Module 2: Nutrition-Related Risk Factors for Dental Caries

INTRODUCTION

The development of dental caries is multi-factorial. Many of the risk factors are related to a child’s dietary intake and/or nutritional status. This module reviews some of the risk factors for dental caries. Treatment strategies were reviewed in Module 1, and prevention is discussed in Module 4.

After completing this module, you should be able to:

? Describe diet-related risk factors for dental caries
? Discuss the effect of sucrose intake on caries development
? Identify specific foods and food combinations that are protective against dental caries development
? Identify specific foods that increase risk of caries development
? Describe eating patterns that can increase caries risk

Caries Triad: host – food – bacteria
Dental caries results when 3 factors come together:

1. Host – The first requirement for dental caries is a susceptible host – a mouth with teeth.
2. Food – Food, specifically carbohydrate-containing food, is the second requirement for dental caries. Carbohydrates include simple sugars (e.g., sucrose) and complex carbohydrates (e.g., starches).
3. Bacteria – Bacteria (most often mutans streptococci, or S. mutans) are the third requirement.

When all 3 factors are present, caries can result: Bacteria are introduced to the host, and “feed” on carbohydrates in the mouth. As the bacteria break down the carbohydrate, organic acid is formed; this acid demineralizes tooth enamel. The bacteria multiply on the tooth’s surface and form dental plaque.

To review the process of caries development in more detail, see Module 1
Diet-Related Risk Factors

Diet-related risk factors are related to an individual’s intake of foods, including the cariogenicity of specific foods consumed and frequency of meals and snacks.

Intake of sugar

Intake of sugar, specifically sucrose, has been linked to the development of dental caries. Three classic studies show an increased prevalence and incidence of caries with increased frequency of sucrose intake. (Gustafsson, Harris, Scheinen)

Sugar consumption increases the number of exposures and the amount of time that enamel is exposed to acid produced by mutans streptococci. In addition, it is thought that frequent exposure will cause the plaque to become more bulky and to serve as an energy source even between snacking events. (Palmer)

More recent studies, conducted since the widespread water fluoridation, do not always demonstrate a clear relationship between sucrose consumption and caries development. One UK study found that intake of sugar was associated with increased caries only among children who brushed their teeth fewer than two times per day, and this has been supported by other studies. (Gibson, Touger-Decker)

Given the relationship between sugar, acid production, and dental caries and the fact that many sweetened foods are not nutrient-dense, many dental and nutritional guidelines consider frequent intake of sucrose to be a risk factor for the development of caries. (Tinanoff, Burt, Touger-Decker)

Diet sodas, although usually sugar-free, can be cariogenic because of their acidity. (See below)
Read more about sugar and dental caries: Is Sugar Bad?

The effect of the consumption of simple sugars (sucrose, dextrose, and fructose) on rates of dental caries has generated some debate in the dental literature. Classic studies indicate that caries incidence can be directly linked to amount and frequency of sucrose consumption (Gustafsson, Harris, Scheinen). More recent studies, since widespread fluoridation of the water supply was started and other fluoride supplements and dentifrices used, indicate that the relationship is more complex.

Sucrose is bad
Biochemically, the argument for the cariogenic effects of simple sugars is sound. The metabolic by-products of sucrose, fructose and glucose by mutans streptococci lead to enamel demineralization. In addition, extracellular polysaccharides, by-products of sucrose metabolism, increase the adherence of mutans streptococci to smooth enamel surfaces. (Burt) Sucrose may also affect the levels of fluoride, calcium, and phosphorus in dental plaque. (Nobre dos Santos)

A 2001 review article compares the increase in added simple sugars to increased caries rates and concludes that "sugar excess" has deleterious effects on oral health, including caries. The author calls for a decrease in intake of sugars and for parents to model "good nutrition" by eating more fruits and vegetables and less refined sugar. (Falco)

Sucrose may not be so bad after all
Epidemiological data show that caries rates decline, even as sucrose (and other sugars) consumption increases or stays the same. (Marthaler) For this reason, it cannot necessarily be concluded that sugar alone leads to increased caries. Instead, cariogenicity is likely influenced by amount and frequency of consumption, type(s) of food, and oral hygiene practices. (Touger-Decker)

The bottom line
It appears that while consumption of sugar under conditions in most industrialized countries is not by itself a major risk factor for caries, it may be for a small group of susceptible children (those who still get proximal-surface of smooth-surface caries). (Burt)

Most investigators are in agreement that, although it is not the only factor, consumption of sugar and other fermentable carbohydrates does play a role in the development of caries, along with fluoride use, oral hygiene, and protection from saliva. The "window of risk" model was developed to describe this.

Recommendations
Individualized counseling about decreasing sugar (and other fermentable carbohydrate) intake for children who are more susceptible to caries has been suggested, along with community-based efforts to promote food patterns that are consistent with general "healthy eating" guidelines. (Burt, Touger-Decker) The US Dietary Guidelines for Americans also suggest moderate use of added sugars. Another resource suggests limiting foods with added simple sugars to fewer than 12 servings (or 40 grams) per day. (Mobley) Dietary recommendations should also include information about frequency of eating and duration of exposure and the presence of buffers, such as calcium. (Touger-Decker)

Intake of other carbohydrates
Carbohydrates other than sucrose are thought to have varying cariogenic potential. Alone, starches have low cariogenicity. However, risk is increased when sucrose is added to starch or when the starch is processed at a high temperature. (Palmer, Touger-Decker)
Intake of acidic foods
Increased risk of dental caries and/or enamel dissolution has been associated with long-term, frequent intakes of acidic foods, including:

- beverages (e.g., carbonated beverages, sports drinks, citrus juices) (O’Sullivan, Palmer, von Fraunhofer)
- vinegar (O’Sullivan)
- citrus fruits (Palmer)
- snacks containing citric acid and other acidic foods, (O’Sullivan, Palmer, Touger-Decker)
- chewable vitamin C tablets (Palmer)

This risk can be increased with xerostomia and gastroesophageal reflux disease. (See Module 3) (Palmer)

Intake of milk and water
Low milk and water intakes have been associated with an increased risk for caries as well. (O’Sullivan) Caries risk has also been shown to decrease with larger amounts of water and milk consumption after 24 months of age. (Levy) One possible explanation is that milk or water is replaced by soft drinks or other sweetened beverages. (O’Sullivan) Increased caries risk has been associated with larger amounts of non-water beverages (soda, sports drinks, and juice drinks) very early in life. (Levy, von Fraunhofer)

Food combinations
Combinations of foods can have protective effects against caries. For example, caries potential is decreased if a sweet food is combined with a source of protein or fat. A food containing calcium or fluoride may help to promote remineralization. (Palmer, Kashket, Edmondson) Other cariostatic foods and food components include:

- phytate/fiber (Edmondson)
- protein (Edmondson)
- neutral agents with buffering capacity
- milk (although lactose is cariogenic, calcium and phosphorus help protect the enamel)
- cheese (Palmer, Touger-Decker, Kashket)

Read more about the potential protective effects of cheese.

Protective effects of cheese
Remineralization can be enhanced by foods that are high in calcium, phosphate, and protein. Cheese has been found to be “anticariogenic” and protective against coronal and root caries.

Proposed mechanisms for the protective effects of cheese include:

- buffering effect against acid – plaque pH of individuals who chewed cheddar cheese after eating a sugary food returned toward neutrality faster than that of individuals who did not eat cheese. Aged cheeses prevented drop in pH more than non-aged cheeses.
- increased salivary flow (and thus, a protective buffer against plaque acids)
- inhibition of plaque bacteria
- enhanced remineralization effects of calcium, phosphate, and casein (Kashket)

In addition, it is thought that xylitol (usually in the form of xylitol-containing chewing gum) is protective against caries. This is discussed in more detail in Module 4.
Textures
The textures of foods consumed may add to a child’s risk of developing caries. Foods that dissolve slowly (e.g., hard candy, fruit roll ups) may expose the teeth to acid for an extended period of time, while liquids generally pass through the mouth quickly. Some foods that are thought to be retentive (e.g., jelly beans, raisins) actually clear relatively quickly, while other foods (e.g., crackers or pretzels) may stay on the teeth longer. (Palmer, Touger-Decker, Edmondson)

Read more: For a list of foods and their cariogenic potential, see Module 4, Table 4-1.

Eating patterns
Some eating patterns have been identified as risk factors, likely because of the potential for increased exposure of the enamel to acid. For example, swishing or holding beverages or food in the mouth for an extended period of time may increase caries risk. (O’Sullivan, Touger-Decker) Frequent meals and snacks can also increase caries risk, if the teeth are exposed to a low pH for a longer period of time. (Edmondson) Sipping on sweetened beverages (e.g., juices, milk, and other drinks from a sippy cup) throughout the day and, for older children, chewing sugared gum increases caries risk. Sleeping with a bottle or breastfeeding at will throughout the night is also considered a risk factor. (AAP)

Figure: sleeping with a bottle

Nutritional status
Three studies (2 cross-sectional and 1 longitudinal) of children in Peru indicate that malnutrition during the first year of life can increase the risk of caries in primary and permanent teeth. (Alvarez, Ismail)

Other risk factors
Other, non-diet related factors indicate risk of oral health problems. These include presence of mutans streptococci, previous caries, structural indicators, special health care needs, socioeconomic status, and lack of access to care. These risk factors are reviewed in Module 1.

PRACTICAL APPLICATIONS
Identify the nutrition- and non-nutrition- related risk factors for caries as well as the protective factors.

Case example: Justine
Justine is a 5-year old who lives in a rural area. She has had some caries in the past. Justine eats foods with a variety of textures and generally eats only at meal and snack time. She is encouraged to snack on foods that are not sweet (e.g., pretzels, crackers, and cheese) between meals and is offered sweet foods at meals that can be followed by
toothbrushing. Justine’s family’s well often runs dry during the summer months, so they use bottled water for drinking.

**Case example: Aaron**
Aaron is a 9-month old who is being seen for routine well child care. His mother is concerned about his teeth, but says that she expects he will have oral health problems because everyone in her family has bad teeth. A brief oral examination reveals white spots on two of Aaron’s teeth. He drinks formula from a bottle and juice from a sippy cup. His mother gives him a bottle with water at bedtime. When he is fussy or needs to be calmed down, he is offered goldfish crackers or graham crackers; mom estimates this is about 6 or 7 times per day. Aaron’s older brother is sipping juice from a water bottle during the visit.

**Table 2-1 Risk Factors for Oral Health Problems**

<table>
<thead>
<tr>
<th>RISK FACTOR</th>
<th>COMMENTS</th>
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<tbody>
<tr>
<td><strong>Diet-related Risk Factors</strong></td>
<td>Most of the diet-related risk factors are related to the amount of time teeth are exposed to acid.</td>
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<tr>
<td>Excessive sugar intake</td>
<td>Poses increased risk, especially if fluoride intake, oral hygiene is inadequate</td>
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<td>Excessive intake of sucrose + starch or starches processed at high temperatures</td>
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<tr>
<td>Long-term, excessive intake of acidic foods (e.g., carbonated beverages, sports drinks, citrus juices, vinegar, chewable vitamin C)</td>
<td>Risk is increased with xerostomia and gastroesophageal disease</td>
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<tr>
<td>Low intake of milk and water</td>
<td>Soft drinks and/or other sweetened beverages often replace milk or water</td>
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<td>Frequent intake of foods that dissolve slowly in the mouth (e.g., hard candy)</td>
<td></td>
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<tr>
<td>Swishing or holding beverages or food in the mouth for an extended period of time</td>
<td></td>
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<tr>
<td>Sleeping with a bottle or breastfeeding at-will throughout the night</td>
<td></td>
</tr>
<tr>
<td>Poor nutritional status</td>
<td>Especially early in life, malnutrition can increase caries risk in primary and permanent teeth</td>
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<tr>
<td><strong>Non-diet-related Risk Factors</strong></td>
<td></td>
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<tr>
<td><em>Mutans streptococci</em></td>
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<tr>
<td>Previous caries experience</td>
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<tr>
<td>High caries rate in mother or sibling</td>
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<tr>
<td>White spot lesions, visible plaque, demineralization, or staining</td>
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<tr>
<td>Special health care need(s)</td>
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<tr>
<td>Low socioeconomic status, barriers to oral health care</td>
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<tr>
<td>Decreased salivary flow</td>
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</table>
**QUIZ**

(1) Sucrose consumption is a risk factor for the development of dental caries because it:
   a. Is acidic
   b. Decreases saliva production
   c. Leads to a decreased intake of fluoride-containing foods
   d. Has the potential to increase acid exposure to teeth, especially with frequent intake

(2) Increased risk of caries has been associated with which of the following:
   a. Increased intake of acidic foods
   b. Increased intake of milk and water
   c. Decreased intake of vitamin C
   d. Decreased intake of sports beverages

(3) If a sweet food is consumed, it is best to:
   a. Consume it quickly
   b. Consume it between meals
   c. Pair it with a source of vitamin C
   d. Pair it with a source of protein or fat

(4) True or false: A food containing vitamin D and phosphorus may help to promote remineralization
   a. True
   b. False

(5) Which food is likely to be MOST cariogenic:
   a. Cheese
   b. Diet soda
   c. Hard candy
   d. Jelly beans

(6) Which food is likely to be LEAST cariogenic:
   a. Cheese
   b. Diet soda
   c. Hard candy
   d. Jelly beans

(7) Which of the following practices is MOST likely to contribute to caries:
   a. Chewing sugarless gum
   b. Drinking a soda with lunch
   c. Eating a slice of cheese for a snack
   d. Snacking on pretzels throughout the day
(8) Which of the following is NOT a risk factor for caries:
   a. Presence of mutans streptococci
   b. Previous caries experience
   c. Malnutrition during the first year of life
   d. Bottle-feeding with a standard infant formula

(9) True or false: Special health care needs can place a child at higher risk for developing oral health problems
   a. True
   b. False

(10) Which of the following indicates increased caries risk:
   a. Deep overbite
   b. Pink mucosa
   c. Increased saliva production
   d. White spot lesions and visible plaque

REFERENCES


**RESOURCES**

**Nutrition-specific**

**Soundbites: Nutrition and oral health guidelines for pregnant women, infants, and young children**

This videotape and video guidebook are designed to help promote good nutrition and oral health for pregnant women, infants, children, and infants’ and children’s caregivers. The videotape discusses common oral health topics, including care of the mouth, nutrition to promote good oral health, and how to prevent common childhood oral health problems. $50.

To order, contact Carole Palmer, Tufts-New England Medical Center, Frances Stern Nutrition Center; telephone: 617/636-6808 or email carole.palmer@tufts.edu.

**Dietary screening and assessment questions for dental settings**

This article includes questions and guidelines for interpretation that have been validated for dietary screening in dental settings and is also a useful review of the diet- and nutrition-related issues around dental caries.

**Clinical and laboratory assessment of nutrition status in dental practice**

This article reviews the relationship between nutrition and oral health and includes criteria useful in screening for nutritional risk.

**Dietary Guidelines for Americans, 2005**

The full-text document, an executive summary, and supporting documents and resources for the 2005 Dietary Guidelines are available online: http://www.healthierus.gov/dietaryguidelines.

**Prevention**

**Share the Care – Dental Health Initiative of San Diego**
Share the Care Dental Health Initiative of San Diego is a partnership between the County of San Diego Health and Human Services Agency, the San Diego County Dental Society, and the San Diego County Dental Health Coalition. It provides access to emergency dental care for children and offers offer information and education to professionals, parents, and children to foster ongoing preventive dental care.
Referrals for dental care can be made by school nurses and health assistants, health clinics, and community agencies. Children ages 5-18 years who are eligible for free or reduced school lunch and do not have resources for dental care are eligible.

Dental Health resources are available on the website and include brochures, curricula and activities related to dental health, nutrition, dental safety, and training materials

http://www.sharethecaredental.org; telephone: 619/692-8858