

Review Article

## A Critical Appraisal of Diet and Nutrition on Oral Health in Children- A Review

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### ABSTRACT

Oral health is related to diet in many ways, for example, nutritional influences on craniofacial development, oral cancer and oral infectious diseases. Nutrition affects the teeth during development and malnutrition may exacerbate periodontal and oral infectious diseases. However, the most significant effect of nutrition on teeth is the local action of diet in the mouth on the development of dental caries and also enamel erosion. Despite improved trends in levels of dental caries in developed countries, dental caries remains prevalent and is increasing in developing countries *undergoing nutrition transition*. Dental caries is the most common chronic disease of childhood and is five times more frequent than asthma, which is the second most chronic disease. Problems with oral health affect all children. However, the importance of oral health for children with special health care needs is particularly relevant.

**Keywords:** diet, nutrition, oral health, dental caries

### INTRODUCTION

Oral health refers to a state of having a full set of intact teeth, healthy gums, no oral pain and no oral disease (including but not limited to caries, periodontitis, xerostomia etc.). Oral health is critical to overall health and quality of life <sup>[1, 2]</sup> and there is a direct connection between oral health and food intake. Although the oral health has dramatically improved in the last 50 years, dental caries and periodontal disease still continue to be a major problem.

The main cause of tooth loss is dental caries in which diet plays an important role. In modern societies, diet and nutrition play a relatively minor role in the etiology of periodontal diseases.

Tooth development begins shortly after conception, usually between the sixth and eighth weeks of gestation and continues throughout the pregnancy. It seems to take severe nutritional deficiencies in the mother to cause obvious changes in the tooth formation of child. Nutritional status and

nutrient intake are critical to good oral health. Inadequate intake of energy and protein can delay tooth eruption, affect tooth size and enamel solubility, and cause salivary gland dysfunction. Calcium and vitamin-D are important to the mineralization process, and deficiencies can lead to compromised tooth integrity and delayed eruption patterns. Fluoride is important to enamel formation, inhibits demineralization, stimulates remineralization and inhibits bacterial growth. Other nutrients, including vitamin-A, vitamin-C, iodine and iron are also involved in the development and maintenance of oral teeth and other structures. [3,4]

### ***The burden of dental diseases***

Dental diseases are a costly burden to health care services. The treatment of dental caries is expensive for governments of both developed and developing countries; and in most developing low-income countries, the prevalence rate of dental caries is high and more than 90% of caries is untreated. The level of caries is higher for the primary dentition than the permanent dentition for children of several developing countries as shown recently for China, [5] Thailand, [6] Madagascar [7] and Niger. [8] Available data [9] show that the mean DMFT at age 12 years of low-income countries is 1.9 compared with 2.1 DMFT for middle-income countries.

### ***The impact of dental diseases on quality of life***

Despite a low mortality rate associated with dental diseases, they have a considerable impact on self-esteem, eating ability and health both in childhood and also in older age. Teeth apart from enhancing facial appearance, also plays an important role in speech and communication. The second International Collaboration Study of

Oral Health Systems (ICSSI) [10] revealed that substantial numbers of children and adults reported impaired social functioning due to oral disease, such as avoiding laughing or smiling due to poor perceived appearance of teeth; also in addition, dental diseases cause considerable pain and anxiety. [11] Dental caries also results in tooth loss, which reduces the ability to eat a varied diet. It is, in particular, associated with a diet low in fruits, vegetables, non-starch polysaccharides (NSP) and with a low plasma vitamin-C level. [12,13] Tooth loss impedes the achievement of dietary goals related to consumption of fruits, vegetables and NSP. It is, therefore clear that dental diseases have a detrimental effect on quality of life both in childhood and older age.

### ***Oral health problems***

#### ***Dental caries***

Dental caries is the most common oral health problem. It has been called a “*diet-dependent bacterial infectious disease.*” Teeth are most susceptible to dental caries soon after they erupt. Nutritional status affects the teeth during the pre-eruptive stage, however, this nutritional influence is much less important than the post-eruptive local effect of dietary practices on caries formation. Deficiencies of vitamin-D, vitamin-A and protein energy malnutrition (PEM) have been associated with enamel hypoplasia.

Navia [14] states ‘*moderate malnutrition, particularly lack of protein and deficiencies of certain micronutrients such as vitamins, zinc and iron, and can influence the amount and composition of saliva limiting the protective effects it has in the oral cavity.*’

When sugars are ingested, there is a resulting fall in dental plaque pH and demineralization occurs (at pH 5.5, known as *critical pH*).Saliva is a critical protective factor in oral health. [15-17] Among its many

functions, saliva prevents aggregation of bacteria on tooth surfaces, speeds clearance of food particles, sugars and bacteria from the oral cavity, buffers oral acids, promotes remineralization of tooth enamel and depresses cariogenic microorganisms.

*Streptococcus mutans* and *Streptococcus sobrinus* are important bacteria in the development of dental caries. Both these bacteria readily produce organic acids from dietary sugars and like most aciduric bacteria can synthesize insoluble plaque matrix polymers from dietary sugars—a factor that aids bacterial colonization of the tooth surface. Growth of these streptococci requires the presence of fermentable monosaccharides. A low pH in plaque is ideal for aciduric bacteria as they are more competitive at low pH.

#### **Early childhood caries**

Early childhood caries (ECC) has also been called nursing caries, nursing bottle caries and baby bottle tooth decay, and occurs in 10% of 2-year olds. [18] It typically occurs in children whose teeth are exposed to sugary liquids for long periods of time. Children who fall asleep with a bottle in their mouths or who carry a bottle or a sippy cup and drink sweetened liquids throughout the day are at a high risk for ECC. ECC increases the risk of decay in child's permanent teeth. [19]

#### **Periodontal disease**

Periodontal disease, seen primarily in adults, is an oral disease of soft and hard tissues supporting the teeth. Gingivitis and periodontitis are the most common types of periodontal disease. [20] Periodontal disease is linked to the development and progression of systemic diseases such as cardiovascular disease, stroke, diabetes mellitus, respiratory infections, osteoporosis and preterm delivery of low birth weight babies. [21, 22] Although further research is needed, control of periodontal disease may prevent and

manage health problems elsewhere in the body. [23]

Poor oral hygiene is the most important behavioral risk factor for periodontal disease. [23] However, risk for this disease can be increased by host response factors such as genetic predisposition, autoimmune diseases, hormonal changes, diabetes mellitus, obesity and intake of a nutritionally poor diet. An emerging area of research is the relationship among dietary calcium, vitamin-D and dairy foods and risk of periodontal disease. Epidemiological studies suggest that low dietary intake of calcium, vitamin-D or dairy foods is associated with loss of alveolar bone, periodontal disease, tooth loss and osteoporosis. [24-28]

#### **Dental erosion**

Dental erosion is the progressive irreversible loss of dental hard tissue that is chemically etched away from the tooth surface by extrinsic and/ or intrinsic acids and/ or chelation by a process that does not involve bacteria. Erosion is often associated with other forms of tooth wear such as abrasion and attrition. Low salivary flow rate or inadequate buffering capacity is factors that exacerbate erosion. [29, 30] The critical pH of enamel is 5.5 and therefore any drink or food with lower pH may cause erosion. Erosion reduces the size of the teeth and in severe cases leads to total tooth destruction. [30]

#### **Nutrition and oral infectious diseases**

Malnutrition consistently impairs innate and adaptive defenses of the host, including phagocytic function, cell mediated immunity, complement system, secretory antibody, and cytokine production and function. In PEM, there are marked changes in the oral microbial ecology resulting in a preponderance of pathogenic anaerobic organisms, increased propensity of bacteria to bind to oral mucosal cells, attenuation of acute phase protein response, and

dysfunction of the cytokine system. Enwonwu *et al* [31] reviewed the possibility of suspected causative factors; he went on to say that no inflammatory oral lesions underscore the association between malnutrition and oral health especially in cases such as acute necrotizing gingivitis (ANUG) and noma (cancrum oris). ANUG is a craterlike lesion involving the interproximal gingival papillae and predominantly affects impoverished young children (3- 10 years of age) who are generally immunocompromised by malnutrition and common tropical infections. If not properly treated, ANUG and other oral inflammatory lesions in malnourished children may evolve into noma; which is a *dehumanizing orofacial gangrene* that destroys the soft and hard tissues of the oral and paraoral structures.

**Current trends in dental diseases**

**Trends in the prevalence of dental caries**

The extent of epidemiological data varies widely between countries; for many countries there is limited information, and

few countries have undertaken repeated cross-sectional data. Different countries use different methods in epidemiological surveys which may complicate comparison between countries. WHO established a Global Data Bank on Oral Health in 1969 and data continue to be added to this valuable source of dental health information. Table 1 shows the trends in dental caries prevalence for both developed and developing countries for children aged 12 years. From these data, two distinct trends are observed; first, the distinct fall in the prevalence of dental caries in developed countries, and second, the increase in the prevalence in some developing countries that have increased their daily ingestion of sugars.

There are few data available on the dental health status of preschool children largely because many dental health surveys are conducted in schools for convenience. Holm [32] reported that in most of the developing countries and in South-East Asia, children have a high prevalence of dental caries in the deciduous dentition.

Table 1: Shows trends in dental caries levels of 12-year-olds in developed and developing countries

MEAN DMFT PER PERSON AGED 12 YEARS						
Country	year	DMFT	year	DMFT	year	DMFT
<b>DEVELOPED COUNTRIES</b>						
Australia	1956	9.3	1982	2.1	1998	0.8
Japan	1975	5.9	1993	3.6	1999	2.4
Norway	1940	12.0	1979	4.5	1999	1.5
United kingdom	1983	3.1	1993	1.4	1996-97	1.1
United States of America	1946	7.6	1980	2.6	1998	1.4
<b>DEVELOPING COUNTRIES</b>						
Chile	1960	2.6	1978	6.6	1996	4.1
Iran	1974	2.4	1976	4.9	1995	2.0
Mexico	1975	5.3	1991	2.5-5.1	1997	2.5
Philippines	1967	1.4	1981	2.9	1998	4.6
Zaire	1971	0.1	1982	0.3	1987	0.4-1.1

**Trends in dental erosion**

Dental erosion is relatively newly recognized dental problem and which has been related to diet. [33-35] Cate and Imfeld [36] summarized information on prevalence of dental erosion and stated that, between 8

and 13% of adults had at least one erosive lesion on the labial surfaces of incisors. A data from UK shows that of children aged 1.5 -2.5 years, 3% had severe erosion that involved the pulp of the teeth but this figure increased to 13% in 3.5-4.5 year-olds. [37]

The Child Dental Health Survey showed that 52% of 5 and 6 year-olds had erosion to deciduous incisors and in half of these cases it was severe, involving the dental pulp. Erosion also affected the permanent dentition by 28% in 11-14 year-olds. [38] The National Diet and Nutrition Survey (NDNS) of young people aged 4-18 years showed that half the study population had evidence of erosion in the maxillary incisors or in the first molars of either deciduous or permanent dentition. In the 4-6 years age group, 65% had erosion and 62% of 15-18 year-olds had erosion of the permanent dentition. [39]

### ***Dietary sugars and dental caries***

Evidence for an association between dental caries and the intake of dietary sugars comes from epidemiological observational studies of dental caries levels in populations before and after an increase in sugar consumption. Isolated communities with a traditional way of life and a consistently low-sugar intake have very low dental caries levels. As economic levels in such societies rise, the amount of sugar and other fermentable carbohydrates in the diet

increases. Further, there is evidence to show that many groups of people with habitually high consumption of sugars also have high levels of caries, for example, children with chronic diseases requiring long-term sugar-containing medicines. [40]

Low dental caries experience has been reported in groups of people who have a habitually low consumption of dietary sugars, for example, children of dentists, [41] children in institutions with strict dietary regimens [42, 43] and in children with hereditary fructose intolerance (HFI). [44]

Children living in the Hopewood House Children's Home in New South Wales reportedly followed a strict lactovegetarian diet that was low in sugars and refined flour. Their oral hygiene was virtually absent and fluoride exposure was low. Dental caries levels were much lower than children of the same age and socioeconomic background attending state schools in New South Wales. But after 12 years of age, when the children's association with the home ended, the rate of caries increased to levels observed in children from the state schools. [44]

Table 2: Conditions with potential to affect oral health.

CONDITIONS	POTENTIAL EFFECTS ON ORAL HEALTH
Down syndrome	<ul style="list-style-type: none"> <li>• Small oral cavity- may develop malocclusion, open mouth and mouth breathing</li> <li>• Excess salivation</li> <li>• Bruxism occurs frequently, resulting in tooth abrasion</li> </ul>
Cerebral palsy	<ul style="list-style-type: none"> <li>• Forward tongue thrust which leads to open bite</li> <li>• Drooling, chewing or swallowing disorders</li> <li>• Food lodgement for long periods due to depressed movement of tongue, lips and cheek</li> </ul>
Cleft lip and/ or palate	<ul style="list-style-type: none"> <li>• Upper half of right or left palate does not fuse, thus leading to food impaction in the nasal region</li> <li>• Malformed teeth</li> </ul>
Autism	<ul style="list-style-type: none"> <li>• May retain food in the mouth rather than swallowing</li> </ul>
Prader Willi syndrome	<ul style="list-style-type: none"> <li>• Increased frequency of food intake because of insatiable appetite</li> </ul>
Children with mental and/ or physical retardation	<ul style="list-style-type: none"> <li>• Frequently have bruxism which may lead to tooth abrasion</li> </ul>
Phenylketonuria	<ul style="list-style-type: none"> <li>• Increased caries rate due to low protein foods</li> </ul>
Lactose intolerance	<ul style="list-style-type: none"> <li>• Interferes with calcium and vitamin-D intake</li> </ul>
Asthma	<ul style="list-style-type: none"> <li>• Medications interferes with absorption of nutrients and/ or have side effects that cause oral problems or interferes with saliva production</li> </ul>
Gastroesophageal reflux disease (GERD)	<ul style="list-style-type: none"> <li>• Erosion of primary and permanent teeth may result from regurgitation of acidic gastric contents into the mouth</li> </ul>
Prematurity	<ul style="list-style-type: none"> <li>• Early malnutrition affects tooth eruption and increased caries rate</li> </ul>
Children with depressed immune response	<ul style="list-style-type: none"> <li>• May develop painful oral lesions which interferes with oral hygiene and food</li> </ul>

**Oral health problems and special health care needs**

Special health care needs can increase a child’s risk of developing oral health problems. Potential effects of specific conditions are summarized in table 2.

Medications can have dental implications such as:

- *Liquid syrups with sugar can contribute to dental caries*
- *Medications that cause dry mouth decrease salivary flow rate*
- *Medications that interfere with vitamin-D metabolism interferes with tooth mineralization*
- *Medications that affect folate status can cause development of lip lesions*

Table 3: Summary of current nutrition and dietary recommendations to protect oral health.

RECOMMENDATIONS	RATIONALE
Consume a nutritionally balanced diet which includes vegetables, fruits, whole grains, fat-free and low-fat milk and milk products and reduced intake of sugars	Provide adequate nutrients for normal growth, development and maintenance of the oral cavity, promotion of immune function, and tissue resistance to cariogenic bacteria
Avoid giving an infant cariogenic drink at night or during naps	Limit exposure to bacteria and acid fermentation products
Minimise intake of carbonated soda, fruit drinks, sport drinks and energy drinks	Limit exposure to erosion and decay promoting sugars and acids
Be deliberate about eating and drinking between meals and avoid prolonged or frequent intake	Limit dental exposure to bacteria and acid fermentation products. Increase salivary flow through chewing
When brushing and flossing are not possible following snacks, chew sugar-free gum for 20 minutes	Stimulates saliva production, removes food debris and plaque from teeth and promotes remineralisation of teeth
Drink fluoridated water and/ or use fluoride containing dental products	Increase tooth resistance to demineralization and increase remineralization
Drink adequate fluids throughout the day, especially water	Prevent dry mouth without exposing the mouth to sugars or acids in other beverages

Table 4: Anticipatory guidance for parents about infant and early childhood feeding.

<ul style="list-style-type: none"> <li>• Birth to 1 year</li> <li>• Breast milk is the ideal food for infants</li> <li>• Do not put an infant to sleep with a bottle or allow frequent bottle feedings</li> <li>• Wean the infant from a bottle gradually, at about 9-10 months</li> <li>• Juice should not be introduced into the diet of infants before 6 months</li> <li>• Do not dip pacifiers in sweetened foods</li> </ul>
<ul style="list-style-type: none"> <li>• 1 to 5 years</li> <li>• Do not put the child to sleep with a bottle or allow frequent bottle feedings</li> <li>• Wean the child from a bottle to a cup by 12 to 14 months</li> <li>• Encourage the child to eat fruits rather than drinking fruit juices</li> <li>• Promote less-cariogenic foods for snacks. Serve grain products, dairy products, fruits and vegetables</li> <li>• Make sure the child drinks plenty of water throughout the day, especially between meals and snacks</li> </ul>

**Prevention of dental diseases**

Prevention of dental diseases is critical because of the pain and the cost associated with the treatment. Table 3 provides an overview of recommendations to protect oral health.

**Anticipatory guidance** (table 4)

The American Academy of Pediatrics (AAP) suggests that dental care begin prenatally, with counselling and anticipatory guidance about the transmission

of bacteria from mother to child and also about oral hygiene for infants and young children. [45]

**Dental visits**

The American Academy of Pediatric Dentistry (AAPD) recommends that a child’s first dental visit should occur before 12 months of age or 6 months after first tooth erupts. [46] An AAP policy statement recommends the establishment of a dental home for children who are at risk. The

dentist may help families identify modifications for toothbrushes as well as to identify positions to support the head and body when teeth are being cleaned.

### **Fluoride**

Fluoride intake from birth has been shown to reduce dental caries by as much as 60%. During tooth development, fluoride is incorporated into the tooth structure making the tooth strong and decay resistant. Many community water supplies are fluoridated at the rate of 1 ppm which has proven safe and effective at reducing dental caries. An alternative to supplements is the daily use of fluoridated toothpaste and mouthwash.

### **CONCLUSION**

Oral health is a significant health problem for children with and without special health care needs. Caries prevention can also be promoted to mothers of bottle-fed infants, with guidance to avoid allowing babies to sleep with a bottle throughout the day. Because snacking is essential for young children who eat only small amounts at a time, guidance regarding food and liquid choices and oral hygiene are preferable in promoting oral health.

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