Title: Xylitol Position Paper

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Abstract

The purpose of this paper is to provide a balanced, evidence-informed review of xylitol from a biological dentistry perspective. It will evaluate both the proposed benefits and the limitations of xylitol while integrating current scientific literature, emerging controversies, and broader oral-systemic health considerations.

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1. Introduction

Xylitol is a 5-carbon sugar alcohol commonly used as a sugar substitute in foods, chewing gums, oral healthcare products, pharmaceuticals, and nutritional products. It occurs naturally in small amounts in fruits, vegetables and oats, but synthetic forms are usually over 1000-fold higher than found in nature (Witkowski, 2024). It also occurs naturally in certain plant fibers and is also produced endogenously within the human body through normal carbohydrate and glucose metabolism via the glucoronate pathway (Sato et al., 2022).

Interest in xylitol expanded significantly during the late twentieth century. Early Finnish studies suggested reduced caries incidence among xylitol users (Mäkinen, 2004). Xylitol has been used as sugar substitute since 1963 (ALHumaid, 2022). As preventive dentistry gained popularity, xylitol became widely incorporated into sugar-free chewing gums and oral healthcare products marketed for cavity prevention. Today, xylitol is commonly included in chewing gums, mints, toothpaste, mouth rinses, syrups, lozenges, and nasal sprays marketed for oral and respiratory health support.

Over the past several decades, xylitol has become increasingly popular within dentistry because of its proposed anti-caries properties and its inability to be readily fermented by cariogenic oral

bacteria (Mäkinen, 2004). Xylitol is a naturally occurring sugar alcohol chemically classified as a pentitol, containing five carbon atoms and possessing a sweetness comparable to sucrose while providing fewer calories and a reduced glycemic impact (Livesey, 2003). Unlike sucrose, xylitol is not readily metabolized into acids by most oral bacteria, a characteristic that has contributed to its widespread incorporation into preventive dentistry and sugar-free oral healthcare products (Mäkinen, 2004). However, growing scientific debate has emerged regarding the extent of xylitol's benefits, the quality of the evidence, manufacturing considerations, gastrointestinal tolerance, and potential systemic implications (Witkowski et al., 2024).

2. Potential Oral Health Benefits

2.1. Dental Caries Prevention

One of the most widely studied applications of xylitol is dental caries prevention (da Silva et al., 2022). Several systematic reviews and clinical trials have reported reductions in caries incidence associated with regular xylitol use, particularly when used multiple times daily (approximately 5-10 grams) in chewing gum or syrup formulations (Milgrom et al., 2006; Campus et al., 2017; da Silva et al, 2022).

Some studies involving children and high-caries-risk adults demonstrated reductions in early lesions and overall caries experience associated with xylitol-containing gum and syrups (Milgrom et al., 2006; Cocco et al., 2024). A systematic review on the effects of xylitol chewing gums and candies in children and adolescents found caries reducing effects in individuals with moderate to high caries level (Pienihäkkinen, 2024). The study also found that xylitol gum use could benefit people with active incipient caries lesions on smooth tooth surfaces (Pienihäkkinen, 2024).

2.2. Potential Oral Microbiome Effects

One proposed mechanism of xylitol involves its interaction with *Streptococcus mutans*, a bacterium strongly associated with dental caries development (Söderling et al., 2025). Unlike fermentable sugars such as sucrose, xylitol cannot be efficiently metabolized by *S. mutans* into usable energy, which can reduce bacterial growth and decrease acid production within dental plaque (Mäkinen, 2004). Because acid production by cariogenic bacteria contributes significantly to enamel demineralization and caries progression, this inability to effectively ferment xylitol has been proposed as one of the primary mechanisms underlying its anticariogenic potential.

Several studies have reported reduced levels of *S. Mutans* in saliva and plaque among individuals regularly using xylitol-containing products (Hayes, 2001; Söderling et al., 2025). Research has also suggested that xylitol may reduce bacterial adhesion to tooth surfaces and alter oral biofilm composition, potentially making the oral environment less favorable for highly acidogenic and cariogenic bacterial species. Xylitol has been found to lower *S. mutans* levels in both saliva and plaque while reportedly having minimal impact on the overall balance of normal oral flora (AL-Humaid, 2022). Although the precise mechanisms continue to be investigated, it is believed that

xylitol can contribute to reduced bacterial lactic acid production and interfere with bacterial metabolic pathways involved in plaque formation and cariogenicity.

Emerging microbiome research further suggests that xylitol exposure can be involved in influence bacterial signaling pathways, plaque biofilm architecture, and microbial adhesion patterns in ways that are not yet fully understood. Given the complexity of the oral microbiome, several researchers have proposed that xylitol may help create ecological conditions less favorable for dominance by acid-producing bacteria, thereby potentially supporting a healthier oral microbial balance. A systematic review additionally concluded that xylitol gum chewing may serve as a useful adjunct to toothbrushing by helping reduce caries-associated bacteria such as *S. mutans* and decreasing plaque accumulation, potentially contributing to caries prevention in both children and adults (Söderling et al., 2025).

2.3. Salivary Flow and Dry Mouth Support

Chewing xylitol-containing gum stimulates salivary flow, which may benefit individuals experiencing xerostomia or dry mouth symptoms (Mäkinen, 2004; Ahuja, 2020). Saliva plays a critical role in maintaining oral health by buffering acids, supporting enamel remineralization, regulating oral pH, facilitating digestion, lubricating oral tissues, and helping maintain microbial balance within the oral cavity. Increased salivary flow has been associated with improved oral comfort, reduced plaque accumulation, decreased oral acidity, and enhanced mechanisms for cleansing the mouth naturally.

Research has also explored the role of xylitol-containing products in managing radiation-induced xerostomia. In a single-arm study involving 40 patients with radiation-induced dry mouth, use of Xerostom oral care products, including toothpaste, mouthrinse, spray, and gel containing xylitol, olive oil, and betaine, was associated with improvements in all measured quality-of-life scores, with statistical significance achieved in 7 of 15 evaluated domains (Martin et al., 2017). The study additionally demonstrated a 45% increase in salivary flow compared with baseline measurements. These findings suggest that xylitol-containing formulations may provide supportive benefits for individuals suffering from xerostomia, particularly in medically compromised populations.

2.4. Potential Remineralization Support

Some researchers have proposed that xylitol may indirectly support remineralization by reducing acid production within dental plaque and improving salivary conditions favorable for calcium and phosphate deposition onto enamel surfaces (da Silva et al., 2022). Because xylitol is not readily fermented by cariogenic bacteria into acids, oral pH is able to remain more stable following xylitol exposure compared with fermentable carbohydrates such as sucrose (Mäkinen, 2004). Maintaining a less acidic oral environment is important because demineralization of enamel occurs when plaque pH falls below critical levels, resulting in loss of calcium and phosphate from the tooth structure.

Xylitol-containing chewing gums and oral products has emerged as a potential factor in remineralization through stimulation of salivary flow. Saliva is supersaturated with calcium and phosphate ions and plays a central role in the natural remineralization process by buffering acids, delivering minerals to enamel surfaces, and facilitating repair of early non-cavitated lesions (Ahuja et al., 2020). Increased salivary flow associated with chewing xylitol gum may therefore enhance the oral environment's natural capacity for enamel repair and mineral redeposition.

Some studies have additionally suggested that xylitol may influence calcium ion transport and reduce the adherence of cariogenic biofilms that contribute to prolonged acidic conditions on tooth surfaces (Söderling, 2009). By reducing levels of Streptococcus mutans and decreasing lactic acid production, xylitol has been observed to create ecological conditions more favorable for remineralization and less favorable for continued enamel dissolution. Certain researchers have also proposed that xylitol-calcium complexes may assist in maintaining calcium availability within saliva and plaque fluid, although the clinical significance of this mechanism remains under investigation (Mäkinen, 2010).

2.5. Periodontal Disease

In addition to its proposed anti-caries effects, xylitol has also been investigated for its potential role in periodontal health. Periodontal disease is a chronic inflammatory condition initiated by dysbiotic bacterial biofilms that contribute to destruction of the supporting tissues of the teeth, including the gingiva, periodontal ligament, and alveolar bone (Kinane et al., 2017). Gram-negative periodontal pathogens release lipopolysaccharides (LPS), endotoxins that play a major role in periodontal inflammation by stimulating host immune responses and promoting the release of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α), interleukin-1β (IL-1β), and interleukin-6 (IL-6). Chronic exposure to LPS contributes to connective tissue breakdown, osteoclastic bone resorption, and progression of periodontal disease.

While xylitol is not considered a primary treatment for periodontal disease, emerging evidence suggests that may contribute to improved periodontal health through modulation of oral microbial composition, reduction of plaque accumulation, stimulation of salivary flow, and possible anti-inflammatory effects. Xylitol consumption has been found to reduce levels of plaque and gingival inflammation (Ahuja, 2020). Several studies have demonstrated that xylitol-containing chewing gums and oral products can reduce dental plaque accumulation and decrease levels of certain pathogenic oral bacteria associated with gingival inflammation (Mäkinen, 2010). Xylitol appears to interfere with bacterial adhesion and biofilm formation, limiting the ability of some microorganisms to colonize tooth and gingival surfaces (Söderling, 2009). Increased salivary flow stimulated by chewing xylitol gum has been proposed as a factor in supporting periodontal health by improving oral clearance, buffering plaque acids, and enhancing the delivery of protective salivary components such as immunoglobulins and minerals (Dodds et al., 1991).

Interest has also grown regarding the potential anti-inflammatory effects of xylitol in periodontal tissues. In a study by Yi et al. (2013), xylitol was shown to inhibit LPS-induced inflammatory cytokine expression. This suggests a possible modulatory effect on the host inflammatory response. Experimental findings demonstrated reductions in inflammatory mediators following

xylitol exposure, indicating that xylitol can potentially help attenuate cellular responses triggered by bacterial endotoxins. Additional in vitro and animal studies have similarly suggested that xylitol can be involved in reducing the production of inflammatory cytokines and oxidative stress associated with periodontal inflammation, although the precise mechanisms remain incompletely understood. These findings are of particular interest because excessive inflammatory signaling, rather than bacterial presence alone, is a key driver of periodontal tissue destruction.

Some clinical research has also suggested that habitual xylitol use is linked to the reduction of gingival inflammation and bleeding indices. A systematic review by Riley et al. (2015) found modest evidence supporting xylitol gum as an adjunctive measure for plaque and gingivitis reduction, although the quality and consistency of available studies varied considerably. Other investigations have reported reductions in inflammatory markers and periodontal pathogens when xylitol-containing products were incorporated into oral hygiene routines (Nayak et al., 2014).

2.6. Additional Possible Health Benefits

Emerging research has explored possible systemic benefits associated with xylitol beyond oral health applications. Preliminary studies have suggested possible effects on ear infections, yeast infections, gut microbial activity, nasopharyngeal pneumonia, metabolic regulation, collagen synthesis, and bone metabolism (Healthline, 2025; Salli et al., 2019; Ahuja, 2020).

2.6.1. Otitis Metia (Ear Infections)

Some pediatric studies have reported reduced incidence of acute otitis media among children regularly consuming xylitol-containing products. Xylitol has been found to reduce the adherence of acute otitis media (AOM), causing pathogens such as Streptococcus pneumoniae and Haemophilus influenzae to nasopharyngeal cells by 40% (Ahuja, 2020). Researchers have proposed that xylitol can play a role in the adhesion of certain respiratory pathogens to mucosal tissues, potentially reducing colonization and infection risk.

2.6.2. Collagen and Bone Density

Additional experimental studies have explored whether xylitol may influence collagen production and bone density. Certain animal studies have suggested improved bone mineralization and altered calcium metabolism associated with xylitol exposure, though these findings remain preliminary and require further human investigation (Mattila et al., 2002; Ainamo et al., 2002; Mäkinen, 2010)

2.6.3. *Candida Albicans*

Researchers have also examined xylitol's possible influence on oral fungal species such as *Candida albicans*. Some laboratory evidence suggests that xylitol can possibly reduce adhesion or growth of certain fungal organisms under specific conditions. However, clinical significance remains uncertain (Söderling & Hietala, 2010; Falony et al., 2009; Mäkinen, 2010)

2.6.4. Diabetes and Low-Glycemic Alternatives

Some practitioners have proposed that replacing refined sugar with lower-glycemic alternatives such as xylitol may help reduce glycemic fluctuations, insulin spikes, and inflammatory stress associated with excessive sugar intake. Xylitol has been approved by the FDA as a food additive and sweetener and is often viewed more favorably than refined sugar and some artificial sweeteners because of its lower glycemic effects and its potential ability to support oral health (Stuart, 2025). Unlike sucrose, xylitol has a negligible impact on blood glucose and insulin secretion, which has led to interest in its possible role in diabetes management and metabolic health support (Witkowski, 2024).

Some research has suggested that xylitol is capable of influencing carbohydrate metabolism through inhibition of carbohydrate-metabolizing enzymes, potentially slowing glucose absorption within the intestines and skeletal muscles (Ahuja, 2020). In one study, participants consuming xylitol over a five-week intervention period demonstrated reductions in body weight, blood glucose, and serum fructosamine levels compared with baseline measurements (Ahuja, 2020). These findings have contributed to growing interest in xylitol as a potentially more metabolically favorable sweetening alternative.

2.6.5. Gut Microbiome

There is also growing interest in the relationship between xylitol and the gut microbiome. Because portions of ingested xylitol undergo colonic fermentation, researchers have investigated whether xylitol may influence microbial diversity and production of beneficial short-chain fatty acids such as butyrate (Sato et al., 2022). Some authors have suggested potential prebiotic properties, although excessive intake may also provoke gastrointestinal symptoms in susceptible individuals.

3. Limitations and Concerns

3.1. Cardiovascular and Platelet Concerns

3.1.1. Overview of Emerging Research

A 2024 study published in the European Heart Journal reported an association between elevated plasma xylitol levels and an increased risk of major adverse cardiovascular events (Witkowski et al., 2024; Hazen, 2023). In addition to these epidemiological findings, Witkowski, Hazen, and colleagues observed increased platelet reactivity and thrombus formation in experimental settings, suggesting a potential mechanistic link between xylitol exposure and pro-thrombotic activity.

Specifically, the study found that higher circulating xylitol levels were associated with major adverse cardiovascular events at a three-year follow-up. Ex vivo analyses demonstrated that xylitol exposure increased multiple indices of platelet reactivity, while in vivo experiments in a mouse model showed enhanced thrombus formation and accelerated arterial blockage when xylitol levels were elevated (Witkowski, 2024; U.S. Department of Health and Human Services, 2024). To

further assess human platelet function, researchers collected blood samples from 10 healthy participants before and after consumption of a xylitol-sweetened beverage. Blood xylitol concentrations increased approximately 1,000-fold within 30 minutes of ingestion and returned to baseline within 4-6 hours. During periods of elevated xylitol concentration, platelets demonstrated heightened sensitivity to clotting signals, indicating a transient but measurable increase in platelet responsiveness (U.S. Department of Health and Human Services, 2024; Hazen, 2023).

The authors further noted that the study included over 3,000 participants across discovery and validation cohorts, strengthening the statistical robustness of the epidemiological findings. The convergence of human observational data, ex vivo platelet analyses, and animal models adds weight to the proposed association between xylitol exposure and thrombotic risk. These findings are particularly noteworthy given that xylitol is often recommended as a sugar alternative for individuals with diabetes and other metabolic conditions, populations that may already carry elevated baseline cardiovascular risk.

3.1.2 Limitations of Current Cardiovascular Studies

Several important limitations should be considered when interpreting these findings. Observational studies identify associations rather than proving causation. Additionally, experimental exposures were substantially higher than amounts commonly encountered in dental applications.

Some sources say that high levels of xylitol in the blood might increase the risk of a heart or blood vessel problem such as a heart attack or stroke, however, there isn't enough reliable information to say whether consuming more xylitol increases cardiovascular event risk (WebMD, 2025).

While the findings in Witowski' and Hazen's study are alarming, there are many flaws with this study. To start, the study used very high levels of xylitol (30g dose of xylitol in water), but this does not directly translate to dental applications. In dentistry, doses are much lower, plasma absorption is transient and minimal, and evidence supports local plaque-reducing effects without systemic accumulation at dental dosing levels. Dental protocols using gum, mints, rinses, etc, involve much smaller doses per use (about 1-1.5 g xylitol per stick). To reach 30 g, you'd need to do many of these per day. High levels of xylitol in acute doses are more likely in sweets or beverages (used as sugar substitutes), not dental applications.

There were also other flaws with Witkowski and Hazen's study. The main observational cohort were patients with high baseline cardiovascular risk factors, not healthy individuals, which could lead to bias. Other cofounding factors such as underlying metabolic changes in CVD patients could impact the results. The authors themselves acknowledge that fasting plasma xylitol levels probably reflect endogenous metabolism rather than dietary intake, because xylitol is rapidly excreted (half-life ~13 min) and doesn't accumulate from food intake if fasting >12 hours. Also, disease states themselves can increase endogenous polyol production (including xylitol). Therefore, high plasma levels might be a symptom of disease, not a cause. In addition, some of the data was used

from animal studies and there is a lot of variability between human and animals with regards to xylitol metabolism.

Lastly, the Witowski and Hazen study showed strong associations, the study design primarily indicates correlation. Longitudinal studies are needed to establish a causal link. The human intervention study involved a small sample size (n=10) and a short duration. Long-term effects of chronic xylitol consumption remain unexamined. Another thing to note is the lack of dietary data on xylitol consumption limits the ability to definitively conclude the role of dietary xylitol versus endogenous production in cardiovascular risk.

3.2. Gastrointestinal and Toxicological Considerations

3.2.1 Gastrointestinal Effects

Like many sugar alcohols, xylitol can potentially lead to gastrointestinal symptoms when consumed in large amounts (up to 50 g per day), including bloating, gas, stomach disturbance, abdominal discomfort, and diarrhea (Livesey, 2003; WebMD, 2025; ALHumaid, 2022).

3.2.2. High-Dose Toxicology Concerns

Current regulatory agencies continue to regard xylitol as generally recognized as safe when consumed within recommended amounts. However, xylitol is highly toxic to dogs and may rapidly trigger hypoglycemia, seizures, liver failure, and death in canine species (WebMD, 2025). According to Web MD, taking high doses of xylitol is possibly unsafe and very high doses long-term might lead to tumor development (WebMD, 2025).

3.2.3 Genotoxicity Research

Some laboratory studies have explored possible genotoxic effects associated with extremely high xylitol concentrations. However, current evidence suggests that low concentrations typically used in dental products are unlikely to produce clinically meaningful DNA damage in humans. Overall, xylitol demonstrates relatively low genotoxic potential at concentrations commonly found in foods and oral healthcare products, and most toxicology reviews and regulatory agencies continue to regard it as generally recognized as safe when used appropriately (Livesey, 2003). Nevertheless, some experimental in vitro studies have evaluated possible chromosomal or cellular stress responses associated with high sugar alcohol concentrations. These findings have occasionally raised questions regarding oxidative stress pathways, cellular metabolism, and DNA stability under non-physiological conditions. Such concerns are often discussed more broadly within sugar alcohol safety literature and artificial sweetener toxicology, particularly in the context of very high-dose experimental exposure.

However, it is important to note that these experimental conditions are difficult to extrapolate directly to normal human exposure. In vitro studies frequently use extremely high concentrations that do not reflect typical dietary or oral healthcare use, and isolated cell models do not necessarily predict clinical outcomes in humans. For example, observations have shown that xylitol may

exhibit genotoxic effects in human lymphocytes only at very high concentrations in vitro; at lower concentrations, no meaningful DNA or chromosomal damage is observed. Using assays such as the cytokinesis-block micronucleus (CBMN) test and Comet assay, significant DNA damage, micronuclei formation, and chromosomal aberrations were only detected at the highest tested concentrations (e.g., up to 1000 μg/mL). Based on these findings, it has been concluded that typical low-dose exposure is unlikely to cause DNA or chromosomal damage (Avuloğlu, 2022).

Beyond genotoxicity discussions, some experimental work has also investigated broader cellular effects of xylitol, particularly in relation to inflammation and angiogenesis. Angiogenesis and inflammation are key processes involved in tumor growth and expansion, and natural compounds with anti-inflammatory properties may also demonstrate anti-angiogenic activity, since these processes share common signaling pathways such as NF-κB and Akt (Yi, 2013). In this context, xylitol has been identified as a compound of interest. Yi et al. (2013) reported that xylitol inhibited migration, invasion, and tube formation of human umbilical vein endothelial cells (HUVECs) in vitro. In vivo, xylitol also inhibited angiogenesis in a mouse Matrigel plug assay. Additionally, mRNA expression of vascular endothelial growth factor (VEGF), VEGFR-II (KDR), basic fibroblast growth factor (bFGF), bFGFR-II, matrix metalloproteinase-2 (MMP-2), and MMP-9 in HUVECs decreased following xylitol treatment. These anti-angiogenic effects were suggested to be mediated through inhibition of NF-κB and Akt activation, leading the authors to conclude that xylitol may act as a beneficial angiogenesis inhibitor under experimental conditions (Yi, 2013).

There are concerns regarding cumulative toxic burden, chronic inflammatory exposure, industrial processing, and long-term metabolic stress. Although current clinical evidence does not demonstrate meaningful genotoxic risk from standard xylitol exposure, it is important to emphasize the need for ongoing long-term safety research.

3.3. Manufacturing, Sourcing, and Environmental Considerations

Commercial xylitol production commonly involves extraction of xylose from plant materials followed by catalytic hydrogenation under high pressure and temperature conditions (Ur-Rehman et al., 2022). A significant portion of commercially available xylitol is manufactured overseas, particularly in China, and is commonly derived from corn sources (Gillco Ingredients, 2017). While corn-derived xylitol is not inherently unsafe, sourcing transparency and non-GMO considerations are important factors. Although not all xylitol produced in China is derived from genetically modified corn, verifying agricultural origin, processing methods, and potential GMO contamination can sometimes be difficult (Gillco Ingredients, 2017).

Some manufacturers instead utilize birch-derived xylitol, often referred to as birchwood xylitol. Birch-derived products are sometimes preferred because of perceived advantages related to sourcing transparency, reduced GMO concerns, and alignment with more natural-product philosophies.

Additionally, some companies emphasize domestic manufacturing, third-party purity testing, and certifications such as Orthodox Union (OU) Kosher certification. These certifications can poten-

tially help support product consistency, manufacturing oversight, and quality assurance standards.

The largest global manufacturer of xylitol is DuPont Danisco. They have plants located in Finland, China and the USA (Dasgupta, 2017). Many individuals remain skeptical of DuPont due to its historical involvement in controversies surrounding chemical manufacturing, environmental contamination, and allegations of withholding or misrepresenting information about the safety of certain chemical products. This is is another important consideration for many people with regards to sourcing of xylitol.

Environmental considerations have been linked to influencing purchasing decisions. International transportation and large-scale global shipping contribute substantially to fuel consumption, emissions, and environmental strain. While imported products cannot always be avoided, some consumers prefer products manufactured domestically or within a closer geographic region when comparable options are available.

3.3.1. Birch Versus Corn-Derived Xylitol

Commercial xylitol is commonly produced from either birch wood hemicellulose or agricultural corn fiber and other corn-derived biomass rich in xylose (Ur-Rehman et al., 2022). Although the final purified xylitol molecule is chemically identical regardless of its original plant source, sourcing origin remains an important consideration.

Birch-derived xylitol is often preferred due to perceived advantages related to sourcing transparency, environmental considerations, and reduced concerns about genetically modified organisms (GMOs). Birch-derived xylitol is also frequently viewed as more “natural,” partly because birch trees were among the original raw materials used in early commercial xylitol development and Finnish xylitol research (Mäkinen, 2004). As a result, many holistic consumers associate birch sourcing with greater historical continuity and alignment with natural-product philosophies.

Corn-derived xylitol, on the other hand, is generally more widely available and less expensive due to the large-scale industrial production of corn biomass and agricultural byproducts. However, concerns surrounding corn-derived ingredients are often less about xylitol itself and more about broader agricultural systems, including monocropping practices, pesticide exposure, glyphosate use, soil depletion, and the widespread use of genetically modified corn in some regions. These considerations contribute to consumer preferences even when the end chemical compound remains identical.

Although there is currently no direct evidence demonstrating that corn-derived xylitol is inherently less safe or less effective than birch-derived xylitol, sourcing transparency remains an important factor for many practitioners and patients in biological and integrative health settings. At present, no direct scientific evidence shows clinically meaningful differences in health outcomes between purified birch-derived and corn-derived xylitol products. Nonetheless, many practitioners emphasize the importance of transparency in sourcing, manufacturing quality control, and

environmental sustainability when selecting xylitol-containing products for clinical or personal use.

3.3.2. GMO Concerns

Although not all corn-derived xylitol originates from genetically modified corn, some consumers and practitioners prefer non-GMO sourcing when possible (World Health Organization [WHO], 2023). Within biological and holistic dentistry, GMO concerns are often discussed in the broader context of agricultural sustainability, pesticide exposure, ultra-processed food production, and long-term ecological health. Some practitioners express concern that large-scale industrial corn agriculture may involve increased glyphosate exposure, monocropping practices, soil depletion, and reduced biodiversity. At present, there is no direct clinical evidence demonstrating that GMO-derived xylitol itself causes harm in humans. However, some individuals choose to source birch-derived or certified non-GMO xylitol products in order to align with broader wellness and environmental philosophies (Ur-Rehman et al., 2022). Additionally, some practitioners argue that transparency in manufacturing and sourcing is important because consumers increasingly seek minimally processed products with clearly identifiable origins. Biological dentistry often incorporates environmental and systemic health perspectives into oral healthcare recommendations. Therefore, discussions surrounding GMO ingredients are likely to extend beyond direct toxicity concerns and include broader ethical, ecological, and agricultural considerations.

3.3.3. Nickel Catalyst and Purity Concerns

Commercial xylitol production typically involves catalytic hydrogenation of xylose under high pressure and temperature conditions (Ur-Rehman et al., 2022). Nickel catalysts are commonly used during this industrial conversion process because they efficiently facilitate hydrogenation reactions. This raises a concerns regarding trace metal contamination and manufacturing purity, especially for people with nickel allergies. Nickel exposure is particularly relevant because nickel is among the most common metal allergens worldwide. Sensitive individuals can experience contact hypersensitivity, dermatologic reactions, immune activation or inflammatory responses associated with nickel exposure (Rydzewska, 2014).

There are concerns regarding residual nickel contamination, manufacturing purity, heavy metal exposure and cumulative toxic burden. Sourcing transparency and third-party testing for purity, particularly among patients with metal hypersensitivity, mast cell activation concerns, autoimmune conditions, chronic inflammatory disorders or multiple chemical sensitivities. Current evidence does not demonstrate that commercially purified xylitol routinely contains clinically dangerous nickel levels. However, direct research specifically evaluating trace catalyst residues in retail xylitol products remains limited.

Although pharmaceutical- and food-grade purification processes are designed to remove catalyst residues, some practitioners emphasize that trace contamination risk may vary depending on:

manufacturing quality, purification standards, sourcing transparency and regulatory oversight (Ur-Rehman et al., 2022).

3.3.4. Sustainability and Environmental Impact

Environmental considerations are increasingly emphasized within holistic and biological healthcare models, where ingredient selection can extend beyond clinical outcomes to include sourcing methods, agricultural practices, industrial processing requirements, transportation demands, ecological sustainability, and long-term environmental impact. Within biological dentistry specifically, broader environmental and ecological factors are often integrated into healthcare decision-making, particularly when comparable lower-impact alternatives are available.

Commercial xylitol production is generally an energy-intensive industrial process involving the extraction of xylose followed by catalytic hydrogenation under high temperature and pressure conditions (Ur-Rehman et al., 2022). This manufacturing process has been said to require substantial water use, chemical refinement, industrial energy input, and complex transportation infrastructure, all of which contribute to its overall environmental footprint. Corn-derived xylitol production may introduce additional environmental considerations associated with large-scale industrial agriculture, including monocropping practices, pesticide and herbicide use, soil degradation, reduced biodiversity, and reliance on intensive farming systems.

In response to these concerns, some holistic practitioners prefer sustainably harvested birch-derived xylitol or manufacturers that provide greater transparency regarding sourcing and environmental standards. However, birch-derived production is not inherently or universally more environmentally favorable in all contexts, as total environmental impact can vary depending on transportation distance, forestry management practices, processing efficiency, and manufacturing logistics. As a result, sustainability assessments often require a broader life-cycle perspective rather than assumptions based solely on raw material origin.

Within biological dentistry, sustainability discussions frequently extend beyond direct toxicity or clinical performance to include ethical and ecological considerations related to healthcare product manufacturing and supply chains. Some practitioners further argue that, from a long-term sustainability perspective, reducing overall reliance on highly processed sweeteners may represent the most environmentally responsible nutritional approach when clinically appropriate.

3.4. Dental Concerns

3.4.1. Mixed Evidence Regarding Caries Prevention

Although many studies report beneficial effects, the evidence supporting xylitol is not universally consistent. Several controlled trials and reviews have found little or no statistically significant reduction in caries when xylitol is compared with control groups or alternative sweeteners, suggesting that its clinical advantage may be limited in some contexts (van Loveren, 2004). As a re-

sult, questions remain regarding whether the observed effects are truly unique to xylitol or partially attributable to increased salivary flow associated with chewing itself.

In fact, some researchers argue that many of the benefits associated with xylitol-containing chewing gum may primarily reflect saliva stimulation rather than distinct antimicrobial properties of xylitol itself (van Loveren, 2004). Since mastication inherently increases salivary flow regardless of sweetener type, this raises the possibility that improved oral outcomes in some studies are possibly linked to mechanical stimulation rather than a specific biochemical effect of xylitol.

Overall, the evidence base is therefore not entirely consistent. Several systematic reviews have reported mixed or limited benefit when xylitol is compared with controls or with interventions that stimulate saliva production alone, reinforcing the need for further well-controlled studies to clarify its independent clinical effect (van Loveren, 2004).

3.4.2. Saliva Stimulation Versus Direct Antimicrobial Effects

Some researchers argue that chewing gum itself stimulates salivary production regardless of the sweetener type used, suggesting that increased salivary flow can account for a substantial portion of the observed benefits attributed to xylitol (Mäkinen, 2004; van Loveren, 2004). Within this framework, it has been concluded that chewing sugar-free gum three or more times daily over prolonged periods may reduce caries incidence irrespective of the specific sugar alcohol used. Similarly, sucking xylitol-containing candies or tablets can produce comparable effects to chewing xylitol gum, primarily through salivary stimulation and mechanical clearance.

Clinical trials have suggested greater caries reductions in some cases with xylitol-sweetened gum compared with sorbitol-sweetened gum; however, the evidence is not fully consistent. The superiority of xylitol was not confirmed in two out of four clinical trials comparing the caries-preventive effects of xylitol- and sorbitol-sweetened gums (van Loveren, 2004). This mixed evidence reinforces ongoing debate regarding whether xylitol provides unique benefits beyond those achieved through general chewing-induced salivary stimulation.

Despite this uncertainty, some clinical data do support potential benefits of xylitol in specific contexts. In a one-year randomized, placebo-controlled clinical trial involving high-caries-risk adults, low-dose xylitol chewing gum was associated with a significantly lower increment of both initial and extensive caries lesions, as well as a reduction in overall caries experience compared with placebo (Cocco et al., 2017). These findings suggest that while salivary stimulation may account for part of the observed effect, xylitol warrants consideration as a contributor to additional protective benefits under certain conditions and dosing regimens.

3.4.3. Remineralization Effects

Clinical evidence regarding xylitol's direct remineralization capabilities remains mixed. While some in vitro and clinical studies report improvements in early enamel lesion remineralization and reductions in demineralization progression, other investigations suggest that the primary benefit of xylitol may be indirect through salivary stimulation and reduction of cariogenic bacterial activity rather than direct mineral deposition itself (Mäkinen, 2004; da Silva et al., 2022). Current evidence therefore suggests that xylitol is likely to function best as a supportive adjunct within broader preventive strategies that include proper oral hygiene, nutritional counseling, fluoride exposure when appropriate, and management of salivary dysfunction (Mäkinen, 2010).

3.4.4. Periodontal Disease

Many of the studies on periodontal disease and xylitol are limited by small sample sizes, short follow-up periods, and variability in dosage, frequency, and delivery methods, which makes direct comparison between trials difficult and limits the strength of long-term conclusions. Despite these potential benefits, current evidence does not support xylitol as a substitute for established periodontal therapies such as mechanical plaque removal, professional periodontal treatment, and comprehensive oral hygiene practices. The American Academy of Periodontology emphasizes that effective management of periodontal disease requires the disruption of pathogenic biofilms and the control of host inflammatory responses through evidence-based clinical interventions rather than adjunctive agents alone.

Within this context, xylitol may be best understood as a supportive adjunct within preventive oral healthcare strategies, particularly for individuals with xerostomia, elevated caries risk, or difficulty maintaining adequate plaque control. Its potential role is most relevant when used alongside conventional preventive and therapeutic approaches rather than as a stand-alone intervention. Nevertheless, further high-quality longitudinal studies are needed to better clarify its long-term periodontal effects, its impact on LPS-mediated inflammatory pathways, and its optimal therapeutic applications in clinical practice.

3.5. Other Concerns and Considerations

3.5.1. Questions Regarding Long-Term Systemic Effects

Recent research has raised questions about potential systemic effects associated with elevated circulating xylitol levels (Witkowski et al., 2024). Although current evidence does not establish that routine dental exposure causes harm, additional long-term human studies are needed.

3.5.2. Concerns About Over-Marketing

Some researchers and practitioners have expressed concern that xylitol products are occasionally marketed in overly simplistic ways that may exaggerate clinical benefits or minimize limitations within the evidence base (van Loveren, 2004). In some cases, xylitol is promoted as a "miracle" cavity-preventive agent, while broader contributors to oral health such as nutrition, oral microbiome balance, salivary function, and lifestyle factors may receive less emphasis.

Although many studies suggest possible reductions in cariogenic bacterial activity and caries risk, the overall literature remains mixed. Systematic reviews have reported modest or inconsistent effects depending on study design, dosage, frequency of use, baseline caries risk, patient compliance, and comparison groups (Cocco et al., 2024). Critics therefore argue that commercial messaging may sometimes overstate benefits while underrepresenting these methodological limitations.

Additionally, there is some concern that frequent exposure to sweet-tasting products, even those containing non-cariogenic sweeteners, can perpetuate cravings for sweetness and reinforce dietary patterns centered around sweetened foods. Critics also highlight that marketing narratives may sometimes underemphasize foundational drivers of oral disease, including high sugar intake, ultra-processed diets, chronic mouth breathing, poor salivary function, nutritional deficiencies, oral dysbiosis, inadequate oral hygiene, and broader socioeconomic determinants of health.

3.5.3. Comparison with Other Sweeteners and Polyols

Sorbitol is another sugar alcohol commonly used in sugar-free oral healthcare products. Although it is generally considered less cariogenic than sucrose, sorbitol may still be slowly fermented by oral bacteria over time, which can limit its long-term anticaries effectiveness compared with non-fermentable alternatives such as xylitol (van Loveren, 2004). This partial fermentability has contributed to interest in alternative polyols with more stable metabolic profiles within the oral environment.

Erythritol has also gained popularity as a sugar alcohol alternative because it is generally well tolerated. It has also been shown to produce fewer gastrointestinal side effects in some individuals compared with other polyols. However, more recent cardiovascular research has raised questions regarding associations between elevated plasma erythritol levels and thrombosis risk, prompting ongoing discussion about its systemic safety profile in certain contexts.

Compared with many artificial sweeteners, xylitol is often viewed more favorably within biological healthcare models because it occurs naturally in small amounts in fruits and vegetables and has a longer history of use in dental research and preventive oral care applications. This historical context, combined with its well-documented non-cariogenic properties, has contributed to its continued popularity in dental and integrative health settings.

At the same time, some holistic practitioners question whether habitual use of concentrated sweeteners, including both artificial sweeteners and sugar alcohols. may perpetuate cravings for sweet tastes and potentially contribute to dysregulated eating behaviors over time. From this perspective, even non-cariogenic sweeteners may warrant mindful and moderated use within broader dietary and behavioral frameworks rather than being consumed without consideration of overall dietary patterns.

3.5.4. Tumors and Enlargements

Toxicological research has shown that long-term, high-dose dietary consumption of xylitol in animal models can be associated with an increased incidence of adrenal pheochromocytomas (tumors of the adrenal medulla) and chromaffin cell proliferation in rats. However, these findings are generally considered species-specific and not directly relevant to human cancer risk assessment (Greim, 2009). In rats, chronic dietary exposure to high levels of sugar alcohols (typically around 5–20% of the diet) has been linked to increased serum calcium and stimulation of adrenal chromaffin cell activity. Over prolonged exposure periods, this persistent stimulation may lead to a higher incidence of benign and, in some cases, malignant pheochromocytomas. Importantly, this mechanism is understood to be driven by rat-specific metabolic pathways, and similar physiological responses have not been demonstrated in mice or humans, indicating limited translational relevance.

Additional rodent studies have also documented cecal enlargement following high-dose sugar alcohol intake (Joint FAO/WHO Expert Committee on Food Additives [JECFA], 1983). Xylitol is highly osmotic in the lower gastrointestinal tract and poorly absorbed, leading to increased water influx into the colon and cecum. Unabsorbed xylitol is subsequently fermented by cecal microflora, producing short-chain fatty acids (SCFAs), which contributes to increased cecal tissue growth through hyperplasia and hypertrophy, as well as additional accumulation of water and gas (Konishi, 1984). Toxicological interpretations generally regard this cecal enlargement as an adaptive physiological response to poorly absorbed carbohydrates rather than a direct toxic effect on intestinal tissue. Similar adaptive changes have been observed in rats consuming other poorly absorbed substances, including polyols, modified starches, and dietary fiber (Konishi, 1984).

Beyond toxicology, some experimental studies have explored potential anticancer-related cellular effects of xylitol. In vitro research using lung cancer cell lines has demonstrated a dose-dependent inhibitory effect of xylitol on cell proliferation, with evidence suggesting that this effect may be mediated through autophagy pathways (Park, 2015). Another in vitro study found that partial substitution of glucose with xylitol in culture media led to reduced proliferation in both non-transformed cells and oral squamous cell carcinoma cell lines. This effect was associated with decreased ATP generation and reduced phosphofructokinase activity, suggesting downregulation of glycolysis as a potential mechanism. Additionally, the xylitol metabolite D-xylulose appeared to enhance its antiproliferative effects (Trachootham, 2017).

Further mechanistic research has investigated xylitol's effects on inflammation and angiogenesis. Xylitol has been reported to inhibit lipopolysaccharide (LPS)-induced inflammatory cytokine expression, suggesting anti-inflammatory potential. Given that inflammation and angiogenesis share overlapping signaling pathways such as NF-κB and Akt, compounds with anti-inflammatory activity may also influence angiogenic processes (Yi, 2013). In vitro and in vivo studies demonstrated that xylitol inhibited endothelial cell migration, invasion, and tube formation, as well as reduced neovascularization in Matrigel assays. These effects were accompanied by decreased hemoglobin content in experimental plugs, supporting suppression of angiogenesis in vivo.

At the molecular level, xylitol has been shown to downregulate key angiogenic factors in a dose-dependent manner, including VEGF, VEGFR-II (KDR), basic fibroblast growth factor (bFGF), and bFGFR-II. It also reduced expression of matrix metalloproteinases MMP-2 and MMP-9, which are involved in extracellular matrix remodeling and cell migration. Although total NF-κB and Akt protein levels were unchanged, phosphorylation of both signaling molecules was suppressed in a dose-dependent manner, indicating inhibition of pathway activation. Collectively, these findings suggest that xylitol can potentially exert anti-angiogenic effects through modulation of NF-κB and Akt signaling pathways and downstream regulation of tumor-associated angiogenic mediators (Yi, 2013).

3.5.5. Other Possible Health Benefits

Research has suggested possible effects on ear infections, yeast infections, gut microbial activity, nasopharyngeal pneumonia, metabolic regulation, diabetes. collagen synthesis, and bone metabolism (Healthline, 2025; Salli et al., 2019; Ahuja, 2020). While these findings are intriguing, many proposed systemic benefits remain speculative and require larger long-term human clinical trials before definitive conclusions can be made.

Caution should be taken with regards to using xylitol as a sugar substitute. Simply substituting sweeteners without addressing broader dietary and lifestyle patterns is unlikely to produce meaningful long-term metabolic improvement. While xylitol can represent a preferable alternative to refined sugar in certain contexts, overall dietary quality, nutrient intake, inflammation, microbiome health, sleep, stress regulation, and lifestyle behaviors remain central components of long-term metabolic and systemic health.

4. Clinical Considerations in Biological Dentistry

In biological and holistic dentistry, xylitol recommendations are rarely made in isolation. Instead, clinicians often evaluate xylitol use within the broader context of airway health, oral microbiome status, salivary resilience, dietary habits, nutritional deficiencies, systemic inflammation, and lifestyle factors.

Biological dentistry recognizes that oral disease is multifactorial and closely connected to chronic inflammatory burden throughout the body. Therefore, while xylitol can possibly offer supportive benefits, long-term oral health outcomes are generally viewed as dependent on deeper physiological factors such as mineral balance, fat-soluble vitamin status, mitochondrial health, breathing patterns, sleep quality, hydration, and nervous system regulation.

An emerging area of interest involves the relationship between oral dysbiosis and systemic inflammatory diseases such as cardiovascular disease, diabetes, autoimmune disorders, and neurodegenerative conditions. Because xylitol may influence plaque ecology and bacterial acid production, some researchers have questioned whether long-term modulation of oral biofilms could have broader systemic implications. However, these connections remain incompletely understood.

Biological dentistry also frequently emphasizes reducing cumulative toxic burden. As a result, sourcing transparency, manufacturing quality, environmental sustainability, and additive exposure may all influence practitioner recommendations regarding xylitol-containing products.

Additionally, many holistic practitioners stress that frequent exposure to intensely sweet flavors, even from non-sugar sweeteners, might reinforce neurological reward pathways associated with sugar cravings and dysregulated eating behaviors. From this perspective, the ultimate long-term goal may involve reducing dependence on sweet tastes altogether rather than merely replacing refined sugar with alternative sweeteners.

4.1. Individualized Patient Recommendations

The IABDM does not recommend a one-size-fits-all approach to xylitol usage. Some individuals may have some benefit from moderate xylitol use, while others may prefer alternative approaches due to many potential health concerns. In addition, not all patients respond to xylitol in the same manner. Biological dentistry emphasizes individualized care plans based on oral microbiome status, nutrition, salivary function, systemic health, and personal preferences.

4.2. Forms and Dosages (Adults)

Several systematic reviews and meta-analyses have concluded that the most effective regimens generally involve approximately 5-10 grams of xylitol daily divided into 3-5 exposures throughout the day ideally after meals or snacks for adults (ALHumaid & Bamashmous, 2022). Some studies suggest that frequencies below approximately three exposures daily may provide little measurable caries-preventive effect (ALHumaid & Bamashmous, 2022). Research supports that Xylitol is considered safe at a recommended dose of 6 g/day with the proper frequency and dosage (ALHumaid, 2022), however the definition of what is considered to be “safe” is debatable. Dosage should be individualized based on age, caries risk, salivary flow, oral microbiome status, airway function, dietary habits, gastrointestinal tolerance, and overall systemic health.

Research suggests that both the total daily dose and frequency of exposure are important factors influencing xylitol’s effectiveness in caries prevention (ALHumaid & Bamashmous, 2022). Many studies indicate that intermittent or very low-dose exposure may provide minimal clinical benefit, whereas repeated exposure throughout the day appears more effective for reducing cariogenic bacterial activity.

4.2.1. Chewing Gum

Chewing gum remains one of the most extensively studied xylitol delivery methods (Cocco et al., 2017). Gum provides both xylitol exposure and salivary stimulation, which has been linked to oral health benefits. Habitual xylitol gum use is often described in the literature as 5-7 grams daily, consumed at least 3 times daily, typically after meals (Ly et al., 2006). However, some biological practitioners caution that chewing gum is not always appropriate for all patients, includ-

ing individuals with temporomandibular joint dysfunction, jaw pain, bruxism, orthodontic appliances, or young children with choking risk.

4.2.2. Lozenges, Candies, and Mints

Lozenges and mints may provide similar bacterial exposure benefits without requiring prolonged chewing. These products are sometimes preferred for patients with TMJ dysfunction, orthodontic limitations or sensory sensitivities. However, dosage consistency varies substantially among commercial products. Some products marketed as "xylitol" contain only small amounts mixed with other sweeteners, potentially reducing clinical effectiveness. It is important to carefully reviewing ingredient labels and total xylitol content rather than relying solely on marketing claims.

4.2.3. Syrups and Pediatric Products

Pediatric studies have evaluated xylitol syrups in infants and young children unable to safely chew gum. Milgrom et al. (2006) reported reductions in early childhood caries among children receiving xylitol syrup multiple times daily. These studies generally used divided doses throughout the day rather than single exposures. Because compliance can be challenging, many pediatric practitioners focus on practical and sustainable dosing strategies rather than attempting to maximize intake.

4.2.4. Toothpaste and Mouth Rinses

Xylitol-containing toothpaste and rinses are increasingly common. Some studies suggest these products may modestly support oral health when combined with broader preventive strategies (Duane, 2015). However, xylitol concentration, duration of contact, and product formulation vary significantly. Many studies evaluating xylitol toothpaste involve other remineralization substances such as fluoride, calcium-phosphate and hydroxyapatite exposure, making it difficult to isolate xylitol's independent effects.

4.3. Pediatric Considerations

Xylitol has been extensively studied in pediatric dentistry because of its proposed ability to reduce dental caries, decrease transmission of cariogenic bacteria, and support oral health during childhood development (Milgrom et al., 2006). It is commonly included in pediatric chewing gums, syrups, toothpaste, wipes, nasal sprays, and oral health products marketed for cavity prevention.

Within biological and holistic dentistry, pediatric xylitol use is often viewed with both interest and caution. While many studies suggest potential oral health benefits, concerns also exist regarding gastrointestinal tolerance, long-term metabolic effects, overuse of sweeteners, choking hazards, and the quality of evidence supporting some commercial claims.

4.3.1. Potential Pediatric Benefits of Xylitol

4.3.1.1. Reduction of Dental Caries

One of the primary reasons xylitol has been studied in children is its possible role in reducing dental caries. Several clinical trials and systematic reviews have reported lower cavity rates among children using xylitol-containing products regularly (Cocco et al., 2024; Milgrom et al., 2006). Xylitol is considered non-fermentable by many cariogenic oral bacteria, particularly *Streptococcus mutans*, meaning might reduce acid production within dental plaque (Mäkinen, 2004). Lower plaque acidity has been said to help decrease enamel demineralization. Some studies suggest xylitol may be particularly beneficial in children at elevated caries risk due to high sugar intake, mouth breathing, xerostomia, orthodontic appliances, poor oral hygiene, frequent snacking, developmental enamel defects, or high levels of cariogenic bacteria. However, not all studies demonstrate strong or consistent benefits, and some reviews conclude that evidence quality remains mixed (van Loveren, 2004).

4.3.1.2. Reduction of Maternal Transmission of *Streptococcus mutans*

One of the more interesting pediatric applications involves maternal xylitol use during infancy and early childhood. Xylitol has been studied extensively in pediatric populations for caries prevention and reduction of *Streptococcus mutans* transmission (Milgrom et al., 2006). Some studies suggest mothers who regularly consume xylitol gum can possibly reduce transmission of *Streptococcus mutans* bacteria to their children (Söderling et al., 2000). Because early colonization of cariogenic bacteria may influence future cavity risk, reducing maternal bacterial transmission has been proposed as a preventive strategy during infancy. Some research found lower *S. mutans* colonization and lower caries rates among children whose mothers used xylitol gum compared with fluoride or chlorhexidine groups (Isokangas et al., 2000). These findings have contributed to interest in maternal oral microbiome management during pregnancy and early childhood.

4.3.1.3. Pediatric Syrup Studies

Several pediatric studies evaluated xylitol syrup in young children who were too young to safely chew gum. A notable randomized clinical trial by Milgrom et al. (2006) found reduced early childhood caries among children receiving xylitol syrup multiple times daily. Researchers proposed that repeated xylitol exposure may reduce bacterial acid production and support healthier oral microbial patterns. However, compliance can be difficult because effectiveness appears dependent on frequent exposures throughout the day.

A double-blinded randomized control trial was performed on Xylitol oral syrup. It was administered topically 2 or 3 times daily at a total daily dose of 8 g. The oral syrup was effective in preventing early childhood caries (Milgrom, 2006).

4.3.1.4. Salivary Support and Mouth Breathing

Children with mouth breathing, airway dysfunction, dehydration, medications, allergies, or sleep-disordered breathing may experience reduced salivary flow and increased cavity risk. Because xylitol gum and lozenges stimulate saliva production, some biological dentists use xylitol-containing products as part of broader salivary support strategies. However, airway-centered dentistry emphasizes correcting root causes such as nasal obstruction, tongue posture dysfunction, tethered oral tissues, allergies, sleep-disordered breathing, and chronic mouth breathing rather than relying solely on preventive products.

4.3.2. Concerns and Limitations Regarding Pediatric Use

4.3.2.1. Gastrointestinal Side Effects

Like other sugar alcohols, xylitol has been demonstrated to cause gastrointestinal symptoms in children, particularly at higher doses (Livesey, 2003). Reported symptoms may include bloating, diarrhea, abdominal discomfort, gas, loose stools, nausea, and cramping. Because children have lower body mass, gastrointestinal symptoms may occur at lower total doses compared with adults. Children with irritable bowel tendencies, sensory sensitivities, autism spectrum disorders, mast cell activation concerns, or gastrointestinal dysbiosis may be especially sensitive to sugar alcohols. Within holistic healthcare, practitioners often emphasize gradual introduction and individualized tolerance assessment.

4.3.2.2. Concerns about Habitual Sweetener Exposure

Concerns have been expressed that frequent exposure to intensely sweet substances, even lower-glycemic sweeteners, can potentially reinforce sugar cravings and dysregulated reward pathways in children. From this perspective, over-reliance on sugar substitutes may perpetuate dependence on sweet tastes rather than encouraging adaptation to less sweet whole foods. This concern is particularly relevant in pediatric populations because taste preferences and dietary habits are established early in life. Some practitioners therefore recommend using xylitol strategically rather than continuously throughout the day.

4.3.2.3. Choking Hazards

Chewing gum is generally not recommended for very young children because of choking risk. For this reason, xylitol syrup, wipes, toothpaste, or dissolvable tablets are often preferred for toddlers and preschool-aged children. Parents should supervise use of gum, lozenges, and mints carefully.

4.3.2.4. Potential Over-Marketing In Pediatric Dentistry

Some critics argue that xylitol products are occasionally marketed as simple solutions to childhood cavities while minimizing broader contributors such as ultra-processed diets, mouth breathing, poor sleep, mineral deficiencies, frequent snacking, oral dysbiosis, inadequate oral hygiene and socioeconomic barriers. Biological dentistry generally emphasizes addressing these foundational factors alongside any product recommendations.

4.3.2.5. Long-Term Metabolic and Cardiovascular Effects

Emerging cardiovascular research involving elevated plasma xylitol levels has raised questions about possible long-term systemic effects, although current evidence does not establish harm from typical pediatric dental exposures (Witkowski et al., 2024). The relevance of these findings to children remains unknown, and additional pediatric-specific research is needed. Because children may consume xylitol from multiple sources simultaneously, including gum, candy, toothpaste, beverages, syrups, and supplements, some practitioners recommend moderation or avoidance until more long-term safety data become available.

4.3.3. Pediatric Dosing

Research suggests xylitol effectiveness may depend on both frequency and total dose. Some pediatric studies used approximately 3-8 grams daily, divided into 3-5 exposures throughout the day (Milgrom et al., 2006). However, optimal pediatric dosing remains uncertain. Excessive intake may increase gastrointestinal symptoms without necessarily improving clinical benefit. Biological dentistry generally favors conservative dosing individualized to age, caries risk, salivary function, diet, microbiome status, and gastrointestinal tolerance.

4.3.4. Special Pediatric Populations

4.3.4.1. Children with Orthodontic Appliances

Children with braces or orthodontic appliances often have increased plaque retention and elevated cavity risk. Xylitol-containing rinses or products may potentially support oral hygiene in these populations, although chewing gum is not always appropriate. It can depend on appliance type.

4.3.4.2. Neurodivergent Children and Sensory Considerations

Children with autism spectrum disorder, ADHD, sensory processing differences, or feeding challenges can respond differently to sugar alcohols and flavored products. Some may experience gastrointestinal sensitivity or aversion to texture and taste. Others may benefit from alternative delivery systems such as wipes or toothpaste.

4.3.4.3. Children with Airway Dysfunction and Mouth Breathing

Airway-centered biological dentistry increasingly recognizes the relationship between mouth breathing, xerostomia, altered oral microbiota, and increased caries risk. While xylitol may provide supportive salivary stimulation, airway correction remains more foundational than sweetener-based prevention strategies.

4.4. Metabolism

After ingestion, xylitol is partially absorbed in the small intestine and partially fermented by colonic bacteria. Xylitol is considered to be a prebiotic due to its ability to promote the proliferation and metabolic activity of beneficial bacteria as well as the production of short-chain fatty acids such as butyrate (Wölnerhanssen et al., 2022) (Sato et al; 2022). Approximately half of ingested xylitol may undergo microbial fermentation in the colon, contributing to production of short-chain fatty acids such as butyrate (Sato et al., 2022). About 49% of the remaining xylitol has absorptive capacity and the rest (less than 2%) for urinary excretion (Wölnerhanssen et al., 2022).

5. IABDM's Stance on Xylitol

The IABDM does not generally recommend xylitol as a routine or primary strategy for oral disease prevention. While research suggests that xylitol may reduce cariogenic bacterial activity, support salivary flow, stabilize oral pH, and contribute to a lower-caries oral environment under certain conditions (Mäkinen, 2004; da Silva et al., 2022), important questions remain regarding its long-term systemic effects.

Of particular concern is emerging research suggesting potential associations between elevated plasma xylitol levels, platelet activation, and increased thrombotic risk, especially in individuals with existing cardiovascular or metabolic risk factors (Witkowski et al., 2024). Although the clinical significance of these findings requires further investigation, the IABDM believes it is prudent to err on the side of caution until more long-term human data are available.

The IABDM supports preventive approaches that address the root causes of oral disease, including nutrient-dense nutrition, reduced refined sugar consumption, oral microbiome balance, healthy salivary function, airway health, hydration, sleep quality, and individualized patient care. Oral health outcomes are influenced by many factors, and no single product should be relied upon as a primary preventive strategy.

In selected cases, however, a biological dental practitioner may determine that conservative xylitol use could serve as a helpful adjunctive tool. This may include patients with elevated caries risk, xerostomia, orthodontic appliances, impaired salivary flow, or other specific clinical circumstances. When xylitol is utilized, practitioners should carefully consider product quality, sourcing, purity, dosage, frequency of use, and the individual patient's overall health status. Patients should be fully informed of both the potential benefits and potential risks before making a decision. Additionally, patients should be advised that xylitol is highly toxic to dogs and can

cause rapid hypoglycemia, liver failure, seizures, and death even at relatively small doses. Proper storage of xylitol-containing products is therefore essential in households with pets.

The IABDM therefore recommends an individualized, precautionary approach with informed discussions between patients and dental practitioners regarding the potential risks and benefits of xylitol use. While limited use of xylitol may be appropriate in certain situations, the organization encourages practitioners and patients to prioritize foundational lifestyle, nutritional, and oral-systemic health interventions over routine reliance on xylitol-containing products. Further high-quality long-term research is needed to clarify xylitol's cardiovascular, metabolic, oral microbiome, and overall systemic health effects.

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