly motivated individuals to clean their teeth regularly and avoid the consumption of sugary foods and beverages, thereby contributing to maintaining oral and general health.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Pediatrics (2017)	Peres, Brazil	Impact of prolonged breastfeeding on dental caries: A population-based birth cohort study	Cohort study	A birth cohort in southern Brazil.	Breastfeeding was the main exposure, with data collected at birth and at 3, 12, and 24 months of age. Sugar consumption data were collected at 24, 48, and 60 months of age.	The study aimed to investigate whether the duration of breastfeeding is a risk factor for dental caries in the primary dentition, independently of sugar consumption.	The prevalence of severe early childhood caries (S-ECC) was 23.9%, with a mean number of decayed, missing, and filled primary tooth surfaces (dmfs) of 4.05. Children breastfed for ≥ 24 months had a higher mean dmfs ratio (1.9; 95% CI: 1.5–2.4) and a 2.4 times higher risk of S-ECC (RR: 2.4; 95% CI: 1.7–3.3) compared to those breastfed up to 12 months. Breastfeeding between 13 and 23 months showed no effect on dental caries. Prolonged breastfeeding increases the risk of dental caries, emphasizing the importance of early preventive interventions for dental health in children.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Journal of IMAB—Annual Proceeding (Scientific Papers) (2015)	Damyanova, Bulgaria	Improvement of oral hygiene status in children influenced by motivation programs	Case control study	Children from 3 to 6 years of age.	Children were divided into two groups. The first group, consisting of 100 children, was further subdivided into two subgroups: children aged 3 to 5 years used toothpaste containing 500 ppm fluoride (F), while those aged 6 used toothpaste containing 1000 ppm F. The second, control group of 100 children, did not receive specific motivation activities.	The study aimed to assess the application and effectiveness of a standardized motivational program for oral hygiene in children, with evaluation based on the Oral Hygiene Index-Simplified (OHI-S) by Green-Vermillion.	Among children influenced by the standardized motivation program combined with toothpaste containing 500 ppm F, 45% showed improved oral hygiene levels. All children showed improvement in their oral hygiene status after the training and motivation period. Additionally, in children at high decay risk, a standardized motivation program should be combined with additional prophylactic approaches.
Journal of Dental Research (2018)	Marchesan, USA	Interdental Cleaning Is Associated with Decreased Oral Disease Prevalence	Cross-sectional study	Data from the National Health and Nutrition Examination Survey (2011 to 2012 and 2013 to 2014).	Evaluation of interdental cleaning behavior and its associations with the prevalence of caries and periodontal disease, as well as the number of missing teeth.	Associations between interdental cleaning behavior and various oral health parameters, including interproximal clinical attachment level (ICAL), interproximal probing depth (IPD), number of coronal and interproximal caries, number of missing teeth, and periodontal profile classes (PPCs).	Non-users of interdental cleaning devices had significantly higher percentages of sites with ICAL, 3 mm and IPD, 4 mm compared to individuals who used interdental cleaning devices. Interdental cleaning was associated with less periodontal disease, decreased coronal and interproximal caries, and fewer missing teeth. The data support the use of interdental cleaning devices as an oral hygiene behavior for promoting health.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Community Dentistry & Oral Epidemiology (2022)	Lin, Taiwan	Long term effects of a lay health advisor intervention on immigrant children's dental caries and maternal preventive behaviour: A randomized controlled trial	Case control study	Immigrant mother and children	Intervention group received a four-chapter one-on-one lesson plan, which included dental caries-related knowledge, brushing techniques, caries prevention, and free preventive services, from the Lay Health Advisor (LHA) over 4 weeks.	Baseline and 1-week, 2-month, and 8-month follow-up information was collected using dental examinations and questionnaires.	Mothers in the LHA group were observed to be 10.9 times more likely than control mothers to assist their children in toothbrushing for 3 min. The Lay Health Advisor (LHA) intervention strategy had positive effects on the immigrant children's new decayed and filled teeth and on maternal preventive behavior, such as assisting their children in toothbrushing.
Community Dentistry & Oral Epidemiology (2019)	Silva, Brazil	Motivational interviewing effects on caries prevention in children differ by income: A randomized cluster trial	Randomized cluster trial	Mothers of children born in 2013 and 2014	A cluster-randomized, double-blind study with two parallel groups in health-care clinical settings (HCCs) comparing conventional oral health education (CE) and Motivational Interviewing (MI).	Children who attended at least one dental visit in the first year of life at their HCC were clinically evaluated by trained examiners, and parents responded to a questionnaire.	Motivational interviewing had a greater preventive effect against caries in children from families with lower income.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Clinical Oral Investigations (2022)	Wu, China	Motivational interviewing for caries prevention in adolescents: a randomized controlled trial	Randomized controlled trial	Adolescents with unfavorable caries-related behaviors ("snacking three times or more a day" and/or "tooth-brushing less often than twice a day")	Adolescents were randomly assigned to three groups to investigate the effectiveness of motivational interviewing (MI) in changing health behaviors (snacking and toothbrushing) and preventing dental caries. Group I received prevailing health education (oral health talks and pamphlets). Group II participated in one-on-one face-to-face MI sessions, and Group III incorporated a patient communication tool (Cariogram) to facilitate the MI process. Comparison: Prevailing health education (Group I).	Self-reported information on participants' sociodemographic characteristics and oral health self-efficacy and behaviors were collected via a self-administered questionnaire at baseline and 24 months post-intervention. Oral hygiene and tooth status were assessed by a blinded examiner.	Motivational interviewing outperformed prevailing health education in improving oral health behaviors and preventing dental caries among adolescents. Incorporating MI into dental care for caries-prone adolescents contributes to optimal health outcomes.
Journal of Adolescent Health (2017)	Wu, China	Motivational Interviewing to Promote Oral Health in Adolescents	Randomized controlled trial	Adolescents from fifteen secondary schools in Hong Kong.	The adolescents were randomly assigned to three groups: (I) prevailing health education, (II) motivational interviewing (MI), and (III) MI coupled with interactive dental caries risk assessment (MI + RA). Participants in each group received their respective interventions.	At baseline, 6 months, and 12 months, participants completed a questionnaire on oral health self-efficacy and behaviors. Oral hygiene (dental plaque score) and dental caries (number of decayed surfaces/teeth status) were recorded.	Motivational interviewing was more effective than prevailing health education in eliciting positive changes in adolescents' oral health behaviors and preventing dental caries.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Journal of Dental Research (2013)	Macpherson, Scotland	National supervised toothbrushing program and dental decay in Scotland	Case control study	Five-year-old children in Scotland.	The intervention involved supervised toothbrushing in nurseries and distribution of fluoride toothpaste and toothbrushes for home use.	The endpoint was the mean decayed, missing, and filled primary teeth (d(3)mft) in five-year-old children, measured over multiple cross-sectional dental epidemiology surveys from 1987 to 2009.	The uptake of nursery toothbrushing correlated with the decline in d(3)mft, suggesting that the national nursery toothbrushing program was associated with improved dental health in five-year-olds.
Journal of Dental Research (2016)	Albino, USA	Preventing Childhood Caries: A Review of Recent Behavioral Research	Literature review	Children up to 18 years old with primary, permanent, and/or mixed dentition.	Behavioral interventions implemented at individual, family, and community levels for caries prevention.	Reductions in caries increments.	Motivational interviewing was effective in three out of four reported studies, with ongoing trials aiming for more definitive results. Future research should focus on the cost-effectiveness of interventions and understanding the mechanisms underlying oral health behavior change.
Journal of Clinical Pediatric Dentistry (2018)	Shiqian Gao, Hong Kong	Risk Factors of Early Childhood Caries among Young Children in Hong Kong: A Cross-sectional study	Cross-sectional study	3-year-old children in Hong Kong.	Distribution of a questionnaire to parents, including inquiries about oral health behaviors and socioeconomic background.	Early childhood caries (ECC) status recorded in dmft index.	Children with later tooth brushing initiation, higher snack-intake frequency, non-local birthplace, lower family income and mother's education level, and non-domestic helper primary caretaker had a significantly higher chance of ECC.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Journal of Dental Research, Dental Clinics, Dental Prospects (2015)	Jain, India	Social and Behavioral Determinants for Early Childhood Caries among Preschool Children in India	Interventional study	Preschool children age 71 months or younger with early childhood caries (ECC)	Structured questionnaire administered to parents or caretakers.	Presence of early childhood caries (ECC) assessed using Gruebel's deft index.	Factors such as age, geographical location, duration of breast-feeding, use of sweetened pacifiers, frequency of snacking, frequency of tooth brushing, the person responsible for child's oral health care, and education level of parents were found to be significantly associated with ECC. The findings emphasize the importance of preventive efforts by healthcare professionals, family physicians, and parents in managing ECC.
Community Dental Health (2011)	Sonbul, Sweden	The effect of a modified fluoride toothpaste technique on buccal enamel caries in adults with high caries prevalence: a 2-year clinical trial	Clinical trial	Saudi adults with high caries prevalence	Modified fluoride (F) toothpaste technique, including specific instructions for toothpaste use. Control group instructed to continue using regular fluoride toothpaste without additional instructions.	Incidence and progression of buccal/lingual enamel caries.	The study found that the modified fluoride toothpaste technique led to a lower incidence of buccal/lingual enamel caries compared to the control group.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Tobacco Induced Diseases (2019)	Wu, China	The effect of smoking on caries-related microorganisms	Review	Adults (diverse populations including pregnant women)	Review of the impact of smoking on caries-related bacteria	Summarized the effect of smoking on caries-related bacteria.	Nicotine acts on oral bacteria. The components of cigarettes were found to promote the growth of cariogenic microorganisms, with nicotine enhancing the activity of Streptococcus mutans, Lactobacilli, Streptococcus gordonii, Actinomyces, and Candida albicans while reducing the competitive capability of commensal bacteria like Streptococcus sanguinis. Smoking also influences saliva by lowering its buffer capability, altering chemical agents and bacterial components, thereby promoting a caries-susceptible environment. Cigarette smoking and nicotine exposure promote the cariogenic activity of oral microorganisms and the formation of a caries-susceptible environment.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Social Science and Medicine (2014)	de Jong-Lenters, Netherlands	The relationship between parenting, family interaction and childhood dental caries: A case-control study	Case control study	Dutch children 5 to 8-year old.	Observation and assessment of parenting practices and parent-child interactions of the child's primary caregiver. These interactions were evaluated using Structured Interaction Tasks and rated on seven dimensions: positive involvement, encouragement, problem-solving, discipline, monitoring, coercion, and interpersonal atmosphere. All tasks were videotaped and coded by trained and calibrated observers blind to the dental condition of the children.	Relationship between parenting practices, parent-child interaction, and childhood dental caries.	Significant association between parenting practices, parent-child interaction, and childhood dental caries. The study suggests that parenting practices may play an important role in caries preventive programs.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
BMC Oral Health (2020)	Li, India	The status and associated factors of early childhood caries among 3- to 5-year-old children in Guangdong, Southern China: a provincial Cross-sectional study survey	Review	Preschool children aged 3 to 5 years old from Guangdong Province, Southern China.	Dental examinations were performed using the dmft (decayed-missing-filled tooth) index, and a structured questionnaire was administered to the parents or grandparents of the participants. The questionnaire covered various aspects, including general information, feeding and dietary habits, oral hygiene habits, and socioeconomic status.	Prevalence and severity of Early Childhood Caries (ECC) and its association with reported oral health-related behaviors.	Initiating toothbrushing after 3 years of age and being exclusively or predominantly breastfed were associated with ECC prevalence, while being female and frequently consuming sweetened milk or powdered milk were associated with mean dmft. The study emphasizes the significant burden of ECC among preschool children and underscores the importance of addressing demographics, oral health measures, dietary habits, and socioeconomic status, in ECC prevention efforts. Strengthening oral health education and promotion, particularly in rural areas, is recommended to reduce disparities between urban and rural populations.

Table 2 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
West Indian Medical Journal (2022)	Casanova-Rosado, Mexico	Toothbrushing Frequency and Maternal Schooling Associated with Caries in Primary Dentition in 6- and 7-year-old Children	Cross-sectional study	Schoolchildren aged 6 and 7 years in Campeche, Mexico	Demographic and socio-economic information, as well as oral hygiene practices and attitudes variables, were collected through questionnaires directed to the mothers of the children. Dental caries were detected using the World Health Organization criteria.	The study analyzed caries experience (decayed, missing, and filled teeth [dmft] average), prevalence (dmft > 0), and severity (dmft > 3 and dmft > 6) among the schoolchildren.	The prevalence of dental caries was found to be high, with one in two children affected. Oral hygiene practices, such as brushing frequency, were associated with dental caries. A mother's positive attitude towards a child's oral health was unexpectedly associated with increased prevalence and experience of caries.

Table 3 Educational interventions

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/ Population	Focus of the Intervention/ Aim of Study	Outcome	Main Results/ Key Findings
International Journal of Dental Hygiene (2019)	Sfeatcu, Romania	A pilot study on the effectiveness of a 2-year school-based oral health educational programme using experiential learning among adolescents	Quasi-randomized field study	Teenagers aged 13–16 from three public schools in Bucharest, Romania, with similar socioeconomic and cultural characteristics	The study implemented a school-based experiential education program focused on oral health promotion. This program spanned a 2-year period and comprised three oral health education lessons covering topics such as the causal chain of dental caries, the cariogenic diet, and the effects of smoking and alcohol consumption on oral health	The participants were split into two groups: a test group who received the experiential lessons and a control group schoolchildren who did not receive the lessons	The study found positive effects of the oral health program on oral health status, knowledge, and behavior among adolescents. The prevalence of dental caries decreased in the test group and increased in the control group. There was a statistically significant decrease in plaque index in the test group compared to an increase in the control group. Moreover, a higher proportion of children in the test group adopted twice-daily tooth brushing compared to the control group

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
International Journal of Dental Hygiene (2018)	Ghaffari, Multiple	Are educating and promoting interventions effective in oral health?: A systematic review	Systematic review	Community members of various age groups, including children, teenagers, adults, and seniors, regardless of their oral health conditions	The focus was on health promotion and health-educating interventions aimed at improving oral health status	Oral health education and promotion interventions were effective in improving various aspects of oral health, including knowledge, attitudes, self-efficacy, oral health behaviors (such as toothbrushing and flossing), and theoretical constructs related to oral health. Additionally, interventions targeting long-term effects showed improvements in decayed teeth, plaque, calculus, and bleeding	The study found that all oral health education and promotion interventions assessed were effective (improvements in knowledge, attitudes, self-efficacy, oral health behaviors (such as toothbrushing and flossing), and theoretical constructs related to oral health), particularly in achieving short-term outcomes. The effectiveness was observed across various target groups, indicating the potential for future interventions targeting families and teachers. The study supports the effectiveness of all oral health education and promotion interventions, especially in achieving short-term outcomes. It suggests that future interventions should consider targeting various community members, including families and teachers, to promote oral health effectively

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Gerodontology (2012)	Welsh, Scotland	Caring for smiles—a new educational resource for oral health training in care homes	Narrative	Dependent residents at care homes	The intervention involves oral health personnel providing training sessions to care staff. These staff members are responsible for administering daily oral hygiene care to dependent residents	Care staff are tasked with delivering daily oral hygiene care for dependent residents	The study suggests that training care staff can lead to improvements in the oral health of dependent residents
International Journal of Dental Hygiene (2021)	Kimhasawad, Thailand	Comparing protection, motivation theory, based intervention with routine public dental health care	Quasi-experimental study	9- to 18-month-old children and their caregivers	Protection-Motivation Theory (PMT)-based educational programmes. The control group received the public hospital's current oral health education programme	PMT-based education programmes encourage suitable motivation and awareness that changes oral healthcare behavior of caregivers, relating to decreased incremental caries rate in infants and toddlers	After 12 months, the PMT group showed lower dmft, dmfs, and incremental caries rate compared with the control group. The control group was at a higher risk of developing additional dental caries, including early carious lesions, compared to the PMT group. The PMT group exhibited significantly higher levels of motivation and awareness among caregivers, particularly in terms of perception of disease severity and belief in self-efficacy. This suggests that PMT-based educational programmes are effective in promoting oral healthcare behavior change among caregivers, leading to reduced caries rates in young children

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/ Population	Focus of the Intervention/ Aim of Study	Outcome	Main Results/ Key Findings
Journal of Dental Materials & Techniques (2019)	Khorakian, Iran	Comparison of the Effect of Two Oral Hygiene Education Approaches on the Gingival Health and Dental Plaque of Boarding School Students in Fariman, Iran	Randomized controlled trial	High school male students in Fariman, Iran	Comparison of two oral health education methods: self-led and peer-led. The effects of self-led and peer-led oral health education methods	Using talented students as "oral and dental health assistants" may be an effective approach for promoting oral and dental hygiene among teenagers	The study demonstrated a significant decrease in all three oral health indices (OHI-S, GI, and PI) in the peer-led group compared to the self-led group. The peer-led intervention proved to be more effective in improving oral health outcomes among high school students. This suggests that utilizing talented students as oral and dental health assistants could be a promising strategy for enhancing oral hygiene practices and promoting better oral health behaviors among teenagers
European journal of paediatric dentistry (2011)	Esfahamizadeh, Iran	Dental health education programme for 6-year-olds: a cluster randomised controlled trial	Randomized controlled trial	Students at preschool centers in Tehran	Oral and dental education for children and parents	Oral hygiene instruction to 6-year-old children and their parents improves their dental health	The study demonstrated that oral hygiene instruction provided to 6-year-old children and their parents led to improvements in dental health. Significant differences were observed in plaque index scores between baseline and follow-up examinations. Providing oral hygiene education to young children and their parents can positively impact dental health outcomes

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
BMC Oral Health (2021)	Zolfaghari, Iran	Development and evaluation of a gamified smartphone mobile health application for oral health promotion in early childhood: a randomized controlled trial	Randomized controlled trial	Preschool children presenting to the specialty clinic of Tehran School of Dentistry	Gamified smartphone application (app) designed to enhance oral health knowledge and practice of mothers	Both apps effectively improved the oral health knowledge and practice of mothers, while oral hygiene, as a result of plaque control, was superior in children of mothers using the gamified app	The study demonstrated that both the simple and gamified smartphone applications effectively improved the oral-health knowledge and practice of children of mothers. However, using the gamified app showed superior oral hygiene outcomes in terms of plaque control. This suggests that gamified educational interventions may have additional benefits for improving oral health behaviors in children
Journal of Dental Hygiene (2015)	Colaizzi, USA	Does the Structure of Dental Hygiene Instruction Impact Plaque Control in Primary School Students?	Randomized controlled trial	Second grade students in 3 public elementary schools in Miami	An educational program focused on tooth brushing, including interactive sessions with dental professionals and teachers. School 1 students received instruction, toothbrushes, and encouragement to brush their teeth daily after lunch. School 2 students received instruction only. School 3 students received toothbrushes to remove plaque	The study aimed to determine the extent to which different intervention types and/or demographic/hygiene practices predicted differences in post-intervention plaque level, once baseline plaque level was taken into account	Overall, mean plaque scores were significantly lower at the 6-month follow-up. The most intensive intervention (instruction, accompanied by repeated practice) may lead to improved oral hygiene compared to instruction alone, when considering oral hygiene practices and demographic characteristics

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
European Journal of Oral Sciences (2020)	Saffari, Iran	Effect of a health education program using motivational interviewing on oral health behavior and self-efficacy in pregnant women: a randomized controlled trial	Randomized controlled trial	Iranian pregnant women	The intervention group received an education program on oral health using motivational interviewing (MI) during two face-to-face sessions, along with routine health education. The control group received two 1-h lectures on oral health changes and needs during pregnancy	Oral health behaviors, oral health self-efficacy, and general self-efficacy were assessed, along with gingival and dental health from baseline to the 3-month follow-up	The intervention group showed improved self-efficacy, DMFT index, and gingival inflammation compared to the control group. Health education interventions using MI techniques may help to improve oral health-related self-efficacy and behaviors among pregnant women
Journal of Clinical Pediatric Dentistry (2017)	Borges-Yáñez, Mexico	Effect of a School-Based Supervised Tooth Brushing Program in Mexico City: A Cluster Randomized Intervention	Cluster randomized	Schoolchildren in elementary schools participating in the SaludARTE program in Mexico City	The intervention involved supervised tooth brushing at school once a day after a meal, as part of the SaludARTE program, which provides health education and preventive strategies	The main outcomes assessed were the mean percentage of gingival units with no inflammation, dental surfaces with no dental plaque, and gingival margins with no bleeding	The study found that supervised tooth brushing at school was effective in improving oral hygiene, with significant increases observed in the mean percentage of plaque-free surfaces and healthy gingival units in the intervention group compared to the control group

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/ Population	Focus of the Intervention/ Aim of Study	Outcome	Main Results/ Key Findings
Journal of Clinical Periodontology (2019)	Toniazzo, Brazil	Effect of mHealth in improving oral hygiene: A systematic review with meta-analysis	Systematic review	Adolescents, adults, and mothers of young children	The use of mobile applications or text messages related to oral hygiene and/or oral health education. Comparison: Conventional oral hygiene instructions	The effectiveness of mobile health (mHealth) interventions in improving oral health knowledge and/or reducing gingival inflammation, assessed through outcomes such as plaque index and gingival bleeding	Mobile health interventions, including mobile applications and text messages, were effective in improving oral health outcomes such as dental plaque control and reduction of gingival bleeding. The majority of the included studies showed better results when mobile technology was used, indicating that mHealth can be a valuable adjunct component in managing gingivitis, acquiring oral health knowledge, and improving oral hygiene

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/ Population	Focus of the Intervention/ Aim of Study	Outcome	Main Results/ Key Findings
Indian Journal of Public Health Research and Development (2020)	Nurbaya, India	Effectiveness dental education and training of tooth brushing on knowledge, attitude, index plaque of patients with schizophrenia	Case control study	Schizophrenic outpatients at Mental Hospital Soeprapto Propinsi Bengkulu	Education and training of teeth brushing	The effectiveness of education and training teeth brushing on knowledge, attitudes, and plaque index among schizophrenic patients, assessed through changes in knowledge and attitudes toward oral health and plaque index scores	The study found that education and training of teeth brushing led to significant improvements in knowledge, attitudes, and plaque index among schizophrenic patients. The experimental group showed increased knowledge and attitudes towards oral health, as well as a decrease in plaque index compared to the control group. This suggests that dental education programs focusing on teeth brushing can be beneficial in improving the oral health of schizophrenic patients. The study recommends implementing education and training programs for scheduled tooth-brushing outpatients with schizophrenia to further enhance oral health outcomes

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Journal of International Society of Preventive & Community Dentistry (2014)	Damle, India	Effectiveness of supervised toothbrushing and oral health education in improving oral hygiene status and practices of urban and rural school children: A comparative study	Comparative study	School children aged 12–15 years from urban and rural areas of India	Supervised toothbrushing and oral health education	Evaluation and comparison of oral health status among school children, including dental caries increment, plaque scores, and gingival status, as assessed by World Health Organization (WHO) criteria, Turesky-Gilmore-Glickman modification of the Quigley Hein Plaque Index, and Loe-Silness Gingival Index, respectively	Supervised toothbrushing and oral health education led to a significant reduction in plaque and gingival scores compared to the control groups. Overall, oral health education was effective in establishing good oral health habits among school children and enhancing parental knowledge about good oral health
International Journal of Pharmaceutical Research (2020)	Chellappa, India	Effectiveness of training the trainers program in improvement of oral health of children in tamilnadu—a randomized trial	Randomized controlled trial	Schools in rural Tamil Nadu, specifically selected from Tiruvallur and Kanchipuram districts	Oral health education, brushing techniques, and oral hygiene instruction provided to Block Resource Teacher Educators (BRITE) and trainers in the test group schools	Assessment of oral health improvement in children, including DMFT and QH plaque index scores, fracture of teeth according to Ell's Classification, dietary sugar intake frequency, brushing frequency, and fluoride toothpaste usage	The study demonstrated that the train the trainers program was successful in improving oral health outcomes. Significant improvements were observed in brushing frequencies, oral hygiene status, and proper brushing techniques following the intervention

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
BMC Oral Health (2021)	Wei, Taiwan	Effects of health-promoting school strategy on dental plaque control and preventive behaviors in school-children in high-carries, rural areas of Taiwan: a quasi-experimental design	Case control study	Schoolchildren in Taichung, Taiwan, particularly those attending elementary schools with higher-than-average caries rates	Implementation of a health-promoting school (HPS) strategy in six intervention schools, aimed at promoting oral health and preventing dental caries. Comparison: Comparison group consisting of students from six schools with similar demographic backgrounds and caries prevalence rates, but not implementing the HPS strategy	Reduction in plaque index and plaque control record scores, improvement in oral health-related knowledge, attitudes, and self-efficacy, and adoption of preventive behaviors such as tooth brushing before sleeping and use of fluoride toothpaste	The HPS strategy effectively reduced dental plaque and promoted preventive behaviors among rural school-children with a high prevalence of caries. Significant improvements were observed in oral health knowledge, attitudes, and self-efficacy related to oral hygiene practices, indicating the effectiveness of the HPS approach in improving oral health outcomes in this population
Tropical Medicine and International Health (2018)	Muhoози, Uganda	Effects of nutrition and hygiene education on oral health and growth among toddlers in rural Uganda: follow-up of a cluster-randomised controlled trial	Randomized controlled trial	Mother-child pairs from rural Uganda	The intervention consisted of a 6-month education program covering nutrition, sanitation/hygiene, stimulation education, and oral health. The program targeted impoverished mothers of children aged 6–8 months. Comparison: The control group received standard care or no specific intervention	The primary outcomes were oral health behavior, occurrence of cavitated carious lesions, and extraction of "false teeth" (ebiino), a traditional operation. Secondary outcomes included fluoride concentration in water samples and any association between early childhood caries and child growth	Education intervention significantly improved oral hygiene practices, reduced the occurrence and progression of caries, and decreased the extraction of bebiino compared to the control group. The education intervention effectively improved oral health outcomes in the study population

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Community dentistry and oral epidemiology (2021)	Turton, Cambodia	Evaluation of a community-based early childhood caries (ECC) intervention in Cambodia	Mixed-methods investigation	Mother-child aged 6–24 months attending four Community Health Centers (CHCs) in rural Cambodia	The intervention included oral health education (OHE), provision of toothbrushes, fluoride toothpaste, and fluoride varnish. These interventions were provided on up to six occasions as part of the routine vaccination schedule at the CHCs	The primary outcomes included the presence of early childhood caries (ECC) and impacts on oral health-related quality of life (OHRQoL). Secondary outcomes included stakeholder perceptions of intervention delivery and parental perceptions of fluoride varnish	Participants in the intervention group had significantly lower odds of developing ECC compared to those in the comparison group, even after controlling for socioeconomic status. The intervention group exhibited a significant reduction in OHRQoL scale scores. Stakeholder feedback revealed favorable views of the intervention delivery, and parents expressed positive perceptions of fluoride varnish placement by medical professionals. Overall, the study suggests that OHE and fluoride varnish interventions provided by non-dental primary health workers were feasible and acceptable in the Cambodian setting, leading to improved oral health outcomes in children at 2 years of age

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
International Journal of Dental Hygiene (2017)	Barros, Brazil	Evaluation of an educational activity in the oral health of students	Cross-sectional study	Students aged between 9 and 12 years from two public secondary schools in Montes Claros, Minas Gerais, Brazil	One of the schools, designated as School A, implemented a preventive and educational program focused on oral health. School B did not receive such intervention	Oral health indicators, including the Simplified Oral Hygiene Index (OHI-S) and the Community Periodontal Index (CPIITN), were assessed. Knowledge and attitudes regarding oral health were evaluated using a structured questionnaire	Students which implemented educational activities, exhibited significantly better oral health indicators. Students had higher rates of satisfactory oral hygiene and better CPIITN results. They also demonstrated greater knowledge of oral health and were more likely to engage in daily dental flossing. The study concluded that the educational activities in Schools positively influenced oral health conditions, knowledge consolidation, and the adoption of oral hygiene habits among students

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Journal of International Society of Preventive & Community Dentistry (2017)	Naidu, India	Evaluation of the Effectiveness of a Primary Preventive Dental Health Education Programme Implemented Through School Teachers for Primary School Children in Mysore City	Quasi-experimental study	School children in the age group of 6–12 years in Mysore City	Primary Preventive Dental Health Education Programme designed to be integrated into the academic curriculum	The study aimed to assess knowledge, attitude, and practice (KAP) towards oral health, dental caries status, oral hygiene, and gingival health status before and after the programme	The Primary Preventive Dental Health Education Programme resulted in improved KAP towards oral health and demonstrated positive effects on dental caries status, oral hygiene, and gingival health among the participating school children. The study supports the implementation of similar programmes in schools and suggests that schoolteachers are suitable personnel for regularly imparting dental health education to school children
African Journal of Biomedical Research (2019)	Dosumu, Nigeria	Evaluation of the effectiveness of some tooth brushing techniques in plaque control among preclinical dental students in a Nigerian tertiary institution	Clinical trial	Preclinical dental students of the University of Ibadan, Nigeria	Participants were randomized into two groups: the Modified Bass Technique (MBT) group, where students were taught the MBT, and the other preferred tooth-brushing methods group, where students continued using their preferred techniques	The study aimed to determine the effectiveness of the MBT compared to other tooth brushing techniques in plaque control. Data was collected using a self-administered semi-structured questionnaire on sociodemographic, oral health habits, and knowledge on brushing techniques. Oral examinations were conducted, and Simplified Oral Hygiene Index (OHI-S), percentage plaque score, and gingival bleeding score were recorded	The study found that the Modified Bass Technique of tooth brushing was more effective in plaque control compared to other brushing techniques among preclinical dental students. There was a significant reduction in plaque scores, especially in facial and interproximal areas; in the MBT group compared to the other group, and in gingival bleeding on probing in the MBT group after seven days, indicating better gingival health

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Community Dentistry & Oral Epidemiology (2020)	Tsai, Australia	Health promotion interventions to improve oral health of adolescents: A systematic review and meta-analysis	Systematic review	Healthy adolescents targeted by oral health promotion interventions	The review focused on randomized controlled trials (RCTs) of oral health promotion interventions specifically designed for adolescents. These interventions ranged from single-session interventions to community-wide programs, including clinical preventive procedures and take-home products. Half of the interventions used a health behavior change theory to inform their design	The primary clinical outcomes evaluated were gingival health, plaque scores, and caries, while secondary proxy outcomes were also assessed. The review conducted meta-analysis of primary outcomes where possible, with subgroup analysis based on the type of intervention (comprehensive health promotion versus education-only)	Most studies reported improvements in oral health knowledge, attitudes, and behaviors. Longer programs tended to yield more positive outcomes, especially regarding dental caries. The review concluded that oral health promotion programs targeting adolescents have the potential to improve clinical oral health outcomes in both the short and long term. It suggested that programs should utilize more behavioral theory-based interactive and strategic methods, including self-awareness and involving the wider community and peers, over longer intervention durations

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Clinical Oral Investigations (2019)	Winter, Germany	Implementation and evaluation of an interdisciplinary preventive program to prevent early childhood caries	Interventional study	3- to 4-year-old children who participated in an early childhood caries (ECC) prevention program	The intervention involved an interdisciplinary prevention program consisting of seven pulses of information delivered by a team comprising gynecologists, midwives, pediatricians, dentists, municipal social services, and the public health office. Comparison: The comparison was made between children who participated in the ECC prevention program and those of the same age who did not receive such measures	The primary dependent variables were caries experience and prevalence among the participating children. Dental diagnoses were performed based on the "ICDAS collapsed" by two calibrated dentists. Data on diet and preventive behavior were collected using a standardized parental questionnaire	The study concluded that the interdisciplinary prevention program effectively prevented ECC and reduced treatment-related issues in small children
Dental Research Journal (2015)	Mohammadi, Iran	Improving oral health status of preschool children using motivational interviewing method	Case control study	Volunteer children and their parents from 10 elementary schools in a community trial	The intervention group received oral health education using the motivational interviewing (MI) method, along with recall and postal reminders during the 6-month study period. Comparison: The control group received traditional oral health education without any reminders	Oral health indexes, including plaque index (PI) and gingival index, were measured at baseline and after 6 months of the intervention. The study compared the differences in PI and gingival index between the two groups. Additionally, the frequency of children with healthy gingiva and low PI was assessed post-intervention	Oral health education programs incorporating MI may be beneficial in improving the oral health status of preschool children when involving parents

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Community Dentistry & Oral Epidemiology (2016)	Lai, Taiwan	Long-term effectiveness of school-based children oral hygiene program on oral health after 10-year follow-up	Prospective cohort study	Schoolchildren aged 10–11 years	The intervention group received instructions on how to practice daily flossing and brushing under the supervision of school nurses for one semester. Comparison: A comparable non-intervention group was selected from 120 classmates matched by gender	Both groups participated in a questionnaire survey and received dental examinations after approximately 10 years of follow-up. The study evaluated various oral health indicators, including overall plaque score, percentage of pocketing, DMFT values, DMFS score, dental knowledge, habits, and dental conditions	The school-based child oral hygiene program that received the intervention demonstrated positive long-term effectiveness, had lower mean overall plaque score, lower percentage of pocketing, lower DMFT values and DMFS score, significantly better dental knowledge, habits, and dental conditions compared to the non-intervention group. This suggests that a highly targeted oral hygiene program implemented in schools can have lasting benefits on oral health outcomes

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/ Population	Focus of the Intervention/ Aim of Study	Outcome	Main Results/ Key Findings
Quintessence International (2013)	Zini, Israel	Media exposure and oral health outcomes among adults	Cross-sectional study	Adults 35 to 44 years in Jerusalem, Israel	Media exposure was operationally categorized by type and frequency to assess its impact on oral health outcomes	Oral health outcomes included caries experience (measured by the DMFT index), level of untreated decay, and periodontal health (assessed using the CPI). Behavioral data such as toothbrushing, dental attendance, oral hygiene aids use, plaque level, sugar consumption, and smoking were also considered	The study found that high type and high frequency of media exposure were associated with higher caries experience, higher level of untreated decay, and lower periodontal health. This relationship was mediated by sociodemographic determinants (such as education) and behavioral determinants (including dental attendance and plaque level). The authors suggest that community health program planners and general practitioners should monitor media exposure and react promptly to counteract negative advertising with positive oral health messages. This approach could lead to improved oral health behavior and outcomes within the community

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Eastern Mediterranean Health Journal (2013)	Jessri, Iran	Oral health behaviours in relation to caries and gingivitis in primary-school children in Tehran, 2008	Cross-sectional study	Tehran schoolchildren aged 9–13 years	The study collected data on the oral hygiene habits of the participants and conducted clinical examinations to determine the prevalence of caries, severe caries, and gingivitis	Clinical examinations were performed to determine the decayed, missed, and filled teeth (DMFT) and the presence of gingivitis. The prevalence of total DMFT ≥ 1 was observed in 83.3% of children, with 55.5% having tDMFT ≥ 4 and 87.7% having ≥ 1 site affected by gingivitis. Additionally, dental visits of 48.2% of children were limited to toothache occasions, with parents' lack of belief in the importance of oral health being the most commonly cited reason. The study identified the source of oral health education as having the strongest independent association with severe dental caries and dental flossing frequency as the strongest predicting factor correlated with gingivitis	The study found a high prevalence of caries, severe caries, and gingivitis among Tehran primary-school children. It identified factors such as the source of oral health education and dental flossing frequency as significant predictors of oral health outcomes. These findings underscore the importance of effective oral health education and regular dental hygiene practices in preventing oral health diseases among schoolchildren

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Indian Journal of public health (2014)	Chandrashekar, India	Oral health promotion among rural school children through teachers: an interventional study	Clinical trial	Children 15-year-old from four schools in Nalgonda district (rural areas)	The study compared the oral hygiene, plaque, gingival, and dental caries status among rural children who received dental health education by qualified dentists and school teachers, with and without the supply of oral hygiene aids	The oral hygiene, plaque, gingival, and dental caries status were assessed using indices such as the oral hygiene index-simplified (OHI-S), plaque index (PI), gingival index (GI), and decayed, missing, filled surfaces (DMFS) score at baseline and 6 months following the intervention	The study found that the group supplied with oral hygiene aids experienced substantial reductions in OHI-S, PI, and GI scores post-intervention compared to baseline. The study suggests that providing low-cost fluoridated toothpaste along with toothbrushes through school systems in rural areas could lead to significant improvements in oral hygiene among children
International Journal of Environmental Research and Public Health (2021)	Milona, Poland	Oral health related behaviors in relation to dmft indexes of teenagers in an urban area of north-west poland. Dental caries is still a common problem	Cross-sectional study	Children aged 15 in North-West Poland	Participants filled out a questionnaire regarding age, sex, frequency of visits to the dentist, dietary habits, and oral hygiene behaviors. Comparison: The study compared the dental caries index between two groups: those with lower or no caries experience (DMFT ≤ 5) and those with higher caries experience (DMFT > 5)	The Decayed Missing Filled Teeth Index (DMFT) was calculated to assess dental caries. The study also analyzed associations between dietary habits, oral hygiene behaviors, frequency of dental visits, and the DMFT index	Caries was prevalent in 88.6% of subjects. The study found that higher caries experience was significantly inversely associated with tooth brushing after the last meal and the daily use of dental floss. The findings highlight the need for effective caries prevention and recovery programs in Poland, with a focus on promoting healthy oral hygiene behaviors and improving dietary habits through multi-sectorial actions

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/ Population	Focus of the Intervention/ Aim of Study	Outcome	Main Results/ Key Findings
International Journal of Dentistry (2018)	Quadri, Saudi Arabia	Oral Hygiene Practices among Saudi Arabian Children and Its Relation to Their Dental Caries Status	Cross-sectional study	Arab school children	The study aimed to assess the relationship between oral hygiene practices (such as tooth-brush use, dental floss use, siwak use, frequency of brushing, number of snacks between meals, and sugar consumption) and dental caries status	The study measured oral hygiene practices and dental caries status using the plaque index and DMFT index, respectively. It analyzed the relationship between these factors to understand their correlation with dental caries	The study found that increased frequency of snacks and sugar consumption per day were significantly associated with higher values of the DMFT index. Additionally, irregular brushing of teeth was linked to higher odds of dental caries compared to regular brushing. The findings suggest that dental public health practitioners should consider the impact of oral hygiene practices on oral health status when designing future health promotion interventions

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
BMC Oral Health (2012)	Masumo, Uganda and Tanzania	Prevalence and socio-behavioral influence of early childhood caries, ECC, and feeding habits among 6–36 months old children in Uganda and Tanzania	Cross-sectional study	Children 6–36 months old and their caretakers	A high fluoride rural area in Manyara, Tanzania, and a low fluoride urban area in Kampala, Uganda. The study aimed to identify socio-behavioral correlates of Early Childhood Caries (ECC) in these two regions	The prevalence of ECC and its correlates were assessed through oral clinical examinations and interviews with caretakers. Factors such as oral health information from health workers was associated with lower odds of ECC, while in Kampala, visible plaque, high sugar intake, and presence of enamel hypoplasia were analyzed	The study found a higher prevalence of ECC in Kampala compared to Manyara. In Manyara, receiving oral health information from health workers was associated with lower odds of ECC, while in Kampala, visible plaque, high sugar intake, and presence of enamel hypoplasia were correlated with ECC. Oral health education targeting caretakers, including information from health care workers about the risks of frequent sugar consumption and poor oral hygiene, is crucial for ECC prevention in Tanzania and Uganda

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
International Journal of Dentistry (2021)	Shitie, Ethiopia	Prevalence of Dental Caries and Its Associated Factors among Primary School Children in Ethiopia	Cross-sectional study	Primary school children in Alem Ketema, North Showa, Ethiopia	A study was conducted to estimate the prevalence of dental caries and its associated factors	The prevalence of dental caries and its associated factors were assessed using the Decayed, Missing, and Filled Teeth (DMFT) index. Factors such as gender, parents' insistence, history of dental aches, and oral health education programs were examined for their association with dental caries	The prevalence of dental caries among primary school children in Alem Ketema was high. Lack of parental insistence, male gender, history of dental aches, poor mouthwash habits, and absence of oral health education programs were identified as significant predictors of dental caries. Implementing oral health education programs and encouraging parents to promote oral hygiene practices among children are crucial steps in preventing dental caries in this population

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
International Journal of Pharmaceutical Sciences Review and Research (2019)	Divya Lalitha, India	School based fluoride mouth rinse program and its effect on dental caries—A systematic review	Systematic review	School children of all ages	To evaluate dental caries among school children. School-based fluoride mouth rinse programs administered by trained school personnel	The effect of school-based fluoride mouth rinse programs on reducing dental caries among school children. School fluoride mouthrinse programs were found to be inexpensive compared to professionally applied fluorides, especially when volunteers were used. The review concluded that these programs reduce the prevalence of caries in school children, indicating their effectiveness in promoting oral health among this population	The review evaluated the effect of school-based fluoride mouthrinse programs on reducing dental caries among school children. School fluoride mouthrinse programs were found to be inexpensive compared to professionally applied fluorides, especially when volunteers were used. The review concluded that these programs reduce the prevalence of caries in school children, indicating their effectiveness in promoting oral health among this population
International Dental Journal (2014)	Angelopoulou, Greece	School-based oral health-education program using experiential learning or traditional lecturing in adolescents: a clinical trial	Clinical trial	13-year-old Greek children	Experiential learning (EL) school-based oral health education program	Oral health knowledge, attitude, habits, oral hygiene, gingival health, and caries incidence. Comparison: Traditional lecturing (TL) school-based oral health education program	The findings suggest that school-based oral health EL for adolescents is more effective than TL in improving various oral health parameters, including attitude, behavior, oral hygiene, gingival health, and caries reduction

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
BMC Oral Health (2013)	Raj, India	Short-term impact of oral hygiene training package to Anganwadi workers on improving oral hygiene of preschool children in North Indian City	Interventional study	Children aged 36–72 months attending selected Anganwadi Centres (AWCs) in Chandigarh city, India	Oral Hygiene Training Package (OHTP) administered to Anganwadi workers (AWWs), including a Power-Point presentation and demonstrations of oral hygiene skills such as proper brushing technique, plaque disclosure, flossing technique, and gum massaging	Improvement in oral health status (plaque, debris, gingival health), oral habits (brushing, rinsing), and decrease in caries activity (Snyder test)	The study concludes that controlled trials using AWWs to improve oral hygiene among preschool children appear to be justified, highlighting the effectiveness of the OHTP intervention in reducing caries activity among children
Serbian Dental Journal / Stomatološki Glasnik Srbije (2012)	Lalić, Serbia	The Efficacy of the Interventional Health Education Program for Oral Health Improvement in School Children	Pilot Program	Second grade students with early mixed dentition and permanent dentition from elementary school	Participants received an interventional program that included oral hygiene education and the application of prophylactic measures	The main outcomes measured were the prevalence of caries, gingivitis, and orthodontic irregularities, as well as changes in oral hygiene indicators over time	The study found high prevalence rates of gingivitis and orthodontic anomalies in both age groups, indicating the need for preventive measures. After six months of the intervention, there was a reduction in gingivitis and carious teeth, as well as improvement in oral hygiene in both groups. The findings suggest that health education programs can effectively improve oral health and motivate children to practice better oral hygiene

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
International Journal of Environmental Research and Public Health (2022)	Dumitrescu, Romania	The Impact of Parental Education on Schoolchildren's Oral Health—A Multicenter Cross-sectional Study in Romania	Cross-sectional study	Schoolchildren aged between 11 and 14 years old from 49 schools located in both rural and urban areas of Romania	First national oral health survey for children in Romania	To determine caries prevalence in correlation with the level of parents' education, preventive behavior, and socioeconomic parameters	The study found a strong correlation between parents' education, preventive behavior, and oral health status. There was a positive correlation between the mother's education level and the frequency of dental check-ups, brushing, and use of dental hygiene aids. A negative correlation was observed between the mother's education level and tooth pain or discomfort. A statistically significant positive relationship was found between the mother's education level and the presence of dental restorations. Regarding the father's education, a positive relationship was identified with oral hygiene behavior but a negative relationship with the D3T index, indicating a potential influence of fathers' education on children's oral health practices. Overall, the findings suggest that higher parental education levels may contribute to better oral health behaviors and outcomes

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/ Population	Focus of the Intervention/ Aim of Study	Outcome	Main Results/ Key Findings
International Journal of Medical Dentistry (2018)	Balcos, Romania	The Role of Health Education in Some Pre-School And School Communities of Iași	Descriptive epidemiological study	Children from 4 primary schools in Iasi, Romania	The study divided the subjects into two groups: Group I consisted of 50 children who received education with written materials only, while Group II comprised 50 children who received education through a PowerPoint presentation, practical demonstrations, and animation films. Data collection was conducted through a questionnaire covering various aspects of oral health and behaviors. Comparison: The study compared the effectiveness of two educational methods: written materials alone versus a combination of PowerPoint presentation, practical demonstrations, and animation films	Assessment of educational methods	The study found that both educational methods resulted in an improvement in the level of knowledge among the children. However, a combination of educational methods, showed better results in the final evaluation. The study concluded that the most effective method of transmitting the educational message was through a PowerPoint presentation combined with practical demonstrations or animated screenings

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Pesquisa Brasileira em Odontopediatria e Clínica Integrada (2020)	Blaya Luz, Brazil	The Role of Mother's Knowledge, Attitudes, Practices in Dental Caries on Vulnerably Preschool Children	Cross-sectional study	Children born in 2008 (3–4-year-old) and registered in one of the GHC Community Health Units in southern Brazil	The severity of dental caries and Early Childhood Caries (ECC) was assessed using the International Caries Detection and Assessment System (ICDAS) criteria. Mothers of the children completed a semi-structured questionnaire (KAP-ECC) that assessed their knowledge, attitudes, and practices related to ECC. Comparison: The study compared the prevalence and severity of ECC among children based on their family income and their mothers' responses to the KAP-ECC questionnaire	Association between Early Childhood Caries (ECC) and mother's knowledge, attitudes, and practices (KAP) regarding oral health, particularly ECC prevention	The study found that 91.4% of the preschool children presented ECC, with 31.9% having cavities. Family income was significantly associated with the presence of ECC, with children from low-income families being more likely to have ECC. The mothers' responses to the KAP-ECC questionnaire revealed that while they had good knowledge related to ECC etiology and reported dental hygiene practices that could prevent ECC, they exhibited less healthy attitudes and practices regarding their child's diet, particularly with respect to bottle and breastfeeding habits. The study concluded that ECC was more common in children from low-income families whose mothers believed that milk with chocolate did not contribute to caries. Good health practices and education may reduce the occurrence of ECC, although socioeconomic status also plays a significant role

Table 3 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/ Population	Focus of the Intervention/ Aim of Study	Outcome	Main Results/ Key Findings
Journal of Dental Research (2020)	Zhang, Hong Kong	Topical Fluoride to Prevent Root Caries: Systematic Review with Network Meta-analysis	Systematic review	Participants from nine clinical trials	To assess the effectiveness of professionally applied and self-applied topical fluorides in preventing dental root caries	Assess various fluoride agents or combinations, including 38% silver diamine fluoride solution, 5% sodium fluoride varnish, and 1.2% acidulated phosphate fluoride significantly reduced root caries increment after 2 years. Fluoride mouth rinse and fluoride toothpaste, either alone or in combination, also showed a reduction in root caries increment after 1 year. Among the professionally applied topical fluorides, annually applied 38% silver diamine fluoride solution combined with oral health education was found to be the most effective in preventing dental root caries. Among the self-applied topical fluoride methods, daily use of a 0.2% sodium fluoride mouth rinse was deemed the most effective, followed by combinations involving fluoride toothpaste	The study found that: 38% silver diamine fluoride solution, 5% sodium fluoride varnish, and 1.2% acidulated phosphate fluoride significantly reduced root caries increment after 2 years. Fluoride mouth rinse and fluoride toothpaste, either alone or in combination, also showed a reduction in root caries increment after 1 year. Among the professionally applied topical fluorides, annually applied 38% silver diamine fluoride solution combined with oral health education was found to be the most effective in preventing dental root caries. Among the self-applied topical fluoride methods, daily use of a 0.2% sodium fluoride mouth rinse was deemed the most effective, followed by combinations involving fluoride toothpaste

Table 4 Dietary interventions

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
BMC Oral Health (2020)	Zhang, China	Assessment of risk factors for early childhood caries at different ages in Shandong, China and reflections on oral health education: a Cross-sectional study	Cross-sectional study	Children 3–5 years old living in Shandong Province	To assessed the association between early childhood caries (ECC) prevalence and various factors, including sweets frequency and methods of feeding. Comparison: The study compared the prevalence of ECC against different risk factors, such as feeding methods within 6 months of birth and bedtime sugar frequency	Data on oral health status and caregivers' oral health knowledge, attitude, and practice (KAP)	Feeding methods primarily contributed to the high ECC risk in the early stage of deciduous dentition, while high-frequency bedtime sweet consumption mainly contributed to that risk in the late stage of deciduous dentition. The study highlights the importance of addressing feeding methods and sugar habits at different stages of deciduous dentition in oral health education to prevent ECC
International Journal of Dental Hygiene (2017)	Tarvonen, Korea	Association between oral health habits and dental caries among children in Pyongyang, Democratic People's Republic of Korea	Cross-sectional study	Children aged 10 and 13 years who had participated in the Children's Oral Health Promotion Programme (COHPP) for 6 years in Pyongyang, Democratic People's Republic of Korea (DPRK)	Evaluation of self-reported oral health habits, particularly focusing on the frequency of sweet snacking	Association between the frequency of sweet snacking and the occurrence of dental caries	The frequent use of sweet snacks appeared to be an exception to the otherwise healthy oral habits and was statistically significantly associated with the occurrence of dental caries. The study suggests that a more effective promotion of healthy dietary habits with innovative approaches and close collaboration with different social actors will be needed in the future

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Community Dentistry & Oral Epidemiology (2016)	Fabruccini, Brazil and Uruguay	Comparative effectiveness of water and salt community-based fluoridation methods in preventing dental caries among school-children	Cross-sectional study	Schoolchildren 12-year-old living in Porto Alegre, Brazil and Montevideo, Uruguay	Comparison of water and salt community-based fluoridation methods	Protective effect against dental caries fluoridated water compared to fluoridated household salt	Schoolchildren exposed to fluoridated water were less affected by dental caries compared to those exposed to fluoridated household salt. This suggests that fluoridated water provides a better protective effect against dental caries in developing countries
BMC Oral Health (2018)	Meyer, USA	Consequences of community water fluoridation cessation for Medicaid-eligible children and adolescents in Juneau, Alaska	Cross-sectional study	0- to 18-year-old patients with Medicaid residing in Juneau, Alaska during an optimal community water fluoridation (CWF)	Community water fluoridation	Assessment of optimal CWF year (2003) to data from five years after cessation of CWF	The study found that cessation of community water fluoridation (CWF) led to increased oral health disparities, as evidenced by higher mean number of caries-related procedures and increased costs for dental caries treatment among children and adolescents. The results underscored the importance of optimal CWF exposure in preventing dental decay and highlighted the fiscal burden associated with CWF cessation policies

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Community Dentistry & Oral Epidemiology (2012)	Cobiac, Australia	Cost-effectiveness of extending the coverage of water supply fluoridation for the prevention of dental caries in Australia	Cross-sectional study	Australian population	Community water fluoridation	Cost-effectiveness of extending coverage of fluoridation to all communities of at least 1000 people and smaller communities. Disability-adjusted life years (DALYs)	Extending coverage of fluoridation to all communities of at least 1000 people is highly cost-effective, leading to improved population health and cost-savings. Given the substantial dental health disparities and inequalities in access to dental care, there may be justification for extending coverage to include all Australians, regardless of where they live
Eastern Mediterranean Health Journal (2012)	Jaghasi, Syria	Dietary patterns and oral health in schoolchildren from Damascus, Syrian Arab Republic	Cross-sectional study	Schoolchildren aged 6–12 years in Damascus, Syrian	Dietary patterns	Oral health assessed by gingival index and presence of untreated dental caries	High sugar consumption, low consumption of dairy products, and poor oral hygiene were identified as risk factors for dental caries. Similarly, poor oral hygiene, high consumption of sugars, and low frequency of tooth brushing were associated with gingivitis. The study suggests the need for comprehensive educational programs about dietary patterns and their relation to oral health for children and their guardians

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Journal of Dental Research (2022)	Davis, USA	Dietary Patterns and Risk of a New Carious Lesion Postpartum: A Cohort Study	Cohort study	Caucasian Pennsylvanian or West Virginian pregnant women 18y of age and older, fluent in English, and not immunocompromised	Dietary patterns, brush frequency, and floss frequency	Risk of an increase in the number of decayed, missing, and filled teeth in the postpartum period. This effect was attenuated among those who also consumed a dietary pattern high in fruits and vegetables. The study emphasizes the importance of considering dietary patterns when devising interventions aimed at preventing dental caries	Eating a dietary pattern high in desserts and crackers was associated with a 20% increase in the number of decayed, missing, and filled teeth in the postpartum period. This effect was attenuated among those who also consumed a dietary pattern high in fruits and vegetables. The study emphasizes the importance of considering dietary patterns when devising interventions aimed at preventing dental caries
Journal of Clinical Pediatric Dentistry (2018)	Yen Hoang Thi, Vietnam	Early Childhood Caries and Risk Factors in Vietnam	Cross-sectional study	Children aged 2–5 years in six kindergartens in Thua Thien Hue province, Vietnam	Mouth rinsing, breastfeeding, sweet consumption, and retaining food in the mouth	Caries prevalence and its associated risk factors	Low mother's educational level and inappropriate oral health behavior as significant risk factors. Prolonged breastfeeding, more frequent sweets consumption, no thumb sucking habit, and higher modified debris index score were associated with increased caries risk among three-to-five-year-old children

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Saudi Medical Journal (2014)	Alamoudi, Saudi Arabia	Early prevention of childhood caries with maternal xylitol consumption	Randomized controlled trial	Mother-child pairs recruited from the pediatric dentistry clinic and the hospital well baby clinic at King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia	Experimental group: Mothers chewed xylitol gum 1.8 g (66% xylitol by weight) three times a day for three months. Control group: Mothers received fluoride varnish	Salivary mutans streptococci (MS) levels, caries activity (decayed, missing, filled scores), and plaque accumulation	Maternal xylitol consumption provided preventive outcomes on salivary MS and caries levels in children compared with fluoride varnish
Indian Journal of Dental Research (2018)	Aluckal, India	Effectiveness of xylitol and polyol chewing gum on salivary streptococcus mutans in children: A randomized controlled trial	Randomized controlled trial	Schoolchildren 12–15 years old residing in hostels in Belgaum city	Participants were randomly allocated into one of three groups: xylitol chewing gum, polyol chewing gum, and control group (no chewing gum). They were instructed to chew one pellet of the assigned gum two times a day after meals for 5 min each for 30 days. Comparison: Participants in the control group did not chew any gum	Salivary Streptococcus mutans counts were measured at baseline, 30 days after chewing gum use, and 30 days after discontinuation for microbiological analysis	Chewing 100% xylitol chewing gum twice a day for 5 min for 30 days successfully reduced salivary Streptococcus mutans counts. Xylitol gum showed greater benefits against salivary S. mutans compared to polyol gum and the control group. Xylitol-containing chewing gums can be used as an adjunct to regular home care preventive procedures to prevent dental caries

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
International Journal of Clinical Practice (2020)	Akgül, Turkey	Effects of short-term xylitol chewing gum on pro-inflammatory cytokines and Streptococcus mutans: a randomized, placebo-controlled trial	Randomized controlled trial	Dental students in Istanbul, Turkey	Participants were divided into two groups: control and xylitol. Dental examination, saliva, and swab samples were collected at baseline and after 3 weeks for clinical and microbiological assessment. Comparison: Participants in the control group received a placebo, while those in the xylitol group consumed xylitol	Assess gingival and plaque index scores through dental examination, saliva, and swab samples collected at baseline and after 3 weeks for clinical and microbiological assessment	At 3 weeks, the xylitol group showed significant decreases in gingival and plaque index scores compared to baseline ($P < .001$ and $P < .05$, respectively). Salivary concentrations of TNF- α , IL-6, and IL-8 were also significantly reduced at 3 weeks in the xylitol group compared to baseline ($P < .001$). S. mutans expression decreased approximately fivefold after 3 weeks of xylitol use short-term consumption of xylitol may contribute favorably to maintaining oral health by decreasing the release of pro-inflammatory cytokines and S. mutans counts

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
International Journal of Dentistry (2016)	de Cock, Europe	Erythritol Is More Effective Than Xylitol and Sorbitol in Managing Oral Health Endpoints	Review	Potential effects of erythritol on dental plaque (biofilm), dental caries, and periodontal therapy	The intervention/exposure was the consumption or application of erythritol, a noncaloric polyol bulk sweetener, in various forms, such as in chewing gum, oral rinses, or as a component of dental products	The main outcomes assessed were the impact of erythritol on dental plaque (biofilm), dental caries, and periodontal therapy	Erythritol demonstrated effectiveness in reducing the weight of dental plaque, inhibiting the adherence of common streptococcal oral bacteria, such as <i>S. mutans</i> , to tooth surfaces, and decreasing the overall number of dental caries; and was found to serve as a suitable matrix for subgingival air-polishing, providing an alternative to traditional root scaling in periodontal therapy. Erythritol may have better efficacy compared to other polyols, such as sorbitol and xylitol, in maintaining and improving oral health

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
J Clin Pediatr Dent (2012)	Alamoudi, Saudi Arabia	Impact of maternal xylitol consumption on mutans streptococci, plaque and caries levels in children	Case control study	Mother and child pairs with high salivary mutans streptococcus (MS) levels, conducted at King Abdul-Aziz University Hospital in Saudi Arabia	The experimental group (30 pairs) received xylitol chewing gum treatment three times a day for three months. The control group (30 pairs) received fluoride varnish. Both groups also received oral hygiene instructions, dietary counseling, and restorative treatment. Comparison: The study compared the effects of maternal xylitol consumption (experimental group) with fluoride varnish treatment (control group) on salivary mutans streptococcus (MS) levels, dental caries, and dental plaque levels in their children	The main outcomes assessed were salivary mutans streptococcus (MS) levels, dental caries (assessed by dmft scores), and dental plaque scores measured at 6, 12, and 18 months from the initiation of the study	The study found that maternal xylitol consumption resulted in better preventive outcomes on salivary (MS) levels compared to fluoride varnish treatments. Maternal xylitol consumption through regular chewing of xylitol gums appeared to have a beneficial effect on reducing salivary mutans streptococcus (MS) levels in children

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
International Journal of Environmental Research and Public Health (2022)	Yousaf, Pakistan	Individual, Family, and Socioeconomic Contributors to Dental Caries in Children from Low- and Middle-Income Countries	Systematic review	Patients in low- and middle-income countries (LMICs)	The study conducted a systematic review and meta-analysis on risk factors for dental caries in deciduous or permanent teeth in LMICs	The main outcomes assessed were risk factors for dental caries, including high sugar consumption, maternal education, socioeconomic status (SES), brushing habits, access to dental services, and the impact of these factors on caries prevalence	High sugar consumption, low maternal education, and low and high socioeconomic status (SES) increased the risk of dental caries in LMICs. Good brushing habits, higher maternal education, help with tooth brushing, and middle SES provided protection against caries across LMIC children. Limiting sugars, improving oral health education, incorporating national fluoride exposure programs, and accounting for sociodemographic limitations are essential for reducing the prevalence of dental caries in these settings
European Journal of Clinical Nutrition (2015)	Staufenbiel, Germany	Influence of fruit consumption and fluoride application on the prevalence of caries and erosion in vegetarians—a controlled clinical trial	Clinical trial	Vegetarians and non-vegetarians	The influence of fruit consumption and topical fluoride application on the prevalence of caries and erosion	Assess vegetarians and nonvegetarians regarding dental health parameters and habits such as fruit consumption and fluoride application	Vegetarians exhibited a higher risk for caries and erosion compared to nonvegetarians. Topical fluoride application was effective in preventing caries but not erosion

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Clinical Oral Investigations (2011)	Cinar, Turkey	Interrelation between obesity, oral health and life-style factors among Turkish school children	Cross-sectional study	10- to 12-year-olds in Turkey	The study aimed to identify clustering between obesity, oral health, and lifestyle factors among school children in Istanbul, Turkey. Data collection included questionnaires for children and their mothers, as well as child oral health data	Compared public school children with private school children regarding dental health parameters, lifestyle factors, and obesity rates	Public school children had higher levels of dental disease, but lower obesity rates compared to private school children. There is a need for comprehensive health promotion strategies addressing obesity, oral health, and nutrition to improve children's well-being and promote healthy lifestyle factors
Community Dentistry & Oral Epidemiology (2013)	Laitala, Finland	Long-term effects of maternal prevention on children's dental decay and need for restorative treatment	Cohort study	High caries risk 10-year-old children	The retrospective study aimed to extend the post-trial follow-up to 10-year-old children who were part of a previous Finnish study. High-caries-risk mothers in the intervention group used xylitol gum daily when their child was 3–24 months old	The dental health outcomes of high-caries-risk children who had maternal xylitol gum use were compared with a reference group comprising the rest of the children in the same age cohort	The reduced mother-child transmission of mutans streptococci had long-term effects on children's dental health. Maternal use of xylitol reduced caries occurrence and the need for restorative treatment in assumed high-caries-risk children to the average level of the whole age cohort
International Dental Journal (2019)	Barrington, Australia	Obesity, dietary sugar and dental caries in Australian adults	Cross-sectional study	Australian adults	The study examined self-reported dietary intake of added sugar, total sugars, and total carbohydrate using a questionnaire of 13 food items	Association of overweight/obesity, dental caries, and dietary sugars was evaluated, controlling for putative confounders such as age, sex, education, smoking status, and usual reason for dental visit	There was a positive association between dental caries experience and being overweight or obese compared to having normal weight or being underweight. Sugar consumption was identified as a key determinant in the relationship between dental caries experience and being overweight or obese

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
International Journal of Paediatric Dentistry (2020)	Lee, USA	Oral health behaviours and dental caries in low-income children with special healthcare needs: A prospective observational study	Prospective observational study	Low-income children with special healthcare needs (CSHCN) aged 7–20 years from Medicaid enrollment files in Washington state, USA	Caregivers completed a 166-item questionnaire regarding oral health behaviors, including diet, fluoride, and dental care practices	Association of sugar-sweetened beverage intake with dental caries	Sugar-sweetened beverage intake was significantly associated with dental caries. CSHCN who consumed more than 4 sugar-sweetened beverages per week were significantly more likely to have dental caries compared to those who consumed no sugar-sweetened beverages. The study suggests that sugar-sweetened beverages should be targeted in future behavioral interventions to prevent dental caries in low-income CSHCN

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
British Dental Journal (2016)	Claxton, UK	Oral health promotion: the economic benefits to the NHS of increased use of sugarfree gum in the UK	Cost-effectiveness analysis	UK 12-year-old population	If all members of the UK 12-year-old population chewed sugar-free gum (SFG) frequently (twice a day)	Economic Savings of sugar-free gum (SFG)	If all members of the UK 12-year-old population chewed sugar-free gum frequently (twice a day), the potential cost savings for the cohort over the course of one year were estimated to range from £1.2 to £3.3 million. If they chewed three times a day, £8.2 million could be saved each year sensitivity analyses of key parameters demonstrated that cost savings would still likely be observed even in scenarios with less significant increases in SFG use. The study suggests that increasing levels of SFG usage in the teenage population in the UK could lead to substantial cost savings in dental care

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Oral Health & Preventive Dentistry (2016)	Gopal, India	Prevalence and Predictors of Early Childhood Caries in 3- to 6-year-old South Indian Children—A Cross-sectional study Descriptive Study	Cross-sectional study	Preschool children aged 3 to 6 years	NA-Observational study	Assessed the prevalence and potential risk factors of Early Childhood Caries (ECC) in 3- to 6-year-old preschool children	ECC increased significantly with age and was more prevalent in girls. The maxillary arch was more affected than the mandibular arch. Children belonging to the low socioeconomic group showed higher caries prevalence. ECC was more prevalent in children accustomed to on-demand breastfeeding, bottle feeding at night, between-meal snacking, and sweetened pacifier use. Factors such as increased frequency of toothbrushing, use of toothbrush, and fluoridated dentifrice were found to be protective against the risk of ECC. Health education, proper guidelines on feeding and oral hygiene practices, and access to early oral health care can substantially reduce the risk and prevalence of ECC

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
PLoS One (2021)	Ndekero, Tanzania	Prevalence of early childhood caries, risk factors and nutritional status among 3–5-year-old preschool children in Kisarawe, Tanzania	Cross-sectional study	3–5-year-old preschool children in Tanzania	The study aimed to assess the prevalence of early childhood caries (ECC), risk factors, and nutritional status among preschool children	The main outcomes included the prevalence of ECC, risk factors such as visible plaque scores, total sugar exposure, anthropometric measures, and socio-demographic attributes	There was a significant negative association between ECC and children's weight-for-age, indicating a correlation between poor nutritional status and ECC. ECC was positively associated with visible plaque scores and total sugar exposure, highlighting the importance of oral hygiene and dietary habits in ECC prevention. Controlling these risk factors could lead to a reduction in ECC prevalence and contribute to the overall health of preschool children
Journal of Pharmacy and Bioallied Sciences (2015)	Punitha, India	Role of dietary habits and diet in caries occurrence and severity among urban adolescent school children	Cross-sectional study	Adolescent children aged 13–19 years	The study aimed to identify the role of dietary habits, including type of diet, skipping meals, snacking between meals, and frequency of visits to fast food restaurants, in caries occurrence and severity	The main outcome was the prevalence of dental caries measured using the decayed, missing, filled teeth (DMFT) index. Additionally, the study examined the correlation between frequency of intake of selected foods (carbonated drinks & confectionery) and dental caries	There was a significant correlation between mean DMFT and mean frequency intake of carbonated drinks and confectionery. Frequent intake of carbonated drinks and confectionery was associated with higher DMFT scores, indicating a harmful effect on oral health. The study emphasized the importance of educating adolescent children on healthy dietary habits to promote oral and general health

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Oral Health & Preventive Dentistry (2018)	Barone, Italy	Short-term and Long-lasting Effects of Hypo-Cariogenic Dietary Advice and Oral Care on Oral Flora: a Randomised Clinical Trial	Randomized Clinical Trial	6-year-old children attending the first grade of elementary school in L'Aquila (Abruzzo, Italy)	Subjects were randomly assigned to one of two groups: group A received repeated verbal and/or written dietary advice (VWDA), while group B received isolated VWDA. The dietary advice included information about foods classified by cariogenic potential. Comparison: The study compared the effects of repeated versus isolated dietary advice on cariogenic food intake and salivary cariogenic bacteria (Streptococcus mutans [SM] and Lactobacillus [LB])	The short-term and long-term effects of different combinations of dietary instructions were investigated. The main outcomes included changes in cariogenic food intake, salivary SM/LB density, and the relative risk (RR) of high-to-low SM/LB density at various time points (T1-T5)	The study found that both repeated and isolated VWDA resulted in an increase in the intake of weakly cariogenic food and a decrease in the intake of intermediately cariogenic food. The study concluded that reinforcement measures on behavioral changes towards a noncariogenic diet not only help maintain long-lasting, healthier eating habits but also decrease the cariogenic bacterial load in the short term, which tends to persist over time

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
BMC Oral Health (2019)	Qin, China	Structural equation modelling for associated factors with dental caries among 3,415-year-old children: a Cross-sectional study	Cross-sectional study	3–5-year-old children in Sichuan Province	Dental caries examination was conducted on all children, and a questionnaire was answered by the children's caregivers to assess various factors related to oral health	The main outcome was the prevalence of dental caries among the children, with a specific focus on exploring the factors influencing caries development	The study identified significant associations between dental caries and dietary behaviors as well as socio-economic status (SES). Specifically, unhealthy dietary behaviors were found to increase the prevalence of dental caries. SES had a direct negative impact on dental caries, while its indirect effect on decayed, missing, and filled teeth (dmft) was in the opposite direction. Oral health knowledge and attitudes did not significantly affect dietary behavior. This suggests a need for strengthening feeding-related knowledge in oral health education initiatives. The study concluded that while it is essential to enhance public awareness about oral health, converting knowledge into action remains a challenge. Future oral health education efforts should focus on finding more effective strategies to translate knowledge into behavioral change

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Journal of the American Dental Association (JADA) (2013)	Naval, India	The effects of beverages on plaque acidity after a sugary challenge	Randomized controlled crossover study	Adults	Participants consumed four combinations of foods: dry sugary Froot Loops cereal alone, Froot Loops followed by milk, Froot Loops followed by juice, and Froot Loops followed by water	Plaque pH readings were taken at specific intervals after consuming the different food combinations to assess their effects on dental plaque acidity	Consumption of milk after a sugary cereal challenge significantly reduced the drop in plaque pH caused by the sugary challenge. This suggests that the order of ingesting sugary and non-sugary foods may impact oral health. Dental professionals should emphasize to patients the importance of the sequence in which sugary and non-sugary foods are consumed, as it can affect their oral health
Oral Health & Preventive Dentistry (2018)	Ugolini, Italy	Trends in Early Childhood Caries: An Italian Perspective	Cross-sectional study	Preschool children from the Chiavari District in Italy, aged between 3 and 5 years old and born between 2006 and 2009	The study conducted clinical examinations and administered a questionnaire to the children's parents to assess lifestyle factors	The prevalence of early childhood caries (ECC) and severe ECC (S-ECC) was evaluated among the preschool children. Additionally, predictors for caries were assessed using univariate and multivariate models	Predictors for caries included age, non-Italian ethnic origin, consumption of sugary beverages more than once per day, and inadequate oral hygiene status. The study highlights the importance of dietary habits and dental care as contributing factors in caries development among preschool children, and suggests that oral health promotion efforts should include oral hygiene instruction programs and dietary guidelines focused on reducing daily sugar intake for both preschool children and their parents

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Evidence-Based Dentistry (2020)	Peng, Hong Kong	What can we do to prevent small children from suffering from tooth decay?	Systematic Review	Healthy children aged equal to or less than six years	The study examined various risk and protective factors related to dental caries in primary teeth, including breastfeeding beyond one and two years of age, consumption of liquids and complementary foods containing free sugars, oral hygiene practices by parents/caregivers, oral health education for caregivers, and exposure to fluoride from water, milk, and salt	The main outcome was the association between the identified risk and protective factors and the prevalence or severity of dental caries in primary teeth among children	The study concluded that moderate-quality evidence supported the effectiveness of fluoridated water and supplements in reducing ECC risk and that oral health education for caregivers was associated with lower levels of ECC. However, evidence of low quality suggested that breastfeeding up to two years old did not increase the risk of ECC, while sugar consumption from bottles and complementary foods increased the risk
Sugar-Free Gum (SFG) Journal of Dental Research (2017)	Wattanasasen, Thailand	Xylitol-containing chewing gum for caries prevention in students with disabilities	Randomized controlled trial	Students aged 7–18 years with visual or hearing impairment attending special needs schools in Khon Kaen, Thailand	The intervention group received xylitol gum along with oral health education, while the control group received only oral health education. Comparison: The comparison was between the intervention group receiving xylitol gum plus oral health education and the control group receiving oral health education alone	The primary outcome was the caries onset rate measured by the change in caries onset on tooth surfaces. The secondary outcome was plaque index	The study concluded that the program of xylitol gum plus oral health education led to a reduction in the caries rate and enhanced remineralization in the primary dentition, as well as improved oral hygiene in students with disabilities

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
BMC Oral Health (2021)	Nasseripour, Multiple	A systematic review and meta-analysis of the role of sugar-free chewing gum on Streptococcus mutans	Systematic review	Adults and children	To determine the difference in level of Streptococcus mutans in adults and children who chew sugar-free gum (SFG), compared with those who did not chew gum, who chewed a control gum or received alternatives such as probiotics or fluoride varnish	The primary outcome was the difference in the level of Streptococcus mutans in the oral cavity between those who chewed sugar-free gum and the control groups	The review concluded that there is a need for further research to explore the use of sugar-free gum as a preventive measure for reducing cariogenic oral bacterial load
Chinese Journal of Dental Research (2022)	Chun Zi, China	Relationship between Chewing Sugar-free Gum and Dental Caries Status in China	Interventional study	Teenagers (aged 12 to 15 years) and adults (aged ≥ 18 years)	Participants completed a questionnaire that assessed their oral health-related knowledge of sugar-free gum (SFG) and their chewing habits of SFG. Comparison: The study compared individuals who consumed sugar-free gum (chewing group) with those who did not consume sugar-free gum (non-chewing group)	The main outcome measured was the dental caries status, indicated by the decayed, missing, and filled permanent teeth (DMFT) index	The study concluded that while oral health-related knowledge and awareness of SFG were low, regular consumption of SFG should be recommended to promote oral health

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Medical Principles and Practice (2011)	Mäkinen, Romania	Sugar alcohol sweeteners as alternatives to sugar with special consideration of xylitol	Cross-sectional study	11–14-year-old schoolchildren from 49 schools distributed in rural and urban	The study focused on assessing the use of sugar substitutes, particularly xylitol, as a dietary intervention for preventing dental caries	The main outcomes included the effects of sugar substitution with polyols, such as xylitol, on dental caries prevention, as well as the potential health benefits associated with sugar substitutes	The study identified a correlation between oral health status, preventive behavior, and the educational level of parents/caregivers of children in Romania. The results suggest that lower parental education levels may contribute to increased caries prevalence among children. Partial sugar substitution with polyols, including xylitol, is deemed an important dietary tool in preventing dental caries, complementing fluoride-based prevention programs

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Clin Cosmet Investig Dent (2014)	Nayak, India	The effect of xylitol on dental caries and oral flora	Review	Xylitol's effect on dental caries, oral hygiene status, and microflora	The use of xylitol, a five-carbon sugar polyol, in various forms to reduce dental caries and improve oral hygiene	The main outcome was the impact of xylitol on dental caries and oral microflora, including its effects on reducing levels of mutans streptococci (MS), incidence of dental caries, increase salivary flow and pH, and reduce the number of cariogenic and periodontopathic bacteria. It also helps in reducing plaque levels, xerostomia, gingival inflammation, erosion of teeth, and transmission from mother to child.	Xylitol, primarily in the form of chewing gum, has been found to reduce the levels of mutans streptococci (MS) in plaque and saliva, decrease the incidence of dental caries, increase salivary flow and pH, and reduce the number of cariogenic and periodontopathic bacteria. It also helps in reducing plaque levels, xerostomia, gingival inflammation, erosion of teeth, and transmission of cariogenic bacteria from mother to child. Xylitol comes in various forms for usage, offering versatility in application. Xylitol demonstrates promising effects in reducing dental caries and improving oral hygiene status. Its various forms provide flexibility in usage, making it a valuable tool in oral health management

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/Population	Focus of the Intervention/Aim of Study	Outcome	Main Results/Key Findings
Journal of the Irish Dental Association (2012)	Dodds, USA	The oral health benefits of chewing gum	Review	Effects of sugar-free gum on oral health	Use of sugar-free chewing gum	The main outcome is the impact of chewing sugar-free gum on oral health, including its ability to promote stimulated saliva flow, enhance oral clearance of sugars, neutralize plaque pH after sugar consumption, and enhanced remineralization of early caries-like lesions. Clinical trials have shown reduced caries incidence in children who chew sugar-free gum. Sugar-free gum may reduce plaque and extrinsic stain, and specific active agents like fluoride can be added to enhance its effects. Chewing gum, particularly sugar-free gum, has a place as an additional mode of dental disease prevention when used alongside traditional preventive methods	Chewing sugar-free gum promotes a strong flow of stimulated saliva, leading to various dental benefits such as rapid oral clearance of sugars, neutralization of plaque pH after sugar consumption, and enhanced remineralization of early caries-like lesions. Clinical trials have shown reduced caries incidence in children who chew sugar-free gum. Sugar-free gum may reduce plaque and extrinsic stain, and specific active agents like fluoride can be added to enhance its effects. Chewing gum, particularly sugar-free gum, has a place as an additional mode of dental disease prevention when used alongside traditional preventive methods

Table 4 (continued)

Journal & Publication Year	First Author & Country	Title	Study Type	Patient/ Population	Focus of the Intervention/ Aim of Study	Outcome	Main Results/Key Findings
Dental Nursing (2013)	Davies, UK	The role of xylitol in oral health	Review	General population, focusing on individuals interested in oral health and dental caries prevention	Use of xylitol, a naturally occurring sugar alcohol, in various forms such as chewing gum, lozenges, sweets, toothpaste, and oral wipes	Xylitol has therapeutic properties that make it promising in the prevention of dental caries. Adequate consumption of xylitol is required to optimize caries reduction. Xylitol can be delivered in various forms, including chewing gum, lozenges, sweets, toothpaste, and oral wipes. Maternal xylitol use during the infant years can reduce her child's caries experience due to the transmission of less virulent oral bacteria	Xylitol shows promise as a preventive measure against dental caries, with various delivery methods available for optimal efficacy. Maternal use of xylitol during infancy may also contribute to reducing the child's risk of caries

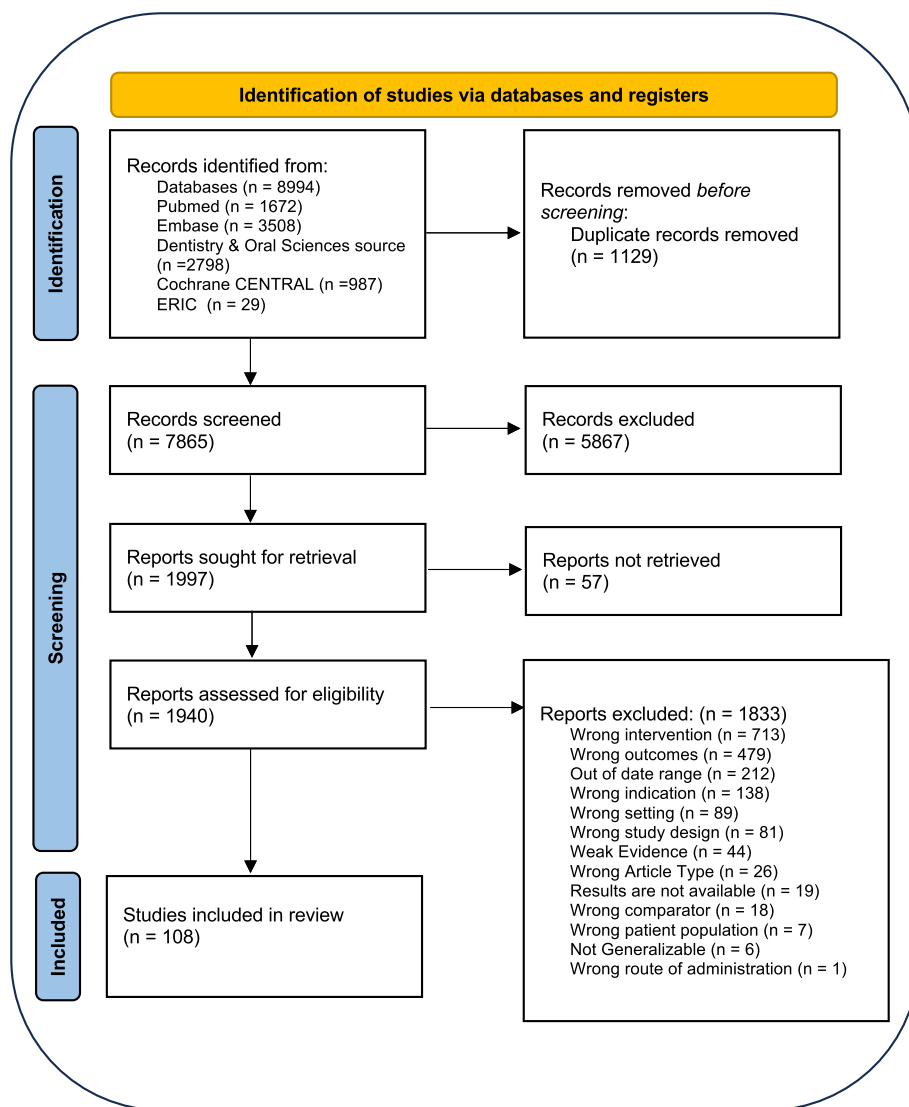


Fig. 1 PRISMA Diagram

caregivers and parents to schoolchildren and teenagers. We observed that interventions involving oral hygiene training and engaging in healthy oral hygiene practices resulted in a notably lower incidence of caries [114, 120]. Similarly, a positive correlation was found between the mother’s level of education and the frequency of her children’s dental visits and tooth brushing [93, 102, 122, 123]. The outcomes include improved oral hygiene practices, reduced caries progression, and better oral health-related QoL. Moreover, articles mentioned that the effectiveness of oral health education programs is influenced by factors such as the source of education, frequency of dental flossing, parental encouragement, and maternal education level. Targeted interventions, especially those involving caretakers and parents, have shown long-term benefits in reducing caries and improving oral health [89, 116, 125].

Dietary interventions described in 35 reported that unhealthy dietary behaviors increase the prevalence of caries, revealing significant insights into the relationship between diet and oral health [126–160]. Out of the 35 studies, 7 reported that oral health-related knowledge and awareness of sugar-free gum (SFG) are low, but its consumption is associated with a lower incidence of caries [154–160]. It was also found that feeding methods contribute substantially to caries risk during early deciduous dentition stages, while sugary habits become more influential in later stages [126]. Additionally, frequent consumption of sweet snacks was associated with a greater incidence of caries, even among individuals with otherwise healthy oral habits [127]. Notably, fluoridated water was shown to provide superior protection against caries compared to fluoridated household salt in schoolchildren from developing

countries [128]. Jaghasi reported that comprehensive educational programs emphasizing dietary patterns and oral health relationships are crucial for children and their guardians [131], while Davis reported that a balanced diet, including the consumption of vegetables, can mitigate the adverse effects of sugary food intake [132]. High caries prevalence and related risk factors, such as low maternal education and inappropriate oral health behavior, were observed among kindergarten children [133]. Maternal xylitol consumption demonstrated promising preventive effects on salivary mutans streptococci and caries levels in children, while xylitol gum and erythritol showed potential for reducing caries-related factors [134–137]. In low- and middle-income countries, socioeconomic status, education, high sugar consumption, and low maternal education were identified as risk factors for caries, emphasizing the importance of oral health education and limiting sugar intake [139, 155]. Unhealthy dietary behaviors, such as frequent intake of carbonated drinks and confectionery, were linked to an increased incidence of caries [140–147, 159].

Discussion

Metabolic and systemic diseases, such as diabetes and cardiovascular disorders, are major contributors to mortality and disability in the U.S. and are significantly influenced by dietary habits [161, 162]. The critical role of the mouth in food intake, digestion, and neurostimulation underscores the importance of oral health. Compromised oral health, as evidenced by caries and tooth loss, can disrupt vital functions of daily living, leading to a preference for softer, carbohydrate-rich, and nutritionally inadequate foods. These dietary shifts can heighten the risk of broader health complications and potentially exacerbate metabolic and systemic disorders [161, 163].

This SR emerges from the urgent need to address the silent epidemic of oral diseases and provides an expansive view of how preventive oral health practices can be integrated into DGAs, with a particular focus on health equity and noninvasive evidence-based interventions. This SR explores the complex effects of behavioral, educational, and dietary interventions and synthesizes evidence from numerous studies informing policies that can pivot the nation toward better oral and systemic health. Most people cannot afford to see a dentist due to cost, and current dental financing mechanisms do not meet the needs of the U.S. population equitably [36, 164–167]. However, there is an opportunity for collaboration among other healthcare professionals to promote oral health. Registered dietitians can play a pivotal role in promoting oral health by utilizing DGAs as guidance. Their expertise in nutrition can complement dental care efforts, fostering interprofessional teamwork and expanding access to preventive care, thus promoting oral health equity. Our findings highlight the

critical link between diet and oral health, reinforcing the American Dental Association's recommendations on regular dental care, increasing fluoride use, and, when snacking, giving preference to selecting nutritious snacks and reduced sugar, as advised by the DGAs [53, 148, 168, 169].

This SR underscores the effectiveness of a comprehensive approach to improving oral health and preventing diseases such as caries, which may also reduce the risk of NCDs and enhance broader health promotion initiatives. Substantiated by data from the Centers for Disease Control and Prevention (CDC), the National Health and Nutrition Examination Survey (NHANES), and Healthy People 2030, our findings emphasize the direct effects of dietary choices, particularly high and frequent sugar intake, on caries and its broader implications for social determinants of health (SDOH) [4, 41, 161, 170–172]. In line with national health initiatives such as the National Plan to Address Alzheimer's Disease (NAPA) by the US Health and Human Services (HHS), our findings highlight the critical role of comprehensive oral health approaches in addressing not only caries but also the prevention and management of NCDs [11]. Such alignment has the potential to not only improve oral health but also contribute to *“accelerate action to promote healthy aging and reduce risk factors for AD/ADRD”*, a goal that the NAPA and similar initiatives aim to achieve through their multifaceted public health strategies [173].

Behavioral interventions for preventing caries and improving oral health

Behavioral interventions and modification strategies have emerged as essential strategies for mitigating the public health challenge of reducing the prevalence of caries and enhancing overall oral health (Fig. 2) [174].

Impact of regular oral hygiene on oral health

The foundation of behavioral interventions lies in regular *dental hygiene practices*, such as toothbrushing and flossing, and regular access to fluoride sources [52]. Numerous studies have consistently shown their positive impact on reducing the prevalence of caries and improving oral health. Research has consistently highlighted the positive impact of these practices on oral health. Notably, interdental cleaning devices are associated with decreased oral disease incidence and fewer missing teeth. Effective brushing habits correlate with reduced cariogenic bacteria and lower caries incidence, emphasizing the need to modify daily oral hygiene behaviors to achieve substantial benefits in oral health [62, 175]. Programs focusing on *early interventions*, such as supervised toothbrushing initiatives, are critical and have proven to be valuable preventive techniques, especially for young children. For example, the “National Supervised Toothbrushing

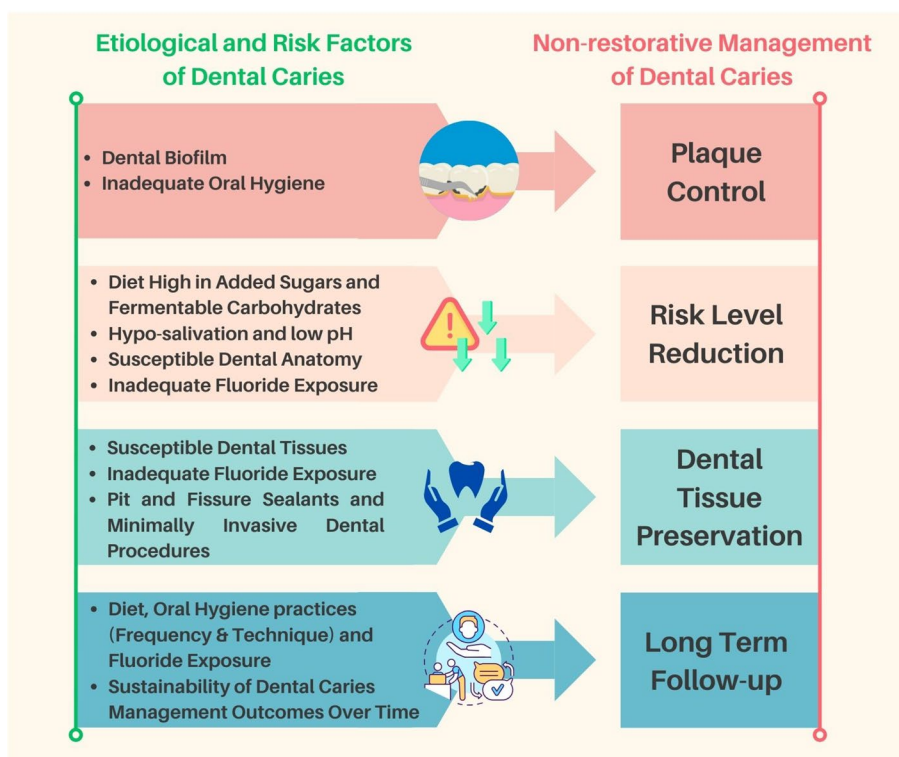


Fig. 2 Essential components of nonrestorative and non-invasive management of caries

Program” in Scotland illustrates the effectiveness and substantial benefits of such early intervention, emphasizing the value of advocacy in instilling good oral hygiene habits from a young age [175].

Integrating oral health education across settings

A *parent/child approach* that integrates nutrition and oral health education underscores the need for comprehensive, family-oriented initiatives to ensure the continuity and effectiveness of oral health practices [84]. *School-based interventions* have also shown a positive impact, especially among schoolchildren, in fostering proper oral hygiene practices, indicating their potential to significantly enhance oral health outcomes when implemented within the educational system [66, 67]. Research consistently indicates that *motivational interviewing* is particularly impactful for adolescents and members of lower-income families, showcasing its potential as a powerful catalyst for change [76–78] (Fig. 3).

Reinforcing oral health through positive parenting and fluoridation

In line with the above interventions, positive *parenting practices*, such as engagement, encouragement, and problem solving, are fundamental for reducing the prevalence of childhood caries [75, 86]. For instance, learning

the distinct patterns of risk factors associated with ECC, as identified in our study, enables parents and caregivers to tailor their approaches to better suit their children’s specific needs, thus enhancing the effectiveness of preventive measures and ultimately leading to a significant decrease in the incidence of ECC [80, 81]. Such practices not only benefit the immediate oral health of children but also contribute to establishing lifelong healthful habits.

Our review is consistent with the thrust of behavioral modification for sustained oral health and supports the *daily use of high-fluoride products* in conjunction with standard toothpaste, particularly for high-risk older children and adults, which is not advised in young children due to fluorosis concerns. This recommendation aligns with the broader theme of comprehensive behavior modification and is supported by studies such as Sonbul et al. (2011), which validate the effectiveness of high-fluoride products in enhancing and sustaining oral health [82]. Furthermore, while advocating for the integration of fluoride-based products as a cornerstone of preventive oral health measures, it is essential to acknowledge existing controversies surrounding fluoridation. Addressing concerns and promoting informed discussions regarding the safety and efficacy of fluoride interventions are paramount. Additionally, ongoing research into alternative clinical solutions that complement or

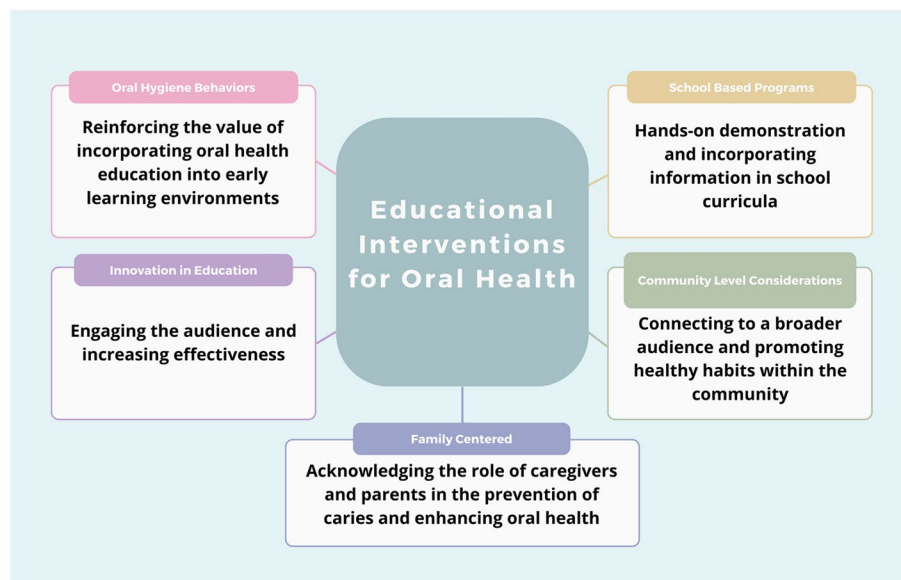


Fig. 3 Educational interventions for oral health

supplement traditional fluoride approaches can offer valuable insights into enhancing oral health outcomes for diverse populations.

Educational interventions for enhanced oral health (Fig. 3)

In addition to established behavioral interventions, educational programs play a pivotal role in oral health promotion. The evidence suggests that interactive and contextually tailored education leads to significant improvements in oral hygiene behaviors, increased utilization of preventive services, and a reduction in the incidence of caries (Fig. 3).

Enhancement of oral hygiene behaviors

Educational interventions have demonstrated their ability to significantly improve oral hygiene behaviors. Studies have consistently shown that individuals who receive oral health education demonstrate better oral hygiene practices than those who do not receive such education. The effectiveness of hands-on demonstrations and integration into school curricula is particularly noteworthy, resulting in improved oral hygiene and a decrease in caries among students. This finding reinforces the value of incorporating oral health education into early learning environments [87, 88, 91].

Innovation in teaching methods

The use of gamified mobile applications and other educational tools for oral health and nutrition has made learning more engaging and effective. Practical

demonstrations, animated screenings, and experiential learning have helped individuals better understand the practical aspects of maintaining good oral health through proper nutrition and hygiene practices [93, 111, 176].

School-based and community-level programs

Educational programs that incorporate hands-on demonstrations and are integrated into school curricula are instrumental in fostering better oral hygiene and reducing the incidence of caries. The strategic integration of oral health education within the general health curriculum has emerged as a pivotal approach to enhancing oral health literacy and outcomes (Fig. 3). Additionally, school-based and community-level programs are vital forums for the widespread dissemination of oral health and nutrition education. Often, these initiatives are geared toward promoting healthy eating habits and understanding the nutritional value of foods. By embedding effective oral hygiene education and practices within a comprehensive health framework, these programs highlight the interdependence of good oral health and overall health and nutrition. Acknowledging that optimal nutrition can be compromised by poor oral health further accentuates the significance of maintaining oral hygiene as a cornerstone of nutritional and overall well-being. Involving schoolteachers as health educators who regularly promote healthy dietary and oral health habits and practices within standard school curricula is key to providing extensive health education, offering substantial benefits to both students and the wider community [94, 96, 99, 104, 113, 119].

However, it is essential to recognize the potential challenges faced by schoolteachers when assuming additional responsibilities in health education. Limited time within the curriculum, competing educational priorities, and varying levels of teacher training in oral health and nutrition may pose obstacles to effective implementation. Strategies such as providing specialized training for teachers, integrating oral health and nutrition education into existing subject areas, and collaborating with external healthcare professionals can help mitigate these barriers, ensuring that comprehensive health education remains a priority within school settings. To further bolster these efforts, policy support and incentives are essential. Implementing policies that support the integration of oral health and nutrition education into school curricula, coupled with incentives such as professional development opportunities and recognition for teachers who excel in health education, can effectively motivate and support educators in delivering high-quality health education to students.

Community-level considerations

Effective oral health promotion extends beyond individual practices, connecting broader oral health and nutrition challenges to the overall wellbeing of communities. Health program planners can foster a culture of health by leveraging local resources to advocate for healthy lifestyle choices and spread positive messages about nutrition and oral health, thereby mitigating negative influences and promoting healthy habits within the community [89, 103, 108, 120] (Fig. 3). Recognizing that people spend a significant amount of time in settings such as preschools,

long-term care facilities, churches, and programs such as the Head Start and Special Supplemental Nutrition Program for Women, Infants, & Children (WIC), integrating oral health and nutrition education into these community-based settings can have a profound and lasting impact on improving oral and overall health outcomes and well-being for children and adults.

Family-centered education

Targeting the family unit, particularly caregivers and parents, is essential for the prevention of ECC [177]. Education targeting families acknowledges the critical role that parents play in shaping their children’s oral health routines, emphasizing how educational attainment correlates with health outcomes. Research has highlighted the nexus between a mother’s education level, the frequency of her child’s dental visits, and her tooth brushing habits, underscoring the influence of socioeconomic status on oral health practices [122, 123] (Fig. 3).

The role of diet in caries prevention and oral health enhancement (Fig. 4)

In addition to behavioral and educational measures, dietary strategies are crucial for preventing caries and enhancing overall oral health. By improving nutritional intake and reducing sugar consumption, these interventions not only lower the incidence of caries but also promote broader oral wellness [161].

Beyond dietary interventions

Effective oral health promotion involves more than just reducing sugar and fermentable carbohydrate intake.

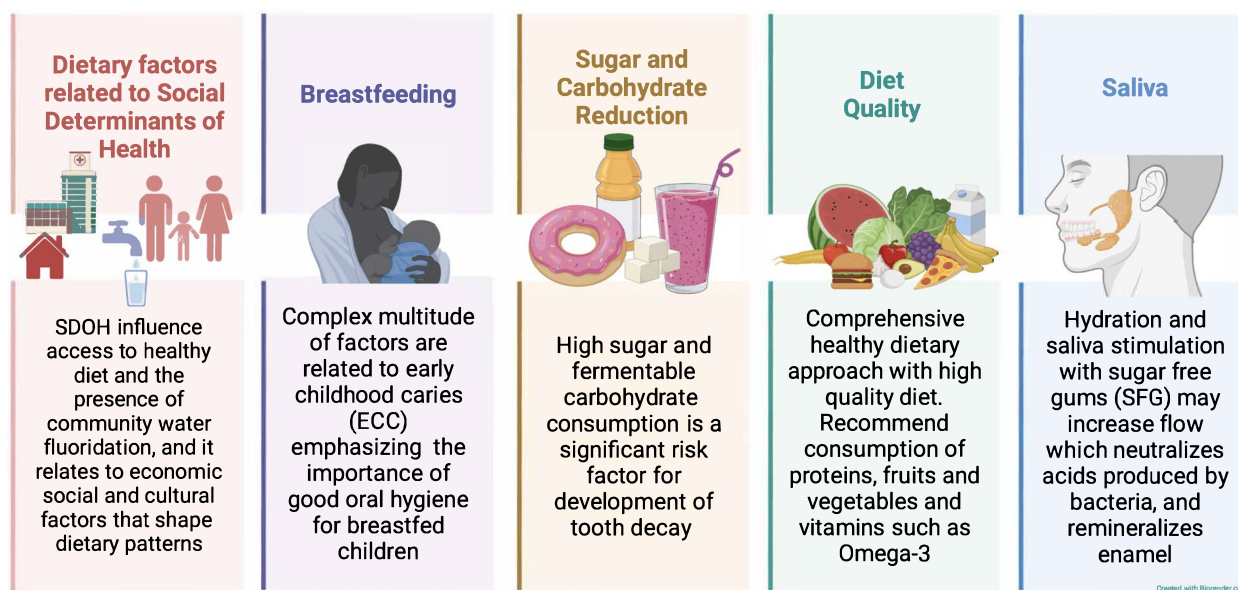


Fig. 4 Key dietary and behavioral factors influencing oral health outcomes

The incorporation of nutritious alternatives such as high-quality proteins and vitamins (i.e. A, B, and C) and other micronutrients, which significantly improve oral health outcomes, is needed to reduce chronic inflammation and the burden of oral diseases [12]. Public health policies must emphasize comprehensive dietary improvements, not just reducing sugar consumption. Recent studies, demonstrate the significant impact of taste preferences, age, oral microbiota, and use of dental prostheses on dietary choices, which in turn influence oral health behaviors and outcomes, underscoring the need for integrated strategies that consider both taste perception and nutritional education in oral health promotion and identify populations at risk [24, 178–180].

By increasing public awareness of the harmful effects of frequent sugar intake and promoting a balanced diet, these policies can broaden the scope of oral disease prevention strategies and enhance overall oral health [134, 149, 181].

Sugar-free gum (SFG)

The role of SFG, particularly that containing xylitol, in caries prevention is well documented. The regular use of SFG contributes significantly to reducing caries risk by stimulating saliva flow, which neutralizes acids produced by bacteria in biofilms (plaques), helps to remineralize tooth enamel, and aids in managing and improving oral health outcomes [138, 142, 155]. Studies suggest that maternal use of SFGs can effectively reduce caries risk in mothers and their children older than 4 years [138, 142, 182]. This preventive dietary ally, though not a source of nutrition, can serve as an adjunct to good dietary practices. Its cost-effectiveness suggests the potential for broader public health applications with potential national savings on dental care costs. Thus, consideration should be given to how various public health and nutrition assistance programs can promote SFG use, emphasizing its role as a supplement to a balanced healthy diet and oral care practices [145, 155]. One potential avenue could be to make SFG available at schools or in vending machines alongside soda and chips or to provide it to students for free, similar to feminine hygiene or birth control products; however, further studies are necessary to implement such a recommendation effectively.

Breastfeeding and early dietary effects

While breastfeeding offers numerous health benefits, its relationship with caries, especially prolonged breastfeeding, is complex. It is essential to maintain good oral hygiene practices for children breastfed beyond one year to mitigate caries risk and ECC. This underscores the need for comprehensive recommendations from health-care providers for reducing nocturnal breastfeeding, and cleaning “wipes” the child’s mouth after feeding is

vital for balancing the benefits of breastfeeding with oral health [133, 139].

Diet quality and oral health

A high-quality diet rich in dairy, proteins, fruits, and vegetables can protect against caries. The Healthy Eating Index (HEI) shows an inverse relationship with ECC risk, suggesting that dietary patterns are more indicative of oral health outcomes than individual nutrients [131, 132, 183]. Post-sugary meal practices, such as consuming dairy or xylitol gum, can further reduce caries risk. On the other hand, combining sugar with starch or having a dietary pattern high in desserts and crackers would intensify the cariogenic effect [132, 134, 138, 151].

Social determinants of health and dietary choices

Access to a healthy diet and fluoridated water, which are crucial for caries prevention, is significantly influenced by social determinants of health (SDOHs), which also shape health behaviors [184, 185]. Our review strongly supports the effectiveness of community water fluoridation, as seen in Australia’s National Oral Health Plan, and advocates for its broader implementation to help prevent caries [129, 130]. Economic barriers, however, often make sugary foods and starches more accessible, challenging healthy dietary choices [186]. Added sugar consumption is notably affected by factors such as socioeconomic status, household dietary habits, the locality of sugar sources, and peer influences [187]. Policies aimed at limiting sugary food consumption and enhancing fluoridation access are vital for reducing oral health disparities [129, 130, 133, 139, 148, 183]. Additionally, ensuring access to affordable, nutritious food is crucial, particularly in underserved communities. Educational strategies should provide practical guidance on budget-friendly, healthy food choices and must consider the cultural relevance of dietary recommendations to effectively promote long-term dietary changes and enhance oral health [139, 187].

Implications for practice and policy

Proper advocacy and implementation of these solutions and strategies within the DGAs framework can address some of the underlying upstream factors contributing to social gradients in oral diseases, thus, significantly contributing to equitable health outcomes and reducing the strain on the national healthcare system [188]. We recommend that policymakers integrate these evidence-based strategies into public health policies to address oral health disparities and lessen the overall healthcare burden [172] (Figs. 5, 6). Effective public health strategies should not only aim to improve food security and promote healthy eating, but also ensure access to oral

health education, literacy, and services for all groups, particularly high-risk groups (Fig. 6). Collaborative efforts among dietitians, allied health professionals, dental-behavioral-mental health experts, and policymakers, especially those representing underrepresented minorities, are essential to developing and implementing comprehensive oral-nutrition guidelines, thereby preventing metabolic and systemic disorders and easing healthcare burdens [189].

Targeting oral-nutrition public health initiatives is crucial for preventing not only caries, but also enhancing quality-adjusted life years (QALYs) and reducing disability-adjusted life years (DALYs) [190–193]. Unfortunately, oral health continues to be overlooked within the current healthcare and policy frameworks [23]. In light of recognizing quality healthcare as a fundamental human right, [194] and in alignment with the WHO Global Oral Health Action Plan, it is imperative to fully integrate oral

health within the healthcare system to achieve comprehensive systemic, planetary, and One Health outcomes [30]. Oral health is as critical as any other aspect of healthcare; and systemic health cannot be fully realized without incorporating oral health into the equations for healthy eating habits and healthcare management [44, 195]. Considering socioeconomic and cultural contexts, local authorities can raise awareness of how eating habits influence oral health and the broader spectrum of NCDs. By integrating public health campaigns and regulatory measures tailored to the unique demographic and geographic variations in oral health practices and resources, authorities can ensure effective and inclusive health promotion strategies [195].

Strengths and limitations

While this scoping review aimed for comprehensive coverage, the literature search may not have been exhaustive,

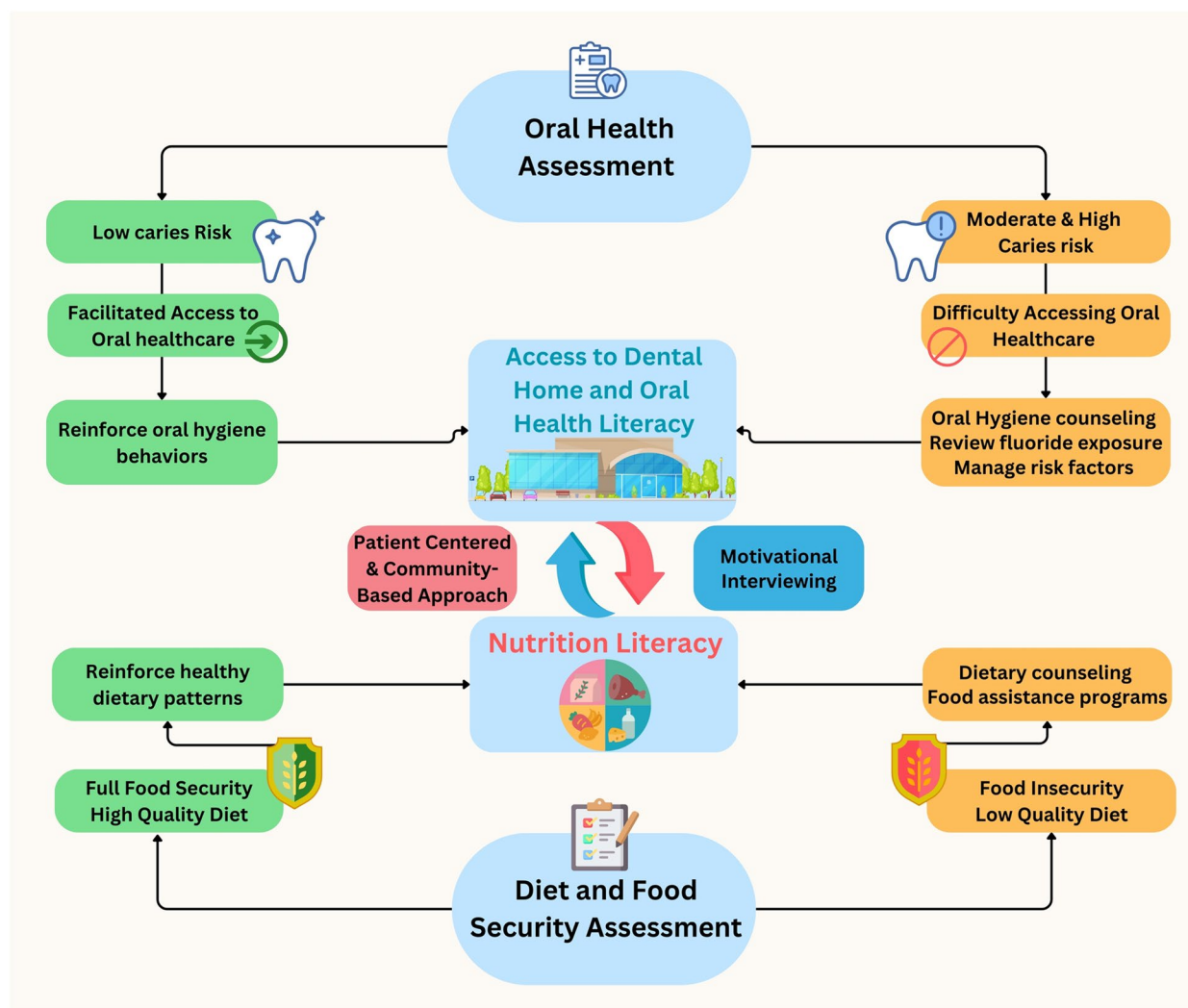


Fig. 5 Integrating diet and oral health-A framework for preventive practices



Fig. 6 Health literacy environment

possibly omitting relevant studies. The included literature encompassed articles focusing on equity principles, health disparities, and SDOH because we aimed to identify and highlight cost-effective, accessible strategies that benefit the broader population, especially those with constrained resources. The focus on equity and inclusivity may have introduced biases or overlooked certain articles. These limitations underscore areas for future research efforts. The review process itself is subject to potential selection biases and the heterogeneity of study designs, cautioning against overinterpretation of findings and suggesting methodological improvements for future studies. Inconsistencies in research data comparability further challenge conclusive interpretations, calling for methodological advancements in data collection and analysis. Despite these limitations, this review lays a foundation for future studies by highlighting the critical role of dietary choices in achieving equitable oral and overall health. Further research is warranted to explore the long-term effects of interventions across diverse populations, including those with varying socioeconomic backgrounds and access to dental care. Our findings can inform targeted interventions and policy changes to improve oral health outcomes and guide future research directions. The SR's commitment to transparency through comprehensive documentation enhances the integrity and utility of its conclusions. Moving forward, long-term studies and randomized controlled trials are needed to elucidate the mechanisms and effectiveness of

interventions, such as sugar-free gum, and to develop tailored oral health promotion programs adaptable to individual needs and contexts.

Conclusion

Effective management of oral health is essential for promoting long-term health equity. This scoping review emphasizes the importance of an integrated approach that includes behavior change, education, and dietary modifications for optimal oral and overall health outcomes. The strategic use of sugar-free chewing gum, such as those containing xylitol, offers a practical and cost-effective alternative to traditional oral hygiene and dietary practices, providing protective benefits against caries and potential healthcare savings.

A robust strategy that combines behavior modification, oral-nutrition health literacy enhancement, and targeted dietary practices, especially in reducing sugar consumption, is imperative. This tripartite approach, which emphasizes personal habits, informed choices, and consumption, serves as the cornerstone for preventing caries and promoting general-systemic health while reducing healthcare expenditures. Integrating educational enhancement, behavioral change, nutritional management, and dietary regulation, particularly in managing sugar intake, forms the foundation for improving oral health. Incorporating oral health recommendations within the DGAs highlights the critical relationship between societal factors and individual

behaviors, holding the potential to enhance QoL and foster sustainable practices that lead to improved health outcomes and positively impact the nation's economic landscape.

This global-to-local perspective emphasizes the urgent need for integrated, multidisciplinary approaches that consider oral health not just as an isolated issue, but as an integral part of overall health and well-being. These efforts are crucial for both improving global health outcomes and addressing specific challenges within the U.S., ensuring that all individuals have access to the necessary resources and care to maintain optimal oral health. Choosing the right foods not only supports overall health, but also safeguards the wellness of the mouth. Committing to this comprehensive approach not only ensures that optimal oral health becomes an achievable goal for everyone, but also fosters transdisciplinary, multi-level, and cross-sector collaboration essential for promoting equitable health and well-being. This approach contributes to a future where oral health achievements are possible, even in context where dental care is limited, absent, or significant oral health inequalities exist.

Supplementary Information

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Supplementary Material 1.

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Disclaimer

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Authors' contributions

S.C. led the project, conceptualized the study, obtained the funding, designed the methodology, and led the writing of the original draft. M.A. contributed significantly to the methodology, managed the literature assessments, data extraction and analysis, interpreted the results, and assisted in integrating the findings with existing literature. A.H. contributed significantly to the

methodology, managed the literature assessments, data extraction and analysis, interpreted the results, and assisted in integrating the findings with existing literature. S.K. assisted in the systematic data extraction and analysis. A.Y. assisted in the systematic data extraction and analysis. C.G.W. designed the search strategy, managed the literature search, was primarily responsible for the data extraction process, and ensured comprehensive database coverage, adhering to PRISMA guidelines. S.A. contributed to the conceptualization and execution of the figures with SC. D.C. contributed to the management of the project administration and created the tables' content with SC and TC. B.B.N. ensured adherence to PRISMA guidelines, synthesis of results and discussion of the project, and contributed to the final version of the manuscript. T.C. conducted the data validation and contributed to the data extraction and tables' development with DC and SC. All authors reviewed and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable.

Competing interests

The authors declare no competing interests.

Author details

¹Harvard School of Dental Medicine, Oral Health Policy and Epidemiology, Boston, MA, USA. ²Faculty of Dentistry, Dental Public Health Department, King Abdulaziz University, Jeddah, Saudi Arabia. ³Harvard Medical School, Countway Library, Boston, MA, USA. ⁴Department of Pediatric Dentistry and Orthodontics, College of Dentistry, King Khalid University, Abha, Saudi Arabia. ⁵Next S-Miles, San Antonio, TX, USA. ⁶Department of Restorative Dentistry and Biomaterial Sciences, Harvard School of Dental Medicine, Boston, MA, USA. ⁷School of Dental Medicine, University of Colorado Anschutz Medical Campus, Aurora, CO, USA. ⁸Dental Administration, Ministry of Health, Riyadh, Saudi Arabia. ⁹Division of General Practice, Virginia Commonwealth University School of Dentistry, Richmond, VA, USA.

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