International Journal of Community Medicine and Public Health
Abdulwahab MA et al. Int J Community Med Public Health. 2025 Jan;12(1):535-539
http://www.ijcmph.com
pISSN 2394-6032 | eISSN 2394-6040

DOI: https://dx.doi.org/10.18203/2394-6040.ijcmph20244068

Review Article

Nutritional deficiencies and their role in endodontic disease susceptibility and recovery

Maha A. Abdulwahab[1]*, Basil K. Alqurashi[2], Faisal K. Albaqawi[3], Khalid L. Al-Harbi[2], Hala S. Alshurtan[3], Fatimah K. Alqahtani[2], Sawsan J. Kazim[4], Rawan S. Shafloot[5], Abdullah H. Alshamrani[2], Ali S. Alsaran[6], Kuthar H. Alzaher[7]

[1]North Jeddah Specialist Dental Center, King Abdullah Medical Complex, Jeddah, Saudi Arabia
[2]College of Dentistry, King Abdulaziz University, Jeddah, Saudi Arabia
[3]College of Dentistry, University of Hail, Hail, Saudi Arabia
[4]College of Dentistry, Imam Abdulrahman Bin Faisal University, Dhahran, Saudi Arabia
[5]College of Dentistry, King Khalid University, Abha, Saudi Arabia
[6]Department of Clinical Nutrition, Prince Sultan Military Medical City, Riyadh, Saudi Arabia
[7]Dental Department, Qatif Central Hospital, Qatif, Saudi Arabia

Received: 03 December 2024
Accepted: 23 December 2024

***Correspondence:**
Dr. Maha A. Abdulwahab,
E-mail: mahaaabbas84@gmail.com

ABSTRACT

Endodontic diseases, characterized by inflammation and infection of the dental pulp and periapical tissues, are influenced not only by microbial factors but also by systemic nutritional deficiencies. Essential nutrients such as vitamins and minerals are critical for maintaining the structural integrity and immune functions of dentin and pulp tissues. Deficiencies in key vitamins like D, C, and A, as well as minerals like calcium, phosphorus, magnesium, and zinc, impair tissue repair, reduce resilience to infections, and delay recovery from endodontic treatments. Vitamin D supports immune modulation and calcium metabolism, while vitamin C promotes collagen synthesis and antioxidant protection. Deficiencies in these nutrients exacerbate pulpal and periapical tissue damage, increasing susceptibility to microbial invasion. Minerals such as calcium and phosphorus are vital for hydroxyapatite formation, ensuring dentin strength and repair. Magnesium and zinc contribute to enzymatic processes, anti-inflammatory responses, and tissue regeneration, playing pivotal roles in dental recovery. Dietary interventions, including the consumption of antioxidant-rich foods, omega-3 fatty acids, and probiotics, enhance oral health by reducing inflammation, promoting microbial balance, and improving nutrient availability. Foods like citrus fruits, fatty fish, and fermented products strengthen the body's defenses against endodontic infections and support healing. The interplay between nutrition and endodontic health highlights the need for an integrative approach that considers systemic factors, dietary patterns, and targeted supplementation. Addressing nutritional deficiencies improves treatment outcomes, accelerates recovery, and enhances the resilience of dental tissues. By combining clinical care with personalized nutritional strategies, the burden of endodontic diseases can be significantly reduced, promoting optimal oral health and systemic well-being. This comprehensive understanding underscores the importance of incorporating nutrition into dental practice and public health initiatives.

Keywords: Endodontic diseases, Nutritional deficiencies, Pulp tissue resilience, Dietary interventions, Oral health recovery

INTRODUCTION

Endodontic diseases, primarily characterized by inflammation and infection of the dental pulp and periapical tissues, pose significant challenges in dental health. These conditions often arise due to microbial invasion, trauma, or other pathological processes, leading to pain, discomfort, and compromised dental function. While the role of microbial factors in the etiology of endodontic diseases is well-established, emerging evidence highlights the importance of systemic factors, particularly nutritional deficiencies, in influencing both the susceptibility to and recovery from these conditions.

Nutrients play a critical role in maintaining the structural integrity and functionality of dental tissues. Vitamins, minerals, and other dietary components are essential for immune regulation, tissue repair, and maintaining the mineralized structure of teeth. Deficiencies in key nutrients such as vitamins D and C, calcium, and zinc have been linked to impaired immune responses, delayed wound healing, and increased susceptibility to infections, including those affecting the dental pulp and periapical tissues. For instance, vitamin D is known for its pivotal role in calcium metabolism and immune modulation, which are essential for healthy dentin and pulp tissues.[1] Similarly, vitamin C is critical for collagen synthesis and wound healing, processes integral to recovery from endodontic procedures.[2]

The interplay between nutritional status and endodontic health becomes particularly evident during the recovery phase. Effective healing following endodontic treatments such as root canal therapy or regenerative procedures requires an optimal supply of nutrients to support cellular regeneration and combat infection. Zinc, for example, is an essential cofactor for numerous enzymes involved in tissue repair and immune function, underscoring its importance in endodontic recovery.[3] Furthermore, deficiencies in calcium and phosphate can impair the mineralization processes necessary for dentin repair and the stabilization of periapical lesions.

Beyond individual nutrients, the broader dietary patterns and overall nutritional status of patients can significantly influence endodontic health outcomes. Chronic malnutrition or imbalanced diets may exacerbate systemic inflammation and impair the body's ability to respond effectively to dental infections. These systemic effects can prolong the inflammatory phase and delay the resolution of periapical infections, complicating the clinical management of endodontic diseases. Moreover, the growing prevalence of conditions such as vitamin D deficiency, particularly in regions with limited sunlight exposure, highlights the need to consider systemic health factors in endodontic care.[4] This recognition of the interplay between nutritional deficiencies and endodontic diseases provides a valuable perspective for preventive and therapeutic strategies. It emphasizes the importance of a comprehensive approach to dental health that includes not only microbial control and clinical intervention but also the optimization of systemic health through dietary improvements and supplementation where necessary.

REVIEW

Nutritional deficiencies are increasingly recognized as influential factors in the susceptibility to and recovery from endodontic diseases. The role of vitamin D in dental health exemplifies this, as it regulates calcium homeostasis and supports immune functions critical for combating infections. Studies have shown that individuals with low serum vitamin D levels exhibit a higher propensity for apical periodontitis and slower healing rates post-endodontic procedures due to impaired bone remodeling and immune responses.[5] The prevalence of vitamin D deficiency worldwide, particularly in regions with limited sunlight exposure, underscores the importance of addressing this deficiency in patients undergoing endodontic treatment. Vitamin C also plays a pivotal role in endodontic health through its involvement in collagen synthesis and its antioxidant properties. Deficiency in vitamin C has been linked to compromised periodontal and periapical tissue integrity, as well as delayed wound healing after dental procedures.[6] These findings suggest that adequate dietary intake or supplementation of vitamin C may enhance the healing process and improve clinical outcomes in endodontics. Considering the systemic impact of nutritional deficiencies, dental practitioners should adopt a holistic approach that includes nutritional assessment and guidance. Such measures not only enhance the success of endodontic treatments but also promote overall oral health and resilience to future dental infections.

Impact of vitamin deficiencies on pulpal and periapical health

Vitamin deficiencies are critical contributors to the development and progression of endodontic diseases, impacting both the susceptibility of pulpal and periapical tissues to infections and their capacity for recovery. Among these, the deficiency of vitamin A has been extensively studied. Vitamin A is vital for epithelial integrity and immune function, and its inadequacy can lead to an impaired mucosal barrier and reduced ability to fight microbial infections. In dental tissues, vitamin A deficiency has been linked to increased inflammation in the pulp and delayed recovery from periapical infections.[7]

Another key vitamin affecting endodontic health is vitamin E, known for its potent antioxidant properties. Vitamin E mitigates oxidative stress, which is often elevated in inflamed dental tissues. Inadequate levels of vitamin E can exacerbate inflammatory responses in the pulp and surrounding tissues, prolonging the disease course and complicating treatment outcomes. Research suggests that vitamin E deficiency can intensify the oxidative damage to dentin and periodontal structures, contributing to the chronicity of pulpal and periapical diseases.[8] The interplay

between vitamin B-complex deficiencies and dental health also deserves attention. For instance, vitamin B12 plays an essential role in DNA synthesis and red blood cell formation, both of which are critical for tissue regeneration and immune response. A deficiency in vitamin B12 has been associated with reduced vascularization and slower healing of periapical lesions following endodontic treatment. Furthermore, studies have shown that vitamin B12 deficiency can indirectly contribute to increased bacterial invasion in dental tissues due to compromised immunity.[9]

Folate, another member of the B-vitamin family, is equally important in maintaining dental health. Folate deficiency has been correlated with increased inflammation and impaired collagen formation, both of which are critical in the context of dental infections and tissue repair. In the pulp, low folate levels can lead to diminished capacity for fibroblast proliferation and extracellular matrix production, thereby weakening the tissue's structural integrity and prolonging the healing process after an infection or injury. Moreover, folate plays a role in modulating homocysteine levels, with elevated homocysteine linked to vascular impairments that can compromise the delivery of nutrients and immune cells to the pulp and periapical tissues.[10] These observations underline the multifaceted impact of vitamin deficiencies on pulpal and periapical health, extending beyond simple structural changes to influence the biochemical and immunological environment within dental tissues. Nutritional inadequacies not only increase vulnerability to infections but also slow down tissue recovery, thereby affecting the overall prognosis of endodontic treatments.

The role of minerals in dentin and pulp tissue resilience

Minerals are indispensable for the structural and functional integrity of dentin and pulp tissues. Calcium, one of the most abundant minerals in the human body, plays a pivotal role in dentin formation and mineralization. It is integral to hydroxyapatite, the mineralized matrix that gives dentin its hardness and resilience. Insufficient calcium levels are associated with compromised dentin quality, increased susceptibility to dental caries, and diminished repair capacity of the pulp-dentin complex. Furthermore, calcium deficiency has been shown to impair the differentiation of odontoblasts, the cells responsible for dentin production, thereby weakening the structural defenses of teeth against microbial invasion.[11]

Phosphorus, often in conjunction with calcium, is another mineral critical for dentin and pulp health. It is an essential component of hydroxyapatite and supports the remineralization process in response to demineralization caused by acids or microbial activity. Phosphorus deficiency not only affects the density of dentin but also disrupts the balance of mineral deposition and resorption within the tooth structure. Studies indicate that phosphorus depletion can result in porous and brittle dentin, making the tissue more vulnerable to external stresses and infection.[12] Additionally, phosphate metabolism is intricately linked to cellular energy production, which influences pulp vitality and the capacity for healing.

Magnesium, though less emphasized, is fundamental for maintaining the structural stability of dental tissues. It acts as a cofactor for enzymatic reactions involved in energy production and protein synthesis, both of which are necessary for pulp cell metabolism and repair. Research suggests that magnesium deficiency leads to decreased mineral density in dentin and weakens the overall mechanical properties of teeth. Moreover, magnesium plays a regulatory role in inflammatory responses within the pulp, potentially mitigating excessive inflammation that could otherwise impair healing processes.[13]

Zinc, a trace mineral, is also crucial for pulp and dentin resilience. It participates in enzymatic activities involved in collagen synthesis and matrix metalloproteinase regulation, both of which are vital for dentin-pulp repair mechanisms. Zinc deficiency has been linked to impaired collagen matrix formation and reduced resistance to microbial invasion in the pulp. Furthermore, zinc's antioxidant properties help mitigates oxidative stress within dental tissues, a factor that can exacerbate tissue damage and compromise healing. Studies have highlighted the role of zinc in enhancing odontoblastic activity, which is essential for the formation of reparative dentin following injury or infection.[14] Together, these minerals form the foundation of dentin and pulp tissue resilience. Their deficiency not only compromises structural integrity but also disrupts the biochemical pathways essential for repair and immune defense within the dental tissues.

Nutritional influence on healing and recovery in endodontics

Nutritional status plays a pivotal role in determining the efficacy of healing and recovery following endodontic procedures. Among the key nutrients, protein stands out for its essential contribution to tissue repair and regeneration. Proteins provide the building blocks for cellular growth and extracellular matrix synthesis, crucial for healing damaged pulp and periapical tissues. A deficiency in dietary protein can impair fibroblast proliferation, reduce collagen production, and delay the formation of granulation tissue, thereby prolonging recovery. In clinical observations, patients with inadequate protein intake have demonstrated slower resolution of periapical lesions and reduced capacity for dentin-pulp complex regeneration.[15]

Omega-3 fatty acids, particularly eicosapentaenoic acid and docosahexaenoic acid, are increasingly recognized for their anti-inflammatory properties and their role in promoting resolution-phase immune responses. These fatty acids are precursors to specialized pro-resolving mediators, which help mitigate excessive inflammation and support tissue regeneration. Research has highlighted that omega-3 supplementation reduces inflammation-

associated damage in periapical tissues, potentially enhancing recovery after endodontic treatments.[16] Furthermore, omega-3 fatty acids improve vascular function, ensuring adequate blood supply and nutrient delivery to injured sites, thereby expediting the healing process.

Iron is another critical nutrient influencing recovery in endodontics due to its role in oxygen transport and cellular energy metabolism. Iron deficiency anemia can compromise the oxygenation of pulpal and periapical tissues, leading to hypoxia and reduced cellular activity. Hypoxia adversely affects the functions of immune cells, such as macrophages and lymphocytes, which are essential for clearing infection and promoting tissue repair. Studies have shown that iron supplementation in deficient individuals significantly improves the healing of soft and hard tissues by enhancing the metabolic activity of repair cells and facilitating the formation of new capillaries in injured areas.[17]

Vitamin K, often overlooked, is vital for its role in the carboxylation of proteins involved in bone metabolism and tissue repair. In the context of endodontics, vitamin K deficiency can impair the mineralization of newly formed bone in periapical regions, delaying the healing of lesions. Moreover, vitamin K supports the regulation of inflammatory responses and prevents excessive tissue degradation. Studies have demonstrated that adequate levels of vitamin K accelerate the healing of bone defects and improve the outcomes of regenerative dental treatments by enhancing osteoblast activity and promoting matrix deposition.[18]

Dietary interventions as preventive strategies for endodontic diseases

Preventing endodontic diseases extends beyond clinical interventions and includes dietary modifications to address underlying risk factors. One such approach is the inclusion of foods rich in calcium and phosphorus to strengthen dentin and enamel. A diet deficient in these minerals predisposes teeth to demineralization, increasing their susceptibility to decay and subsequent endodontic infections. Fortified dairy products, leafy green vegetables, and nuts serve as accessible sources of these minerals. Evidence suggests that populations with higher dietary calcium intake exhibit lower rates of caries and pulp-related complications, underlining the importance of maintaining adequate calcium and phosphorus levels for dental health.[19]

Antioxidant-rich foods, such as fruits and vegetables high in vitamins C and E, play a crucial role in neutralizing oxidative stress within dental tissues. Oxidative stress contributes to the progression of endodontic diseases by exacerbating inflammatory responses and damaging pulp cells. Dietary inclusion of citrus fruits, berries, and nuts not only supports collagen synthesis essential for pulp and periapical tissue repair but also reduces the chronic inflammatory burden on these tissues. A study demonstrated that individuals with diets rich in antioxidants showed reduced levels of inflammatory markers and improved resistance to microbial invasion in the dental pulp.[20]

The role of omega-3 fatty acids as a dietary intervention is increasingly recognized in dental health. Found in fatty fish, flaxseeds, and walnuts, omega-3 fatty acids exhibit anti-inflammatory effects by modulating the production of cytokines and eicosanoids involved in inflammatory responses. Regular consumption of omega-3-rich foods has been linked to a decreased prevalence of apical periodontitis and improved outcomes in endodontic treatments. Research indicates that omega-3 fatty acids may also enhance the regenerative potential of dental tissues by promoting vascularization and reducing oxidative damage.[21] Probiotics are another dietary strategy gaining attention for their potential in preventing endodontic diseases. Fermented foods such as yogurt, kefir, and sauerkraut contain beneficial bacteria that contribute to a balanced oral microbiome. An imbalance in oral microbiota is a significant risk factor for the development of pulpal and periapical infections. Probiotics can inhibit the growth of pathogenic bacteria, such as *Enterococcus faecalis*, commonly implicated in refractory endodontic infections. Clinical trials have shown that regular probiotic consumption reduces the microbial load in oral biofilms and may prevent the progression of carious lesions into the pulp chamber.[22]

CONCLUSION

Nutritional deficiencies play a pivotal role in the susceptibility to and recovery from endodontic diseases, influencing inflammation, tissue repair, and immune function. Key vitamins and minerals, alongside dietary interventions, contribute significantly to maintaining the health and resilience of dentin and pulp tissues. Incorporating nutrient-rich diets and targeted supplementation can enhance both prevention and treatment outcomes in endodontics. A holistic approach addressing systemic and dietary factors is essential for optimizing oral health and long-term patient care.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Bikle DD. Vitamin D - newer concepts of its metabolism and function at the basic and clinical level. J Endocr Soc. 2020;4:10.
2. Naidu KA. Vitamin C in human health and disease is still a mystery? An overview. Nutr J. 2003;2:1-10.
3. Prasad AS. Zinc in human health: effect of zinc on immune cells. Mol Med. 2008;14:353-7.
4. Vitamin D. deficiency. Holick MF. N Engl J Med. 2007;357:266-81.

5. Botelho J, Machado V, Proença L, Delgado AS, Mendes JJ. Vitamin D deficiency and oral health: a comprehensive review. Nutrients. 2020;12(5):1471.
6. Touyz L. Vitamin C, oral scurvy and periodontal disease. South Afr Med J. 1984;65(21):838-42.
7. Tanumihardjo SA. Vitamin A and bone health: the balancing act. J Clin Densitometr. 2013;16(4):414-9.
8. Traber G. Stevens M, Jan F. Vitamins C. E: Beneficial effects from a mechanistic perspective. Free Rad Biol Med. 2011;51(5):1000-13.
9. Allen LH. Causes of vitamin B12 and folate deficiency. Food Nutr Bull. 2008;29(2):S20-34.
10. Bailey LB, Gregory III JF. Folate metabolism and requirements. J Nutr. 1999;129(4):779-82.
11. Rude RK, Gruber HE. Magnesium deficiency and osteoporosis: animal and human observations. J Nutr Biochem. 2004;15(12):710-6.
12. Heaney RP. Phosphorus nutrition and the treatment of osteoporosis. Paper presented at: Mayo Clinic Proceedings. 2004.
13. Rude R, Gruber H, Wei L, Frausto A, Mills B. Magnesium deficiency: effect on bone and mineral metabolism in the mouse. Calcified Tissue Int. 2003;72:32-41.
14. Powell SR. The antioxidant properties of zinc. J Nutr. 2000;130(5):1447S.
15. Phillips SM, Tang JE, Moore DR. The role of milk- and soy-based protein in support of muscle protein synthesis and muscle protein accretion in young and elderly persons. J Am Coll Nutr. 2009;28(4):343-54.
16. Calder PC. Omega-3 fatty acids and inflammatory processes: from molecules to man. Biochem Soc Transactions. 2017;45(5):1105-15.
17. Beard JL, Dawson H, Piñero DJ. Iron metabolism: a comprehensive review. Nutr Rev. 1996;54(10):295-317.
18. Schwalfenberg GK. Vitamins K1 and K2: the emerging group of vitamins required for human health. J Nutr Metabolism. 2017;2017(1):6254836.
19. Weaver CM, Heaney RP. Calcium in human health. Springer Science & Business Media; 2007.
20. Halliwell B, Gutteridge JM. Free radicals in biology and medicine. Oxford university press, USA; 2015.
21. Simopoulos AP. Omega-3 fatty acids in inflammation and autoimmune diseases. J Am Coll Nutr. 2002;21(6):495-505.
22. Haukioja A. Probiotics and oral health. Eur J Dentistry. 2010;4(03):348-55.

Cite this article as: Abdulwahab MA, Alqurashi BK, Albaqawi FK, Al-Harbi KL, Alshurtan HS, Alqahtani FK, et al. Nutritional deficiencies and their role in endodontic disease susceptibility and recovery. Int J Community Med Public Health 2025;12:535-9.