Health People 2030: Reducing proportion of children and adolescents with lifetime tooth decay

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Oral hygiene is an important contributor to oral health and overall well-being. According to Healthy People 2030, tooth decay is the most common chronic disease amongst children and adults in the United States.[1,2] Dental health impacts functional use of the mouth, speech, smile, and psychosocial environment.[2] The most recent National Health and Nutrition Examination Survey revealed a significant increase in primary tooth decay in children ages 2-11. Of this population, 42% of children in the United States have dental caries in their primary teeth and 21% have dental caries in their permanent teeth, with even greater proportions in individuals of lower socioeconomic status (SES) where preventative dental care visits are lacking.[3,4] Dental caries are a potential source of pain, infection, and reduced quality of life contributing to overall health—affecting nutritional intake, school attendance, ER visits, and development.[5] Visits to the dentist are expensive and this financial burden often limits access to care. Therefore, it is important to educate elementary school children about oral hygiene techniques including brushing, flossing, and fluoride supplementation as well as dietary contributions to create habits that can prevent oral disease and improve overall health and well-being.

Dental caries (commonly referred to as cavities) and periodontal disease are preventable diseases which negatively impact oral health.[2,6] Dental caries is the multifactorial disease of dental hard tissues caused by oral bacteria, fermentable carbohydrates, and available tooth surface. Bacteria ferment carbohydrates on the tooth introduced by oral intake, creating acids which demineralize the tooth surface. If untreated, the demineralization could involve the pulp and lead to swelling, abscess, and systemic signs of infection.[2] Additionally, bacteria create a biofilm called plaque which causes an inflammatory response in the gingival tissue or in the bone supporting the teeth, leading to gingivitis and periodontitis, respectfully.[7]

Preventative oral health care, including regular dental visits, are more cost effective than dental treatments for dental caries, gingivitis, and periodontitis. Regular dental visits can prevent caries through measures such as professional cleanings, fluoride varnishes, and dental sealants. Current American Association of Pediatric Dentistry recommendations are to initiate dental care visits no later than 12 months of age and subsequent visits every 6 months.[8] In 2018, 85% of children 2-17 years of age had a dental visit the year prior.[9] However, research has found that individuals from lower-income and lower-educated households had decreased likelihood of preventative dental visits and specific services.[10] Since access to professional dental services is limited in certain populations, it is crucial to educate populations on at-home preventative care .

Brushing teeth is one of the most important tools to prevent dental caries and periodontal disease. Studies suggest that most individuals brush an average of 45 to 60 seconds, whereas the current American Dental Association (ADA) – the professional body guiding dental practices in the United States and America's leading advocate for oral health – recommendation is to brush for a minimum of two minutes, twice a day.[11,12] The recommendation for two-minute brushing is based on research that revealed two minutes of brushing removed 26% more plaque when compared to 45 seconds. One explanation for this is that some plaque is more accessible; therefore, the first time brushing over an area will only remove the most readily available plaque, whereas repetition and longer brushing times are required to reach and remove that harder to get plaque.[12] Additionally, brushing without proper timing and technique has been shown to be ineffective in preventing plaque buildup.[13] Proper brushing technique, according to the ADA, is as follows: place the toothbrush at a 45-degree angle to the gums, and gently moving the brush back and forth in short strokes as wide as the tooth; for the inner surface of the front teeth, the

brush should be tilted to make vertical strokes.[11] The brushing technique may vary depending on the type of brush that is used, which has also been a big topic of research for dental hygiene.

There are many types of toothbrushes available, ranging from mechanical brushes costing as low as 99 cents to electric toothbrushes which can cost up to hundreds of dollars. The effectiveness of a toothbrush preventing dental caries and gingival disease may depend on many factors including bristle type, soft vs hard bristles, the speed, brush head, etc. Overall, both manual and powered toothbrushes are effective in plaque removal. A systematic review of clinical trials of individuals ≥18 years of age, in good oral health, revealed powered toothbrushes are more effective in reducing plaque than manual toothbrushes.[14] When comparing the bristles, studies found medium bristled-toothbrushes removed higher amounts of dental biofilm, however they consequently cause gingival damage. Therefore, soft bristles are the current ADA recommendation.[15,16] The ADA provides a list of endorsed manual and powered toothbrushes to help guide the decision of exactly which brush is preferred.

In addition to the type of brush used, the ingredients in toothpaste and/or water also influence oral health. One way to help prevent the breakdown of carbohydrates on the tooth into acids is with fluoride, the ionized form of fluorine. Fluoride is a naturally existing mineral in water – the fluoride ion reacts with tooth enamel making it more resistant to acids, essentially making the tooth stronger.[17] Fluoride has both systemic and topical uses in the prevention of dental caries. When fluoride contacts the tooth, it is taken up by plaque and enamel which protects against the demineralization-remineralization process. When given systemically, it impacts bone formation during tooth development and increases concentrations in the saliva.

Fluoride has been supplemented in community drinking water since the mid-1900s.[18] Community water fluoridation has been an effective way to prevent dental caries as it does not

require behavioral change and is cost effective regardless of SES. Most importantly, the ADA states fluoride use results in 20-40% reduction in tooth decay in both children and adults.[19] Today, the U.S. Public Health Services recommends 0.7 ppm fluoride concentration to maintain caries prevention while preventing risk of dental fluorosis, which will be discussed later in the paper.[20] Interestingly, only 19 of the 36 counties with public water systems in Oregon had at least one water source with fluoride; however, Multnomah County does *not* have any fluoride in their water.[21] Therefore, the topical use of fluoride and dietary fluoride supplements are especially important in this population.

In addition to water as a systemic source of fluoride, dietary supplements including drops and tablets can be prescribed for individuals at high risk of tooth decay. Of note, is important as a healthcare provider to be aware of *all* possible sources of the patient's fluoride intake, given that there are often multiple sources of exposure and the amount in drinking water affects the supplement recommendation. Supplementation should begin at 6 months of age until 16 years of age. If the fluoride ion level in drinking water is <0.3ppm, then children ages 6 months-3 years, 3-6 years, and 6-16 years should be given 0.25mg/day, 0.50mg/day, and 1.0mg/day, respectively. If the fluoride ion level is 0.3-0.6ppm, then children ages 3-6 years and 6-16 years should be given 0.25mg/day and 0.50mg/day, respectively. If the fluoride ion level in drinking water is >0.6ppm, there is no need for supplemental fluoride.[19]

Topically, fluoride can be found as an additive in toothpaste, mouth rinses, and professional pastes.[18] Studies support the use of fluoride toothpaste for improving oral health. Researchers found 1,500 ppm fluoride toothpaste reduces caries when compared to non-fluoride toothpaste. Additionally, high-certainty evidence revealed that toothpaste with 1,000-1,250 ppm fluoride is more effective than non-fluoride toothpaste in preventing tooth decay of permanent

dentition of children and adolescents.[22] The amount of fluoride in toothpaste usually varies from 400-1,500ppm and is even lower for children.[2] The ADA recommends children under the 3 years of age brush with toothpaste amount the size of a grain of rice, whereas children 3-6 years of age brush with pea-sized toothpaste in order to reduce the risk of dental fluorosis.[23] Dental fluorosis is caused by excess fluoride exposure during tooth formation before 8 years of age.[24] The symptoms include a range of clinical manifestations, from white opaque enamel to a brown appearance caused by pitting and loss of enamel. The severity of dental fluorosis is influenced by amount and time of exposure. Treatments for this condition are limited, therefore it is critical to adhere to the guidelines for daily fluoride exposure intake to prevent this condition.[25]

Although brushing is effective in removing plaque on the tooth surface, it is not always able to reach foods and plaque trapped in between the teeth. The consensus has been that individuals must supplement brushing with other oral health care such as flossing. Historically, compliance with flossing has been low due to lack of ability and motivation. A Cochrane Systematic Review suggests flossing plus toothbrushing has a statistically significant benefit in reducing gingivitis, but weak evidence to support reduction in plaque.[26] In contrast, other systematic reviews of the evidence comparing brushing alone with brushing *and* flossing was unable to find statically significant evidence that self-performed flossing improves gingival disease nor caries risk, but professional flossing with low fluoride did reduce interproximal caries risk.[27,28] One reason for this could be the flossing technique is not accurate, thereby suggesting that professional flossing may be more effective in preventing dental caries and gingivitis. Nonetheless, the ADA continues to recommend flossing or use of other interdental cleaner (i.e., water flosser, interdental brushes) once a day – the timing and order of brushing to flossing does not make a difference.[29] In order to floss properly, take about 18 inches of floss

wrapped around one finger of each hand, gently insert the floss in between the tooth. Then, curve the floss into a "C" shape against the side of the tooth, gently rubbing the floss up and down while pressed against each tooth, including behind the back teeth.[30]

In addition to proper oral health hygiene techniques, dietary counseling is essential in the prevention and management of dental caries. Diet and health are both intertwined – certain foods and eating patterns can affect oral disease whereas oral health also plays a role in nutritional intake.[31] Associations between foods and their impact on oral health have been found in the literature, however it is important to note that there are many variables in the study of diet and dental health making it difficult to follow subjects long term and thereby affecting the quality of evidence.[32] The medical and dental community agree that a balanced diet should be encouraged according to the food pyramid.[33] Since dental caries are formed from fermented carbohydrates into acids, it has been generally understood that increased carbohydrate intake is associated with increased risk of caries. However, it is important to note the type of carbohydrate influences how the bacteria will ferment it. Sugars have the biggest influence on causing dental caries, including sugar-sweetened liquids, sugary starchy snacks, simple sugars, slowly dissolving candies, as well as sticky foods.[2,31] On the other hand, fresh, whole, unprocessed foods, including fibrous foods, are protective against caries because they stimulate salivary flow.[31]

When considering interventions to improve oral health of school children, studies have examined a variety of services including education of elementary school children and their families, and increased access to community programs and resources, amongst others. Research suggests that oral health education in school children is an effective intervention with statistically significant results in increasing oral health knowledge and more positive attitudes towards oral health.[34,35,36] These results were seen in a randomized clinical trial after 3 months of oral health

educational sessions with teachers and monthly brushing activities.[34] Similarly, a systematic review of schoolchildren 6 to 12 years of age looking at health education modes ranging from lectures, models, projects, activity-based strategies, and audiovisual aids found an improvement in oral health knowledge, the frequency and duration of brushing, the use of fluorinated toothpaste, and reduction in the frequency of eating candies.[37]

Most studies which yield these positive results are researched outside of the United States and conducted over multiple sessions ranging from weeks to multiple year-long interventions. There are few studies examining single-session oral health initiatives. In one study, a 30-minute session given by a dental student to 6-year-old children and their parents about oral health (importance of healthy teeth, oral hygiene routines, and nutrition) resulted in significantly lower plaque index and difference in frequency of brushing, but no significant change in brushing techniques.[38] In a similar study educating children 3, 6, and 11 years of age and their parents, researchers found preventative education decreased plaque-induced diseases. Those authors concluded preventative plans should begin at age 6, the age the first molar has erupted.[39] Researchers have suggested oral health promotion as a part of elementary school education, including daily supervised toothbrushing drills, parental training, and training staff. Oral health topics which have been effectively taught to schoolchildren in Denmark for children between ages 6-10 include picture books, slides, videos, puppet shows, models, fishing games, food, puzzles, and drawing.[40]

The elementary school years play an important role in development and shaping a child's behaviors and habits. Education about proper oral hygiene can be impactful in preventing oral disease in children and costly dental procedures down the road. Although studies support long-term programs efficacy in educating and changing habits of children and their families, research

has also revealed presentations as short as 30 minutes having significant results. In addition to helping meet the Healthy People 2030 goal of reducing the proportion of children and adolescents with lifetime tooth decay, a presentation to elementary school children on the pathology of dental caries, the influence diet plays in dental care, effective brushing and flossing techniques, and fluoride supplementation will play an important role in improving oral health in children.

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