

Nutrition & Oral Health

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ABSTRACT

To maintain optimal health proper nourishment in the form of proteins, carbohydrates, vitamins & minerals is required. There are numerous elements that play a crucial role in the complicated relationships between dietary practices, oral health issues, nutritional status, and general health. By affecting tissue structural and functional integrity, lowering resistance to microbial biofilm, and delaying tissue healing, a diet lacking in nutrients can accelerate progression of disease in one's oral cavity. Poor dental health can influence eating habits and change dietary preferences, which can have a severe impact on the overall health. Improving one's health and quality of life requires identifying and treating issues with oral hygiene and nutrition. The article's goal is to review the data supporting the link between diet, nutrition, and dental disorders and to offer dietary suggestions for preventing them.

KEY WORDS

Nutrition, Nutrients, Oral mucosa, Periodontium, RDA.

INTRODUCTION

An essential component of human development is nutrition.¹ For survival, physical development, mental growth, performance and productivity, health, and general well-being, proper nutrition is crucial. Nutrition can be defined as the study of nutrients in food, how the body

uses nutrients, and the relationship between diet, health and disease and how food affects the body. It is the adequate provision of minerals, fibre, vitamins, water and other food components to cells and organisms, to support life.² According to Williams Osler "Father of Modern

Medicine”, Mouth is the mirror of the body, as mouth reflects many systemic diseases.³ The health of the body can both influence and be influenced by the health of the mouth. As Oral health depends heavily on nutrition both getting impacted by one another hence leading to an overall impact to the general health. In this mutually reinforcing link, good nutritional health enhances the dental health of an individual, and vice versa. A diet low in nutrients can accelerate disease in the oral cavity due to altered tissue repair, poor resistance to microbial biofilm, and a decrease in tissue healing.⁵ In contrast to micronutrients, which are needed in much smaller quantities (milligrams or micrograms) to sustain health and wellbeing, macronutrients are needed in huge quantities (grams) to produce energy. Depending on the demographic subtype, such as adult versus child, female versus male, pregnant versus not pregnant, various dietary recommendations are offered for the intake of macronutrients and micronutrients.

NUTRIENT DEFECIENCY & ORAL MUCOSA

As a result of mouth cavity's high rate of cellular cycle and substantial microbiological layer, micronutrient deficiencies are frequently initially detected in the mouth. A healthy oral

epithelium has about three days to a week cellular replacement and functions as a strong toxin barrier. Insufficient nutrition can lead to tissue breakdown, that can result in infection and/or the onset of oral lesions.⁶ Whether brought on by illnesses that impede absorption, lifestyle choices, or poor dietary habits, some groups are more susceptible to vitamin and mineral shortages than others. Numerous inadequacies may affect the components of oral cavity in people with eating disorders such bulimia & anorexia nervosa.⁷

Deficiency of Vitamin B Complex and its effect on Oral Mucosa

The vitamin B complex is made up of eight distinct vitamins with various chemical and pharmacological characteristics. Vitamin B are essential forerunners for many metabolic processes coenzymes. Patients frequently report experiencing a burning feeling in their mouths, especially on their tongues, as one of the symptoms of vitamin B complex insufficiency. Inflammation of the tongue (glossitis) and mouth lining, a painful throat, and cracked-red lips (angular cheilosis) are some additional oral symptoms of vitamin B complex insufficiency⁸. Along with these stomatitis (oral ulcer), a painful condition that causes the oral mucosa to inflame widely and patchily, along with

accompanying burning sensation and stiffness is also noticed in those who lack vitamin B complex in their diet.

Deficiency of Iron and its effect on Oral Mucosa

Anaemia, a condition marked by an iron deficiency, can result from a lack of nutrients, loss due to bleeding (external or internal), low vitamin C levels with lower levels of thyroid hormone, problems with iron assimilation, and a strict meal full of only vegetables, which typically has few natural sources of iron. In the latter category, the absorption of iron can be effectively increased by adding the right iron supplements to a vegetarian diet. In handful of patients with recurrent oral ulcer, iron deficiency has been linked to the disease's origin, and iron therapy has helped these patients' symptoms⁹. Oral Atrophic glossitis, angular cheilitis, and burning mouth syndrome are few common symptoms of iron and vitamin B deficiency that are evident in an individual's oral cavity. The rare premalignant condition known as Plummer-Vinson syndrome can be brought on by persistent iron deficiency. Additionally characterised by glossitis, upper oesophageal webs, and post-cricoid dysphagia. Due to their higher likelihood of developing oesophageal squamous cell carcinoma, the primary therapeutic

objective for these patients is to address their iron deficiency anaemia. For the bone marrow to manufacture healthy red blood cells, iron, cobalamin, and vitamin B9 are necessary. Patients suffering with Crohn's disease that is an inflammatory bowel diseases may also experience nutrient deficits in iron, cobalamin, and vitamin B9 since these conditions limit the absorption of these nutrients, which can lead to the oral signs described earlier.

Deficiency of Vitamin A and its effect on Oral Mucosa

Vitamin A serves as a crucial element needed to maintain the mucosal membranes, salivary glands, and teeth in addition to playing a role in better eyesight.^{10,11} Lack of availability to foods high in retinol commonly known as vitamin A is a common cause of its insufficiency, which is prominent in communities whose diets do not contain enough animal products. Gastrointestinal disorders, Crohn's disease, cystic fibrosis, bile duct obstruction, malabsorption, diarrhoea, measles, and respiratory illness could make it worse.¹² Deficiency of retinol or vitamin A in a diet has been linked to delayed tooth development, enamel hypoplasia, and periodontitis, as well as decreased growth of oral epithelial tissue.^{13,14,15} Leukoplakia, a premalignant disease, and carcinoma are thought to arise

as a result of vitamin A deficiency because it causes the metaplasia and hyperkeratization of epithelial tissues.¹⁶

Deficiency of Vitamin E and its effect on Oral Mucosa

A class of chemical substances with structural similarities to tocopherol are referred to as "vitamin-E.". There are eight distinct forms of vitamin E in nature: four of them are tocopherols: α , β , γ , δ tocopherols, and four of them are tocotrienols: α , β , γ , δ tocotrienols. By acting as a lipid-soluble free radical neutralizer in cell membranes, vitamin E shows antioxidant characteristics. Vitamin E may therefore be involved in both the commencement and maintenance stages. Ability of vitamin E to inhibit the formation of the carcinogenic compound nitrosamine from nitrites in some meals and to support immune system function are two of its other potentially anti-carcinogenic effects.¹⁷

Deficiency of Vitamin K and its effect on Oral Mucosa

Blood clotting, bone metabolism, and atherosclerosis prevention are all affected by vitamin K. Bleeding gums is the most typical oral symptom of vitamin K insufficiency, and avitaminosis K is one of the many factors that can cause bleeding from the oral cavity. Increased bleeding

from gums after brushing or even on its own was quite evident in an individual with vitamin K deficiency. The oral mucosa may develop petechiae, ecchymosis, and hematoma.¹⁶ In extreme cases, there is a gradual, steady haemorrhage from the gums. Adults with vitamin K insufficiency experience occult bleeding and unusual blood coagulation.

NUTRIENT DEFICIENCY AND PERIODONTAL DISEASES

Periodontal disease refers to infection of the attachment apparatus of the teeth: the gingiva, periodontal ligament, and alveolar bone. James Lind's description of scurvy in the first-ever controlled treatment trial, carried out in 1747, is one of the earliest observations on diet and periodontal health. Before Loe et al. released their research on the bacterial cause of gingivitis in 1965, it was believed that dietary and other systemic variables were almost solely to blame for periodontal disorders. In populations that are malnourished, periodontal disease develops more quickly. The periodontal ligament and alveolar bone may be affected by the pathology, which begins in the gingiva. Poor dental care is the main risk factor for the onset of periodontal disease.¹⁸

Deficiency of Vitamin B Complex and its effect on periodontium

The WHO conducted an epidemiological study in Sri Lanka to examine the link between poor diet that lacks sufficient vitamins and periodontal disorders, and the results revealed that vitamin B complex deficiencies were linked to reduced bacterial irritant resistance. The majority of the B complex vitamins are rarely deficient in contemporary society, and folic acid is the only B vitamin now being studied in relation to periodontal disease. Due to the frequent replacement of cells, gingival epithelium is particularly susceptible to vitamin B9 deficiency, which decreases this tissue's capacity to act as a barrier against bacterial assaults.¹⁸

Deficiency of Vitamin C and its effect on periodontium

Vitamin C, also referred to as L-ascorbic acid, functions as an enzyme cofactor in a number of crucial metabolic activities as ascorbate. Proline and lysine are among them, and their hydroxylation is necessary for stabilising the collagen's structural integrity during production. In order to maintain the integrity of connective tissues like the periodontium, vitamin C plays a crucial function in this action.¹⁹ Throughout life, ascorbic acid is essential for the regrowth of bone, teeth, and connective tissue.²⁰ The condition brought

on by a lack of vitamin C is known as scurvy, a term originally used by Sir Thomas Barlow in 1883. Periodontal markers of scurvy include bleeding, swollen, and sore gums in addition to malaise, lethargy, and skin patches. Intake of vitamin C not only cures scurvy but also prevents it.²¹

Deficiency of Vitamin D and its effect on periodontium

A number of crucial bodily processes depend on vitamin D. It improves the intestine's ability to absorb nutrients like zinc, calcium, magnesium, iron, and other trace elements so that bones and teeth can properly mineralize. Vitamin D2 (cholecalciferol) and Vitamin D3 are the two major vitamin D subgroups in humans (ergocalciferol) dietary and endogenous varieties are physiologically inactive and thus activated by two hydroxylation procedures. The first response in the liver, where the conversion of vitamin D takes place while the second takes place in the kidneys.⁵ Studies on periodontitis have suggested that the vitamin D receptor (VDR) gene may contain polymorphisms. The osteoprotegerin receptor, which stimulates osteoclasts and increases bone resorption, is significantly suppressed by the vitamin D receptor (VDR), whereas the osteoblast receptor is stimulated.²² 1,25(OH)₂D₃ is produced as a result of

VDR activation, and it then activates antimicrobial peptides such as LL-37, an innate immune response to periodontal infections found in gingival epithelial cells.²³ Hypoplasia of the enamel and dentin is linked to a vitamin D deficit. During the development of teeth, inadequate vitamin D levels may cause the lamina dura and cementum to emerge more slowly that results in tooth loss.²⁴

Deficiency of Vitamin A and its effect on periodontium

Due to its crucial role in maintaining the epithelium, vitamin A deficiency is likely to have an impact on the gingiva. Periodontal disease and vitamin A insufficiency are closely related, and it was discovered that Vitamin A insufficiency has been associated to gingival inflammation, gingival hypoplasia, crevicular epithelium formation, and resorption of alveolar bone.¹⁸

Deficiency of Vitamin K and its effect on periodontium

Bacteroides melaninogenicus, an organism deeply connected to periodontal diseases, has indeed been found to require Vitamin K compounds for growth.²⁵ The rapid growth of this organism might be hindered by an appropriate antimetabolite of vitamin K, which would halt the course of periodontal disease.²⁶ Due to insufficient

prothrombin and other clotting component production, vitamin K deficiency causes coagulopathy. In associated symptoms, gingival bleeding is most common. At bleeding sites, there is inflammation and a risk of eventual attachment loss. Following periodontal surgery, the administration of antibiotics to treat intestinal bacteria leads in vitamin k deficiency, that induces blood loss and inadequate wound healing.²⁶

Deficiency of Vitamin E and its effect on periodontium

Tocopherols and tocotrienols, which are plant-based compounds with significant antioxidant and anti-inflammatory properties, make up the two core component of the lipophilic vitamin E referred to as vitamin E. Multiple health advantages of vitamin E include protection against cancer, heart disease, and musculoskeletal disorders. Given that immune cells' prolonged inflammation causes the destruction of periodontal tissue, vitamin E's anti-inflammatory properties may help maintain periodontal health by lowering excessive inflammation.²⁷

MINERALS AND ORAL HEALTH

CALCIUM & PHOSPHORUS

Once the protein matrix has fully mineralized, the bones and teeth have their

compressive strength due to the formation of hydroxyapatite. Made of the minerals calcium and phosphorus, hydroxyapatite is an essential component of enamel and dentin.²⁸ Since enamel cannot regenerate once the maturation process is complete, insufficient calcium consumption during pregnancy may result in malformed teeth, inadequate tooth calcification, irregularly formed teeth, and increased susceptibility to caries during tooth emergence.²⁸ Through all of childhood and adolescence, bone growth continues. Osteopenia, or decreased bone mass and density, results from insufficient calcium intake. If this shortage is not corrected, osteoporosis will develop, a disorder that makes bones weak, fragile, and fracture-prone. There may be tooth movement and early tooth loss as a result. In addition to having an impact on the teeth, calcium shortage is linked to periodontal disease that is more advanced.²⁹

FLOURIDE

Fluoride is a mineral that is present in all soil, water, plants, and animals, hence to an extent it is a part of every diet. It facilitates the integration of calcium and phosphate into enamel by incorporating with it during mineralization. This produces fluorapatite, which is tougher and less acid-soluble than hydroxyapatite.²⁸ ECC being one of the leading risk factors

for caries in the permanent dentition, primary prevention become crucial. A key component of such prevention is fluoride, which is also found in fluoridated toothpaste and varnish in addition to communal water.

MAGNESIUM

Numerous physiological processes depend on magnesium, an essential cation. There was a correlation between a greater Mg/Ca ratio and fewer probing depths, less attachment losses, lower levels of periodontitis, and more no of teeth present. Hypomagnesia can cause PMNLs to become active, and magnesium is thought to be involved in the suppression of free-radical production. So, hypothetically, a low magnesium level could lead to an augmented inflammatory response⁵.

PROTEIN

Proteins are the fundamental nutrient required for the synthesis of all body tissues of a living organism. Collagen is a protein that is crucial for the biochemical development of dentin, cementum, periodontal ligaments, and other components of oral cavity like gingiva, oral mucosa, bones, etc. Amino acids, the building blocks of protein, are essential for the maintenance and repair of oral tissues as well as the generation of antibodies necessary to fight infection.²⁸ Lack of

protein impairs the structural strength of the teeth, causes the tissues that support them to age and deteriorate, slows the healing of lesions, and makes individuals more prone to oral diseases. Although it is conceivable, protein deficiency has a close association with protein-energy malnutrition(PAN), which is characterised by a low intake of calories and, as a result, a low intake of protein. Enamel hypoplasia, primary dentition caries, and delayed exfoliation of the primary teeth are all symptoms of early childhood malnutrition.^{30,31}The function of the salivary glands can be decreased during adolescence as a result of early or chronic protein-energy malnutrition, which has significant effects on the body's ability to defend itself against microorganisms.³²

CARBOHYDRATES

Carbohydrates have a wide range of uses,including storing energy as well as providing it instantly. Despite of being

necessary for human nutrition,they encourages pathogenic growth in the oral cavity.²⁸Acidic metabolites are produced at the dentition

when microbes including *Streptococcus mutans*, *Lactobacillus spp.*, and *Streptococcus sanguis* break down carbohydrates; as the metabolites build up, they jointly cause the salivary pH to go below 5.5. Demineralization of enamel followed by demineralization of dentin occurs when the pH of the tooth surfaces is acidic. If this process is unregulated, the tooth will eventually die more quickly.³³Furthermore, microbes at the gingiva may build up a microbial film, putting areas at threat of plaque-induced gingivitis, a condition in which the gingival tissue is affected.

RECOMMENDED DIETRARY ALLOWANCE

Table 1. The effects of micronutrient deficiency on oral health ⁵

Deficient nutrient	Effect on oral structures
Protein malnutrition	malfunction of the salivary glands
Vitamin A	reduced saliva flow and decreased growth of epithelial tissue
Vitamin B1 (Thiamine)	Red cracked lips
	Angular cheilitis

Vitamin B2 (Riboflavin)	Tongue inflammation
Vitamin B3 (Niacin)	Gingival ulceration
Vitamin B6	Periodontal disease
	Painful tongue, anaemia,
	Burning sensation in the oral cavity
Vitamin B12	Angular cheilitis
	Halitosis
	Loss of bone
	Bleeding gums
	Detachment of periodontal fibres
	Oral ulceration
Vitamin C	Diseases affecting periodontium
	Delay in wound healing
	Impaired collagen formation
Vitamin D and calcium	Alveolar bone loss, inflamed gingiva
Iron	Atrophic glossitis
	Angular cheilitis
	Burning mouth syndrome
	Oral ulcers

Dietary reference intakes by age group ⁽¹⁾

Age	F	M
14 to 18 years		
Ca	1300	1300
P	1250	1250
Mg	360	410
Vitamin D ⁽²⁾	5	5
F	3	3
Vitamin B1	1	1.2
Vitamin B2	1	1.3
Vitamin B3	14	16

Vitamin B6	1.2	1.3
Vitamin B9 ⁽³⁾	400	400
Vitamin B12	2.4	2.4
Vitamin B5	5	5
Vitamin B7	25	25
Choline	400	550
Vitamin C	65	75
Vitamin E	15	15
Se	55	55
19 to 30 years		
Ca	1000	1000
P	700	700
Mg	310	400
Vitamin D ⁽²⁾	5	5
F	3	4
Vitamin B1	1.1	1.2
Vitamin B2	1.1	1.3
Vitamin B3	14	16
Vitamin B6	1.3	1.3
Vitamin B9 ⁽³⁾	400	400
Vitamin B12	2.4	2.4
Vitamin B5	5	5
Vitamin B7	30	30
Choline	425	550
Vitamin C	75	90
Vitamin E	15	15
Se	55	55
31 to 50 years		
Ca	1000	1000
P	700	700
Mg	320	420

Vitamin D ⁽²⁾	5	5
F	3	4
Vitamin B1	1.1	1.2
Vitamin B2	1.1	1.3
Vitamin B3	14	16
Vitamin B6	1.3	1.3
Vitamin B9 ⁽³⁾	400	400
Vitamin B12	2.4	2.4

(1) Milligrams are used to express quantities.

(2) Cholecalciferol 1 milligramme equals 40 IU of vitamin D.

(3) As nutritional folate substitutes (DFE). 1 DFE equals 1 mg of dietary folate and 0.6 mg of folic acid, which is available as a supplement or in foods that have been fortified. Due to research linking inadequate folate consumption to foetal neural tube defects it is advised to all pregnant women to consume 400 mg of folate daily from supplements or foods that have been fortified in addition to acquiring adequate folate from a varied diet.

The four separate reference values that make up the dietary reference intakes are as follows:

1. RDAs: the usual dietary consumption of a nutrient required to meet the needs of nearly all healthy people on a daily basis.

2. Adequate intake: a nutritional level when an RDA cannot be derived based on the known intakes of groups of healthy people.

3. Tolerable upper intake level: a nutrient's maximum daily consumption that is likely to not be hazardous for the majority of healthy individuals.

4. Estimated average requirement: the amount of a nutrient that is expected to satisfy the needs of 50% of the population's healthy people.

Standards like the Recommended Daily Allowances and Dietary Reference Intakes cater to the population's numerous subgroups, including infants, men and women of all ages, children, and

circumstances like pregnancy or breastfeeding.³⁴

CONCLUSION

The nutritional environment has an impact on growth and development scientific evidences are growing in support of the notion that changes in diet can have both good and bad, impact on health throughout life. Nutrition has an impact both before and after the eruption of teeth since tooth development starts in pregnancy and lasts till adulthood. Nutritional inadequacies during dental development are correlated with tooth size, formation, eruptive timing, and susceptibility to caries, according to various studies.

Protein malnutrition, or a lack of protein, is more common in underdeveloped nations, but it can also occur in lower socioeconomic groups in industrialised nations, in people who abuse drugs or alcohol, and in those who have eating disorders or other long-term illnesses. During the crucial growth phases, protein inadequacy has been linked to poor bone calcification, immature centres of new bone formation, smaller teeth, delayed osseointegration, delayed jaw development, and overcrowded dentition.³⁴

For the development of bones and teeth, phosphorus, calcium, and vitamin D are

necessary. Deficiency of nutrients during crucial developmental stages have been linked to dental repercussions, including disrupted maxilla, mandible, tooth, and condyle development along with compromised quality of tooth enamel and dentin.³⁵ Deficits in vitamin D and calcium have also been associated with generalised jaw bone resorption and the loss of the periodontal ligament.³⁴

Tooth movement, gingival bleeding, and connective tissue loss have all been linked to vitamin C insufficiency. However, depending on the type of biofilm present, these symptoms, which are a result of the infectious process, might vary substantially. Furthermore, a variety of populations, including smokers and diabetics, have been associated with an increased risk of periodontal disease when vitamin C deficiency is present.^{36,37} Vitamin C has a critical part in the production of collagen, which is necessary for the development of bone & teeth. Additionally, vitamin C has certain antioxidant qualities and is essential for mending soft and hard tissue damages in the mouth. According to numerous studies, vitamin A and beta-carotene are essential for the healthy growth and development of the oral epithelium, teeth, periodontium, and salivary glands. For instance, vitamin A is essential for the inflammatory stage of

wound healing because it aids in the creation of epithelium, collagen, and the immune system.³⁵

A pink, raw, fissured, smooth, or swollen tongue may be an indication of a vitamin B-complex deficiency. Additional symptoms could include scaly dermatitis, itchy eyes, and angular cheilitis. A lack of iron is evident by the following symptoms: tissue pallor, spoon-shaped nails, atrophic tongue, pale conjunctivae, and susceptibility to cold.

CONFLICT OF INTEREST

No conflict of interest

REFERENCES

- 1- www.unicef.org/india/resources_188.html
- 2- Mahan LK and Krause ES. Food, Nutrition and Diet Therapy. 10th Edition 2000
- 3- International Journal of Engineering Applied Sciences and Technology, 2019 Vol. 4, Issue 7, ISSN No. 2455-2143, Pages 165-168
- 4- Sheetal A , Hiremath VK, Patil AG, Sajjanetty S, and Kumar SR. Malnutrition and its Oral Outcome – A Review. Journal of Clinical Diagnostic Research 2013;7(1):178–180.
- 5- Rahman N, Walls A. Chapter 12: Nutrient Deficiencies and Oral Health. Monogr Oral Sci. 2020;28:114-124. doi: 10.1159/000455379. Epub 2019 Nov 7. PMID: 31940618.
- 6- Romito LM: Introduction to nutrition and oral health. Dent Clin N Am 2003; 47:187–207.
- 7- Yager J, Andersen AE. Anorexia nervosa. N Engl J Med 2005;353: 1481-8.
- 8- Sheetal A, Hiremath VK, Patil AG, Sajjan setty S, Kumar S: Malnutrition and its oral outcome. J Clin Diagn Res 2013;7:178– 180.
- 9- Rennie JS, MacDonald DG, Dagg JH: Iron and the oral epithelium: a

The manifestation of nutritional deficits have received particular attention in this review. One can overcome the nutrient deficiency either by enhancing their diet or by consuming some additional supplements. By offering nutritional advice for conditions relevant to both oral health & general health, the provider of oral health care can contribute to patient's health and well-being and thus can enhance the quality of life.

- review. *J R Soc Med* 1984;77:602–607.
- 10-Jontell M, Linde A. Nutritional aspects on tooth formation. *World Rev Nutr Diet.* 1986;48: 114-136.
- 11- Morriss-Kay GM, Sokolova N. Embryonic development and pattern formation. *FASEB J.* 1996; 10(9):961-968.
- 12-Akhtar S, Ahmed A, Randhawa MA, et al: Prevalence of vitamin A deficiency in South Asia: causes, outcomes, and possible remedies. *J Health Popul Nutr* 2013;31:413–423.
- 13-Park JA, Lee JH, Lee HJ: Association of some vitamins and minerals with periodontitis in a nationally representative sample of Korean young adults. *Biol Trace Elem Res* 2017;178:171– 179.
- 14-Sheetal A, Hiremath VK, Patil AG, Sajjansetty S, Kumar SR: Malnutrition and its oral outcome – a review. *J Clin Diagn Res* 2013;7:178–180.
- 15- Chaitanya NC, Muthukrishnan A, Babu DBG: Role of vitamin E and vitamin A in oral mucositis induced by cancer chemo/radiotherapy – a meta analysis. *J Clin Diagn Res* 2017; 11:ZE06–ZE09.
- 16-Mohammad Iqbal Khadim. Oral manifestation of malnutrition I-the effect of vitamins-a review *JPMA* 1981;31(2):44-48.
- 17- Iqbal MA, Khan M, Kumar P, Kumar A, Ajai K. Role of vitamin e in prevention of oral cancer:-a review. *J Clin Diagn Res.* 2014 Oct;8(10):ZE05-7. doi: 10.7860/JCDR/2014/9166.4958. Epub 2014 Oct 20. PMID: 25478472; PMCID: PMC4253290.
- 18-Ghosh, Abhishek & SK, Pallavi & Nagpal, Dr.Bhuvan& Hegde, Usha & S., Archana & Nagpal, Jyoti. (2015). Nutrition and Oral Health: A Review. *Indian Journal of Applied Research.* 5. 546-549.
- 19.Varela-López A, Navarro-Hortal MD, Giampieri F, Bullón P, Battino M, Quiles JL. Nutraceuticals in Periodontal Health: A Systematic Review on the Role of Vitamins in Periodontal Health Maintenance. *Molecules.* 2018 May 20;23(5):1226. doi: 10.3390/molecules23051226. PMID: 29783781; PMCID: PMC6099579.
- 20-Pflipsen M, Zenchenko Y. Nutrition for oral health and oral manifestations of poor nutrition and unhealthy habits. *Gen Dent.* 2017 Nov-Dec;65(6):36-43. PMID: 29099364.
- 21-Najeeb S, Zafar MS, Khurshid Z, Zohaib S, Almas K. The Role of Nutrition

in Periodontal Health: An Update. *Nutrients*. 2016 Aug 30;8(9):530. doi: 10.3390/nu8090530. PMID: 27589794; PMCID: PMC5037517.

22-Brock G, Chapple IL: The potential impact of essential nutrients vitamins C and D upon periodontal disease pathogenesis and therapeutic outcomes. *Curr Oral Health Rep* 2016;3:337–346.

23-Wang, TT, Nestel FP, Bourdeau V, Nagai Y, Wang Q, Liao J, Tavera-Mendoza L, Lin R, Hanrahan JW, Mader S, White JH: Cutting edge: 1,25-dihydroxyvitamin D3 is a direct inducer of antimicrobial peptide gene expression. *J Immunol* 2004;173:2909–2912.

24- Rugg-Gunn AJ, Al-Mohammadi SM, Butler TJ. Malnutrition and developmental defects of enamel in 2- to 6-year-old Saudi boys. *Caries Res*. 1998;32(3):181-192.

25-Gibbons, R. J., and L. P. Engle. Vitamin K compounds in bacteria that are obligate anaerobes. *Science* 1964; 146:1307-1309.

26-K. Malathi, E. Amuthavalli, R. Thanmanam, V. Dasarathan. Effects of Vitamin K in Periodontium, *International Journal of Science and Research (IJSR)*, Volume 6 Issue 12, December 2017, 996-999.

27-Shadisvaaran S, Chin KY, Shahida MS, Ima-Nirwana S, Leong XF. Effect of vitamin E on periodontitis: Evidence and proposed mechanisms of action. *J Oral Biosci*. 2021 Jun;63(2):97-103. doi: 10.1016/j.job.2021.04.001. Epub 2021 Apr 20. PMID: 33864905.

28-Pflipsen, Matthew & Zenchenko, Yevgeniy. (2017). Nutrition for oral health and oral manifestations of poor nutrition and unhealthy habits. *General Dentistry*. 65. 36-43.

29-Nishida M, Grossi SG, Dunford RG, Ho AW, Trevisan M, Genco RJ. Calcium and the risk for periodontal disease. *J Periodontol*. 2000;71(7):1057-1066.

30-Psoter WJ, Reid BC, Katz RV. Malnutrition and dental caries: a review of the literature. *Caries Res*. 2005;39(6):441-447.

31- Alvarez JO, Lewis CA, Saman C, et al. Chronic malnutrition, dental caries, and tooth exfoliation in Peruvian children aged 3-9 years. *Am J Clin Nutr*. 1988;48(2):368-372.

32-Psoter WJ, Spielman AL, Gebrian B, St Jean R, Katz RV. Effect of childhood malnutrition on salivary flow and pH. *Arch Oral Biol*. 2008;53(3):231-237.

33-Rigassio Radler D. Nutrition for oral and dental health. In: Mahan LK,

Raymond JL, eds. Krause's Food & the Nutrition Care Process. 14th ed. St Louis: Elsevier; 2017:468-477.

34-Romito LM. Introduction to nutrition and oral health. Dent Clin North Am. 2003 Apr;47(2):187-207, v. doi: 10.1016/s0011-8532(02)00096-4. PMID: 12699227.

35-Nizel AE, Papas AS. The macrominerals calcium, phosphorus and magnesium: their role in the health of the body and especially the oral cavity. In: Dyson J, Gandy J, editors. Nutrition in

clinical dentistry. 3rd edition. Philadelphia: WB Saunders; 1989. p. 144–64

36- Fontana M. Vitamin C (ascorbic acid): clinical implications for oral health—a literature review. Compendium 1994;25(7):916–26.

37- Nizel AE, Papas AS. Vitamin C. In: Dyson J, Gandy J, editors. Nutrition in clinical dentistry. 3rd edition. Philadelphia: WB Saunders; 1989. p. 113–20.

How to cite this article: Malik A, Tangade P, Kalantharakath T, Singh V, Jain A, Yadav J . Nutrition & Oral Health. TMUJDent2022;9(4):43-58.