

# Fluoride Therapy

## Latest Revision

2023

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### Abstract

*This best practice provides information for practitioners regarding the use of fluoride as an aid in preventing and controlling dental caries in pediatric dental patients. These recommendations address systemic fluoride (water fluoridation, dietary fluoride supplements), topical fluoride delivery via professional application (acidulated phosphate fluoride gel or foam, sodium fluoride varnish, silver diamine fluoride), and home-use products (toothpastes, mouthrinses) as well as the associated risks of fluoride agents. The standard level for community water fluoridation (0.7 parts per million fluoride) helps balance the risk of caries and the possibility of dental fluorosis from excessive fluoride ingestion during the early years of tooth development. Specific recommendations for dietary supplementation of fluoride for children ages six months through 16 years are based on fluoride levels in the drinking water, other dietary sources of fluoride, use of a fluoridated toothpaste, and caries risk. The specific needs of each patient determine the appropriate use of systemic and topical fluoride products, whether delivered in a professional clinical or a home setting. Fluoride has proven to be an effective therapy in reducing the prevalence of dental caries in infants, children, adolescents, and persons with special needs.*

*Through a collaborative effort of the American Academy of Pediatric Dentistry Councils on Clinical Affairs and Scientific Affairs, this best practice was revised to offer updated information and recommendations to assist healthcare practitioners and parents in using fluoride therapy for management of caries risk in pediatric patients.*

KEYWORDS: ADOLESCENT; CHILD; FLUORIDATION; FLUORIDE; ORAL HEALTH; SILVER DIAMINE FLUORIDE; TOOTHPASTE

### Purpose

The American Academy of Pediatric Dentistry intends these recommendations to help practitioners make decisions concerning appropriate use of fluoride as part of the comprehensive oral health care for infants, children, adolescents, and persons with special health care needs.

### Methods

This document was initially developed by the Liaison with Other Groups Committee, adopted in 1967<sup>1</sup>, and last revised by the Council on Clinical Affairs in 2018<sup>2</sup>. To update this guidance, an electronic search of the PubMed®/MEDLINE database was conducted using the terms: fluoride caries prevention, fluoridation, fluoride gel, fluoride varnish, fluoride toothpaste, fluoride therapy, silver diamine fluoride, and topical fluoride; fields: all; limits: within last five years, English. Because 4077 papers were identified through these electronic searches, an alternate strategy of limiting the information gathering to systematic review using the term fluoride caries prevention yielded 116 new systematic reviews or trials since 2017. Expert opinions and clinical practices also were relied upon for these recommendations.

### Background

Fluoride has been a major factor in the decline in prevalence and severity of dental caries in the United States (U.S.) and other economically developed countries. It has several caries-protective mechanisms of action. Topically, low levels of fluoride in plaque and saliva inhibit the demineralization of sound enamel and enhance the remineralization of demineralized

enamel.<sup>3,4</sup> The topical effect may be enhanced when combined with good oral hygiene practices at home and use of a fluoride dentifrice.<sup>5</sup> Fluoride also inhibits dental caries by affecting the metabolic activity of cariogenic bacteria.<sup>6</sup> High levels of fluoride, such as those attained with the use of topical gels or varnishes, produce a temporary layer of calcium fluoride-like material on the enamel surface. The fluoride is released when the pH drops in response to acid production and becomes available to remineralize enamel or affect bacterial metabolism.<sup>7</sup> Although fluoride-rich enamel is less acid-soluble than enamel with less fluoride, the topical and remineralization effects of fluoride have been found to have a greater impact on caries prevention than incorporation of fluoride into developing teeth.<sup>8</sup>

### Community water fluoridation

Fluoridation of community drinking water is the most equitable and cost-effective method of delivering fluoride to all members of most communities.<sup>9</sup> As of 2018, 73 percent of the U.S. population on community water systems had access to fluoridated water.<sup>10</sup> Water fluoridation at the level of 0.7-1.2 milligrams (mg) fluoride ion (F) per liter (i.e., parts per million fluoride [ppm F]) was introduced in the U.S. in the 1940s. Since community water is now one of several sources of fluoride,

#### ABBREVIATIONS

**CaF:** Calcium fluoride. **F:** Fluoride. **FSIQ:** Full scale intelligent quotient. **IQ:** Intelligence quotient. **mg:** Milligram. **mg/kg:** Milligrams per kilogram. **NaFV:** Sodium fluoride varnish. **ppm F:** Parts per million fluoride. **SDF:** Silver diamine fluoride. **U.S.:** United States.

the U.S. Department of Health and Human Services revised these recommendations in 2015 to a standardized level of 0.7 ppm F to balance the benefits of preventing dental caries while reducing the chance of fluorosis.<sup>11</sup>

Community water fluoridation has been associated with the decline in caries prevalence in U.S. adolescents, from 90 percent in at least one permanent tooth in 12-17-year-olds in the 1960s, to 60 percent in a 1999-2004 survey,<sup>12,13</sup> with more recent estimates of 35 percent caries reduction in primary teeth and 26 percent in permanent teeth of children<sup>14</sup>. Additionally, a Cochrane review found that water fluoridation led to a 15 percent increase in caries-free children in primary dentition and 14 percent increase in caries-free children with permanent dentition.<sup>14</sup>

Consuming fluoridated drinking water is both safe and effective in preventing and controlling dental caries. Although adverse health effects (e.g., decreased cognitive ability, endocrine disruption, cancer) have been ascribed to the use of fluoride over the years, the preponderance of evidence from large cohort studies and systematic reviews does not support an association of such health issues and consumption of fluoridated water at the recommended concentration.<sup>11</sup> Regarding cognitive ability, a recent study of mothers' urinary fluoride levels and their child's intelligence quotient (IQ) levels suggested an association with exposure levels much greater than those recommended in the U.S. for water fluoridation.<sup>15</sup> Also utilizing maternal urinary fluoride levels, a multicenter prospective cohort study<sup>16</sup> followed children born in Canada between 2008 and 2012. Forty-one percent of followed patients lived in fluoridated communities. This study assessed IQ at ages three and four years using the Wechsler Preschool and Primary Scale of Intelligence with Full Scale Intelligence Quotient (FSIQ) as the primary outcome.<sup>16</sup> Results indicated that a one mg increase in daily fluoride intake (e.g., an extra six cups of optimally-fluoridated water each day) during pregnancy was associated with a 4.49 point lower FSIQ score in boys but did not significantly impact girls.<sup>16</sup> The study results suggested maternal exposure to high fluoride levels was associated with lower IQ scores in boys and girls; however, it overlooked confounding variables that did not adjust for differences in socioeconomic status or maternal IQ, and there was no IQ difference when evaluating the full population.<sup>16</sup> Moreover, a prospective study in New Zealand did not support an association between fluoridated water and IQ measurements<sup>17</sup>, and a national sample in Sweden found no relationship between fluoride levels in water supplies and cognitive ability, noncognitive ability, and education<sup>18</sup>. The current evidence does not support that consuming water fluoridated at the level 0.7 ppm F is associated with reductions in IQ.

Repeated consumption of fluoride at levels higher than those recommended in this document during enamel development, however, can cause dental fluorosis (children 15-30 months of age being most susceptible for fluorosis of the permanent incisors).<sup>19</sup> The National Health and Nutrition Examination Survey (NHANES) 1999-2004 study found 23

percent of the U.S. population aged six through 49 had very mild or mild fluorosis.<sup>20</sup> Very mild and mild levels of fluorosis are associated with decreased caries experience and present clinically as an increase in diffuse or lacy appearing white opacities of the enamel and generally are not considered an esthetic problem.<sup>21,22</sup> The Iowa Fluoride Study was a longitudinal study that gathered data on fluoride intake from multiple sources (water, beverages, foods, fluoride supplements, and dentifrices) on subjects from birth to 36 months.<sup>23</sup> Those subjects were examined at about age nine to assess permanent incisors and first molars for fluorosis using the Fluorosis Risk Index.<sup>24</sup> This study found the prevalence of mild fluorosis was 13 percent among those children with average fluoride intakes of 0.04 mg per kilogram (mg/kg) body weight and increased to 23 percent when intakes were between 0.04 to 0.06 mg/kg.<sup>24</sup> When fluoride intakes average 0.06 mg/kg or more per day, mild fluorosis prevalence was 38 percent.<sup>24</sup> A more recent study found mild fluorosis levels increased to over 60 percent for adolescents ages 16 and 17 in 2011-2012 compared to 29.4 percent in 2001-2002; this is a greater than 31 percent increase.<sup>25</sup>

#### Fluoride supplements and infant formula

Fluoride supplements are effective in reducing prevalence of dental caries and may be considered for children at high caries risk who drink fluoride-deficient (less than 0.6 ppm F) water<sup>26</sup> (see Table). Fluoride supplementation schedules were last revised in the early 1990s<sup>27</sup> and have not been adjusted since 1) fluoride concentration in municipal water was standardized and 2) recommendations to use fluoridated toothpaste with the eruption of the first tooth were promulgated.

Before prescribing supplements, determination of dietary fluoride intake from all sources can help reduce intake of excess fluoride. Sources of dietary fluoride may include drinking water from home, day care, and school; beverages such as soda<sup>28</sup>, juice<sup>29</sup>, and infant formula<sup>30</sup>; prepared food<sup>31</sup>; and toothpaste. Concentrated infant formulas requiring reconstitution with water have raised concerns regarding an increased risk of fluorosis.<sup>32</sup> Infants may be particularly susceptible because of the large consumption of such liquid while the body weight is relatively low<sup>4</sup> and the enamel is mineralizing. An evidence-based review found that consumption of reconstituted

Table. DIETARY FLUORIDE SUPPLEMENTATION SCHEDULE

Age	<0.3 ppm F	0.3 to 0.6 ppm F	>0.6 ppm F
Birth to 6 months	0	0	0
6 months to 3 years	0.25 mg	0	0
3 to 6 years	0.50 mg	0.25 mg	0
6 to at least 16 years	1.00 mg	0.50 mg	0

Abbreviations in this table: ppm F=Parts per million fluoride; mg=milligram.

*Note:* The recommendations in this table have not been revised since fluoride concentration in municipal water was standardized and use of fluoridated toothpaste for dentate infants was promulgated. All dietary sources of fluoride should be taken into consideration before recommending fluoride supplements for patients with fluoride-deficit community water.

infant formula can be associated with an increased risk of mild fluorosis but recommended the continued use of fluoridated water.<sup>33</sup> One study has shown that dental fluorosis levels do not vary in fluoridated areas regardless of premixed versus reconstituted formula.<sup>34</sup> Nevertheless, over-supplementation of fluoride, even for patients residing in areas with unfluoridated water, can cause fluorosis.<sup>35</sup> Since standardization of the optimal fluoride levels in drinking water to 0.7 ppm F in 2015, dental fluorosis is less likely to occur. However, caution is indicated when considering the use of fluoride supplements for children under age six due to their continued dental development and consumption of fluoride from a variety of sources.

### Professionally-applied fluoride varnish, gel, and foam

Professionally-applied topical fluoride treatments are efficacious in reducing prevalence of dental caries. The most commonly used agents for professionally-applied fluoride treatments are five percent sodium fluoride varnish ([NaFV]; 2.26 percent F, 22,600 ppm F) and acidulated phosphate fluoride ([APF]; 1.23 percent F, 12,300 ppm F). Meta-analyses of 23 clinical trials, most with twice yearly application, favors the use of fluoride varnish in primary and permanent teeth to prevent decay.<sup>36</sup> Fluoride varnish appears to be effective at preventing caries in higher-risk children younger than five years of age.<sup>37</sup> Unit doses of five percent fluoride varnish are the only professional topical fluoride agent recommended for children younger than age six for safety reasons.<sup>36</sup> Meta-analyses of placebo-controlled trials show that fluoride gels, applied at three-months to one-year intervals, also are efficacious in reducing caries in permanent teeth.<sup>38,39</sup> Some topical fluoride gel and foam products are marketed with recommended treatment times of less than four minutes, but there are no clinical trials showing efficacy of shorter than four-minute application times.<sup>40</sup> Evidence that topical fluoride foams are efficacious in children is limited.<sup>36</sup> Children at risk for caries should receive a professional fluoride treatment at least every six months.<sup>40</sup> In 2014, the U.S. Preventive Services Task Force recommended a schedule for fluoride varnish application specifically by non-dental personnel to provide this preventive strategy to children in medical settings, especially when children are more likely to see a medical provider rather than a dental provider.<sup>41,42</sup> Recent meta-analyses tried to determine whether professionally-applied fluoride can reverse incipient/white spot caries lesions<sup>43-45</sup> but, due to heterogeneity of studies included in the systematic review coupled with home use of fluoride dentifrices by research subjects, a valid conclusion could not be made<sup>43</sup>. Yet another study has shown that incipient enamel lesions (International Caries Detection and Assessment System Code 2) can be arrested with semiannual applications of five percent NaFV.<sup>46</sup>

### Silver diamine fluoride

Thirty-eight percent silver diamine fluoride ([SDF]; five percent F, 44,800 ppm F) has been cleared by the U.S. Food and Drug Administration as a dentin desensitizer in adults.<sup>47</sup> It currently is used frequently to arrest cavitated caries lesions. SDF is

thought to arrest caries by the antibacterial effect of silver and remineralization of enamel and dentin by fluoride.<sup>48</sup> Silver ions have an antimicrobial effect mainly in the treated carious dentin<sup>49</sup>, and the combination of silver and fluoride in an alkaline solution have a synergistic effect that creates an unfavorable environment for collagen enzyme activation, thereby reducing dentin degradation.<sup>50</sup> Clinical trials show caries arrest rates ranging from 35 to 80 percent<sup>51</sup>, but such studies have a high risk of bias and a high heterogeneity between them, leading to conditional recommendations for its use.<sup>52</sup> Numerous clinical trials conclude that biannual application of SDF results in higher caries arrest in dentin caries lesions as compared to fluoride varnish.<sup>47,53</sup> Thus, SDF is an important adjunct therapy in the individualized comprehensive care plan for children and adolescents for whom access to definitive dental restorative care may be limited for a variety of reasons or preferentially postponed. As the product is highly concentrated, less than a drop is needed to treat several caries lesions, making it cost-effective. SDF is best used as part of an ongoing caries management plan within the context of a dental home.<sup>54,55</sup>

SDF is safe to use in children and adults when delivered in accordance with dosing and application criteria.<sup>56</sup> While current data on the systemic effects of silver is limited<sup>47</sup>, data supports a cytotoxic effect to the dental pulp cells when applied directly on pulp tissue<sup>57-59</sup>. SDF solution, when applied to deep caries lesions (0.25-0.5 millimeters dentin thickness remaining), can be rapidly absorbed into dentin and produce a mild inflammation.<sup>60</sup> Whether tertiary dentin formation is a response to cariogenic bacteria or to the SDF remains undetermined.<sup>60</sup> Two investigations<sup>61,62</sup> have evaluated SDF as an indirect pulp therapy medicament. One study<sup>62</sup> found application of SDF arrested further caries progression but did not significantly increase the amount of reparative dentin radiographically. Similarly, the other found no significant difference between SDF, SDF combined with potassium iodide, and the control (resin-modified glass ionomer) at preventing secondary caries.<sup>61</sup> The absence of postoperative pain and maintenance of tooth vitality indicated that SDF did not adversely affect the pulp when applied as an indirect pulp therapy agent.<sup>61</sup> The other reported side effects of SDF are that caries lesions stain black after treatment and that skin and gingiva temporarily stain with contact.

### Home-use fluoride products

The goal of home-use fluoride products for children is to maximize the time fluoride is in direct contact with the tooth surface, in lower-dose higher-frequency approaches.<sup>63</sup> In children having higher baseline levels of caries, utilizing higher concentrations of fluoride in the toothpaste, brushing with greater frequency, and having supervision of brushing were efficacious in reducing the prevalence of dental caries in permanent teeth.<sup>64,65</sup> A meta-analysis of eight clinical trials on caries increment in preschool children also shows that toothbrushing with fluoridated toothpaste significantly reduces dental caries prevalence in the primary dentition.<sup>66</sup> Using no more than a

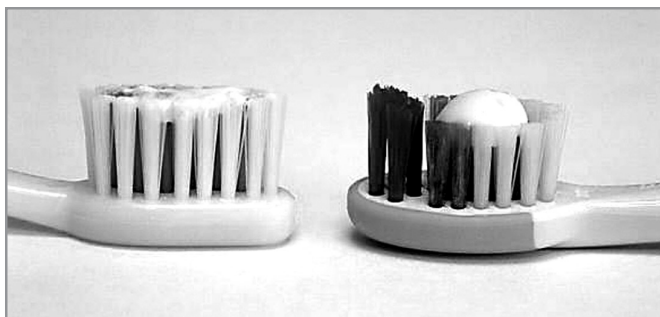


Figure. Comparison of a smear (left) with a pea-sized (right) amount of toothpaste.

smear or rice-sized amount (0.1 mg F) of fluoridated toothpaste for children less than three years of age may decrease risk of fluorosis. Using no more than a pea-sized amount (0.25 mg F) of fluoridated toothpaste is appropriate for children aged three to six<sup>67,68</sup> (see Figure). To maximize the beneficial effect of fluoride in the toothpaste, supervised toothbrushing should be done twice a day, and rinsing after brushing should be kept to a minimum or avoided altogether.<sup>69</sup> Other topical fluoride products (e.g., prescription-strength home-use 0.5 percent F gels and pastes; prescription-strength home-use 0.09 percent F mouthrinse) have benefit in reducing dental caries in those patients at higher risk, such as adolescents, adolescents with special health care needs, or patients with fixed orthodontic appliances; these products are recommended for use in children six years or older.<sup>36</sup> Having children spit after brushing and parents supervise the amounts administered to children will help avoid over-ingestion. Over-ingestion of fluoridated toothpaste combined with other dietary fluoride sources may lead to daily intake greater than the recommended amount and could lead to development of dental fluorosis.<sup>4</sup>

Over 20,000 reports per year regarding fluoride ingestion are received at poison control centers<sup>70</sup>, and over 80 percent of suspected cases occur in the under-six-years age group<sup>71</sup>. The probably-toxic dose for fluoride is five mg/kg body weight.<sup>72</sup> Lower dosage may result in gastrointestinal disturbances with higher doses producing central nervous system side effects such as seizures or tetany.<sup>73</sup> Fifteen mg/kg body weight of fluoride likely could be fatal for a small child.<sup>74</sup> Over-the-counter toothpastes approved by the American Dental Association contain at least 1000 ppm F and less than 1500 ppm F.<sup>75</sup> Currently available prescription strength toothpastes may contain 5000 ppm F<sup>75</sup> or 605 mg F per 100 milliliters<sup>76</sup>. Parental dispensing of toothpaste for use by children under the age of three, supervised toothbrushing for all children unable to expectorate, and keeping prescription fluoride supplements and/or home-use fluoride products out of reach of young children can prevent unintended ingestion which has acute (toxicity) as well as chronic (fluorosis) implications.

## Recommendations

The AAPD recommends:

1. the use of fluoride for the prevention and control of caries as it is both safe and highly effective in reducing dental caries prevalence.
2. consumption of optimally-fluoridated community water as a cost-effective method to prevent and control caries at the population level.
3. toothbrushing at least twice daily with an age-appropriate amount of over-the-counter fluoride-containing toothpaste to prevent caries as first line for caries prevention.
4. professionally-applied topical fluoride treatments such as five percent NaFV or 1.23 percent F gel preparations at least twice per year to reduce incidence of dental caries.
5. 38 percent SDF be used to arrest cavitated caries lesions in primary teeth and permanent teeth as part of a comprehensive caries management program.
6. prescription-strength home-use 0.5 percent F gels and pastes and 0.02-0.09 percent F mouth rinses to reduce dental caries in high-risk patients over six years of age.
7. decisions concerning the administration of fluoride be based on the unique needs of each patient, including the risks and benefits (e.g., risk of mild or moderate fluorosis versus the benefits of decreasing caries increment and, in some cases, preventing devastating dental disease).
8. fluoride dietary supplements be cautiously considered for children at caries risk who drink less-than-optimally-fluoridated water as supplementation—in the face of all other sources of fluoride—could exceed the recommended amount of daily fluoride intake.

## References

1. American Academy of Pedodontics. Fluoride. Chicago, Ill. 1967.
2. American Academy of Pediatric Dentistry. Fluoride therapy. *Pediatr Dent* 2018;40(6):250-3.
3. Featherstone JD. Prevention and reversal of dental caries: Role of low level fluoride. *Community Dent Oral Epidemiol* 1999;27(1):31-40.
4. Tinanoff N. Use of fluoride. In: Berg J, Slayton RA, eds. *Early Childhood Oral Health*. 2nd ed. Hoboken, N.J.: Wiley-Blackwell; 2016:1064.
5. Toumba KJ, Twetman S, Splieth C, Parnell C, van Loveren C, Lygidakis NA. Guidelines on the use of fluoride for caries prevention in children: An updated EAPD policy document. *Euro Arch Paed Dent* 2019;20:507-16.
6. Buzalaf MA, Pessan JP, Honório HM, ten Cate JM. Mechanism of action of fluoride for caries control. *Monogr Oral Sci* 2011;22:97-114.
7. Center for Disease Control and Prevention. Recommendations for using fluoride to prevent and control dental caries in the United States. *MMWR Recomm Rep* 2001; 50(RR-14):1-42.



8. Gerth HU, Dammaschke T, Schäfer E, Züchner H. A three-layer structure model of fluoridated enamel containing  $\text{CaF}_2$ ,  $\text{Ca(OH)}_2$  and FAp. *Dent Mater* 2007;23(12):1521-8.
9. Division of Oral Health, National Center for Chronic Disease Prevention and Health Promotion, Center for Disease Control and Prevention. Achievements in public health, 1900-1999; Fluoridation of drinking water to prevent dental caries. *JAMA* 2000;283(10):1283-6.
10. Centers for Disease Control and Prevention. Division of Oral Health, National Center for Chronic Disease Prevention and Health Promotion. Community Water Fluoridation: Water Fluoridation Data & Statistics. Last reviewed: August 28, 2020. Available at: "<https://www.cdc.gov/fluoridation/statistics/index.htm>". Accessed May 24, 2023.
11. U.S. Department of Health and Human Services Panel on Community Water Fluoridation. U.S. Public Health Services recommendation for fluoride concentration in drinking water for the prevention of dental caries. *Public Health Reports* 2015;130(4):318-31. Available at: "<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4547570/>". Accessed May 24, 2023.
12. U.S. Department of Health and Human Services. Proposed HHS recommendation for fluoride concentration in drinking water for prevention of dental caries. *Federal Register* 2011;76(9):2383-8. Available at: "<https://www.govinfo.gov/content/pkg/FR-2011-01-13/pdf/2011-637.pdf>". Accessed May 24, 2023.
13. Dye BA, Tan S, Smith V, et al. Trends in oral health status: United States, 1988-1994 and 1999-2004. *Vital Health Stat* 2007;11(248):1-92. Available at: "[https://www.cdc.gov/nchs/data/series/sr\\_11/sr11\\_248.pdf](https://www.cdc.gov/nchs/data/series/sr_11/sr11_248.pdf)". Accessed May 24, 2023.
14. Iheozor-Ejiofor A, Worthington HV, Walsh T, et al. Water fluoridation for the prevention of dental caries. *Cochrane Database Syst Rev* 2015;(6):CD010856. Available at: "<https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD010856.pub2/pdf/full>". Accessed January 3, 2023.
15. Bashash M, Thomas D, Hu H, et al. Prenatal fluoride exposure and cognitive outcomes in children at 4 and 6-12 years of age in Mexico. *Environ Health Perspect* 2017;125(9):097017. Available at: "<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5915186/>". Accessed November 3, 2022.
16. Green R, Lanphear B, Hornung R, et al. Association between maternal fluoride exposure during pregnancy and IQ scores in offspring in Canada. *JAMA Pediatr* 2019;173(10):940-8. Available at: "<https://jamanetwork.com/journals/jamapediatrics/article-abstract/2748634>". Accessed January 1, 2023.
17. Broadbent JM, Thomson WM, Ramrakha S, et al. Community water fluoridation and intelligence: Prospective study in New Zealand. *Am J Public Health* 2015;105(1):72-6.
18. Aggeborn L, Öhman M. The effects of fluoride in drinking water. 2017. Available at: "<https://www.ifau.se/globalassets/pdf/se/2017/wp2017-20-the-effects-of-fluoride-in-the-drinking-water.pdf>". Accessed June 6, 2023.
19. Evans RW, Darvell BW. Refining the estimate of the critical period for susceptibility to enamel fluorosis in human maxillary central incisors. *J Pub Health Dent* 1995;55(4):238-49.
20. Beltrán-Aguilar ED, Barker L, Dye BA. Prevalence and severity of dental fluorosis in the United States, 1999-2004. NCHS Data Brief, No. 53. Hyattsville, Md.: National Center for Health Statistics. 2010:1-8. Available at: "<https://www.cdc.gov/nchs/data/databriefs/db53.pdf>". Accessed May 24, 2023.
21. Chankanka O, Levy SM, Warren JJ, Chalmers JM. A literature review of aesthetic perceptions of dental fluorosis and relationships with psychosocial aspects/oral health-related quality of life. *Community Dent Oral Epidemiol* 2010;38(2):97-109.
22. Szpunar SM, Burt BA. Dental caries, fluorosis, and fluoride exposure in Michigan schoolchildren. *J Dent Res* 1988;67(5):802-6.
23. Levy SM, Warren JJ, Davis CS, Kirchner HL, Kanellis MJ, Wefel JS. Patterns of fluoride intake from birth to 36 months. *J Public Health Dent* 2001;61(2):70-7.
24. Hong L, Levy SM, Warren JJ, et al. Fluoride intake levels in relation to fluorosis development in permanent maxillary central incisors and first molars. *Caries Res* 2006;40(6):494-500.
25. Wiener RC, Shen C, Findley P, Tan X, Sambamoorthi U. Dental fluorosis over time: A comparison of National Health and Nutrition Examination Survey data from 2001-2002 and 2011-2012. *J Dent Hyg* 2018;92(1):23-9. Available at: "<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5929463/>". Accessed March 10, 2023.
26. Rozier RG, Adair S, Graham F, et al. Evidence-based clinical recommendations on the prescription of dietary fluoride supplements for caries prevention: A report of the American Dental Association Council on Scientific Affairs. *J Am Dent Assoc* 2010;141(12):1480-9.
27. Adair SM. Overview of the history and current status of fluoride supplementation schedules. *J Pub Health Dent* 1999;59(4):252-8.
28. Heilman JR, Kiritsy MC, Levy SM, Wefel JS. Assessing fluoride levels of carbonated soft drinks. *J Am Dent Assoc* 1999;130(11):1593-9.
29. Kiritsy MC, Levy SM, Warren JJ, Guha-Chowdhury N, Heilman JR, Marshall T. Assessing fluoride concentrations of juices and juice-flavored drinks. *J Am Dent Assoc* 1996;127(7):895-902.
30. Levy SM, Kohout FJ, Guha-Chowdhury N, Kiritsy MC, Heilman JR, Wefel JS. Infants' fluoride intake from drinking water alone, and from water added to formula, beverages, and food. *J Dent Res* 1995;74(7):1399-407.

*References continued on the next page.*

31. Heilman JR, Kiritsy MC, Levy SM, Wefel JS. Fluoride concentrations of infant foods. *J Am Dent Assoc* 1997; 128(7):857-63.
32. Hujoel PP, Zina LG, Moimas SAS, Cunha-Cruz J. Infant formula and enamel fluorosis. A systematic review. *J Am Dent Assoc* 2009;140(7):841-54.
33. Berg J, Gerweck C, Hujoel PP, et al. Evidence-based clinical recommendations regarding fluoride intake from reconstituted infant formula and enamel fluorosis. *J Am Dent Assoc* 2011;142(1):79-87.
34. Do LG, Levy SM, Spencer AJ. Association between infant formula feeding and dental fluorosis and caries in Australian children. *J Public Health Dent* 2012;72(2): 112-21.
35. Pendrys DG. Risk of enamel fluorosis in nonfluoridated and optimally fluoridated populations: Considerations for the dental professional. *J Am Dent Assoc* 2000;131(6): 746-55.
36. Weyant RJ, Tracy SL, Anselmo T, et al. Topical fluoride for caries prevention: Executive summary of the updated clinical recommendations and supporting systematic review. *J Amer Dent Assoc* 2013;144(11):1279-91. Available at: "<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4581720/>". Accessed January 1, 2023.
37. Chou R, Pappas M, Dana T, et al. Screening and Interventions to Prevent Dental Caries in Children Younger Than Age Five Years: A Systematic Review for the U.S. Preventive Services Task Force. Evidence Synthesis No. 210. AHRQ Publication No. 21-05279-EF-1. Rockville, Md.: Agency for Healthcare Research and Quality; 2021:15-18. Available at: "<https://www.ncbi.nlm.nih.gov/books/NBK575915/>". Accessed June 6, 2023.
38. Marinho VCC. Cochrane reviews of randomized trials of fluoride therapies for preventing dental caries. *Euro Arch Paed Dent* 2009;10(3):183-91.
39. Marinho VC, Higgins JP, Logan S, Sheiham A. Fluoride toothpaste for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev* 2003;(1): CD002278. Available at: "[ncbi.nlm.nih.gov/pmc/articles/PMC8439270/](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8439270/)". Accessed May 24, 2023.
40. Hunter JW, Chan JT, Featherstone DB, et al. Professionally-applied topical fluoride: Evidence-based clinical recommendations. *J Am Dent Assoc* 2006;137(8):1151-9.
41. Moyer VA, U.S. Preventive Services Task Force. Prevention of dental caries in children from birth through age 5 years: U.S. Preventive Services Task Force recommendation statement. *Pediatrics* 2014;133(6):1102-11. Available at: "<https://publications.aap.org/pediatrics/article-abstract/133/6/1102/76111/Prevention-of-Dental-Caries-in-Children-From-Birth?redirectedFrom=fulltext>". Accessed March 1, 2023.
42. U.S. Preventive Services Task Force; Davidson KW, Barry MJ, et al. Screening and interventions to prevent dental caries in children younger than 5 years: U.S. Preventive Services Task Force recommendation statement. *JAMA* 2021;326(21):2172-8. Available at: "<https://jamanetwork.com/journals/jama/fullarticle/2786823>". Accessed May 24, 2023.
43. Cumerlato CBdF, Santos CSD, Rotta RN, Cademartori MG, Corrêa MB. Is professionally applied topical fluoride effective in treating incipient caries? A systematic review. *Braz Oral Res* 2022;36:e083.
44. Gao SS, Zhang S, Mei ML, Lo ECM, Chu CH. Caries remineralization and arresting effect in children by professionally applied fluoride treatment. A systematic review. *BMC Oral Health* 2016;16:12. Available at: "[https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4736084/pdf/12903\\_2016\\_Article\\_171.pdf](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4736084/pdf/12903_2016_Article_171.pdf)". Accessed February 26, 2023.
45. Lenzi TL, Montagner AF, Soares FZ, de Oliveira Rocha R. Are topical fluorides effective for treating incipient carious lesions?: A systematic review and meta-analysis. *J Am Dent Assoc* 2016;147(2):84-92.
46. Phonghanyudh A, Duangthip D, Mabangkhu S, Jirattanasopha V. Is silver diamine fluoride effective in arresting enamel caries? A randomized clinical trial. *Int J Environ Res Public Health* 2022;19(15):8992. Available at: "<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9331268/>". Accessed March 12, 2023.
47. Crystal YO, Niederman R. Evidence-based dentistry update on silver diamine fluoride. *Dent Clin N Am* 2019; 63(1):45-68.
48. Zhao IS, Gao SS, Hiraishi N, et al. Mechanisms of silver diamine fluoride on arresting caries: A literature review. *Int Dent J* 2018;68(2):67-76.
49. Sulyanto RM, Kang M, Srirangapeatanam S, Berger M, et al. Biomineralization of dental tissues treated with silver diamine fluoride. *J Dent Res* 2021;100(10):1099-108.
50. Mei ML, Lo ECM, Chu CH. Arresting dentine caries with silver diamine fluoride: What's behind it? *J Dent Res* 2018;97(7):751-8.
51. Gao SS, Zhao IS, Hiraishi N, et al. Clinical trials of silver diamine fluoride in arresting caries among children: A systematic review. *JDR Clin Trans Res* 2016;1(3): 201-10.
52. Crystal YO, Marghalani AA, Ureles SD, et al. Use of silver diamine fluoride for dental caries management in children and adolescents, including those with special health care needs. *Pediatr Dent* 2017;39(5):E135-E145.
53. Mabangkhu S, Duangthip D, Hung CC, Phonghanyudh A, Jirattanasopha V. A randomized clinical trial to arrest dentin caries in young children using silver diamine fluoride. *J Dent* 2020;99:103375.
54. American Academy of Pediatric Dentistry. Policy on the use of silver diamine fluoride for pediatric dental patients. *The Reference Manual of Pediatric Dentistry*. Chicago, Ill.: American Academy of Pediatric Dentistry; 2023: 103-5.

55. Krol DM, Whelan K, AAP Section on Oral Health. Maintaining and improving the oral health of young children. *Pediatrics* 2023;151(1):e2022060417. Available at: “<https://doi.org/10.1542/peds.2022-060417>”. Accessed May 24, 2023.
56. American Academy of Pediatric Dentistry. Chairside guide: Silver diamine fluoride in the management of dental caries lesion. *The Reference Manual of Pediatric Dentistry*. Chicago, Ill.: American Academy of Pediatric Dentistry; 2023:638-9.
57. Manuschai J, Talungchit S, Naorungroj S. Penetration of silver diamine fluoride in deep carious lesions of human permanent teeth: An in vitro study. *Int J Dent* 2021;2021:3059129. Available at: “<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8716243/>”. Accessed May 24, 2023.
58. Srisomboon S, Kettratad M, Stray A, et al. Effects of silver diamine nitrate and silver diamine fluoride on dentin remineralization and cytotoxicity to dental pulp cells: An in vitro study. *J Funct Biomater* 2022;13(1):16-28.
59. Zaeneldin A, Yu OY, Chu CH. Effect of silver diamine fluoride on vital dental pulp: A systematic review. *J Dent* 2022;119:104066. Available at: “<https://doi.org/10.1016/j.jdent.2022.104066>”. Accessed May 24, 2023.
60. Korwar A, Sharma S, Logani A, Shah N. Pulp response to high fluoride releasing glass ionomer, silver diamine fluoride, and calcium hydroxide used for indirect pulp treatment: An in vivo comparative study. *Contemp Clin Dent* 2015;6(3):288-92.
61. Baraka M, Tkeya M, Bakry NS, Fontana M. Twelve-month randomized controlled trial of 38% silver diamine fluoride with or without potassium iodide in indirect pulp capping of young permanent molars. *J Am Dent Assoc* 2022;153(12):1121-33.
62. Divyashree R. Effectiveness of silver diamine fluoride when used as an indirect pulp therapy (IPT) material—A clinical and radiographic assessment. *Int J Applied Dent Sci* 2021;7(2):466-78. Available at: “<https://doi.org/10.22271/oral.2021.v7.i2g.1255>”. Accessed January 24, 2023.
63. Adair SM. Evidence-based use of fluoride in contemporary pediatric dental practice. *Pediatr Dent* 2006;28(2):133-42.
64. Marinho VCC, Higgin JP, Logan, S, Sheiham A. Systematic review of controlled trials on the effectiveness of fluoride gels for the prevention of dental caries in children. *J Dent Educ* 2003;67(4):448-58.
65. Walsh T, Worthington HV, Glenny AM, Marinho VCC, Jeronic A. Fluoride toothpastes of different concentrations for preventing dental caries. *Cochrane Database Syst Rev* 2019;(1):CD007868. Available at: “<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6398117/>”. Accessed June 6, 2023.
66. Dos Santos APP, Nadanovsky P, Oliveira BH. A systematic review and meta-analysis of the effects of fluoride toothpaste on the prevention of dental caries in the primary dentition of preschool children. *Community Dent Oral Epidemiol* 2013;41(1):1-12.
67. American Dental Association Council on Scientific Affairs. Fluoride toothpaste use for young children. *J Am Dent Assoc* 2014;145(2):190-1.
68. Wright JT, Hanson N, Ristic H, et al. Fluoride toothpaste efficacy and safety in children younger than 6 years. *J Am Dent Assoc* 2014;145(2):182-9.
69. Scottish Intercollegiate Guidelines Network (SIGN). Dental interventions to prevent caries in children. March 2014. Edinburgh: SIGN; 2014. (SIGN publication no. 138). Available at: “<https://www.scottishdental.org/wp-content/uploads/2014/04/SIGN138.pdf>”. Accessed June 6, 2023.
70. Bronstein AC, Spyker DA, Cantilena LR Jr, Green JL, Rumack BH, Giffin SL. 2009 Annual Report of the American Association of Poison Control Centers’ National Poison Data System (NPDS): 27th Annual Report. *Clin Toxicol (Phila)* 2010;48(10):979-1178. Erratum in: *Clin Toxicol (Phila)* 2014;52(10):1284. Available at: “<https://www.tandfonline.com/doi/full/10.3109/15563650.2010.543906>”. Accessed May 24, 2023.
71. Shulman JD, Wells LM. Acute fluoride toxicity from ingesting home-use dental products in children, birth to 6 years of age. *J Pub Health Dent* 1997;57(3):150-8.
72. Whitford GM. Fluoride in dental products: Safety considerations. *J Dent Res* 1987;66(5):1056-60.
73. Smith FA. Fluoride toxicity. In: Corn M, ed. *Handbook of Hazardous Materials*. New York, N.Y.: Academic Press; 1993:277-83.
74. Whitford GM. Acute toxicity of ingested fluoride. *Monog Oral Sci* 2011;22:66-80.
75. American Dental Association. Oral Health Topics. Fluoride: Topical and systemic supplements. 2021. Available at: “<https://www.ada.org/resources/research/science-and-research-institute/oral-health-topics/fluoride-topical-and-systemic-supplements>”. Accessed March 12, 2023.
76. Drugs.com. Sodium fluoride paste prescribing information. Available at: “<https://www.drugs.com/pro/sodium-fluoride-paste.html>”. Accessed March 12, 2023.