



KEYNOTES AND RESOURCES

Episode 87 – Dental Caries: Part 2

June 23, 2023

Introduction

Dental caries is a multifactorial chronic noncommunicable disease that affects individuals of all ages and is the most prevalent of all health conditions, worldwide. An estimated two billion people are negatively impacted by caries of permanent teeth and 514 million children are impacted by caries of primary teeth, globally. [1] [2]

Severe dental caries affects general health, causing pain, infection, and tooth loss. Severe dental caries can impair quality of life, including difficulties in eating and sleeping, and is a frequent cause of absence from school or work. [1]

Dental caries results from oral microbiome dysbiosis with involvement of multiple cariogenic species that have the cariogenic traits of acid production and acid tolerance. Sugar consumption plays a major role interacting with microbiome dysbiosis, determining caries development. [3]

Risk factors for dental caries include sugar consumption; lack of fluoride exposure in drinking water, oral hygiene products (e.g., toothpaste), and professional applications; and inadequate oral self-care. The disease is also associated with socioeconomic status, with high prevalence rates among poor and disadvantaged populations. [1] [4]

Dental caries is largely preventable through simple and cost-effective individual and population-wide interventions, whereas treatment is costly, and is often unavailable in low- and middle-income countries. [1]

Prevention and control

Various measures are available to help prevent and control dental caries, including sugar reduction,¹ fluorides, optimum oral hygiene, and dental sealants.

Sugar reduction

Dental caries can be largely prevented by avoiding dietary free sugars. There is a clear dose-response relationship between sugar consumption and dental caries. [1]

The amount and frequency of carbohydrate consumption should be reduced, especially for those at high risk of caries development. Strategies to reduce consumption include:

¹ Note: sugar reduction is also important for gingiva health. A recent systematic review and meta-analysis by [Woelber et al. \(2023\)](#) demonstrated restricting free-sugar consumption was associated with reduced gingival inflammation. [46]

- Eating a healthy diet that limits added sugars and high-acid foods that can affect enamel mineralization.²
- Limiting sugary snacks between meals.
- Avoiding sugary drinks (e.g., soft drinks, sports drinks, fruit juices, fruit drinks), including diet soft drinks due to their erosive potential. Drink water instead. Drinking water can be encouraged by flavouring water with berries or fresh mint. See footnote below for information on non-sugar sweeteners.³
- Reading the nutrition facts table and the ingredient list on packaged foods. The nutrition facts table states the total amount of sugar in the product (from both naturally occurring and added sugars), and the ingredient list states where the sugar is coming from (e.g., sucrose, honey, syrup, etc.) in order of the amount from greatest to least. Added sugars (e.g., glucose, fructose, sucrose, honey, evaporated cane juice, fruit puree, molasses, corn syrup, dextrose, concentrated fruit juice) provide no nutritional benefits. Choose products with the lowest amounts of added sugars.⁴ [5] [6]

Liquid or chewable medications containing sugars, either prescription or over the counter, can contribute to the amount and frequency of sugar intake. Sugar-free medications, where available, should be utilized.

Advise clients to discuss with pharmacists if sugar-free versions of over-the-counter or prescription medications are available for themselves or their children.

Clients that are dentate and on long-term medication that is not sugar-free, and where sugar-free alternatives are not available, should be advised where possible to take medications at mealtimes. This may not be possible if there are specific instructions such as taking medications on an empty stomach, or caregivers are only permitted to distribute medications at specific times. After taking the medication, the client should rinse out their mouth with water, if possible. [7]

² Refer to Episode 82 for discussion on dental acid erosion.

³ The World Health Organization released guidance on non-sugar sweeteners (NSS) in May 2023, recommending against their use to control weight or reduce disease risk. The recommendation is based on findings of a systematic review that collected data from 283 studies including 50 randomized controlled trials (RCTs), 97 prospective cohort studies, and 47 case-control studies in adults, children, and pregnant individuals, which suggest NSS use does not help with long-term weight control. Other ways need to be considered to reduce free sugars intake, such as consuming food with naturally occurring sugars (e.g., fruit, unsweetened food/beverages). Long-term use of NSS may cause undesirable effects, such as increased risk of type 2 diabetes, cardiovascular diseases, and mortality in adults. NSS are not essential dietary factors and have no nutritional value. People should reduce sweetness of the diet altogether, starting early in life, to improve health. The NSS recommendation does not apply to individuals with pre-existing diabetes, and includes all synthetic and naturally occurring or modified non-nutritive sweeteners found in manufactured foods and beverages, or sold on their own to be added to foods/beverages (e.g., aspartame, saccharin, sucralose, stevia, stevia derivatives). It does not apply to medications and oral hygiene products (e.g., toothpaste) containing NSS, which are added in small amounts to make them more palatable, or to low-calorie sugars and sugar alcohols (polyols), such as xylitol, which are sugars or sugar derivatives containing calories and are not considered NSS. [40] [41]

⁴ Refer to the Keynotes for Episode 87 for a comprehensive list of sugars “hidden” in processed foods.

Fluorides

Fluoride is a naturally occurring mineral and is abundant in the environment. The main sources of fluoride are drinking water and toothpaste. Drinking water was fluoridated in many areas of the world when epidemiological studies reported fluoride was an important factor in caries prevention. Fluoride ions are highly reactive, and their incorporation in dental enamel during the development phase at low concentrations promotes mineralization and decreases enamel solubility. Enamel formed by fluorapatite is more resistant to acid attack. Together with decreasing sugar consumption, dental caries can be effectively reduced or prevented by ensuring optimal fluoride exposure. [8] [9]

Effects of fluoride is largely topical when present in the saliva in the appropriate concentration. Fluoride prevents dental caries and arrests carious lesions by several different mechanisms, including:

- Delaying demineralization and increasing remineralization of tooth enamel lesions.
- Inhibiting bacterial growth.
- Interfering with the process by which bacteria metabolize sugars to produce acid that dissolve enamel and causes carious lesions. [9]

Negative side effects (fluorosis) only occur if excess fluoride is ingested during the formation of teeth, approximately between birth and nine years of age. Regular use of fluoride at recommended low levels is safe, effective, and plays an important role in preventing dental caries and improving oral health of vulnerable populations. There is a body of scientific evidence on the safety, efficacy, cost-effectiveness, and population-wide feasibility of various fluoride vehicles. Fluoride toothpaste and water fluoridation are among the population-level fluoride interventions with the strongest evidence. [9]

Fluoride toothpaste⁵

Brushing teeth with fluoride toothpaste twice-daily is a simple and effective way to prevent dental caries, slow progression of existing caries, and reduce caries severity among children, adults, and seniors. Fluoride toothpaste is highly cost-effective when compared with other fluoride interventions. However, cost of toothpaste can be a barrier

⁵ In 2021, fluoride toothpaste, silver diamine fluoride (SDF), and glass ionomer cement was included in the WHO Model List of Essential Medicines and the Essential Medicines List for Children for the prevention and treatment of dental caries. Essential medicines are those that satisfy priority healthcare needs of a population and are selected based on disease prevalence; public health relevance; and evidence of efficacy, safety, and cost-effectiveness. Fluoride toothpaste was recommended for inclusion in paste, cream, or gel form containing between 1000-1500 ppm of any type of fluoride because of its proven effectiveness in preventing dental caries and for better quality control of fluoride content. The Expert Committee asked WHO to identify and define other formulations and strengths of topical fluoride preparations (i.e., fluoride gel, mouthrinse, varnish) to prevent dental caries so these could be added to the Model Lists in 2023. The inclusion of fluoride toothpaste in the WHO model list of essential medicines for adults and children will hopefully help address the affordability of fluoride toothpaste. Governments are encouraged to improve availability, affordability, and quality of these fluoride products (fluoride toothpaste, SDF, glass ionomer), particularly for vulnerable and disadvantaged groups, through appropriate regulations and legislation (e.g., tax reductions or exemptions, inclusion in government procurement, etc.). [10] [43] [44] [45]

to its usage for some populations.⁶ The effects of fluoride toothpaste also depend on compliance with the recommended twice-daily toothbrushing. [9] [10]

The World Health Organization (WHO) and other public health agencies recommend a fluoride concentration in toothpaste between 1000 ppm and 1500 ppm. Low-fluoride toothpastes containing less than 1000 ppm fluoride are not effective in preventing caries. [9] [10]

Caregivers should begin brushing children's teeth twice daily as soon as teeth erupt. For children under 3 years old, a smear or rice-sized amount of toothpaste should be used over the width of the brush. For children aged 3-6 years old, a pea-sized amount should be used. Supervision is required to prevent swallowing of toothpaste and ensure proper spitting after brushing without subsequent rinsing. [5] [9]

Individuals older than 6 years of age should brush teeth twice daily with a pea-sized amount of fluoride toothpaste and spit out the toothpaste afterward. They should not rinse their mouths with water to maximize the effectiveness of the toothpaste. [9]

A Cochrane review⁷ (2003) found children aged 5 to 16 years who used a fluoridated toothpaste had fewer decayed, missing, and filled permanent teeth after three years, regardless of whether their drinking water was fluoridated. Twice a day use increased the benefit. [11]

High-fluoride toothpastes may be prescribed in special circumstances, such as for individuals at high risk of caries or for root caries. [9]

A Cochrane review (2019) supported the benefits of using fluoride toothpaste in preventing caries when compared to non-fluoride toothpaste. Evidence for the effects of different fluoride concentrations was more limited, but a dose-response effect was observed for caries prevention in children and adolescents. The choice of fluoride concentration in toothpaste should be based on concurrent fluoride use whether from self-care measures (e.g., fluoride mouthrinse, community water fluoridation) or professionally applied (e.g., fluoride varnish). Stronger fluoride toothpaste may offer greater protection against decay. However, the choice of fluoride toothpaste concentration for young children should be balanced against the risk of fluorosis. [12]

Extensive clinical trials over the last 60 years have shown fluoride toothpaste delivers fluoride safely. Moreover, when using the concentration of 1000-1500 ppm fluoride and the recommended amount of fluoride toothpaste, no association with dental fluorosis was found. [9]

⁶ Refer to Episode 86 for discussion on the cost barrier of toothpaste for some populations.

⁷ A Cochrane review is a systematic review of research in healthcare and health policy that is published in the *Cochrane Database of Systematic Reviews*. Cochrane reviews base their findings on results of studies that meet certain quality criteria, since the most reliable studies provide the best evidence for making healthcare decisions. Cochrane review authors apply methods which reduce the impact of bias across different parts of the review process. Cochrane reviews are considered the gold standard. [42]

Fluoride varnish

Fluoride varnish can help prevent and arrest carious lesions. It is a clear liquid typically containing 1-5% fluoride and is applied topically and stays on teeth for several hours. Applications every three to six months are required to maintain effectiveness.

Fluoride varnish is sticky but hardens once it meets saliva. Post operative instructions include eating soft foods, and cold or warm (not hot) foods or beverages for the time specified by the manufacturer. Ensure there are no allergies to any of the ingredients before application. Depending on the manufacturer, fluoride varnish comes in a variety of flavours, unit doses or multidose containers enabling the clinician to dispense the amount required. [9]

Benefits of fluoride varnish include:

- Safe, simple to use, and cost-effective. Fluoride varnish is relatively thick and sets rapidly, which contributes to its ease of application, helps it adhere to tooth surfaces, and reduces the amount of fluoride that may be accidentally ingested. It takes just a few minutes to paint on a small amount on each tooth.
- Applied without complex or specialized equipment, making it suitable for oral healthcare settings, primary care facilities, or community settings (e.g., preschools, or schools), including use for people with special needs.
- Prolonged contact time between tooth enamel and a high concentration of fluoride improves the effect of the fluoride.
- Well accepted by children and may be useful with children with special needs and/or children at high risk of caries.
- A [Cochrane review \(2013\)](#) found application of fluoride varnishes two to four times a year, either in the permanent or primary dentition, was associated with a substantial reduction in dental caries. [13]
- Effective in decreasing radiation caries and dental sensitivity after radiotherapy of the head and neck. [9] [14]

Silver diamine fluoride

Silver diamine fluoride (SDF) was developed in the late 1960s to combine the anti-bacterial properties of silver ions and the preventive effects of fluoride. SDF is a clear liquid containing high concentrations of fluoride and silver that work together to arrest dental caries when applied to teeth. SDF is commonly used with a fluoride concentration of 38%. Application of SDF creates a highly mineralized surface on carious lesions that is rich in calcium fluoride and silver phosphate. As previously noted, both the general 2021 WHO Model List of Essential Medicines and the list specific to children include 38% SDF.

Applying SDF is simple, a drop of SDF solution in a dental dappen dish and then a small amount is applied on the dried decayed tooth surface with a disposable microbrush or applicator for approximately one minute without removing any carious tissue. [9]

Benefits of SDF include:

- Application is quick, easy, and painless and can be applied as soon as caries is clinically diagnosed.

- Kills caries-causing bacteria, thereby arresting decay.
- Remineralizes enamel and dentin, hardening the tooth and preventing further decay.
- Potentially prevents new caries from developing since its fluoride component can remineralize carious tooth structures and prevent bacteria growth, while its silver component also inhibits the growth of cariogenic bacteria.
- Arresting carious lesions when restorative treatment is not possible due to:
 - Limited access to dental restorative care (e.g., in remote areas).
 - Difficult to treat areas (e.g., caries in partially erupted teeth) and root caries.
 - Individuals are not able to tolerate conventional treatment because of young age or cognitive ability.
 - Sedation is not desirable or available for young children or individuals with special needs.
 - Inability to treat multiple caries lesions in a single visit. SDF stabilizes the disease prior to proceeding with conventional restorative treatment.
- Applied without complex or specialized equipment in an oral healthcare setting, primary care facility, or community setting (e.g., school, long-term care home).
- Involves minimal intervention and is suitable for children, individuals with special needs, older people, and urban, rural, remote, and vulnerable populations because it is simple to use and does not require extensive training.
- Minimally invasive, cost-effective, widely available, and has negligible risks or adverse effects, based on intensive study over 30 years of global use.
- SDF application does not generate aerosols, which is beneficial when there is concern about possible airborne transmission of illness (e.g., during COVID-19 pandemic). [9] [15]

A systematic review by Mungar et al. 2023 found SDF use had more preventative potential in permanent teeth of children and older populations when compared to other topical applications (e.g., sodium fluoride varnish). [16]

A randomized clinical trial by Ruff et al. (2023) showed SDF was as effective as dental sealants in caries prevention among children receiving care at a school-based dental clinic. The study, which included nearly 3,000 children in grades kindergarten through grade three attending New York City public schools, found the one-time application of SDF prevented 80% of caries lesions and arrested 50% of cavitated lesions when children were seen two years later. [17]

A systematic review by Hendre et al. (2017) evaluated SDF effectiveness in caries management in older adults. Three RCTs were identified that addressed the effectiveness of SDF on root caries in older adults. The clinical trials supported SDF use to prevent and arrest of root caries in older adults. [18]

Disadvantages of SDF include:

- Possible unpleasant metallic taste.
- Potential to irritate gingival and mucosal tissues.
- Dark staining on arrested carious lesions, which may cause aesthetic concerns.
- Potential pulp irritation. [9] [15]

Sommerfeldt et al. (2023) investigated older individuals' perceptions of root caries treatment with SDF. Fifteen interviews in participants aged 71 to 92 years were conducted. In general, participants accepted SDF treatment for root caries. However, there was a concern for aesthetics. Participants preferred SDF treatment in less visible areas of the mouth or in comparison to more invasive treatment options. [19]

Zaeneldin et al (2022) conducted a systematic review to investigate the effect of SDF on vital dental pulp through direct and indirect SDF applications. Directly applying SDF to the pulp resulted in pulpal necrosis. However, indirect SDF application was generally biocompatible to dental pulp tissue with no detectable inflammation to mild inflammation of the pulp, increased odontoblastic activity, and increased tertiary dentin formation. Silver particles appeared not to cross the dentin layer into the pulp tissue. While more clinical studies on SDF and dental pulp are needed, indirect SDF pulp application appears to be safe and beneficial. [20]

Water fluoridation

Adjusting the fluoride level in drinking water is a safe, cost-effective public health measure for dental caries prevention. This includes adding fluoride in areas where the natural fluoride levels are too low as well as removing fluoride from drinking water in areas where natural fluoride concentrations are too high. As a population-based health strategy, water fluoridation does not discriminate by social class and provides universal health benefit to all groups within a community, thereby reducing inequalities. The estimated reduction rates for dental caries range between 25% and 60% depending on the study, location, and population. [10]

The WHO and other public health agencies recommend appropriate fluoride levels range between 0.5 mg/L and 1.0 mg/L of water, depending on:

- Average water consumption;
- Climate (in warm climates water consumption is greater); and
- A population's exposure to other fluoride sources (e.g., certain foods⁸). [10]

The recommended fluoride concentration for caries prevention in Canada (called the optimal level) is 0.7 mg/L or 0.7 parts per million (ppm). The optimal level also takes into consideration the fluoride that people are getting from other sources, like fluoridated toothpaste or mouthrinse. [21] [22]

Water fluoridation is often restricted to urban and peri-urban areas due to access to piped water systems. In 2022, around 14.4 million Canadians (38.8%) had access to community water fluoridation through water systems, leaving the majority of Canadians not benefitting from the caries protective effect of fluoridated drinking water. [21]

⁸ In most parts of the world, food is the primary source of fluoride intake. While almost all food contains trace amounts of fluoride, levels can be high in fish products that contain bones (e.g., canned salmon, sardines). Levels in meat, fruit, and vegetables are usually low. Tea plants may take up considerable amounts of fluoride from soil. Thus, tea consumption (particularly brick tea, popular in parts of Asia) can increase fluoride intake. [47]

Depending on geographical location, natural concentrations of fluoride in water can be elevated (e.g., parts of China, India, and United States, and along the East African Rift Valley). Prolonged excessive fluoride concentrations elevate risk of severe dental and skeletal fluorosis. In these areas, water defluoridation measures need to be taken. [10]

Optimum oral hygiene

Poor oral hygiene has been associated with dental caries. For example, poor oral hygiene has been found to be the main cause of early childhood caries in children. Gao et al. (2020) showed seniors with dementia had significantly poorer oral hygiene and more caries than those without dementia. [23] [24]

Regular biofilm disruption is essential to prevent accumulation and maturation of bacterial communities. Thus, it is important to educate all clients in optimal oral hygiene practices, including brushing with fluoride toothpaste twice a day and cleaning between teeth daily. In the presence of fluorides, oral self-care is effective for preventing and controlling dental caries when plaque removal is performed properly. [5] [23]

Hujoel et al. (2018) conducted a systematic review of randomized trials to assess the association between personal oral hygiene and dental caries in the absence of the confounding effects of fluoride. The authors found personal oral hygiene in the absence of fluorides failed to show a benefit in terms of reducing the incidence of dental caries. This highlights the importance of incorporating fluoride into oral hygiene regimes. [25]

Lima-Holanda et al. (2021) compared 28 young children with dental caries and 28 caries-free children relative to the effects of mechanical biofilm control (tooth brushing and oral hygiene instruction) in salivary pH change in response to exposure to a sucrose solution. The sucrose solution exposure significantly decreased the pH while the mechanical biofilm control improved the pH. However, in the caries-free children, the saliva buffer regulated the pH better, even without mechanical biofilm control. In the early childhood caries group, the pH remained lower after the sucrose solution exposure even with mechanical control of the biofilm. This study suggests young children with caries may have compromised buffer capacity of the saliva and; therefore, tooth brushing and oral hygiene instruction alone may not be sufficient. Careful control of sugar intake is also needed in this population. [26]

Dental sealants

Dental sealants were introduced in the 1960s to help prevent dental caries, mainly in the pits and fissures of occlusal tooth surfaces. Dental sealants act to prevent bacteria growth that can lead to dental caries. A Cochrane systematic review (2017) found resin-based sealants applied on occlusal surfaces of permanent molars were effective for preventing caries in children and adolescents. [27]

Dental sealants vs fluoride varnish

Applying fluoride varnish or resin-based fissure sealants to first permanent molars helps prevent occlusal caries. A Cochrane review (2020) found no evidence suggesting the superiority of dental sealants over fluoride varnish or vice versa, although this was very low certainty evidence. Other Cochrane reviews have shown both interventions are

effective for preventing occlusal caries in the first permanent molars. Studies are currently ongoing and their findings may allow for firmer conclusions whether sealants and varnish work equally well or whether one is better than the other. [28]

In a prospective study by Wang et al. (2021), 5,397 6- to 7-year-old children in a low fluoridated area (<0.2 ppm) in China participated in the evaluation of fluoride varnish application on the caries incidence on occlusal surfaces of first permanent molars. Children in the fluoride varnish group received varnish every six months for a 3-year period; the control group received no fluoride varnish. At 24 months, the fluoride varnish group had a mean decayed/restored score of 0.41 compared to 0.64 in the control group, a statistically significant difference. At 36 months, the rate of caries increase on occlusal surfaces in both groups was not significantly different. The authors concluded fluoride varnish placed on occlusal surfaces of first permanent molars can decrease caries activity in the first two years after eruption. Nonetheless, the use of fluoride varnish with additional treatments, such as dental sealants should be considered for optimized benefit after 24 months for long-term caries prevention. [29]

Fluoride mouthrinses

A Cochrane review (2016) found supervised regular use of fluoride mouthrinse by children and adolescents was associated with a large reduction in caries in permanent teeth. [30]

Management of xerostomia

Xerostomia management depends on the etiology (e.g., medical condition, drug-induced). Goals of managing xerostomia include relieving discomfort and preventing complications (e.g., dental caries). [31] [32]

Strategies to manage dry mouth include:

- Drinking or sipping water throughout the day.
 - Sucking on ice chips.
 - Limiting alcoholic beverages and beverages high in sugar or caffeine, such as juices, sodas, teas, or coffee (especially sweetened).
 - Smoking cessation.
 - Over the counter commercial saliva substitutes, moisturizers, and lubricants.
 - Sugarless gums, mints, lozenges to help stimulate saliva flow (e.g., xylitol-sweetened). For example, chewing sugar-free gum with xylitol can help promote salivary flow, remineralization, and cannot be metabolized by cariogenic bacteria.
 - Nighttime use of bedside humidifier.
 - Use of self-adhering xylitol discs.
 - Drug substitutions if similar drugs are available with fewer xerostomic side effects.⁹
- [5] [32] [33] [34] [35]

Probiotics

Several studies have suggested short term consumption of some probiotics may reduce cariogenic bacteria counts, decrease dental plaque formation, and thus control dental

⁹ Refer to Episode 55 for additional information on xerostomia.

caries progression. These effects appear to require temporary colonization of the oral cavity which may lead to decreased bacterial pathogens. However, probiotics were unable to definitively eliminate pathogenic bacteria. Future research is required to evaluate cariogenic bacteria counts as well as dental caries progression and incidence considering reduced salivary counts do not imply a reduction of bacterial plaque virulence. [36]

A recent systematic review and meta-analysis by Meng et al. (2023) demonstrated probiotics, in particular, *Lactobacillus rhamnosus*, could effectively prevent dental caries through their ability to reduce the number of *Streptococcus mutans* in saliva. However, probiotic use could not reduce the number of lactic acid bacteria in saliva or dental plaques. There remains a lack of relevant research on the dose, route of administration, and frequency of probiotic use. Further RCTs are needed to standardize probiotic use to achieve more beneficial effects before general use in clinical practice. [37]

Novel research

Seredin et al. (2022) developed a dental coating that replicates tooth enamel at a molecular and structural level by adding a complex of amino acids to hydroxyapatite. According to the study, the new biomimetic material also exhibits strength surpassing that of natural tooth structure. The new strategy may have potential application in oral healthcare practices, including treatment of dental caries and tooth hypersensitivity. [38]

Cho et al. (2023) have discovered a bacterial species called *Selenomonas sputigena*, (previously only associated with periodontal disease) works in partnership with *S. mutans*, greatly enhancing *S. mutans*' ability to cause tooth decay. *S. mutans* builds sticky constructions called glucans that are part of the protective plaque environment. The study showed *S. sputigena* can become trapped by these glucans as they crawl across tooth surfaces with tiny appendages. Once trapped, *S. sputigena* quickly reproduce, creating "superstructures" that encapsulate and protect *S. mutans*. The result is a greatly increased and concentrated production of acid, which significantly worsens caries severity.

The study provides new insights into the complex microbial interaction of dental caries development and may lead to new methods to prevent caries, such as disrupting these protective *S. sputigena* superstructures using specific enzymes or more precise and effective toothbrushing methods. [39]

Take home messages

Protecting teeth and preventing and arresting carious lesions reduces infection, pain, tooth damage and the need to restore cavitated lesions. This in turn reduces financial burden on individuals and healthcare systems. Other potential positive impacts include reduced absence from school and work and improved quality of life. Dental caries can be reduced by addressing common risk factors, such as:

- Promoting a well-balanced diet low in free sugars and high in fruit and vegetables, and favouring water as the main drink.
- Adequate exposure to fluoride.

- Optimizing homecare by encouraging twice-daily tooth brushing with fluoride-containing toothpaste and cleaning between teeth daily.

References

- [1] World Health Organization, "Sugars and dental caries," 9 November 2017. [Online]. Available: <https://www.who.int/news-room/fact-sheets/detail/sugars-and-dental-caries>. [Accessed 26 May 2023].
- [2] World Health Organization, "Oral Health," 14 March 2023. [Online]. Available: <https://www.who.int/news-room/fact-sheets/detail/oral-health>. [Accessed 31 May 2023].
- [3] L. Zhan, "Rebalancing the caries microbiome dysbiosis: Targeted treatment and sugar alcohols," *Advances in Dental Research*, vol. 29, no. 1, pp. 110-116, February 2018.
- [4] World Health Organization, "WHO/Europe calls for urgent action on oral disease as highest rates globally are recorded in European Region," 20 April 2023. [Online]. Available: <https://www.who.int/europe/news/item/20-04-2023-who-europe-calls-for-urgent-action-on-oral-disease-as-highest-rates-globally-are-recorded-in-european-region>. [Accessed 7 June 2023].
- [5] American Dental Association, "Caries Risk Assessment and Management," 9 June 2021. [Online]. Available: <https://www.ada.org/en/resources/research/science-and-research-institute/oral-health-topics/caries-risk-assessment-and-management>. [Accessed 31 May 2023].
- [6] Heart and Stroke Foundation of Canada, "Reduce sugar," 2023. [Online]. Available: <https://www.heartandstroke.ca/healthy-living/healthy-eating/reduce-sugar>. [Accessed 1 June 2023].
- [7] Gov.UK, "Chapter 4: Dental caries," 9 November 2021. [Online]. Available: <https://www.gov.uk/government/publications/delivering-better-oral-health-an-evidence-based-toolkit-for-prevention/chapter-4-dental-caries>. [Accessed 31 May 2023].
- [8] F. Aulestia, J. Groeling, G. Bomfim, et al., "Fluoride exposure alters Ca²⁺ signaling and mitochondrial function in enamel cells," *Science Signaling*, vol. 13, no. 619, pp. 1-11, 18 February 2020.
- [9] World Health Organization, "Prevention and treatment of dental caries with mercury-free products and minimal intervention," 16 March 2022. [Online]. Available: <https://www.who.int/publications/i/item/9789240046184>. [Accessed 8 June 2023].
- [10] World Health Organization, "Global oral health status report: Towards universal health coverage for oral health by 2030," 18 November 2022. [Online]. Available: <https://www.who.int/publications/i/item/9789240061484>. [Accessed 29 May 2023].
- [11] V. Marinho, J. Higgins, S. Logan and A. Sheiham, "Fluoride toothpastes for preventing dental caries in children and adolescents," *Cochrane Database of Systematic Reviews*, no. 1, 20 January 2003.

- [12] T. Walsh, H. Worthington, A. Glenny, V. Marinho and A. Jeroncic, "Fluoride toothpastes of different concentrations for preventing dental caries," *Cochrane Database of Systematic Reviews*, no. 3, 4 March 2019.
- [13] V. Marinho, H. Worthington, T. Walsh and J. Clarkson, "Fluoride varnishes for preventing dental caries in children and adolescents," *Cochrane Database of Systematic Reviews*, no. 7, 2013.
- [14] K. Dholam, P. Somani, S. Prabhu and S. Ambre, "Effectiveness of fluoride varnish application as cariostatic and desensitizing agent in irradiated head and neck cancer patients," *International Journal of Dentistry*, vol. 2013, article 824982, pp. 1-5, 2013.
- [15] American Dental Association, "Silver Diamine Fluoride," 19 July 2021. [Online]. Available: <https://www.ada.org/resources/research/science-and-research-institute/oral-health-topics/silver-diamine-fluoride>. [Accessed 8 June 2023].
- [16] A. Mungur, H. Chen, S. Shahid and A. Baysan, "A systematic review on the effect of silver diamine fluoride for management of dental caries in permanent teeth," *Clinical and Experimental Dental Research*, vol. 9, no. 2, pp. 375-387, 23 February 2023.
- [17] R. Ruff, T. Barry-Godín and R. Niederman, "Effect of silver diamine fluoride on caries arrest and prevention: The CariedAway school-based randomized clinical trial," *JAMA Network Open*, vol. 6, no. 2, pp. 1-10, 9 February 2023.
- [18] A. Hendre, G. Taylor, E. Chávez and S. Hyde, "A systematic review of silver diamine fluoride: Effectiveness and application in older adults," *Gerodontology*, vol. 34, no. 4, pp. 411-419, 15 August 2017.
- [19] W. Sommerfeldt, P. Gellert, A. Müller, et al., "Older patients' perception of treating root caries with silver diamine fluoride – A qualitative study based on the Theoretical Domains Framework," *Journal of Dentistry*, vol. 130, March 2023.
- [20] A. Zaeneldin, O. Yu and C. Chu, "Effect of silver diamine fluoride on vital dental pulp: A systematic review," *Journal of Dentistry*, vol. 119, pp. 1-8, April 2022.
- [21] Public Health Agency of Canada, "The State of Community Water Fluoridation across Canada," 20 12 2022. [Online]. Available: <https://www.canada.ca/en/public-health/services/publications/healthy-living/community-water-fluoridation-across-canada.html>. [Accessed 10 June 2023].
- [22] Government of Canada, "Fluoride and Oral Health," 23 December 2022. [Online]. Available: <https://www.canada.ca/en/health-canada/services/healthy-living/your-health/environment/fluorides-human-health.html>. [Accessed 10 June 2023].
- [23] D. Duangthip and C. Chu, "Challenges in oral hygiene and oral health policy," *Frontiers in Oral Health*, vol. 1, article 575428, pp. 1-4, October 2020.
- [24] S. Gao, K. Chen, D. Duangthip, et al., "The oral health status of Chinese elderly people with and without dementia: A cross-sectional study," *International Journal of Environmental Research and Public Health*, vol. 17, no. 6, pp. 1-8, 15 March 2020.
- [25] P. Hujoel, M. Hujoel and G. Kotsakis, "Personal oral hygiene and dental caries: A systematic review of randomised controlled trials," *Gerodontology*, vol. 35, no. 4, pp. 282-289, 15 May 2018.

- [26] Lima-Holanda, "The role of mechanical control of biofilm in the salivary pH after sucrose exposure in children with early childhood caries," *Scientific Reports*, vol. 11, article 7496, pp. 1-12, 5 April 2021.
- [27] A. Ahovuo-Saloranta, H. Forss, T. Walsh, et al., "Pit and fissure sealants for preventing dental decay in permanent teeth," *Cochrane Database of Systematic Reviews*, vol. 7, 31 July 2017.
- [28] W. Kashbour, P. Gupta, H. Worthington and D. Boyers, "Pit and fissure sealants versus fluoride varnishes for preventing dental decay in the permanent teeth of children and adolescents," *Cochrane Database of Systematic Reviews*, no. 11, 4 November 2020.
- [29] Z. Wang, W. Rong and T. Xu, "Effect of fluoride varnish in caries prevention on permanent first molars: A 36-month cluster randomized controlled trial," *Pediatric Dentistry*, vol. 43, no. 2, pp. 82-87, March-April 2021.
- [30] V. Marinho, L. Chong, H. Worthington and T. Walsh, "Fluoride mouthrinses for preventing dental caries in children and adolescents," *Cochrane Database of Systematic Reviews*, no. 7, 29 July 2016.
- [31] American Dental Association, "Aging and Dental Health," 9 November 2021. [Online]. Available: <https://www.ada.org/resources/research/science-and-research-institute/oral-health-topics/aging-and-dental-health>. [Accessed 16 February 2022].
- [32] American Dental Association, "Xerostomia (Dry Mouth)," 22 February 2021. [Online]. Available: <https://www.ada.org/resources/research/science-and-research-institute/oral-health-topics/xerostomia>. [Accessed 17 February 2022].
- [33] M. Turner and J. Ship, "Dry mouth and its effects on the oral health of elderly people," *JADA*, vol. 138, no. Suppl 1, pp. S15-S20, 1 September 2007.
- [34] A. Gupta, J. Epstein and H. Sroussi, "Hyposalivation in elderly patients," *JCDA*, vol. 72, no. 9, pp. 841-846, November 2006.
- [35] J. Burgess, "Salivary Abnormalities in Dentistry," Medscape, 2020 December 2020. [Online]. Available: <https://emedicine.medscape.com/article/2091828-overview>. [Accessed 17 February 2022].
- [36] P. Saiz, N. Taveira and R. Alves, "Probiotics in oral health and disease: A systematic review," *Applied Sciences*, vol. 11, no. 17, pp. 1-19, 31 August 2021.
- [37] N. Meng, Q. Liu, Q. Dong, J. Gu and Y. Yang, "Effects of probiotics on preventing caries in preschool children: a systematic review and meta-analysis," *Journal of Clinical Pediatric Dentistry*, vol. 47, no. 2, pp. 85-100, 3 March 2023.
- [38] P. Seredin, D. Goloshchapov, A. Emelyanova, et al., "Engineering of biomimetic mineralized layer formed on the surface of natural dental enamel," *Results in Engineering*, vol. 15, pp. 1-8, September 2022.
- [39] H. Cho, Z. Ren, K. Divaris, et al., "Selenomonas sputigena acts as a pathobiont mediating spatial structure and biofilm virulence in early childhood caries," *Nature Communications*, vol. 14, no. article 2919, pp. 1-19, 22 May 2023.
- [40] World Health Organization, "WHO advises not to use non-sugar sweeteners for weight control in newly released guideline," 15 May 2023. [Online]. Available: <https://www.who.int/news/item/15-05-2023-who-advises-not-to-use-non-sugar>

sweeteners-for-weight-control-in-newly-released-guideline. [Accessed 8 June 2023].

- [41] World Health Organization, "Use of non-sugar sweeteners: WHO guideline," 15 May 2023. [Online]. Available: <https://www.who.int/publications/i/item/9789240073616>. [Accessed 8 June 2023].
- [42] Cochrane Library, "What is a systematic review?," 2022. [Online]. Available: <https://www.cochranelibrary.com/about/about-cochrane-reviews>. [Accessed 15 November 2022].
- [43] World Health Organization, "WHO model list of essential medicines - 22nd list, 2021," 30 September 2021. [Online]. Available: <https://www.who.int/publications/i/item/WHO-MHP-HPS-EML-2021.02>. [Accessed 8 June 2023].
- [44] World Health Organization, "WHO Model List of Essential Medicines for Children - 8th list, 2021," 30 September 2021. [Online]. Available: <https://www.who.int/publications/i/item/WHO-MHP-HPS-EML-2021.03>. [Accessed 8 June 2023].
- [45] World Health Organization, "Executive summary: the selection and use of essential medicines 2021: report of the 23rd WHO Expert Committee on the selection and use of essential medicines," 30 September 2021. [Online]. Available: <https://www.who.int/publications/i/item/WHO-MHP-HPS-EML-2021.01>. [Accessed 8 June 2023].
- [46] J. Woelber, D. Gebhardt and P. Hujoel, "Free sugars and gingival inflammation: A systematic review and meta-analysis," *Journal of Clinical Periodontology*, 28 May 2023.
- [47] World Health Organization, "Preventing disease through healthy environments: inadequate or excess fluoride: a major public health concern," 2019. [Online]. Available: <https://apps.who.int/iris/handle/10665/329484>. [Accessed 9 June 2023].

Client resources

Tooth Decay (Caries), ODHA Factsheet

<https://odha.on.ca/wp-content/uploads/2016/08/Tooth-Decay.14.1-copyright.pdf>

Brushing, Flossing, Rinsing, ODHA Factsheet

<https://odha.on.ca/wp-content/uploads/2016/08/Brushing-Flossing.14.1-copyright.pdf>

Oral Health for Children – A Parent's Guide, ODHA Factsheet

<https://odha.on.ca/wp-content/uploads/2016/08/ODHA-Facts-children.VFS18.9-copyright.pdf>

Oral Care for Seniors, ODHA Factsheet

<https://odha.on.ca/wp-content/uploads/2016/08/ODHA-Facts-seniors.VFS21.11.pdf>

For Caregivers – A Guide to Providing Oral Care, ODHA Factsheet

<https://odha.on.ca/wp-content/uploads/2016/08/ODHA-Facts-Caregivers-VFS18-copyright.pdf>

Fluoride, ODHA Factsheet

<https://odha.on.ca/wp-content/uploads/2016/08/ODHA-Facts-Fluoride.VFS18-copyright.pdf>

Nutrition and Oral Health, ODHA Factsheet

<https://odha.on.ca/wp-content/uploads/2016/08/Nutrition.19.1-copyright.pdf>

Dry Mouth, ODHA Factsheet

<https://odha.on.ca/wp-content/uploads/2016/08/ODHA-Facts-Dry-Mouth.VFS18-copyright.pdf>

Additional Resources

Rebalancing the caries microbiome dysbiosis: Targeted treatment and sugar alcohols, Zhan, L. *Advances in Dental Research*, Volume 29, Issue 1, February 2018, p 110-116

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5784483/>

Caries Risk Assessment and Management, American Dental Association, June 9, 2021

<https://www.ada.org/en/resources/research/science-and-research-institute/oral-health-topics/caries-risk-assessment-and-management>

Xerostomia (Dry Mouth), American Dental Association, April 24, 2023

<https://www.ada.org/resources/research/science-and-research-institute/oral-health-topics/xerostomia>

Use of non-sugar sweeteners: WHO guideline, World Health Organization, May 15, 2023 <https://www.who.int/publications/i/item/9789240073616>

Prevention and treatment of dental caries with mercury-free products and minimal intervention, World Health Organization, March 16, 2022

<https://www.who.int/publications/i/item/9789240046184>

Evidence-based clinical practice guideline on nonrestorative treatments for carious lesions: A report from the American Dental Association, Slayton, R; Urquhart, O; Araujo, M; et al. *JADA*, Volume 149, Issue 10, October 2018, p 837-849

[https://jada.ada.org/article/S0002-8177\(18\)30469-0/fulltext](https://jada.ada.org/article/S0002-8177(18)30469-0/fulltext)

The state of community water fluoridation across Canada, Office of the Chief Dental Officer of Canada, Public Health Agency of Canada, December 20, 2022

<https://www.canada.ca/en/public-health/services/publications/healthy-living/community-water-fluoridation-across-canada.html>

Pit and fissure sealants for preventing dental decay in permanent teeth, Ahovuo-Saloranta, A; Forss, H; Walsh, T; et al. *Cochrane Database of Systematic Reviews*, Issue 7, July 31, 2017

<https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD001830.pub5/full>

Fluoride toothpastes for preventing dental caries in children and adolescents, Marinho, V; Higgins, J; Logan, S; Sheiham, A. *Cochrane Database of Systematic Reviews*, Issue 1, January 20, 2003

<https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD002278/full>

Fluoride toothpastes of different concentrations for preventing dental caries, Walsh, T; Worthington, H; Glenny, A. *Cochrane Database of Systematic Reviews*, Issue 3, March 4, 2019

<https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD007868.pub3/full>

Fluoride varnishes for preventing dental caries in children and adolescents, Marinho, V; Worthington, H; Walsh, T; Clarkson, J. *Cochrane Database of Systematic Reviews*, Issue 7, July 11, 2013

<https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD002279.pub2/full>

Effectiveness of fluoride varnish application as cariostatic and desensitizing agent in irradiated head and neck cancer patients, Dholam, K; Somani, P; Prabhu, S; Ambre, S. *International Journal of Dentistry*, Volume 2013, Article 824982, June 13, 2013, p 1-5

<https://www.hindawi.com/journals/ijid/2013/824982/>

Clinical evidence for professionally applied fluoride therapy to prevent and arrest dental caries in older adults: A systematic review, Chan, A; Tamrakar, M; Jiang, C; et al. *Journal of Dentistry*, Volume 124, October 2022, p 1-8

<https://www.sciencedirect.com/science/article/pii/S0300571222003293>

Silver Diamine Fluoride, American Dental Association, July 19, 2021

<https://www.ada.org/resources/research/science-and-research-institute/oral-health-topics/silver-diamine-fluoride>

A systematic review on the effect of silver diamine fluoride for management of dental caries in permanent teeth, Mungur, A; Chen, H; Shahid, S; Baysan, A. *Clinical and Experimental Dental Research*, Volume 9, Issue 2, February 23, 2023, p 375-387

<https://onlinelibrary.wiley.com/doi/full/10.1002/cre2.716>

Effect of silver diamine fluoride on caries arrest and prevention: The CariedAway school-based randomized clinical trial, Ruff, R; Barry-Godín, T; Niederman, R. *JAMA Network Open*, Volume 6, Issue 2, February 9, 2023, p 411-419

<https://jamanetwork.com/journals/jamanetworkopen/fullarticle/2801193>

A systematic review of silver diamine fluoride: Effectiveness and application in older adults, Hendre, A; Taylor, G; Chávez, E; Hyde, S. *Gerodontology*, Volume 34, Issue 4, August 15, 2017, p 411-419

<https://onlinelibrary.wiley.com/doi/10.1111/ger.12294>

Older patients' perception of treating root caries with silver diamine fluoride – A qualitative study based on the Theoretical Domains Framework, Somerfeldt, W; Gellert, P; Müller, A; et al. *Journal of Dentistry*, Volume 130, March 2023

<https://www.sciencedirect.com/science/article/abs/pii/S0300571222004602>

Effect of silver diamine fluoride on vital dental pulp: A systematic review, Zaeneldin, A; Yu, O; Chu, C. *Journal of Dentistry*, Volume 119, April 2022, p 1-8
<https://www.sciencedirect.com/science/article/pii/S0300571222001233>

Pit and fissure sealants versus fluoride varnishes for preventing dental decay in the permanent teeth of children and adolescents, Kashour, W; Gupta, P; Worthington, H; Boyers, D. *Cochrane Database of Systematic Reviews*, Issue 11, November 4, 2020
<https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD003067.pub5/full>

Fluoride mouthrinses for preventing dental caries in children and adolescents, Marinho, V; Chong, L; Worthington, H; Walsh, T. *Cochrane Database of Systematic Reviews*, Issue 7, July 29, 2016
<https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD002284.pub2/full>

Effects of probiotics on preventing caries in preschool children: a systematic review and meta-analysis, Meng, N; Liu, Q; Dong, Q; et al. *Journal of Clinical Pediatric Dentistry*, Volume 47, Issue 2, March, 3, 2023, p 85-100
<https://www.jocpd.com/articles/10.22514/jocpd.2023.014/htm>

Probiotics in oral health and disease: A systematic review, Saiz, P; Taveira, N; Alves, R. *Applied Sciences*, Volume 11, Issue 17, August 31, 2021, p 1-19
<https://www.mdpi.com/2076-3417/11/17/8070/htm>