# Sugar-free chewing gum in oral health

## A clinical overview

WRIGLEY
Oral Healthcare
Program

Working for better oral healthcare

## Editorial review board

The Wrigley Oral Healthcare Program would like to thank the following people for their contributions:

• Michael Dodds, BDS, PhD, Senior Principal Scientist, Science & Technology, Mars Wrigley

• Kirstie Canene Adams, PhD, Senior Principal Scientist, Scientific & Regulatory Affairs, Mars Wrigley

## About the Wrigley Oral Healthcare Program (WOHP)

WOHP partners with dental professionals worldwide, helping them improve their patients' oral health through one extra simple and enjoyable step in their daily routine: chewing sugar-free gum after eating and drinking on-the-go. WOHP supports independent clinical research into the oral care benefits of sugar-free chewing gum, including saliva stimulation, plaque acid neutralization and tooth strengthening. For more information, visit: www.wrigleyoralcare.com

Published by the Wrigley Oral Healthcare Program. August 2021



# Contents

# Introduction

**Dental caries is a biofilm-mediated, diet modulated, multifactorial, non-communicable, dynamic disease resulting in net mineral loss of dental hard tissues.[1] It remains one of the most common non-communicable diseases in the world. Untreated caries in permanent teeth was the most common condition evaluated for the Global Burden of Disease (GBD) 2017 study, affecting 2.3 billion adults worldwide, and more than 530 million children also suffer from dental caries of primary teeth.[2] The global burden of untreated carious lesions reported in 187 countries between 1990 and 2010 makes dental caries a health problem yet to be appropriately managed.[3,4]**

Poor oral health has an adverse effect on general wellbeing and places a significant burden on public health expenditure through the cost of curative dental treatment.[5] While the fluoridation of water supplies and changes in lifestyle have all contributed to an overall downward trend in the prevalence of dental caries,[6] global rates continue to present a major public health concern. This suggests that new preventive strategies may be required to supplement existing measures in reducing the risk of dental caries and improving oral health.

The understanding of the complex etiology and pathogenesis of dental caries has advanced significantly over the past decade.[7]

This increased level of understanding has led to new insights and the development and implementation of new caries preventive measures, particularly among high-risk populations of children and adults.[8]

An important outcome of these shifting trends and insights around caries is an increased understanding of the oral health benefits of chewing sugar-free gum after eating and drinking. Research shows that chewing sugarfree gum results in a 10-12 fold increase in salivary flow rate, which enhances the ability of saliva to clear the mouth of food debris and sugars, neutralize acids, and support remineralization, all of which can help to reduce the incidence of caries.[9,10]

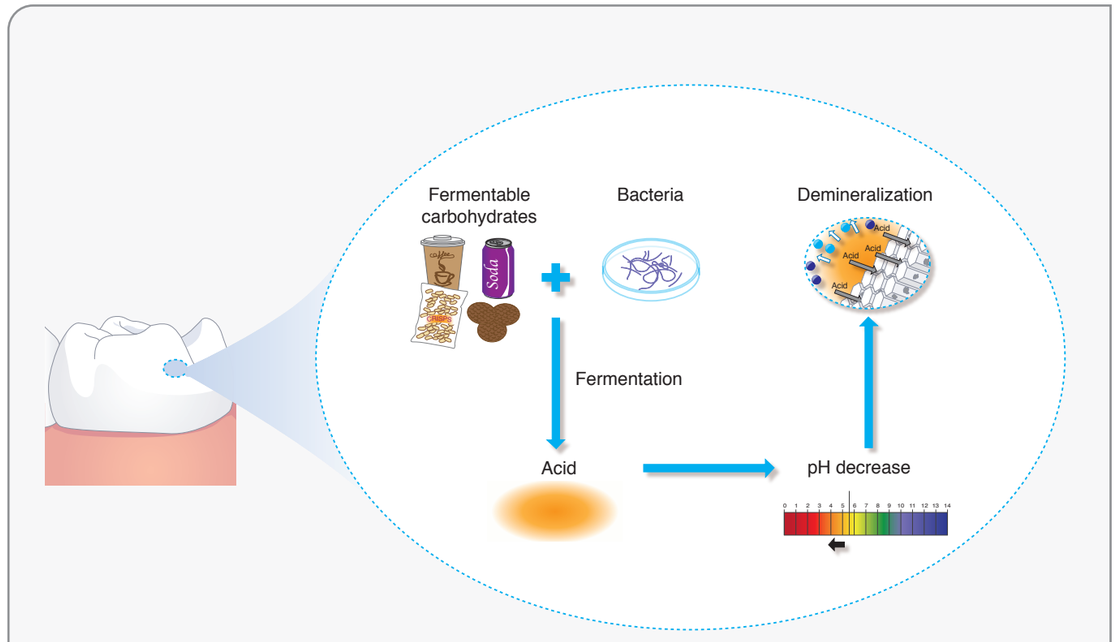
A 2020 systematic review and meta-analysis showed that the use of sugar-free gum may contribute to prevention and control of dental caries in children with a preventative fraction (PF) of 28%.[11]

This booklet provides a detailed summary of the science behind the oral care benefits of sugar-free gum. To download additional resources and learn more, visit: www.wrigleyoralcare.com

# The link between diet, nutrition and caries development

Oral health is related to diet in many ways. Early in development, nutrition influences both craniofacial and tooth formation, and later in life, malnutrition may exacerbate periodontal and oral infectious diseases. However, the most significant effect is the local action of diet on the development of dental caries and enamel erosion.[12]

**Figure 1: The mechanism of dental caries**




Epidemiological studies have been used to try to establish the relationship between various types of diets and their components to caries incidence.[12]

The cariogenic potential of a food is influenced by a number of factors, including a food's effect on plaque pH and the sequence and frequency of food intake.[13]

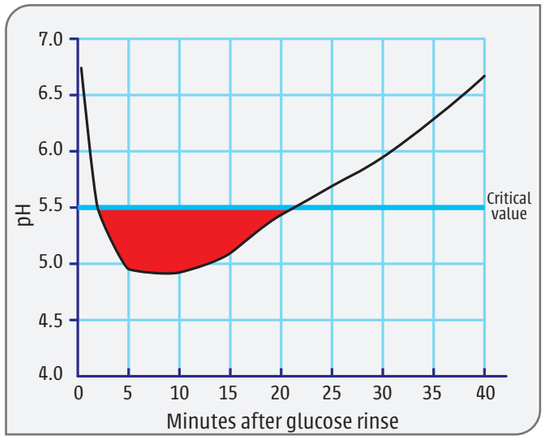
## Plaque pH

Foods which lower oral pH below 5.5, known as the 'critical pH,' can negatively impact oral health, as enamel becomes demineralized due to acid production when fermentable carbohydrates are metabolized. Remineralization occurs when the plaque pH rises.[14]

The period of time taken to return to resting pH levels is influenced by a number of factors, including the buffering capacity of saliva, which varies according to the volume of saliva in the mouth and the rate of flow.[15]

Saliva is essential for the preservation of tooth health by providing the minerals necessary for remineralization;[7] if the salivary flow is reduced, plaque pH may remain depressed for a considerable time, leading to the formation of caries.[16]

**Figure 2: The Stephan Curve***




The Stephan Curve illustrates how plaque pH changes after the consumption of fermentable carbohydrate (i.e. glucose). The curve illustrates the pH value before the consumption of fermentable carbohydrates (0min; minimum 12 hours without exposure), the initial decline in plaque pH after exposure to fermentable carbohydrates, the time when pH is below the 'critical value' (5.5), and the recovery phase.

**Source: Bowen, William H. The Stephan Curve revisited. Odontology. 2013; 101:2–8.*

## Frequency of eating

Worldwide, eating habits are changing. There has been an increase in snacking throughout the day, and a decline in the consumption of the traditional three meals-a-day.[17]

This trend has been accelerated by the COVID-19 pandemic, with consumer surveys showing an increase in overall snacking, and in eating when bored or not hungry.[18] This increased frequency of eating can impact oral health by increasing the incidence of dental caries; the more frequently that cariogenic food is consumed throughout the day, the more frequently the plaque pH falls and the greater the potential risk becomes to teeth for caries development.[19]

In the frequently cited Vipeholm study, inmates of a Swedish medical institute were fed increased sucrose or other foods in different patterns, and caries experience was monitored.[20] Groups of patients receiving high levels of sucrose (up to 330g/day) with other meals, experienced a minimal increase in caries. But if smaller quantities of sucrose were consumed between meals, very high levels of caries ensued. The authors concluded that the relationship was not, therefore, between the quantity of sucrose and caries but rather between frequency of intake and caries experience.[20]

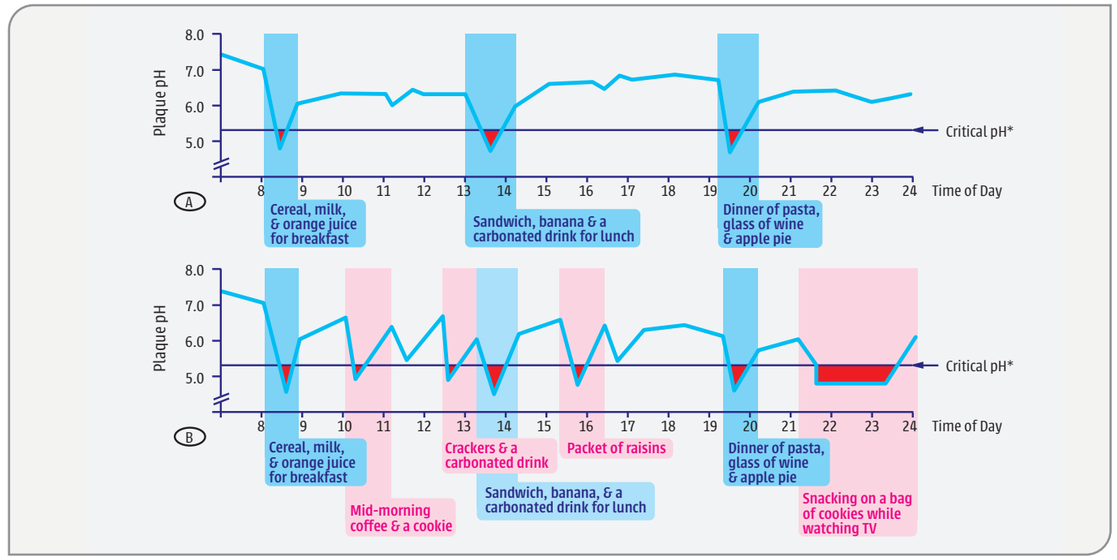
## Amount of food vs. plaque pH

Research has demonstrated that even a small amount of fermentable carbohydrate can produce a drop in plaque pH. A three-series study by Maiwald compared plaque acid development during the chewing of gum containing either sucrose, sorbitol or xylitol, alone or after the consumption of sugar-containing foods, beverages, and gums. The second of the three series showed that after administration of a solution containing only 10% sucrose, plaque pH decreased drastically – reaching a pH of less than 4.5 after about 20 minutes. In a third study, Maiwald et al. demonstrated the effect on plaque pH after the consumption of a "normal" breakfast. During the series, subjects consumed one honey roll. After consumption of the roll, pH dropped relatively quickly to below 4.5 and it took an hour before it had begun to rise. After 2 hours, the pH level had still not risen back above 5.5.[21]

A further report, of a study by Imfeld, examined the correlation between the quantity of substrate and intraplaque acid produced by telemetrically recording pH of 4-day old plaque in a subject during and following rinsing with increasing concentrations of aqueous sucrose solutions. The results showed that sucrose is quickly fermented in plaques and regardless of the concentration, plaque pH drops immediately following the sugar intake and throughout the entire two-minute rinsing period. Moreover, even a very low amount of sucrose remaining in the mouth after the expectoration of 15 milliliters (ml) of 0.025% sucrose solution (which equates to 0.00375 grams) was enough to cause the pH to drop below 5.7.22

**Figure 3: Frequency of eating vs. plaque pH***

Schematic representation of the changes in plaque pH in an individual who A) limits their food and drink intake to main meals only or B) has frequent food and drink intake during the day. The critical pH is 5.5, below which teeth may begin to demineralize.




*Source: Adapted from Marsh PD and Martin MV. Oral Microbiology. 5th Edition. Churchill Livingstone, 2009.*

# Saliva – A review of its role in maintaining oral health and preventing dental disease

**Saliva plays a significant role in maintaining oral health, helping to build and maintain the health of soft and hard tissues. When saliva flow is reduced, oral health problems such as dental caries and oral infections can develop.**

## Composition and production

Saliva is an exocrine solution consisting of 99% water. The remaining 1% consists of a variety of electrolytes and proteins. These components combined are responsible for the various functions attributed to saliva.[23] Saliva is formed primarily (approximately 90%) from the secretions of the three paired major salivary glands, the submandibular (around 65%), parotid (around 20%) and sublingual (around 5-7%). These glands are controlled by the autonomic nervous system, while minor glands (labial, lingual, buccal and palatine), distributed around the oral cavity, produce the remaining saliva (<10%).[23] At rest, without exogenous or pharmacological stimulation, there is a small, continuous salivary flow, an unstimulated secretion, present in the form of a film that covers, moisturizes, and lubricates the oral tissues. This flow of saliva at rest is in the region of 0.25–0.35mL/minute in healthy subjects.[23]

Stimulated saliva is produced in response to a mechanical, gustatory, olfactory, or pharmacological stimulus, contributing to around 40-50% of daily salivary production.[24] The Salivary Flow (SF) index is a parameter allowing stimulated and unstimulated saliva flow to be classified as normal, low or very low (hyposalivation). In adults, normal total stimulated SF ranges 1–3 mL/minute, low ranges 0.7 –1.0 mL/minute, while hyposalivation is characterized by a stimulated SF <0.7mL/minute.[23]

## Key functions

**The two major functions of saliva are:[23]**

1. **Protection of the oral and peri-oral tissues**
   - Lubrication
   - Dilution of sugars after food and drink intake
   - Antimicrobial and cleansing activity, degrading some bacterial cell walls and inhibiting growth
   - Buffering (neutralizing) acid production and controlling plaque pH with bicarbonate
   - Remineralization of enamel with calcium and phosphates
   - Tissue repair
2. **Facilitating eating and speech**
   - Food preparation, enhancing chewing, the clearing of food residues and swallowing
   - Digestion, food breakdown with enzymes
   - Enhancing taste
   - Enabling speech by lubricating the moving oral tissues

**In addition, saliva is used in diagnostic testing**

- Bacterial, yeast, and viral counts indicating caries activity and altered immune responses, as well as many diagnostic tests for oral and systemic diseases
- Hormonal balance to identify steroids and sex hormones
- As an alternative sample material for RT-PCR testing for COVID-19 when nasopharyngeal swabs cannot be collected[25]



## Saliva and dental caries

In addition to moderating microbial factors and encouraging preventive dietary behaviors, a core goal in caries prevention is promoting the natural protective mechanisms of saliva.[26] The pH of dental plaque is a key factor in the balance between acid demineralization of the teeth and the remineralization of the initial caries lesion. Plaque pH falls each time acid accumulates in the plaque due to bacterial acid production following the consumption of fermentable carbohydrates – mainly sugars – in foods and drinks. Conversely, plaque pH rises when the acids are washed away or neutralized by saliva, which contains the important buffer, bicarbonate.[23]

In healthy teeth, the loss of minerals is balanced by the reparative mechanisms of saliva. This equilibrium can be depicted chemically by the equation on page 13– see Figure 6.[27]

When the saliva pH or the plaque pH is below a 'critical value' of about 5.5, the saliva or plaque becomes unsaturated with respect to tooth mineral.[14] As a result, tooth enamel can begin to dissolve. However, when the pH is above this value, the saliva and plaque are supersaturated with respect to tooth mineral. The calcium and phosphate ions in saliva then start to repair any damaged mineral crystals in the enamel – the process of remineralization.[7]

Thus, acidic conditions contribute to bringing phosphate and hydroxyl ions below saturation levels, allowing the solid hydroxyapatite crystals of the tooth mineral to dissolve. If above saturation levels, the chemical reaction will move towards remineralisation and any damaged crystals will be repaired by the acquisition of ions from the solution.[7] Stimulation of saliva flow results in an increase in the washing out of acids (and sugars), and also an increase in the amount and concentration of bicarbonate buffer and of remineralizing ions.[7]

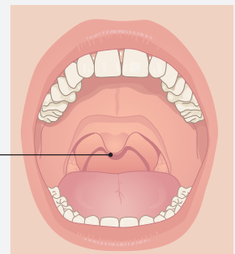
## Salivary gland disorders

The importance of the salivary glands – and saliva – tends to go unnoticed until the glands malfunction. The consequences are severe and impact greatly on quality of life. Symptoms may start with a constant thirst, difficulty in speaking, eating, tasting and swallowing foods and progress to tooth decay and oral infections.[28] The most common salivary gland disorder is xerostomia, which is the subjective feeling of dryness throughout the mouth.

**Figure 4: Factors affecting the development of dental caries**

**Inside the mouth**

- Bacterial composition of the biofilm
- Plaque pH
- Salivary flow rate (stimulated and unstimulated)
- Buffering effect of saliva
- Food retention
- Inorganic compounds ($Ca^{2+}$ and $PO_4^{3-}$)



**Outside the mouth**

***General health***

- Medical history
- Hormones
- Age
- Genetic heritage
- Medical treatment

***Environment***

- Diet
- Frequency of eating
- Oral hygiene
- Fluoride

**Figure 5: Salivary glands and saliva function**

**Minor salivary glands** in lips and oral mucosa (especially buccal) are collectively responsible for 8-10% of unstimulated salivary flow.

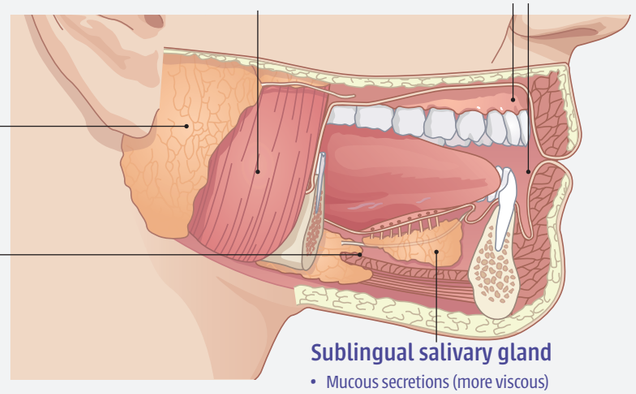
### Parotid salivary gland

- Serous, watery secretions
- **High inorganic content (calcium, bicarbonate)**
- Responsible for 20% of unstimulated salivary flow

This proportion rises to 50-60% for stimulated salivary flow

### Submandibular salivary gland

- Mixture of serous and mucous secretions
- Responsible for 65% of unstimulated salivary flow



### Sublingual salivary gland

- Mucous secretions (more viscous)
- Responsible for 5-7% of unstimulated salivary flow

## Xerostomia

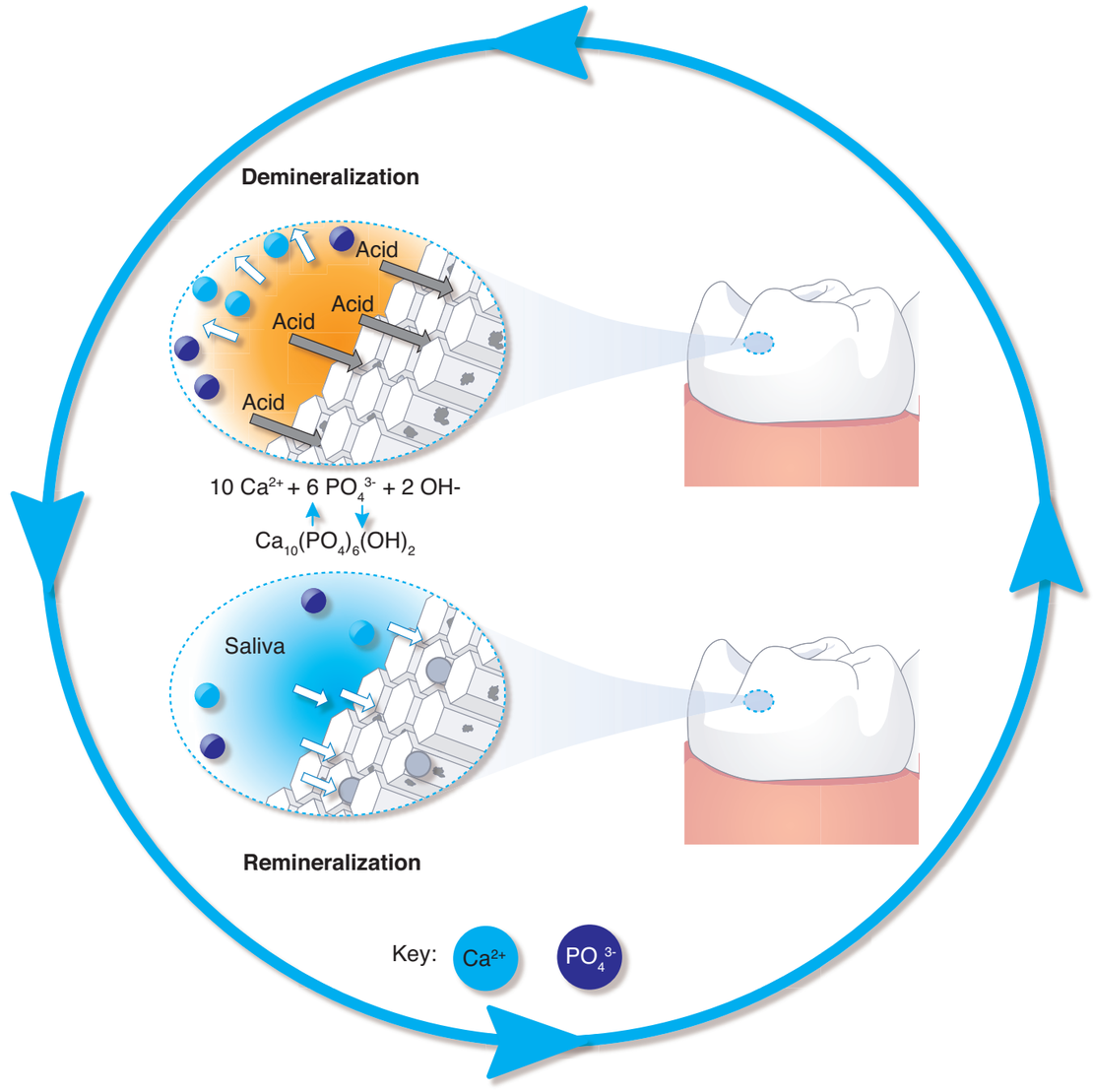
The prevalence of xerostomia in population based studies ranges from 10 to 46%, with a lower prevalence for men than women.[29] Salivary flow rate patterns demonstrate both daily and seasonal variation, with peaks in mid-afternoon and higher flow rates in the winter than in the summer. During sleep, saliva flow rate is minimal.[30] People who complain of dry mouth do not necessarily have a very low flow rate; conversely, those with a low unstimulated flow rate do not always complain of dry mouth. It is therefore of greater significance to establish whether or not the flow rate has changed adversely in a particular individual.[31]

Reduced salivary flow is due to hypofunction of the salivary glands. This may be reversible, due to anxiety, acute infection, dehydration or the effects of some drugs. There are also some permanent causes of xerostomia such as congenital abnormalities, Sjögren's syndrome, HIV/AIDS and the result of head and neck irradiation. However, xerostomia is most commonly associated with the use of xerogenic drugs. More than 400 medicines induce salivary gland hypofunction, including tricyclic antidepressants, antihistamines, certain antihypertensives and drugs with sympathomimetic actions (e.g. some bronchodilators).[32]

In the past, it was commonly believed that dry mouth and declining salivary function were purely a natural consequence of aging. While it is true that salivary gland dysfunctions are more prevalent in older populations, studies suggest that salivary gland dysfunction is due to a combination of aging per se and the higher incidence of chronic illnesses and the greater use of drugs by the aging population – both of which can impact the production of saliva.[33]



**Figure 6: The process of tooth remineralization**



# The oral care benefits of sugar-free gum

Clinical studies have shown that chewing gum stimulates the salivary glands to produce a strong flow of saliva.[10] Chewing gum is a unique food because it is chewed for a prolonged period (often around 20 minutes), while at the same time it contributes relatively few calories. As this chapter will illustrate, chewing sugar-free gum enhances production of saliva and its oral health benefits, namely: clearing the mouth of food debris and sugars, neutralizing acids, and supporting remineralization. Research shows that people who regularly chew sugar-free gum develop significantly fewer cavities than those who do not.[11]

## Debris removal and plaque neutralization

When gum is chewed by healthy subjects, the flow of saliva increases to around 10-12 times the resting rate.[10] The effect of stimulation is to increase the concentration of bicarbonate in the saliva entering the mouth. This bicarbonate raises the pH of the saliva and greatly increases its buffering power; the saliva is, therefore, much more effective in neutralizing and buffering food acids and acids arising in plaque from the fermentation of carbohydrate. At the same time, the phosphate of saliva changes as a result of the rise in pH, so that a higher proportion of it is in the form of $PO4^{3-}$ The calcium content of saliva rises as well.[23]

These changes in the composition of stimulated saliva lead to a greater ability to prevent a fall in pH and a greater tendency to favor hydroxyapatite crystal growth.[24] In addition, the greater volume and rate of flow of stimulated saliva results in an increased ability to clear sugars and acids from around the teeth.[24] These three properties of saliva are correlated to the caries susceptibility of the individual and are all enhanced by salivary stimulation.

After fermentable carbohydrates are consumed, plaque pH drops rapidly and within 3-5 minutes falls below the critical value of 5.5. It remains below the critical value for around 20 minutes, before gradually returning to normal – see Figure 2.[9,15] The action of stimulated saliva is therefore most important during the plaque acid threat during the 20-30 minutes after a cariogenic food intake. However, with most foods, salivary stimulation ceases shortly after the final swallow and salivary composition returns to normal in less than 5 minutes, so the protective effects are not mobilized when most needed.

In order to enhance salivary protection during the acid exposure, a stimulant is needed which is not itself cariogenic and the effects of which last as long as possible.[34] Sugar-free chewing gum is a very practical and acceptable stimulus that can be chewed after the intake of fermentable carbohydrates, and brings no undue calories. Several studies have shown that chewing sugar-free gum stimulates saliva production which can last up to two hours.[31]



## Enhancing remineralization

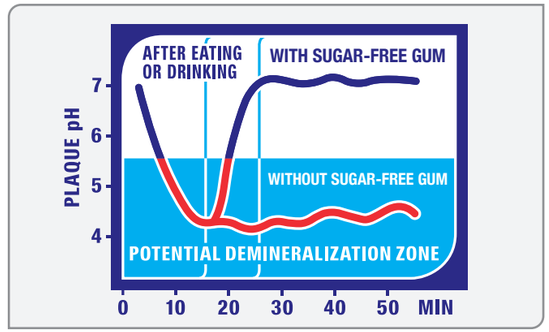
The concentrations of ions which make up the lattice structure of hydroxyapatite ($Ca2+$, $PO43-$, $OH-$) are higher in stimulated than in unstimulated saliva; thus stimulated saliva is a more effective medium for remineralizing enamel crystals damaged by initial acid exposure. In an in situ caries study by Leach et al.[35] subjects chewed sorbitol gum for 20 minutes after meals and snacks (five times daily). The gain or loss of mineral content of human enamel slabs, bearing artificial lesions and mounted intra-orally for 3 weeks, was then measured and compared with results after similar periods without gum chewing.

Remineralization of the enamel lesions occurred both with and without gum, but with gum the remineralization was approximately doubled.
A similar experiment demonstrated that, even with sucrose gum, remineralization was significant with a 30 minute chewing period, but not after a 20 minute chewing period.[36]

These reports were broadly confirmed by Creanor et al.[37] and are consistent with a reduction in enamel demineralization (measured as iodide penetration) by chewing sorbitol gum, as found by Kashket et al.[38] The findings of Steinberg et al.[39] further support these studies; briefly that six-week use of sugar-free gum (sweetened with either xylitol or sorbitol) resulted in an increase in plaque calcium and a significant reduction in plaque index, compared with no gum. Remineralization in vivo is generally considered to be a slow process[40] and significant remineralization occurred within 3 weeks. These model experiments suggest that sugar-free gum use can help prevent decay by tilting the equilibrium towards remineralization and away from demineralization.

Furthermore, the use of sugar-free gum has been associated with a reduction in the quantity and development of plaque,[41] and a reduction in the acid-forming ability of plaque.[42]

**Figure 7: Chewing sugar-free gum for twenty minutes after meals and snacks has been proven to help keep teeth healthy[35,37,38,39]**




# Polyols and sugar-free gum

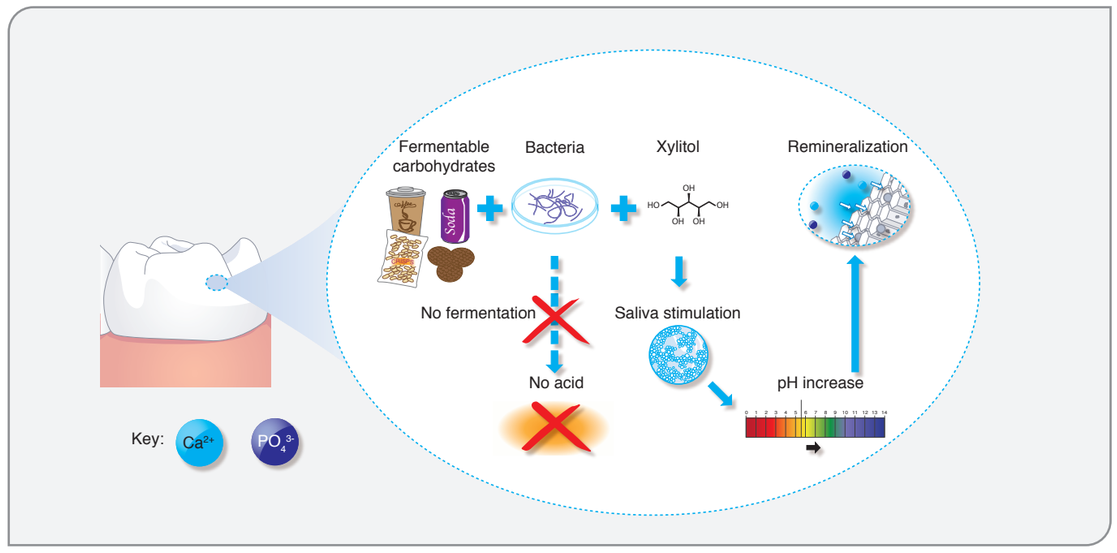
**Sugar-free gums are traditionally sweetened with polyol (sugar alcohol) sweeteners. Examples of polyols include sorbitol, mannitol, xylitol, and blends of these compounds.[43] Polyols have a positive impact on oral health: they help to stimulate production of saliva and do not cause a drop in plaque pH.[44] The net result is an increase in the plaque pH, thereby protecting teeth after eating and drinking. Two recent systematic reviews have concluded that the regular use of polyol combination chewing gum leads to a reduction in dental caries and is an effective addition to oral health regimens.[11,45]**

## Xylitol

Xylitol is a five-carbon sugar polyol that is approved for use in foods, pharmaceuticals, and oral health products in more than 35 countries around the world. It occurs naturally in small amounts and is the constituent of many plants, including fruits and vegetables such as raspberries, strawberries, plums, lettuce, mushrooms, cauliflower and trees.

It is also produced through microbial processes, including fermentation and enzymatic processes in bacteria, fungi, and yeast.[46] In fact a human adult can make as much as 15 grams of xylitol per day as a by-product of normal glucose metabolism.[47] It can also be manufactured, which is the predominant method of obtaining xylitol today. In comparison to other forms of sweetener, including sorbitol and other six-carbon alternative sweeteners, xylitol is bacteriostatic, inhibiting the growth of bacteria.[48]

**Figure 8: The role of xylitol in remineralization**




The oral health benefits of xylitol relate to its impact on Mutans Streptococci (MS) in the plaque and saliva. Research demonstrates that xylitol disrupts the energy production processes of MS, leading to growth inhibition and reductions in their oral salivary counts. Additionally, studies have shown that people who consumed clinically effective levels of xylitol demonstrated MS strains which had a reduced capacity to adhere to teeth and a reduction in other bacteriological properties (e.g. less acid production).[49] A systematic review of randomized controlled trials with adults and children where chewing xylitol containing sugar-free gum was the main intervention showed that it reduces the load of Mutans Streptococci in the oral cavity in comparison to non-chewing controls. Due to the range of impact seen in these trials, more research is needed to learn the exact dose of xylitol to be provided in each piece of gum.[45]

These benefits of xylitol are particularly relevant in the context of modern eating habits. Around the world, people are eating more frequently throughout the day – a trend which has been accelerated by the COVID-19 pandemic – which puts teeth at higher risk of decay.[17,18] Plaque pH falls due to bacterial acid production after eating or drinking fermentable carbohydrates. When used in oral care products such as sugar-free gum, xylitol can help change the bacterial environment in the mouth and help keep teeth healthy after eating and drinking.

Given its antimicrobial effects on *Mutans Streptococci*, scientists have conducted numerous studies to determine whether xylitol has a specific and superior effect on dental caries relative to other polyol sweeteners. Clinical studies have demonstrated a decrease in caries in children exposed to xylitol,[50,51] and long-term benefits in caries reduction have been demonstrated up to five years after a person ceased consuming xylitol.[52,53] Xylitol has been shown to work most effectively on erupting teeth,[53] and some evidence suggests that pregnant women and nursing mothers who consume xylitol may reduce the acquisition of *S. mutans* and dental caries by their children.[54] A study published in 2017 showed an advantage for gum containing a low dose of xylitol over polyol gum containing no xylitol, with subjects in the xylitol group presenting significantly lower caries increment after one year.[55]

A 2006 review suggested xylitol-sweetened gum may have an anticariogenic effect, concluding that the evidence is strong enough to support its regular use as a way to prevent caries.[56] However, a more recent narrative review was less assertive and concluded that evidence for superior noncariogenicity of xylitol over other sugar alcohols is not sufficient.[57] Further study is needed to establish whether xylitol has an anticariogenic advantage in comparison to other sweeteners.

A 2013 systematic review showed that the use of sugar-free chewing gum provides a small but significant reduction in plaque scores,[41] and this is supported by a recent randomized controlled trial in children consuming sugar-free gum sweetened with sorbitol and xylitol which showed a small but significant reduction in both plaque and gingival scores.[58] Again, further research is needed to establish whether this effect is clinically relevant.

# The health economic benefits of sugar-free gum

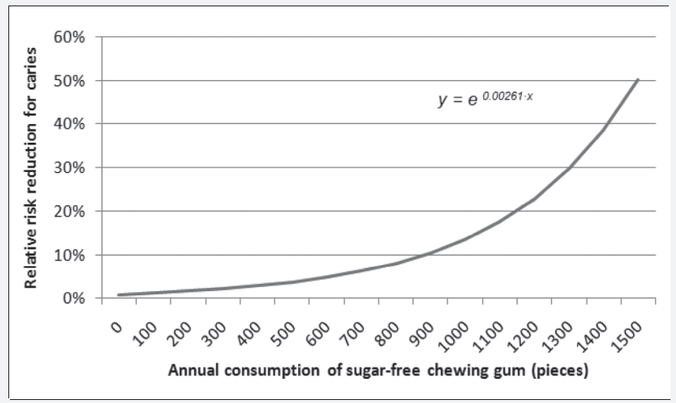
**The global economic burden of caries treatment is significant. A recent analysis of published data conducted on behalf of the non-profit Alliance for a Cavity-Free Future estimated that the combined direct and indirect costs total as much as $245 billion.[59] The caries-preventive effects of regular use of sugar-free chewing gum may have significant economic advantages with high savings on health expenditures due to treatment of caries.**

## Potential cost savings

A 2017 economic modelling study analysed the effect that increasing the average consumption of sugar-free gum would have on dental expenditures due to caries in 25 industrialized countries representing 77.1% of global GDP. The share of dental costs that account for treatment of caries were estimated based on expert opinion or governmental data.[60]

The modelling demonstrated that increasing sugar-free gum consumption by one more piece per day (seven pieces per week), in addition to a complete oral hygiene routine, could lead to $4.1 billion savings in dental care costs worldwide annually due to caries prevention. It was noted that countries which already have a high level of sugar-free gum consumption would profit the most from any such increase.[60]

Figure 9: Relationship between annual SFG consumption and relative risk reduction for caries. Exponential approach.




Similar studies focusing on specific markets have also shown that chewing sugar-free gum can help reduce the burden of treating dental disease. A paper published in 2016 found that if all members of the 12-year-old population in the UK chewed sugar-free gum after each meal (three times per day), the subsequent prevention of dental caries could save the National Health Service £8.2 million each year.[61]

A separate study published two years later found that elevating the level of chewing gum consumption per capita in Germany to that of Finland, a country with a much higher level (202 pieces of gum per year compared to 111 pieces per year in Germany), could result in annual per capita savings of more than €80.[62]

# Recognition and endorsement of sugar-free gum

**The important role of sugar-free gum in oral care is widely recognized and accepted by experts, dental associations and regulatory authorities around the world.**

## The European Commission

The European Commission (EC) has approved six oral health claims for sugar-free chewing gum[63] one of the few food categories to gain such recognition. A health claim states, suggests or implies that a relationship exists between a food category, or one of its constituents and health; they are required to be clear, accurate and evidence-based.

### Three claims: general function (EC authorized Article 13 claim)

1. Sugar-free chewing gum contributes to the neutralization of plaque acids.
2. Sugar-free chewing gum contributes to the maintenance of tooth mineralization.
3. Sugar-free chewing gum contributes to the reduction of oral dryness.

### Three claims: disease risk reduction (EC authorized Article 14 claim)

1. Chewing sugar-free gum helps neutralize plaque acids. Plaque acids are a risk factor in the development of dental caries.
2. Chewing sugar-free gum helps reduce tooth demineralization. Tooth demineralization is a risk factor in the development of dental caries.
3. Chewing gum sweetened with 100% xylitol has been shown to reduce dental plaque. High content/level of dental plaque is a risk factor in the development of caries in children.

## Health Canada

Health Canada went further with their advice, concluding in 2014 that scientific evidence exists to support a claim about sugar-free chewing gum and dental caries risk reduction. This claim is considered relevant and applicable to the general population of Canada, since dental caries often begins to develop during childhood and continue into adulthood. The prevalence of dental caries is much higher in adults than in children, and the process of caries development is the same in adults and children.

### Health Claim

Chewing sugar-free gum, three times per day after eating/meals, helps reduce/lower the risk of dental caries/tooth decay/cavities.[64]



## Association of the Scientific Medical Professional Societies in Germany

Federal guidelines, issued in 2016 by the Association of the Scientific Medical Professional Societies in Germany to aid dentists in decision making, recommended that people regularly chew sugar-free gum, especially after meals, to protect teeth from caries. The guidelines cite numerous studies and systematic reviews which demonstrate the role of sugar-free gum in stimulating saliva production and reducing caries incidence and progression.

### Health Claim

Regular chewing of sugar-free gum can contribute additionally to caries prevention and therefore, can be recommended especially after meals.[65]

## Australia's National Oral Health Plan 2015-2024

Chewing sugar-free gum is one of the 11 evidence-based oral health promotion messages developed in 2009 for the Australian public and included in Australia's National Oral Health Plan 2015-2024, which aims to improve health and wellbeing across the Australian population by reducing the burden of poor oral health.

### Health Claim

Chewing sugar-free gum can reduce dental decay.[66]

## Additional recognition of the benefits of sugar-free gum

The oral care benefits of chewing sugar-free gum are also recognized by the World Dental Federation (FDI). In its 2014 white paper, entitled 'Oral Health Worldwide',[67] the FDI specifically recommended sugar-free gum as a simple and effective way for families and individuals to improve their oral health, alongside other equally essential oral care behaviors such as brushing teeth twice daily and using fluoride toothpaste. Furthermore, the oral care benefits of chewing sugar-free gum are supported by more than 20 national dental or dental health associations worldwide.

"Chewing sugar-free gum, like Extra, is proven to benefit dental health as it helps neutralize plaque acids."- FDI

# Frequently asked questions

**Does chewing gum cause Temporomandibular joint disorders?**
Temporomandibular joint (TMJ) disorders are a cluster of related conditions affecting the masticatory muscles, the TMJ and associated structures. Around 1 in 10 people in the general population have symptoms and signs of TMJ disorders.[68] The level of disorders of the temporomandibular joint and muscles of mastication and how people respond to them vary widely and the causes of TMJ disorders are not fully understood. Trauma, malocclusion and bruxism have been implicated but evidence is weak and only a small proportion of people with these disorders develop TMJ disorders.[69] There have also been suggestions that psychological factors are involved but, while they may be exacerbating or maintaining factors, they are not likely to be causal. Research has found no evidence to suggest a causal link between gum chewing and TMJ disorders.

**What happens to gum that is swallowed?**
Gum is not designed to be swallowed. However, if it is, it simply passes through the gastrointestinal system within a few days, similar to roughage.

**Are ingredients in sugar-free gum bad for one's health?**
Chewing gum is made of five basic ingredients – sweeteners, softeners, flavors, gum base, and colors. All of the ingredients used in Wrigley's products are safe for consumption and meet high domestic and international food regulations.

**Can chewing sugar-free gum help with weight loss?**
Certain studies have suggested that some people may experience reduced desire to snack between meals when chewing sugar-free gum. However, there is no specific evidence to suggest a correlation between chewing sugar-free gum and the achievement or maintenance of a healthy weight.

**Is it safe to chew sugar-free gum while wearing braces or dentures?**
All Wrigley's chewing gums are now specially formulated to stick even less to most dental work and teeth. However, there is no clinical evidence to support Wrigley's sugar-free gum as the most non-stick gum for denture wearers. It is advised that patients try various Wrigley sugar-free brands and formats in order to establish which feels best for them.

**Does sugar-free gum provide relief for patients with xerostomia?** [70,71]
There have been a number of studies that have shown that chewing gum increases salivary flow in patients with xerostomia (subjective feeling of dryness throughout the mouth) of varying etiology. Research suggests that in xerostomic patients, the initial stimulated salivary flow rate while chewing sugar-free gum is seven times greater than the unstimulated flow rate. Chewing sugar-free gum has been shown to be one of the most preferred treatments for xerostomia.

**Is there an association between chewing gum and bruxism?**
Sleep bruxism is characterized by the grinding or clenching of the teeth during sleep. The cause of bruxism remains unclear, but it has been associated with several factors including tooth interference, psychosocial and environmental factors. It has been suggested that there is a link between chewing gum and bruxism, and several consumer health websites recommend that patients suffering from bruxism should stop chewing gum. Whilst there is no clinical evidence to support the link – nor the recommendations to stop chewing gum – it is, nonetheless, widely accepted that sufferers should avoid all unnecessary chewing in order not to exacerbate their condition.

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