

Feature Article

Xylitol

Xylitol and Dental Caries: An Overview for Clinicians

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abstract

*An overview of studies about xylitol and dental caries suggests potential clinical dental applications for xylitol. Xylitol is a naturally occurring, low-calorie sugar substitute with anticariogenic properties. Data from recent studies indicate that xylitol can reduce the occurrence of dental caries in young children, schoolchildren, and mothers, and in children via their mothers. Xylitol, a sugar alcohol, is derived mainly from birch and other hardwoods trees. Short-term consumption of xylitol is associated with decreased *Streptococcus mutans* levels in saliva and plaque. Aside from decreasing dental caries, xylitol may also decrease the transmission of *S. mutans* from mothers to children. Commercial xylitol-containing products may be used to help control rampant decay in primary dentition. Studies of schoolchildren in Belize and Estonia, along with data from the University of Washington, indicate that xylitol gum, candy, ice pops, cookies, puddings, etc., in combination with other dental therapies, are associated with the arrest of carious lesions. A prospective trial in Finland has demonstrated that children of mothers treated with xylitol had lower levels of *S. mutans* than children of mothers treated with chlorhexidine or fluoride varnish. Food products containing xylitol are available commercially and through specialized manufacturers, and have the potential to be widely accessible to consumers.*

The infectious nature of dental caries and its vertical mode of transmission from mother to child have led to interest in interventions that can interrupt the disease process or prevent its initiation. To this end, xylitol, a naturally occurring sugar substitute with anticariogenic properties, has been a focus of scientific inquiry for several decades. The purpose of this paper is to present an overview of what is currently known about xylitol and dental caries, and to list xylitol's potential clinical applications in the prevention of decay. Current application for dental practice and potential community-based public health interventions are discussed.

Sugar Alcohols

Xylitol is a sugar substitute with sweetness equal to that of table sugar.¹ It is a member of the group of compounds known as sugar alcohols, which includes other common dietary sweeteners

such as sorbitol and mannitol. Xylitol is produced commercially from birch trees and other hardwoods containing xylan. It can also be found in small quantities in fruits and vegetables. In contrast, sorbitol, commonly found in sugar-free products such as chewing gum, candies, and toothpaste, is less sweet than sucrose and is generally combined with other sweeteners such as saccharine or aspartame as well as xylitol to improve the flavor of the product.

Xylitol contains 40 percent fewer calories than sucrose. Because xylitol is absorbed slowly by the human gastrointestinal tract, the main side effect associated with its consumption is osmotic diarrhea. This usually occurs only when xylitol is consumed in large quantities, four to five times those needed for the prevention of dental caries.^{2,3} This side effect is common to all sugar alcohols.

Xylitol and *Streptococcus mutans*

Microorganisms do not readily metabolize xylitol, and its consumption has minimal effect on plaque pH.⁴ However, xylitol does accumulate intracellularly in *S. mutans*. This accumulation inhibits the bacteria's growth. This has been demonstrated in-vitro and may contribute to a reduction of *S. mutans* levels in the plaque and saliva of those consuming xylitol.⁵ In addition, xylitol has a number of effects on *S. mutans* that may account for some of its clinical effects in caries reduction. Short-term consumption of xylitol is associated with decreased *S. mutans* levels in both saliva and plaque.⁵ Long-term habitual consumption of xylitol appears to have a selective effect on *S. mutans*, resulting in selection for populations less adherent to tooth surfaces. These colonies, therefore, are shed more easily from plaque into saliva.⁶ This effect may not only be important to the individual's decay experience, but may also influence the transmission of *S. mutans* from mothers who consume xylitol to their children.

Clinical Applications

Children at High Risk for Caries

There are surprisingly few well-studied strategies available to clinicians to prevent and control high rates of caries in the primary dentition. In the absence of water fluoridation, fluoridated toothpaste and topical fluoride varnish are the mainstays in the United States. For older children, sealants are added to the regimen. Effective strategies to reduce risk by modifying the diet of children are not readily applicable to dental practice, nor are they typically effective without significant effort. As a result, the use of xylitol is particularly attractive because its action is not dependent upon reducing the amount of other sugars in the diet. Thus, a clinician can recommend adding xylitol to the diet without asking patients to make additional alterations to their dietary patterns. Xylitol-containing products have the potential to improve success in controlling the problem of rampant decay in the primary dentition.

A number of studies conducted among schoolchildren of various ages have shown that consumption of gum containing xylitol reduces the rates of dental decay in the treatment groups (relative risks ranging from 0.27 to 0.56). Increasing use and higher doses lead to greater reductions.⁷ One study conducted among schoolchildren in Belize with very high rates of dentine caries showed that consumption of xylitol gum was associated with arrest of carious lesions and, as expected, that the highest dose of xylitol had the greatest effect. The number of lesions that rehardened ranged from 9 percent to 27 percent in all groups and from 12 percent to 27 percent in the 100 percent xylitol groups.⁸ This study is important because the children continued to consume very high levels of sucrose in their everyday diet. However, a major

limitation in extending these results to the United States is that chewing gum is not considered safe for very small children and is actively discouraged in schools.

Other xylitol-containing products have been studied. A field trial of the use of xylitol-containing candies among 10-year-old schoolchildren in Estonia showed a 33 percent to 59 percent caries reduction in the groups using the candies and a 53.5 percent caries reduction in the group using the gum relative to the control group. This suggests that candy may be as effective as chewing gum as a vehicle for the delivery of xylitol in caries prevention.⁹ At the University of Washington, researchers have produced and field tested xylitol-containing ice pops, chewy worms, puddings, macaroons, and sorbet.¹⁰ They have initiated studies that suggest that children will fairly readily accept such foods when offered as part of the daily diet and that they suffer no side effects from their use.^{10,11} Food producers are available to develop these foods, but considerable work is needed to produce commercially viable products and have them accepted.

According to available data, there is no vehicle in the United States for using xylitol in toddlers and preschool children too young to chew gum. In older children, four to five pellets or sticks (1 gram of xylitol per pellet or stick) of xylitol gum per day, chewed for five minutes, should reduce dental caries activity. [PETER – do you have the reference for this recommendation?] Xylitol, approved by the Food and Drug Administration, has been used as a sweetener in foods since the 1960s.¹² It is safe for use with children.³ The use of fluoridated toothpaste, topical fluorides, and sealants should also be encouraged.

Pregnant Women and New Mothers

Kohler and colleagues demonstrated that the combination of good dental care, instruction to improve oral hygiene, and chlorhexidine gels and toothpastes led to reductions in maternal *S. mutans* levels and reduction in the extent of transmission to the child.¹³ More recently, Hildebrandt and colleagues showed that the use of commercially available chlorhexidine rinses for two weeks followed by the daily use of xylitol gum (two pellets containing 1.7g xylitol) in high-caries-rate adults with recent restorations led to major reductions in *S. mutans*.¹⁴

A clinical trial comparing the effects of strategies to modify the maternal transmission of *S. mutans*, conducted in Finland, demonstrated that xylitol had the greatest effect.¹⁵ The mothers, all of whom had high *S. mutans* levels at the beginning of the study, were treated with either chlorhexidine varnish or fluoride varnish or 100 percent xylitol gum (65 percent xylitol by weight, chewed at least two to three times per day) for 18 to 21 months. The outcome measures were decay rates among the children and *S. mutans* levels in both the mothers and the children. The children of mothers treated with xylitol had the lowest levels of *S. mutans* during the intervention period (treatment continued until the child was 2 years old) and during followup.¹⁶ The percentage of colonization with *S. mutans* in the children in the xylitol group at 2 years old was 9.7 percent. This was statistically different from the other two groups, in which 28.6 percent were colonized in the chlorhexidine group and 48.5 percent in the fluoride group.¹⁷ These children were followed up most recently at 6 years old and were found still to have the lowest *S. mutans* levels (51.6 percent were colonized in the xylitol group vs. 83.9 percent in the fluoride group and 86.4 percent in the chlorhexidine group).¹⁶ Children of mothers treated with xylitol also had the lowest rates of decay. Followup at 5 years of age found that dentinal caries among children in the xylitol group was reduced by 70 percent as compared with children in the fluoride or chlorhexidine groups.¹⁵

These studies have been conducted only in settings in which child rearing is done primarily by the mother and in which mother-to-child transmission is presumed. No studies have been completed in communities where child rearing is shared among greater numbers of people. The use of xylitol gum by mothers as well as other family members is currently being investigated in one such community.¹⁸

Whether used alone or in combination with other antimicrobial therapies such as chlorhexidine, xylitol has an important role in the prevention of dental decay among children born to mothers with high levels of *S. mutans* not only because of its effects on *S. mutans* levels and bacterial properties during the period of consumption, but also because its beneficial effect on decay reduction in these children appears to persist far beyond the period of consumption.¹⁶ Both chlorhexidine and xylitol may be used safely by pregnant women and nursing mothers.^{19,20} Currently available data suggest that twice daily use of chlorhexidine gluconate rinse (0.12 percent) for two weeks, followed by four to five sticks or pellets of xylitol gum per day chewed for five minutes each time, should lead to a major reduction in *S. mutans* levels in the mother and should benefit the child. In very high-risk individuals, follow-up periods of chlorhexidine use may also be beneficial.

Xylitol Products Available in the United States

Food products containing xylitol, including chewing gums and mints, are available commercially in retail consumer settings and through specialized manufacturers (See table). Products containing 100 percent xylitol are generally available through specialized manufacturers such as Advantage International, Inc., which makes Clén*Dent chewing gum and Tundra Trading, Inc., which makes Xylichew products, including chewing gum and mint candies. There is no scientific evidence available to establish the value of xylitol-containing nasal sprays or xylitol-sweetened children's vitamins in preventing dental caries.

Despite the limitations of the current literature, there is sufficient evidence for clinicians to consider including xylitol-containing products in their clinical armamentarium for the prevention of dental decay in high-risk populations. Xylitol's favorable side-effect profile, its benefits as a sugar substitute in other areas of health, and its potential to be widely accessible to the general population through retail vendors add to its utility and applicability.

Table Products Containing Xylitol in the U.S. Market			
Bars	Confections	Oral Hygiene	Health Care
Atkins - Diet Advantage Bar	Brown & Halay - Zingos Peppermints	Biotene - Oral Balance	B&T - Echina Spray
Biochem - LoCarb 2 Energy Bar	EcoDent - Between Dental Gum	Crest - Multicare Toothpaste	Bayer - Flintstone Vitamins
Country Life - Ultimate LoCarb 2	Ford Gum - Extreme Sugarfree Gums	Gerber - Tooth & Gum Cleanser	Natures Life - Sugarless Chews
Richardson Labs - Carb Solutions	Godiva Chocolate - Holiday Truffles	Rambrandt - Canker Pain Relief Kit	Nicorette - Gum Extension
	Health-Tech - Ice Chunk Mints	Rambrandt - Dazzling Beathdrops	Shiseido - Gentle Clean Soap
	Leaf - Xylifresh 100 Cinnamon	Rambrandt - Natural Oral Care Line	Shiseido - Moisturizing Lipstick
	Nabisco - Carefree Koolerz Gum	Tom's Maine - Baking Soda Line	Shiseido - Purifying Mask
	Naturesmart - Xyl chew Gum	Tom's of Maine - Sensitive Toothpaste	Shiseido - Skincare
	Naturesmart - Xyl chew Licorice Gum		
	Naturesmart - Xyl chew Mints		
	Scanlab - V6 Dental Chewing Gum		
	Schuster Marketing - Blitz Power Mints		
	Simply Life - Sweet 'N Low Mint Patty		
	Tic Tac - Silvers		
	Warner-Lambert - Trident Advantage		
	Warner-Lambert - Trident for Kids		
	Wrigley - Everest Mint Gum		
	Wrigley - Stay Alert Gum		
	Wrigley - Sugarfree Gum		

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