Macronutrients, Micronutrients, and Oral Health

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Introduction
There are several conditions affecting the oral cavity, ranging from very common conditions such as dental caries (cavities) and periodontal (gum) disease, to rare conditions such as oral cancer. Oral diseases include very innocuous as well as debilitating or fatal diseases. This report will be limited to the diseases selected either because of their high frequency of occurrence, severity, or relation to nutrition, as a comprehensive review would be too extensive. The diseases are described in chronological order starting from birth defects in the newborn to diseases affecting the elderly. Since the main function of the mouth is eating, this report also discusses how oral health may impact food selection and systemic disease.

Conditions at Birth
Teeth formation of the infant begins in utero, hence, nutrition counseling for good oral health should begin with the pregnant mother. Inadequate amounts of calcium, phosphorus, or vitamins A, C and D during pregnancy could lead to enamel hypoplasia, which in turn could lead to increased susceptibility for caries. Several studies have suggested that adequate intake of folic acid could help prevent cleft lip and palate in the infant, however the evidence is yet inconclusive.

Dental Caries
Macronutrients are important in the development of caries. The quantity and type of sugar and other carbohydrate intake are major risk factors for dental caries. A classic experiment showed that ingestion of sugars caused an immediate sharp drop in plaque pH, followed by a gradual return to normal pH from salivary buffer action. Although early studies suggested that frequency of carbohydrate intake was an important factor in dental caries, two later well-conducted studies did not confirm this. In Britain, a two-year follow-up study was conducted on 405 children from a low fluoride area, who were 11.5 years of age on average. In this study, caries increment was significantly but weakly correlated with total intake of sugars. A second study based in a low fluoride area of Michigan, followed 499 children, aged 11 to 15, for 3 years. This study found that caries experience was weakly related to total intake of sugars only among the high caries group. Both studies showed no relationship between caries and frequency of sugar consumption. Contrary to popular belief, there is no epidemiologic evidence that consumption of sticky foods is more strongly associated with caries than are sugared drinks.

Although, cheese has been found to be protective against caries, probably due to the calcium and phosphorous content, the primary protective factor for caries is fluoride. The majority of fluoride intake is from water either naturally or artificially fluoridated. Fluoride is also available from toothpaste, mouth rinse, drops and tablets. In some countries mainly in Latin America, fluoride is added to salt. Caries on the root surface of the teeth occur when the root surface is exposed, due to gingival recession. Root caries share many of the same dietary and other risk factors as coronal caries.

Periodontal Disease
Deficiencies in vitamin C or folate are related to increased risk of gingivitis (inflammation of the gums). Periodontal disease is a disease that affects the tissues surrounding the tooth, leading to loss of attachment, and alveolar bone. The few studies that have evaluated the association between nutrients and periodontal disease have been mostly cross-sectional, with some methodological limitations such as small samples and/or lack of adjustment for confounders. However, recent studies have been relatively well designed. These studies suggest that high intake of vitamins A, C, D, E, calcium, and phosphorus are protective against periodontal disease. A recent study suggests that increased levels of total serum cholesterol (but not HDL) are associated with periodontal disease. Malnutrition could also be a risk factor for periodontal disease. Further studies are needed to evaluate dietary risk factors for periodontal disease.

Oral Cancer
Oral and pharyngeal cancers (OC) include tumors affecting the oral cavity and pharynx, the majority of which are squamous cell carcinoma. About 30,000 people in the US develop oral cancer each year. The overall five-year survival rate is about 52%. Early detection is the key to improving the survival rate. Oral cancer is generally preceded by pre-cancerous lesions, which include oral epithelial dysplasia, erythroplakia, leukoplakia, lichen planus, and submucous fibrosis (rare in western countries). The major risk factors for OC are tobacco, and alcohol. In Asian countries chewing tobacco, betel nut and betel quid are major risk factors. The practice of chewing tobacco is increasing in the US.

Food and micronutrients
A protective effect of fiber was observed for both oral submucous fibrosis and leukoplakia and for oral cancer. There is a suggestion that meat, desserts, maize, and saturated fats and/or butter may be risk factors. Olive oil may be protective. Nitrate, nitrite, and nitrate reductase activity in saliva and high intake of nitrate containing meats, have been linked with increased risk. Iron may be protective against OC and leukoplakia.

Fruits and vegetables
A consistent finding across numerous studies is that a diet high in fruits and vegetables is protective against oral precancer and cancer. Fruits are associated with a 20-80% reduced risk of OC even when smoking and alcohol intake and other factors including total caloric intake are taken into account. While vegetables are generally believed to protect against OC, some studies did not show a protective effect. The inconsistencies may be explained by variation in specific vegetables consumed and a suggestion that raw vegetables may be more protective than cooked vegetables.

A study evaluating specific fruits and vegetables suggested that green vegetables, salad, and apples were most protective. Tomato shows a strong and consistent protective effect for oral cancer in 12 of 15 studies, and in one study on leukoplakia. Raw tomatoes were more protective than cooked tomatoes. A protective effect was also found for raw vegetables among the Japanese. Glutathione, an anti-oxidant, was protective only if it was derived from fruits and raw vegetables.

Anti-oxidants
Several anti-oxidants found in vegetables and fruits show a protective effect. There are varying degrees of evidence regarding the protective effect of specific anti-oxidants which include vitamin A, vitamin B12, vitamin C, tocopherol (vitamin E), retinoids, carotenoids, lycopene, beta-carotene, folate, glutathione, thiamine, vitamin B6, folic acid, niacin, α-tocopherol, and lutein have been shown to be protective.
against oral cancer23,30,44 and pre-cancer29,65 et al. in other studies. That evaluated subgroups have generally found a more profound effect of fruits and vegetables, and their constituent micronutrients, particularly among smokers and drinkers.48

**Evidence from clinical trials on anti-oxidants**

Retinoids and beta-carotene in controlled therapeutic doses show protective effects, with fewer new primary tumors in persons with previous oral cancers and reversals or reduction in size of premalignant lesions.40 High doses of 13-cis retinoic acid (50-100 mg/m² body surface area/day) for a year have been effective in the treatment of oral leukoplaikia44. 67% showed major decreases in lesion size vs. 10% among placebo group and in prevention of second primary tumors29. 2% had secondary tumors after a median follow up of 32 months vs. 12% in placebo group. Trials using beta-carotene supplements (60 mg/day for 6 months) have shown reduced risk of oral cancers and remission of precancers with an improvement of at least one grade dysplasia in 39% and no change in 61%.48

**Other Soft Tissue Lesions**

Soft tissue conditions such as oral leukoplaikia54,55 have been related to vitamin deficiencies, especially the B vitamins. Tenderness of the tongue and palate are associated with deficiencies in vitamin B complex46, or iron. Vitamin E deficiency is related to atrophy of the papillae.55 Recurrent aphthous ulcers have been associated with nutritional deficiencies including iron, folic acid, B vitamins. Angular cheilitis is associated with iron deficiency58. Malnutrition is related to a variety of conditions such as malnutrition, respiratory disease and diabetes.55 The results to date are inconsistent and inconclusive, and more rigorous studies are needed, but a causal relationship mediated through inflammatory mediators, dietary factors, or other factors is plausible58.

**Impact of Oral Health on Nutrition and Systemic Disease**

In recent years there has been growing interest in research related to oral conditions and systemic diseases. This research suggests that periodontal disease and tooth loss are risk factors for systemic disease such as cardiovascular disease, respiratory disease and diabetes.56 The results to date are inconsistent and inconclusive, and more rigorous studies are needed, but a causal relationship mediated through inflammatory mediators, dietary factors, or other factors is plausible58.

**References**

22. Russell AL, Consolazio CF. Vitamin C and connective tissue disease. *Arch Intern Med. 1940; 70:279-84.
37. taking into account that the risk of oral leukoplaikia has been related to vitamin deficiencies, especially the B vitamins. Tenderness of the tongue and palate are associated with deficiencies in vitamin B complex, or iron. Vitamin E deficiency is related to atrophy of the papillae. Recurrent aphthous ulcers have been associated with nutritional deficiencies including iron, folic acid, B vitamins. Angular cheilitis is associated with iron deficiency. Malnutrition is related to a variety of conditions such as malnutrition, respiratory disease and diabetes. The results to date are inconsistent and inconclusive, and more rigorous studies are needed, but a causal relationship mediated through inflammatory mediators, dietary factors, or other factors is plausible. In summary, both macronutrients and micronutrients play a role in several oral diseases including dental caries and oral cancer. Dental diseases, or other factors may lead to change in diet and nutritional status.