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## RESEARCH ARTICLE

## ORAL HEALTH &amp; MALNUTRITION-“THE MISSING LINK”

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**Abstract**

Nutrition is major determinants of health status exerting the “womb to tomb” effect which mediates the course of various health outcomes. Each individual has got different nutritional requirements at different ages and stages of their life. Each nutrient has a unique role in maintaining the integrity of the oral tissues. The world faces two kinds of compromised nutrition - one associated with hunger or nutritional deficiencies like protein energy malnutrition (P.E.M) and the other with dietary excess or obesity. Although not life threatening, oral diseases exert detrimental effect on quality of life from childhood to old age. A bi-directional relationship exists between nutrition, diet and dental health. Incorrect diet may lead to oral diseases and also poor oral health may compromise healthy food choices and general health. The unfavourable outcomes of malnutrition and oral diseases are likely to be greatest among the pediatric and geriatric populations who are particularly susceptible to malnutrition.

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**INTRODUCTION**

Nutrition has increasingly been recognized as a basic pillar for social and economic development and one of the main determinants of individual, family and community health. It is the science of how the body utilizes food or nutrients to meet requirements for development, growth, repair and maintenance.<sup>1</sup> Proteins, fats and carbohydrates, vitamins, minerals and trace elements are the essential nutrients required for growing and thriving. Nutritional status is a measurement of the extent to which an individual's defined physiological need for nutrients are being met by his or her dietary patterns and choices. Thus these measurements entail review of dietary intake, biochemical markers of nutrient status and anthropometric changes.<sup>2</sup>

Each individual has got different nutritional requirements at different ages and stages of their life like infancy, childhood, adolescent, adulthood, geriatrics, pregnancy and convalescence. The choice of food and the dietary patterns are influenced by the cultural practices, ethnicity, religious considerations, socio-economic factors like income, occupation and education, geographic variations, food production and distribution systems.

Today the world faces two kinds of compromised nutrition - one associated with hunger or nutritional deficiencies like protein energy malnutrition (P.E.M) and the other with dietary excess or obesity. W.H.O. defines malnutrition as “the cellular imbalance between the supply of the nutrients and the energy and body's demand

for them to ensure growth, maintenance and specific functions.”<sup>3</sup> In India, it constitutes over 22% of the disease burden, making it one of the nation's largest health threats.<sup>4</sup>

Oral health is fundamental to overall health. It has strong biological, psychological and social projections because it affects our aesthetics and communications. Although not life threatening, oral diseases exert detrimental effect on quality of life from childhood to old age.<sup>5</sup>

The oral cavity is the doorway through which the body receives and processes nourishment. Multiple oral tissues like oral mucosa, teeth and periodontal tissues work together and are no less susceptible to nutritional

stresses. There is a two-way interaction between nutrition, diet and dental health. Incorrect diet causes dental diseases but, also poor oral health (edentulism) can compromise healthy food choices and general health.<sup>6</sup>

### **MALNUTRITION AND ORAL DISEASES IN CHILDREN**

PEM occurs when there are deficiencies in protein or energy foods or both leading to failure of body to grow in height (stunting) and weight (underweight). The World Bank estimates that India is ranked 2<sup>nd</sup> in the world for the number of children suffering from malnutrition.<sup>7</sup>

#### **(i) Malnutrition and dental caries<sup>7-10</sup>**

Both malnutrition and tooth decay are the most prevalent childhood diseases affecting almost 80% of the children in India.<sup>11</sup> A longitudinal study provided the evidence of a relationship between early childhood PEM and permanent dentition caries. The authors suggested that a single, prolonged, mild to moderate malnutrition episode in the first year of life may result in higher primary dentition caries rates, an increase in permanent dentition caries and that the caries risk may be mediated by means other than enamel hypoplasia. In a recent study conducted among Indian school children<sup>11</sup>, the authors observed that most of the subjects were malnourished and acute and chronic nutritional stress predisposed to higher incidence of dental caries.

The disparity among the prevalence of malnutrition, dental caries and socioeconomic status is also evident across the genders and rural urban populations. Studies have revealed that malnutrition was more evident among the females.<sup>12</sup> Dental caries and malnutrition was also more commonly observed in children from low income families<sup>13,14</sup>, and children residing in rural areas of India disproportionately suffered more than their urban counterparts.<sup>14</sup>

#### **(ii) Malnutrition and enamel hypoplasia**

Enamel hypoplasia is the most common abnormality of development of enamel and its mineralization.<sup>15</sup> 85% of all enamel hypoplasia occur during 1<sup>st</sup> year of life and often are a result of a relatively mild gastrointestinal upset, dietary incompatibility or **nutritional deficiency**.<sup>5</sup> On a world-wide basis, this enamel defect may be most common lesion of the deciduous dentition.<sup>16</sup> A specific form of generalized enamel hypoplasia of primary teeth called **Linear Enamel Hypoplasia (LEH)** is commonly seen in malnourished children and the prevalence is reported to be greater among children of the lower social class. The prevalence of LEH in the developing countries have ranged from 14% to 85%.<sup>16,17</sup> It may prove to be a unique indicator of nutritional status.<sup>18</sup>

Prenatal and perinatal malnutrition are often associated with enamel hypoplasia, reduced salivary secretion and buffering capacity. Human population studies have shown that maternal malnutrition can lead to low birth weight and preterm delivery with enamel hypoplasia in the primary and permanent dentition.

The reason why malnourished children were more susceptible to hypoplasia was attributed to web of potential interactions involving socioeconomic conditions, feeding patterns, dietary intake and both upper-respiratory and gastrointestinal illness like diarrhoea. Nikiforuk and Fraser (1981)<sup>19</sup> hypothesized that chronic diarrhoea causes malnutrition which is reflected in hypocalcaemia, which in turn result in LEH. Acute diarrheal disease may also lead to low serum vitamin A, which may also contribute to the development of hypoplasia.

#### **(iii) Association between hypoplasia of enamel and dental caries**

In addition to the aesthetic disadvantages of enamel defects, there is evidence that hypoplasia is associated with as increased risk of caries.<sup>5</sup> Lady May Mellanby (1923) correlated the degree of hypoplasia of 1500 teeth with their degrees of caries and concluded that hypoplastic teeth are more liable to the disease. Similar findings were also reported by other authors.<sup>15,16,17,18,19</sup>

#### **(iv) Other oral manifestations of malnutrition-**

- Chronic malnutrition may also affect tooth exfoliation of primary teeth. In a recent study conducted by Gaur et al, (2011)<sup>20</sup> on permanent teeth emergence in Rajputs of Himachal Pradesh observed that past long-term and chronic malnutrition resulted in delayed emergence of permanent teeth, particularly in younger age groups. Nutritional deficiencies of vitamin D and A during pregnancy can also affect tooth size, timing of tooth eruption, defects in enamel mineralization and salivary gland formation and can create increased susceptibility to caries.<sup>5,6</sup>
- PEM is also associated with a smooth, red glossitis affecting in particular the anterior margins of the tongue. This condition is often referred to as “**scarlet tongue**”.<sup>21</sup> Angular stomatitis and hypopigmentation circumorally have also been recorded which lead to impairment of oral functions.
- Study in children of low and middle income countries indicate that protein-energy deficient groups, in comparison with their age-matched well-fed counter parts, have a high prevalence of various potentially pathogenic oral microorganisms, particularly the anaerobic micro flora like *Prevotella melaninogenus*,

*Porphyromonas gingivales*, *Prevotella oralis*, *Prevotella ruminicola*, *Actinomyces israelii*, *Fusobacterium species*, and the spirochetes predisposing to periodontal diseases.

### EFFECT OF COMPROMISED NUTRITION ON GERIATRIC ORAL HEALTH

Oral disorders are cumulative across the life span so that unfavourable outcomes of oral conditions are likely to be greatest among the elderly population who are particularly susceptible to malnutrition. Compared to younger individual they have a significantly decreased ability to respond to physiologic challenges with decrease in sensory function, functional problems such as arthritis or diminished vision and limited ability to digest, absorb and utilize food properly can affect the ability to prepare and eat food. Psychosocial problems such as loneliness, depression, lack of money and poor access to food can all undermine good eating habits. Malnutrition can be an important indicator of elderly neglect. Osteoporosis, periodontitis, tooth mobility and tooth loss represents the most prevalent diseases associated with advancing age.<sup>23,24</sup> According to World Health Organization (WHO), osteoporosis is second only to cardiovascular disease as a global healthcare problem. In India, 1 out of 8 males and 1 out of 3 females suffer from osteoporosis, making India one of the largest affected countries in the world.<sup>25</sup> Primary osteoporosis consists of two separate entities: “**Type I osteoporosis**”, due to loss of trabecular bone after menopause, and “**Type II osteoporosis**” due to loss of cortical and trabecular bone in men and women as the end result of age-related bone loss and nutritional deficiency. The oral disease which Atwood termed “reduction of residual ridges” is a manifestation of osteoporosis.<sup>26</sup> Dietary factors influence peak bone mass, age-related bone loss and fracture risk. Calcium and vitamin D are particularly important since deficiencies are potentially correctable. Low protein intake is an important determinant of peak bone mass and therefore of the risk of osteoporosis in later life.<sup>27</sup> The mechanism whereby a low protein intake has adverse effects on bone may be due to inadequate production of (Insulin-like Growth Factor) IGF-1, which exerts anabolic effects on bone mass, not only during growth, but also during adulthood.

Periodontal disease is one of the most widespread diseases of the mankind and one of the principal causes for tooth loss in humans. The most recent National Oral Health Survey (2000-2003) states that prevalence of periodontal disease was 89.6% and 79.9% in 35-44 years and 65-74 years age groups respectively.<sup>28</sup> Nutrition may contribute to the pathogenesis of periodontal diseases by influencing factors like amount and consistency of dental plaque formed and also the epithelial integrity, immune response and formation and repair of collagen and bone. Human studies of calcium intake, bone mineral density and tooth loss provide a rationale for hypothesizing that low dietary intake of calcium is a risk factor for periodontal disease.

**Table 1: Effect of micronutrient deficiencies and excess on oral health**<sup>1,16,21,29-31</sup>

Nutrient	Oral deficiency state	Excess state
<b>Vitamin A</b>	<ul style="list-style-type: none"> <li>• Mucosal keratinisation</li> <li>• Cheilitis</li> <li>• Affects taste buds</li> <li>• Enamel hypoplasia</li> </ul>	<ul style="list-style-type: none"> <li>• Periodontal Inflammation</li> </ul>
<b>Vitamin C (Ascorbic acid)</b>	<ul style="list-style-type: none"> <li>• Recurrent aphthae</li> <li>• Angular cheilitis</li> <li>• Angular stomatitis</li> <li>• Gingivitis/periodontitis</li> </ul>	-
<b>Vitamin D (Sterols)</b>	<ul style="list-style-type: none"> <li>• May affect parotid function</li> <li>• Enamel hypoplasia</li> </ul>	-
<b>Vitamin E</b>	-	-
<b>Vitamin K</b>	<ul style="list-style-type: none"> <li>• Osteoporosis</li> <li>• Residual ridge resorption</li> </ul>	-
<b>Vitamin B<sub>1</sub> (Thiamine)</b>	<ul style="list-style-type: none"> <li>• Role in BMS</li> <li>• Oral sensitivity</li> <li>• Reduced taste perceptions</li> <li>• Angular cheilitis</li> <li>• Recurrent aphthae</li> <li>• Glossitis</li> </ul>	-
<b>Vitamin B<sub>2</sub> (Riboflavine)</b>	<ul style="list-style-type: none"> <li>• Angular stomatitis</li> <li>• Angular cheilitis</li> </ul>	-

	<ul style="list-style-type: none"> <li>• Recurrent aphthae</li> <li>• Glossitis</li> </ul>	
<b>Vitamin B<sub>6</sub></b> <b>(Pyridoxine)</b>	<ul style="list-style-type: none"> <li>• Glossitis</li> <li>• Cheilosis / Lip fissures</li> <li>• BMS</li> <li>• Ulcerations</li> </ul>	-
<b>Pantothenic acid</b>	<ul style="list-style-type: none"> <li>• Glossitis</li> </ul>	-
<b>Vitamin B<sub>12</sub></b> <b>(Cobalamine)</b>	<ul style="list-style-type: none"> <li>• Atrophic glossitis</li> <li>• Stomatitis</li> <li>• Recurrent aphthae</li> <li>• Angular cheilitis</li> <li>• BMS</li> <li>• Candidiasis</li> <li>• Dysplasia</li> <li>• Smooth (filiform papillae atrophy), red (or pale if anaemia is marked) and painful.</li> </ul>	-
<b>Vitamin B<sub>3</sub></b> <b>(Niacin or nicotinic acid)</b>	<ul style="list-style-type: none"> <li>• Oral mucosal erythema</li> <li>• Papillary atrophy of tongue</li> <li>• Angular stomatitis</li> <li>• Angular cheilitis</li> <li>• Smooth (filiform papillae atrophy), red (or pale if anaemia is marked) and painful.</li> </ul>	-
<b>Folic acid</b>	<ul style="list-style-type: none"> <li>• Glossitis</li> <li>• Stomatitis</li> <li>• RAS</li> <li>• Angular cheilitis</li> <li>• Chronic hyperplastic or atrophic candidiasis</li> <li>• Cleft lip/palate</li> <li>• Smooth (filiform papillae atrophy), red (or pale if anaemia is marked) and painful.</li> </ul>	-
<b>Calcium</b>	<ul style="list-style-type: none"> <li>• Enamel hypoplasia</li> <li>• Residual bone resorption</li> </ul>	-
<b>Biotin</b>	<ul style="list-style-type: none"> <li>• Red and swollen oral mucosa</li> <li>• Magenta, swollen and painful tongue</li> </ul>	-
<b>Iron</b>	<ul style="list-style-type: none"> <li>• Smooth, painful, pale tongue (filiform papillae atrophy)</li> <li>• Angular stomatitis</li> <li>• Burning Mouth Syndrome</li> <li>• Aphthous ulcerations</li> <li>• Candidiasis</li> <li>• Mucosal atrophy (increases susceptibility to carcinoma)</li> </ul>	-
<b>Zinc</b>	<ul style="list-style-type: none"> <li>• Taste disturbances</li> <li>• Cleft lip/palate</li> </ul>	-
<b>Fluorides</b>	<ul style="list-style-type: none"> <li>• Hypomineralized enamel leading to dental caries</li> </ul>	<ul style="list-style-type: none"> <li>• Dental and skeletal fluorosis</li> </ul>
<b>Selenium</b>	<ul style="list-style-type: none"> <li>• May be protective against oral cancer</li> </ul>	<ul style="list-style-type: none"> <li>• Dental caries</li> </ul>
<b>Boron</b>	<ul style="list-style-type: none"> <li>• Dental caries</li> </ul>	-

<b>Vanadium</b>	• Dental caries	-
<b>Strontium</b>	• Dental caries	-

## SUMMARY-

Nutrition is major determinants of health status, exerting the “womb to tomb” effect which mediates the course of oral health outcomes. Each nutrient has a unique role to play with both excess and deficiency affecting an individual’s overall growth and development. India has the vast geographical expanse and varying socio economic, cultural and dietary habits which can have an inevitable effect upon the incidence and severity of non communicable diseases. Malnutrition and oral diseases not only pose as major public health problems but the trends and variations in their incidence can also highlight the more deeper seated social issues in Indian society like gender inequality, neglect of elderly and socioeconomic disparities among rural and urban populations.

The dental health professionals must understand the many ways in which nutrition is woven into the fabric of oral health concerns. Compared with other health care workers, dentists reach a larger number of general public and are in a position to be the first to notice compromised nutrition. Just as the eyes are the windows to the soul, the oral cavity is a mirror of the body. This “magic mirror” can help the dental health professionals to observe the very early signs of suboptimum or compromised nutrition which may also affect general health.

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