



Nutritional deficiencies and their oral manifestations

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Introduction

Nutrition plays a vital role in human health, particularly in the development and maintenance of oral health. Proper functioning is dependent on adequate intakes of macro and micronutrients. Macronutrients consist of carbohydrates, proteins and fats, whilst micronutrients are divided into vitamins and minerals. Vitamins are organic compounds that are either fat soluble (A, D, E, K) or water-soluble (B and C). Minerals are inorganic substances including calcium, iron, potassium, phosphate, magnesium and zinc, among others.

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Nutrition is essential for immune function, growth and development, bone health, metabolic processes and prevention of disease. The nutritional aspect of diet and dietary behaviours can therefore directly impact the progression of oral diseases including dental caries, as well as increasing susceptibility to infection, poor wound healing, mucosal conditions, enamel defects and periodontal disease.^{1,2}

The connection between nutritional insufficiency and oral manifestations is often overlooked, which is not surprising given the majority of dental students claim to receive between zero to four hours of nutritional training.³ The objective of this article is to highlight how specific nutritional deficiencies can manifest orally and why dental professionals should be vigilant.

The mouth as a window to nutritional status

Malnutrition is defined as a state of nutrition in which deficiency of macro or micronutrients causes measurable adverse effects on bodily function and clinical outcomes.⁴ Given 3 million people in the UK are malnourished or at risk of malnutrition and this costing an estimated £19.6 billion

annually,⁵ the need for early detection and intervention is critical.

With the oral cavity often being one of the first sites where nutritional deficiencies become apparent, oral healthcare professionals are integral for enabling early diagnosis. They also play a crucial role in identifying signs of systemic disease including Crohn's, ulcerative colitis, anaemia, coeliac disease, diabetes and eating disorders.

Common oral signs of nutritional insufficiency include painful, minor recurrent aphthous stomatitis (RAS), gingival bleeding, glossitis, taste changes, burning mouth syndrome (BMS), enamel hypoplasia and damage to the periodontium.^{1,2,6} Furthermore, extra-oral signs of nutritional deficiency must not be overlooked and may include pale skin, dry or cracked lips, angular cheilitis, dry flaky skin, skin rashes or dermatitis.⁷

If nutritional deficiency is suspected, dental professionals are encouraged to liaise with the GP for further investigation. Referral to a dietitian can also be considered for nutritional assessment and analysis, or this can be a recommended action for the GP. A comprehensive diet history collected from the dental professional may also be useful to supplement the referral.

Key nutritional deficiencies and oral manifestations

Vitamin B-complex deficiencies

B-complex vitamins comprise of B1 (thiamine), B2 (riboflavin), B3 (niacin), B5 (pantothenic acid), B6 (pyridoxine), B7 (biotin), B9 (folate), B12 (cobalamin). These are essential for cell metabolism, DNA synthesis and nerve function⁸ with dietary sources including green leafy vegetables, legumes and animal products. (Table 1)

Vitamin C deficiency

Vitamin C (ascorbic acid) is required for collagen synthesis, protein metabolism and immune function. It is abundant in fruits and vegetables such as citrus fruits, tomatoes, red peppers and fortified breakfast cereals. Severe vitamin C deficiency can lead to scurvy, presenting with gingival bleeding, swelling, poor wound healing and petechiae, due to impaired collagen production and blood vessel fragility.¹⁰ Given its crucial role

Table 1 Vitamin B-complex deficiencies

Nutrient deficiency	Oral signs
Vitamin B1 (Thiamine)	RAS, glossitis, angular cheilitis ¹
Vitamin B2 (Riboflavin)	RAS, atrophic glossitis with magenta tint, angular cheilitis ^{1,9}
Vitamin B3 (Niacin)	Glossitis, xerostomia, angular cheilitis, RAS, halitosis, BMS (Pellagra) ^{1,9}
Vitamin B5 (Pantothenic Acid)	Xerostomia, angular cheilitis, paraesthesia ¹
Vitamin B6 (Pyridoxine)	Halitosis, glossitis, angular cheilitis, RAS ¹
Vitamin B9 (Folate)	Gingivitis, glossitis, angular cheilitis, RAS ¹
Vitamin B12 (Cobalamin)	Anaemia-related mucosal pallor, xerostomia, red atrophic glossitis, RAS, angular cheilitis, taste alterations, neuropathy-related BMS ^{1,6,9}

'Considering the significance of nutrient deficiencies and their impact on oral health, dental professionals should reflect on the importance of taking a thorough diet and medical history.'

in connective tissue repair and powerful antioxidant properties, vitamin C deficiency may also exacerbate periodontal disease resulting in tooth mobility.¹⁰

Vitamin D and calcium deficiency

Vitamin D is essential for the absorption of calcium and phosphate in the small intestine, thus allowing for mineralisation of bones and teeth.¹¹ Animal products including oily fish and dairy are rich in vitamin D and calcium. Vitamin D also plays a significant role in the immune system, owing to its immunosuppressive and anti-inflammatory properties.⁹ Consequently, vitamin D and calcium deficiency has been linked with enamel and dentine defects in children, particularly enamel hypoplasia, as well as gingival inflammation and increased risk of periodontal disease.^{1,6,9,10} Furthermore, calcium deficiency can lead to secondary hyperparathyroidism, which may be identified

radiographically as a generalised radiolucency due to bone resorption.^{11,12}

Vitamin K deficiency

Vitamin K is crucial for the synthesis of proteins that are precursors for coagulation factors including factor II (prothrombin), VII, IX and X. Vitamin K deficiency may therefore impair haemostasis resulting in prolonged and/or excessive bleeding following dental extraction or oral surgery.⁹ Dietary sources of vitamin K mostly include green leafy vegetables (e.g., spinach) and vegetable oils.

Iron deficiency

Iron is a prerequisite for the formation of haemoglobin and oxygen transport, growth and development, as well as immune function. Red meats, green leafy vegetables, pulses and legumes are rich sources of iron.¹³ Iron deficiency anaemia is associated with RAS, angular cheilitis, atrophic glossitis,

mucosal pallor and stomatitis. It has also been linked with oral lichen planus and increased prevalence of oral candidiasis and periodontitis.^{9,14,15}

Zinc deficiency

Zinc is an important trace element found in meat, shellfish, Quorn, nuts, seeds, and legumes. It plays a major role in DNA synthesis, tissue repair, immunity and sense of taste and smell.^{16,17} Deficiency may therefore lead to taste disturbance (dysgeusia), impaired wound healing following oral surgery or injury and increased risk of infection. Zinc deficiency has further been associated with RAS, BMS, atrophic glossitis and xerostomia, thereby increasing caries susceptibility.^{6,16,17}

Clinical implications and the role of the oral healthcare team

Considering the significance of nutrient deficiencies and their impact on oral health, dental professionals should reflect on the importance of taking a thorough diet and medical history and be alert to oral presentations that could indicate broader systemic issues. The bidirectional relationship between nutrition and oral health must also not be overlooked; whilst nutrient insufficiencies can lead to oral signs and symptoms, sequentially oral pain or poor dentition can impair an individual's ability to eat. This highlights the importance of dental professionals within a multidisciplinary team, ensuring effective and holistic person-focused care.

'Dental professionals have a unique opportunity to play an integral role in the prevention and management of nutritional deficiencies.'

Conclusion

Oral healthcare professionals have a unique opportunity to play an integral role in the prevention and management of nutritional deficiencies, which in turn can improve oral health and prevent against associated oral diseases. Further interdisciplinary collaboration and education is encouraged, particularly at undergraduate level, to increase awareness and understanding in this domain.

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