




# Application of Fluoride for Dental Caries Prevention in Older Adults with Dry Mouth: a Clinical Review

Young Joo Shim<sup>1,2</sup> 

<sup>1</sup>Department of Oral Medicine, Wonkwang University Daejeon Dental Hospital, Daejeon, Korea

<sup>2</sup>Department of Oral Medicine, Institute of Wonkwang Dental Research, College of Dentistry, Wonkwang University, Iksan, Korea

Received March 17, 2024

Revised March 18, 2024

Accepted March 18, 2024

## Correspondence to:

Young Joo Shim

Department of Oral Medicine, Wonkwang

University Daejeon Dental Hospital, 77

Dunsan-ro, Seo-gu, Daejeon 35233, Korea

E-mail: gc21@wku.ac.kr

<https://orcid.org/0000-0001-7514-5974>

Dry mouth is common among older adults and significantly affects the oral health-related quality of life. It is a significant risk factor for dental caries, particularly root caries, in older adults due to concurrent periodontal disease and age-related comorbidities. Clinicians managing patients with dry mouth must be aware of preventive measures against dental caries. This clinical review aims to update our knowledge on the use of fluoride for caries prevention in order to establish better strategies for the management of dry mouth in older adults.

**Keywords:** Aged; Dental caries; Fluoride; Older adult; Xerostomia

## INTRODUCTION

Life expectancy and the aging population are increasing globally. According to Statistics Korea, the number of individuals aged 65 years or older is expected to reach 9.9 million by 2024, accounting for 19.2% of the total population [1].

Older individuals become more susceptible to various chronic conditions with increasing age. The prevalence of dry mouth increases with age and is reported to affect one in four older adults [2,3]. Dry mouth negatively affects the oral health-related quality of life [4,5] and leads to problems such as dental caries, periodontal disease, fungal infections, halitosis, dysgeusia, impaired chewing and swallowing, and difficulty tolerating dentures [6]. Dental caries and periodontal disease are the most common oral health problems in older adults, and managing these issues is critical to maintaining adequate oral function and the overall quality of life in older adults.

Oral medicine professionals are experts in managing dry mouth and associated oral conditions, such as oral candidiasis and burning mouth syndrome. However, dental caries prevention is often overlooked in clinical practice. Regular visits, professionally applied fluoride, home-use fluoride products, and dietary advice are the primary defense against the disease. The use of topical fluorides in patients with salivary gland hypofunction (SGH) is crucial for preventing dental caries.

This clinical review aims to update our knowledge on the use of fluoride to prevent dental caries and to provide better strategies for the management of dry mouth in older adults.

## CAUSES AND DIAGNOSIS OF DRY MOUTH

Dry mouth presents as xerostomia, a subjective sensation of oral dryness, or SGH, defined as an objective reduction in salivary flow. Xerostomia is diagnosed by questioning individuals about their dry mouth symptoms, while SGH

can be determined through objective measures of saliva production [7]. The causes of dry mouth encompass commonly prescribed medications, radiation therapy, oncologic chemotherapy, malnutrition, psychological factors, and systemic diseases such as Sjögren's syndrome, sarcoidosis, graft-versus-host disease, diabetes mellitus, hepatitis C virus infection, human immunodeficiency virus infection, and thyroid disease [6]. Medication-induced dry mouth is the most prevalent type, with a greater risk linked to several medications, resulting in increased anticholinergic burden [7]. Medication-induced xerostomia and SGH are increasingly prevalent oral health concerns in older and geriatric patients due to the high prevalence of medication intake and polypharmacy in this age group [8].

The evaluation of dry mouth necessitates a comprehensive past and present medical history, oral examination, and salivary function assessment. A positive response to questions about using liquids to aid in swallowing dry food, feeling dryness while eating, or experiencing difficulties swallowing food has been linked to SGH, even in those without xerostomia [9]. Clinicians should inspect and palpate the major salivary glands during oral and extra-oral examinations for tenderness, swelling, or lumps.

Measurement of the salivary flow rate is essential for the diagnosis of xerostomia. Unstimulated whole salivary rates below  $<0.1$  mL/min and stimulated whole salivary rates below  $<0.5$ – $0.7$  mL/min are considered abnormally low and indicate marked SGH; unstimulated whole salivary rate is the most valuable indicator [10]. Laboratory studies are recommended when systemic disease-related dry mouth is suspected. Minor salivary gland biopsy is a useful diagnostic tool for identifying pathological changes associated with SGH.

## DRY MOUTH AND DENTAL CARIES IN OLDER ADULTS

Persistent dry mouth can cause rapid tooth loss due to an increased risk of dental caries and erosion [7]. Reduced salivary flow and buffering capacity can lead to plaque retention and acidic pH, thereby increasing the risk of dental caries. Studies have revealed that individuals with dry mouths show significantly higher mean numbers of decayed,

missing, and filled permanent teeth [11,12]. Among younger adults, anticholinergic exposure and medication-induced xerostomia have been linked to dental caries [13].

Additional factors contributing to the susceptibility to dental caries among older adults include attachment loss, dry mouth, dental restorations, polypharmacy, frailty, functional disability, and cognitive impairment [14,15]. The continued use of medications that cause dry mouth can escalate the risk of tooth loss in this population [16]. A study conducted in Oslo reported irregular dental visits and SGH as the most significant risk factors for dental caries in 65-year-olds [17]. Dental caries caused by dry mouth often appears in atypical locations, such as the incisal surfaces of anterior teeth, cusp tips, and root surfaces. Surveys suggest that older adults have a much higher rate of root surface caries compared to other adult age groups [18]. The prevalence of root caries is increased in the older population due to notable predisposing factors, such as periodontal status and comorbidities related to aging [15].

## FLUORIDE

Fluoride, an inorganic monatomic anion of fluorine, was serendipitously discovered to effectively prevent dental caries in the early 1900s. Numerous residents in Colorado, USA, experienced brown spots on their teeth. After conducting an epidemiological investigation, it was revealed that the drinking water in the region contained an excessive concentration of fluoride, resulting in a significantly reduced incidence of dental caries [19]. Thus, higher fluoride levels correlate with a lower incidence of dental caries [19].

The caries-preventive effects of fluoride are mainly exerted when applied topically because it restrains the demineralization of enamel crystals within the tooth, supports remineralization on the tooth surface, and hinders bacterial metabolism [20]. After application, fluoride may combine with hydroxyapatite within the tooth structure to create fluorapatite or form calcium fluoride deposits in the dental plaque. Fluorapatite reinforces the tooth structure and increases the resistance to bacterial acids. Calcium fluoride dissociates slowly in the presence of these acids, and the constant supply of low fluoride levels in saliva and the dental biofilm is most beneficial in preventing dental caries [20].

Many studies have been published showing that applications of fluoride are effective in preventing dental caries [21-33]. Most studies have demonstrated the effectiveness of fluoride in preventing dental caries in children and adolescents [22-29], with relatively fewer studies in older populations [30-33]. Evidence of the effectiveness of fluoride in preventing dental caries has led to the implementation of oral health policies using fluoride throughout the world [34].

There are various methods of applying fluorides, such as community water fluoridation, fluoride tablets, fluoride salt, fluoride milk for consumption, fluoride toothpaste, and fluoride mouth rinse solution for self-application; professionally applied topical methods, such as fluoride varnish and fluoride gel, are also available [21].

### 1. Water Fluoridation

Water fluoridation is a cost-effective public health intervention that significantly reduces the severity and occurrence of dental caries [23]. It is the only oral health improvement intervention that does not require individual behavior change, irrespective of age or sex. The optimal fluoride concentration in water for caries prevention is 1 mg per liter or 1 ppm. Community water fluoridation began in the USA in 1945 [19] and commenced in South Korea in 1981 at a concentration of 0.7-0.8 ppm. Nevertheless, a lack of public consent led to the discontinuation of water fluoridation across South Korea in 2018.

### 2. Fluoride Toothpaste

Fluoride toothpaste is the most commonly used system to deliver fluoride, and the World Dental Federation recommends using toothpaste with fluoride concentrations ranging between 1,000 and 1,500 ppm twice daily [35]. Substantial evidence indicates that toothpastes with  $\geq 1,000$  ppm fluoride can prevent dental caries in primary and permanent teeth [24]. Studies have demonstrated that toothpastes with 1,500 ppm fluoride are more efficient in preventing dental caries than those with 1,000 ppm fluoride [36,37].

It is advised to brush the teeth twice a day and rinse the mouth with minimal use of water after spitting out the fluoride toothpaste. Patients should rinse before brushing their teeth and brush before going to bed. The effectiveness of

fluoride toothpaste depends on its fluoride concentration, not on the amount used [21]. Thus, it is recommended to use only a pea-sized amount of toothpaste for brushing [38].

### 3. Fluoride Varnish

Fluoride varnish is a potent choice for topical fluoride application because it adheres to the enamel surface for prolonged periods and acts as a fluoride reservoir [25]. Evidence suggests that biannual applications significantly decrease dental caries by 37% in primary teeth and 43% in permanent teeth among children and adolescents [26]. While many studies have focused on children and adolescents, it is equally important to consider the use of fluoride varnish in high-risk adults, specifically older individuals and those with dry mouth [31,39,40]. Research has shown that fluoride varnish can potentially prevent and reverse root caries, particularly noncavitated lesions in patients with xerostomia [40].

It is recommended that individuals at high-risk receive a 2.26% fluoride varnish treatment every 3-6 months. After application, they should refrain from eating for 2-4 hours and stick to a soft diet. It is advised to avoid hot foods, sodas, toothbrushing, dental floss, or any alcohol-containing solutions for 4-24 hours.

### 4. Fluoride Gel

The application of acidulated phosphate fluoride (APF) gel with a fluoride concentration of 1.23% considerably decreased the occurrence of dental caries in both primary and permanent teeth [27]. Nonetheless, the gel's popularity has waned due to the ease of fluoride varnish application.

Gels are applied using a gel tray for about four minutes. The frequency of application can be up to four times annually, depending on the individual's risk level. When administering the fluoride gel, it is imperative to ensure that the patient does not swallow it. Clinicians instruct the patient to sit in an upright position, apply the gel to one arch at a time, use suction throughout the procedure, and ask the patient to spit out any remaining gel when finished.

### 5. Fluoride Mouthrinse

Commercially available mouth rinses for daily use generally contain 100-500 ppm fluoride. A fluoride mouth rinse

with 900 ppm fluoride is employed in weekly programs for children in schools or institutionalized older adults with a high prevalence of caries. According to a Cochrane review, regular use of a fluoride mouth rinse under supervision in children and adolescents reduced caries increment in permanent teeth [28].

Several public health clinics in South Korea run a program for mouth rinsing with a fluoride solution. The fluoride solution contains 0.05% sodium fluoride (NaF) (225 ppm fluoride) for once-daily use and 0.2% NaF (900 ppm fluoride) for once-weekly use. It is recommended not to use a fluoride mouth rinse and toothpaste at the same time; using the mouth rinse at a different time will help maintain the intraoral fluoride levels [21].

## 6. Silver Diamine Fluoride (SDF)

SDF has been used as a therapeutic agent to arrest cavitated carious lesions, particularly in areas with limited accessibility to dental care [29]. An investigation revealed that SDF proves efficient in arresting root caries in older adults [32]. Systematic reviews have demonstrated that the annual application of a 38% SDF solution and oral hygiene education are most effective for preventing root caries [33]. However, SDF has an aesthetic issue because it causes black stains on the carious lesions and the adjacent gingiva. Recently, new products have been introduced to overcome this disadvantage [41].

## RECOMMENDATIONS FOR PREVENTING DENTAL CARIES IN OLDER ADULTS WITH DRY MOUTH

The clinically recommended methods for applying topical fluoride to prevent dental caries in high-risk individuals include the application of a 2.26% fluoride varnish or a 1.23% APF gel; alternatively, the use of a home-use 0.5% fluoride gel or paste, or a 0.09% fluoride mouth rinse has been advised by the American Dental Association [42]. A systematic review demonstrated the effectiveness of a 2.26% fluoride varnish, 38% SDF solution, and 1.23% APF gel among professionally applied fluoride methods in preventing root caries in older adults, with no single method proving superiority [32]. In clinical settings, the selected method depends

on the ease of application and the patient's preference.

Counseling for older adults with dry mouth should prioritize the elimination of foods with high levels of simple sugars and discourage the use of medications containing sugar. Regular dental visits are recommended, and dental caries prevention should be emphasized based on current research. Fluoride can be applied using the following methods:

A fluoride toothpaste with a fluoride concentration of approximately 1,500 (1,350-1,450) ppm.

Rinse daily with a 0.05% NaF (225 ppm fluoride) solution once a day at home.

Biannual application of a 2.26% fluoride varnish with a frequency adjustment based on the individual's risk.

## CONCLUSION

It is crucial to preserve the oral health over longer periods, particularly considering the increase in the life expectancy of the older population. Preventing dental caries through fluoride application and managing dry mouth are of utmost importance to preserve adequate oral function and enhance the overall quality of life in older adults. Most of the previously published studies on the caries prevention effect of fluoride have been conducted in children and adolescents. Evidence for the effect of fluoride in preventing dental caries in the older population is limited. Thus, additional studies evaluating this effect in the older population are warranted.

## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

## DATA AVAILABILITY STATEMENT

The datasets used in this study are available from the corresponding author upon reasonable request.

## FUNDING

This study was supported by Wonkwang University in 2023.

## REFERENCES

- Korean Statistical Information Service (KOSIS). Future population estimation [Internet]. Statistics Korea; 2024 [cited 2024 Mar 4]. Available from: <https://kosis.kr/search/search.do>
- Ship JA, Pillemer SR, Baum BJ. Xerostomia and the geriatric patient. *J Am Geriatr Soc* 2002;50:535-543.
- Agostini BA, Cericato GO, Silveira ER, et al. How common is dry mouth? Systematic review and meta-regression analysis of prevalence estimates. *Braz Dent J* 2018;29:606-618.
- Thomson WM, Poulton R, Broadbent JM, Al-Kubaisy S. Xerostomia and medications among 32-year-olds. *Acta Odontol Scand* 2006;64:249-254.
- Benn AM, Broadbent JM, Thomson WM. Occurrence and impact of xerostomia among dentate adult New Zealanders: findings from a national survey. *Aust Dent J* 2015;60:362-367.
- Bowers LM, Fox PC, Brennan MT. Salivary gland disease. *Burket's Oral Medicine*. 12nd ed. PMPH Ltd.; 2014. pp. 219-262.
- Thomson WM. Dry mouth and older people. *Aust Dent J* 2015;60 Suppl 1:54-63.
- Barbe AG. Medication-induced xerostomia and hyposalivation in the elderly: culprits, complications, and management. *Drugs Aging* 2018;35:877-885.
- Fox PC, Busch KA, Baum BJ. Subjective reports of xerostomia and objective measures of salivary gland performance. *J Am Dent Assoc* 1987;115:581-584.
- Navazesh M, Christensen C, Brightman V. Clinical criteria for the diagnosis of salivary gland hypofunction. *J Dent Res* 1992;71:1363-1369.
- Kongstad J, Ekstrand K, Qvist V, et al. Findings from the oral health study of the Danish health examination survey 2007-2008. *Acta Odontol Scand* 2013;71:1560-1569.
- Iwasaki M, Yoshihara A, Ito K, et al. Hyposalivation and dietary nutrient intake among community-based older Japanese. *Geriatr Gerontol Int* 2016;16:500-507.
- Kakkar M, Caetano de Souza Valentim E, Barmak AB, Arany S. Potential association of anticholinergic medication intake and caries experience in young adults with xerostomia. *J Dent Sci* 2023;18:1693-1698.
- Saunders RH Jr, Meyerowitz C. Dental caries in older adults. *Dent Clin North Am* 2005;49:293-308.
- Gavriilidou NN, Belibasakis GN. Root caries: the intersection between periodontal disease and dental caries in the course of ageing. *Br Dent J* 2019;227:1063-1067.
- Edman K, Öhrn K, Nordström B, Holmlund A. Prevalence of dental caries and influencing factors, time trends over a 30-year period in an adult population. Epidemiological studies between 1983 and 2013 in the county of Dalarna, Sweden. *Acta Odontol Scand* 2016;74:385-392.
- Diep MT, Skudutyte-Rysstad R, Sødal ATT, Young A, Hove LH. Caries experience and risk indicators of having decayed teeth among 65-year-olds in Oslo, Norway: a cross-sectional study. *BMC Oral Health* 2023;23:726.
- López R, Smith PC, Göstemeyer G, Schwendicke F. Ageing, dental caries and periodontal diseases. *J Clin Periodontol* 2017;44 Suppl 18:S145-S152.
- Mullen J. History of water fluoridation. *Br Dent J* 2005;199:1-4.
- Rošin-Grget K, Peroš K, Sutej I, Bašić K. The cariostatic mechanisms of fluoride. *Acta Med Acad* 2013;42:179-188.
- O'Mullane DM, Baez RJ, Jones S, et al. Fluoride and oral health. *Community Dental Health* 2016;33:69-99.
- Pollick H. The role of fluoride in the prevention of tooth decay. *Pediatr Clin North Am* 2018;65:923-940.
- Iheozor-Ejiofor Z, Worthington HV, Walsh T, et al. Water fluoridation for the prevention of dental caries. *Cochrane Database Syst Rev* 2015;2015:CD010856.
- Walsh T, Worthington HV, Glenny AM, Marinho VC, Jeroncio A. Fluoride toothpastes of different concentrations for preventing dental caries. *Cochrane Database Syst Rev* 2019;3:CD007868.
- Øgard B, Seppä L, Rølla G. Professional topical fluoride applications clinical efficacy and mechanism of action. *Adv Dent Res* 1994;8:190-201.
- Marinho VCC, Worthington HV, Walsh T, Clarkson JE. Fluoride varnishes for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev* 2013;7:CD002279.
- Marinho VCC, Worthington HV, Walsh T, Chong LY. Fluoride gels for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev* 2015;6:CD002280.
- Marinho VCC, Chong LY, Worthington HV, Walsh T. Fluoride mouthrinses for preventing dental caries in children and adolescents. *Cochrane Database Syst Rev* 2016;7:CD002284.
- dos Santos VE, de Vasconcelos FM, Ribeiro AG, Rosenblatt A. Paradigm shift in the effective treatment of caries in school children at risk. *Int Dent J* 2012;62:47-51.
- Griffin SO, Regnier E, Griffin PM, Huntley V. Effectiveness of fluoride in preventing caries in adults. *J Dent Res* 2007;86:410-415.
- Tan HP, Lo EC, Dyson JE, Luo Y, Corbet EF. A randomized trial on root caries prevention in elders. *J Dent Res* 2010;89:1086-1090.
- Chan AKY, Tamrakar M, Jiang CM, Tsang YC, Leung KCM, Chu CH. Clinical evidence for professionally applied fluoride therapy to prevent and arrest dental caries in older adults: a systematic review. *J Dent* 2022;125:104273.
- Zhang J, Sardana D, Li KY, Leung KCM, Lo ECM. Topical fluoride to prevent root caries: systematic review with network meta-analysis. *J Dent Res* 2020;99:506-513.
- Whelton HP, Spencer AJ, Do LG, Rugg-Gunn AJ. Fluoride revolution and dental caries: evolution of policies for global use. *J Dent Res* 2019;98:837-846.
- FDI World Dental Federation. Promoting oral health through fluoride toothpaste: Adopted by the FDI General Assembly: 7 September 2018, Buenos Aires, Argentina Original version adopted by the FDI General Assembly: November 2000, Paris, France. *Int Dent J* 2019;69:17-18.
- O'Mullane DM, Kavanagh D, Ellwood RP, et al. A three-year clinical trial of a combination of trimetaphosphate and sodium fluoride in silica toothpastes. *J Dent Res* 1997;76:1776-1781.
- Kim AO, Jeong SS, Kim DE, et al. Remineralisation effect of 1,500 ppm fluoride-containing toothpaste in enamel early caries lesion.

- J Korean Acad Oral Health 2016;40:270-276.
38. Parnell C, O'Mullane D. After-brush rinsing protocols, frequency of toothpaste use: fluoride and other active ingredients. *Monogr Oral Sci* 2013;23:140-153.
  39. Jabir E, McGrade C, Quinn G, et al. Evaluating the effectiveness of fluoride varnish in preventing caries amongst long-term care facility residents. *Gerodontology* 2022;39:250-256.
  40. Sleibi A, Tappuni AR, Baysan A. Reversal of root caries with casein phosphopeptide-amorphous calcium phosphate and fluoride varnish in xerostomia. *Caries Res* 2021;55:475-484.
  41. Detsomboonrat P, Thongmak P, Lertpayab P, Aiemsri W, Sooampon S. Optimal concentration of potassium iodide to reduce the black staining of silver diamine fluoride. *J Dent Sci* 2022;17:300-307.
  42. Weyant RJ, Tracy SL, Anselmo TT, et al; American Dental Association Council on Scientific Affairs Expert Panel on Topical Fluoride Caries Preventive Agents. Topical fluoride for caries prevention: executive summary of the updated clinical recommendations and supporting systematic review. *J Am Dent Assoc* 2013;144:1279-1291.