

## Association between Teeth Loss and Nutritional Deficiencies: A Literature Review

Hassan Ahmed Darwish<sup>1\*</sup>, Hassan Essa Alkhalaf<sup>2</sup>, Asrar Saud Alraddadi<sup>3</sup>, Fawziah Marwan Ghandoor<sup>4</sup>, Dania Mohammed Alnowaiser<sup>5</sup>, Rahaf Abdullah Niyazi<sup>6</sup>, Hussain Zaki Al Abdulwahhab<sup>7</sup>, Khulud Ali Zabbani<sup>4</sup>, Murtadah Hussain Alkhamees<sup>8</sup> and Ebtihal Taher Alahdal<sup>9</sup>

<sup>1</sup>Gharb Al-Hawiyah Primary Health Center, Ministry of Health, Taif, Saudi Arabia

<sup>2</sup>Department of Dentistry, Alsaeera General Hospital, Hafer Albatin, Saudi Arabia

<sup>3</sup>College of Dentistry, Ibn Sina National College, Jeddah, Saudi Arabia

<sup>4</sup>College of Dentistry, Batterjee Medical College, Jeddah, Saudi Arabia

<sup>5</sup>College of Dentistry, Riyadh Elm University, Riyadh, Saudi Arabia

<sup>6</sup>Department of Dentistry, Samir Abbas Hospital, Jeddah, Saudi Arabia

<sup>7</sup>Department of Dentistry, Ras Tanoura General Hospital, Ras Tanoura, Saudi Arabia

<sup>8</sup>Department of Dentistry, Qaryat Al Ulya Hospital, Qaryat Al Ulya, Saudi Arabia

<sup>9</sup>Department of Dentistry, King Abdulaziz University Dental Hospital, Jeddah, Saudi Arabia

**\*Corresponding Author:** Hassan Ahmed Darwish, Gharb Al-Hawiyah Primary Health Center, Ministry of Health, Taif, Saudi Arabia.

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### Abstract

Tooth loss (TL) is considered a reflection of many combined factors related to prior dental diseases, patients' and dentists' attitudes, dentist-patient relationship, and availability as well as the accessibility of dental care services. Even though the incidence of tooth loss has declined significantly during the past two decades, there is yet no clear understanding of the epidemiology and burden of such a condition. For that, we performed an extensive literature search of the Medline, Cochrane, and EMBASE databases using the medical subject headings (MeSH) terms. Papers discussing the association between teeth loss and nutritional deficiencies were screened for relevant information. There were no limits on date, language, age of participants or publication type. Periodontal diseases, especially periodontitis, and untreated dental caries are the two major causes of TL, followed by trauma, prosthodontics, and wisdom tooth. It has been reported that tooth loss is associated with various nutritional deficiencies, including vitamin B12, folate, vitamin C, vitamin D3 and calcium deficiency. Various pathways have been reported, where nutritional deficiencies have been correlated with the progression of periodontal diseases, increase clinical attachment loss, and pocket depth with the consequent occurrence of tooth loss. Therefore, we conducted this current investigation to review the recent literature on the association between nutritional deficiencies and the risk of tooth loss.

**Keywords:** Tooth Loss; Nutritional Deficiency; Review

### Introduction

Tooth loss (TL) is considered a complex outcome, reflecting a person's history of dental diseases and its management through dental healthcare services over the life course [1,2]. TL also reflects patients' and dentists' attitudes and the dentist-patient relationship, as well as the availability and accessibility of dental services [1,3]. A better comprehension of current trends in TL is critical for planning dental services as well as for updating the dental curriculum. TL is perceived as an effective marker of a population's oral health status, and, thus is monitored thoroughly in most countries.

That being said, there is no clear understanding of the epidemiology of TL, where prior evidence is conducted and limited to the developed world [4,5] and the elderly population [6]. Periodontal disease, such as periodontitis, a chronic inflammatory state characterized by attachment loss, is highly prevalent worldwide [7,8]. Untreated dental caries is considered a very common oral disease with a high prevalence rate in the elderly [9]. Both disease categories, periodontal diseases, and caries are perceived as the primary causes of tooth loss, accounting for 70% of TL, while trauma, prosthodontics, and wisdom tooth account for around 30% of TL [10]. Periodontitis, dental caries, and the associated TL are significantly correlated with poor quality of life (QOL) [11].

Teeth loss has been reported to be associated with several nutritional factors deficiencies, such as serum 25-hydroxy vitamin D3 [12-14] vitamin C [15], vitamin B12, and folic acid deficiency [16]. Therefore, we conducted this current investigation to review the recent literature on the association between all of the nutritional deficiencies reported, to date, with the risk and/or incidence of tooth loss. We also investigated whether there is a negative impact on dietary intake and nutritional status following tooth loss or not.

### Methods

We performed an extensive literature search of the Medline, Cochrane, and EMBASE databases on 10 December 2019 using the medical subject headings (MeSH) terms. Papers discussing the association between teeth loss and nutritional deficiencies were screened for relevant information. There were no limits on date, language, age of participants or publication type.

### Global burden of teeth loss

In 2014, a systematic review and meta-analysis pooled the data of 158 million people worldwide, providing the most comprehensive and largest epidemiologic data on severe tooth loss to date and shaping the public health policy [17]. A total of 2.3% of the global population, represented by 158 million participants, had tooth loss “edentate”. The global age-standardized prevalence rate of tooth loss in 2010 was reported to be 205 cases per 100,000 person-years, with a significant reduction in the incidence rate by 45% from the 1990 incidence rate of 374 cases per 100,000 person-years. Even though the global age-standardized prevalence of tooth loss in the whole population was noted to reduce from 4.4% to 2.4% between 1990 and 2010, however, it’s critical to note that the coordinated efforts in managing dental diseases and preventing tooth loss throughout life might have had a significant positive effect on minimizing the rates of tooth loss, the ultimate oral health disposition of populations [17].

These findings implicate how essential the understanding of the epidemiology of severe tooth loss and its consequences are for the management and decision-making in clinical dentistry, in addition to requirements assessment and planning healthcare services in public health.

Moreover, it was noted that the main etiology of tooth loss is untreated caries and periodontal diseases [17]. Once oral disease occurs, treatment is the critical step to take in order to stop its progression; lack of treatment is highly likely to cause tooth loss eventually. From the aforementioned observations, it’s suggested that dental health services have been of significance in preventing the consequences of the main two oral diseases, periodontal diseases, and untreated dental caries. That being said, the prevention of tooth loss might be the explanation to the non-significant concurrent increase in the prevalence of the discusses two major dental disease categories [6,18].

### Micronutrients

#### Vitamin B12 and folate deficiency

Inadequate serum vitamin B12 levels have been associated with severe systemic diseases, in addition to a certain variety of oral symptoms, implicating a potential essential role of vitamin B12 in oral health [19]. In this context, a large prospective cohort study was conducted in 2016 in order to validate this hypothesis. The associations between serum vitamin B12 levels and changes in periodontitis were observed through the measurement of probing pocket depth (PD), clinical attachment loss (CAL) and eventually tooth loss (TL)

[16]. Compared to those with the highest vitamin B12 levels, patients with the lowest level (quartile) of vitamin B12 had 0.10 mm more increase in mean PD; 0.23 mm more increase in mean CAL; relative risk (RR) of 1.57 for TL. That being said, there was no significant association noted between folic acid level and changes in mean PD, CAL, or TL in the multivariate model. In comparison to participants with normal levels of vitamin B12 ( $\geq 259$  pmol/l), the authors noted a significant increase in mean PD, CAL, and TL in the vitamin B12-deficient group. Moreover, the relative risk of tooth loss was significantly higher in patients with vitamin B12 deficiency.

All of these observations were noted over a mean follow-up period of 5.9 years. In addition to that, these findings are independent of various known confounding factors, such as sociodemographic, lifestyle, and oral health behavioral factors as well as smoking status [16].

Unfortunately, this was the only study reported in the literature, presenting the data related to the correlation between vitamin B12 and tooth loss. In this matter, more studies, especially prospective randomized clinical trials with large sample sizes, are warranted to confirm the observations noted by Zong, *et al.* [16] and to determine the changing patterns in the incidence rate of tooth loss with serum vitamin B12 levels in patients taking vitamin B12 supplementations.

### Vitamin C deficiency

Considered as a global burden affecting more than 743 million individuals worldwide, Periodontal disease is noted to be a primary cause of tooth loss in the high age group [17,20]. It has been reported that the intake of vitamin C seems to play a critical role in the pathogenesis of gingival and periodontal inflammation. Vitamin C has been described as an essential micronutrient for the periodontal health status, both in clinical and in-vitro research. It was noted that the absence of vitamin C leads to scurvy, which in turn is accompanied by the massive periodontal bone loss [21-24].

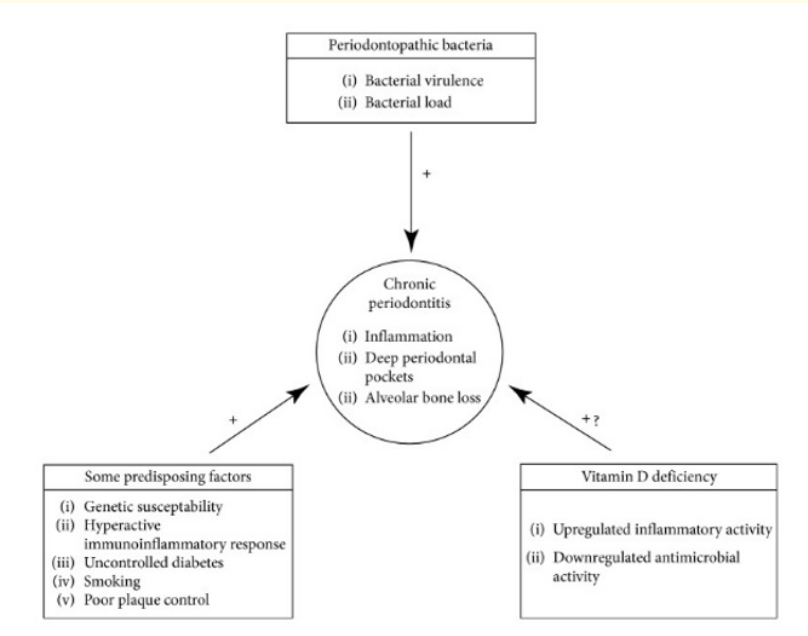
To date, only three investigations were conducted to determine the correlation between clinical attachment loss (CAL) and plasma vitamin C levels [21,23,25]. Two of those studies demonstrated that the extent of CAL was negatively associated with the levels of plasma vitamin C among studied participants. Amarasena, *et al.* [26] noted that serum vitamin C concentration was inversely associated with CAL. Chapple, *et al.* [25] noted that the rate of occurrence of severe periodontitis was significantly higher in those with low serum vitamin C concentration ( $< 8.52$  mmol/L), compared to participants with other concentrations. On the other hand, the last study found that the extent of attachment loss was negatively associated with plasma vitamin C concentrations among studied individuals [21].

Noteworthy, the aforementioned observations are based on the data from studies conducted from 2005 to 2007 with no current investigations on the correlation between vitamin C levels and the incidence of tooth loss, as a primary outcome. Therefore, more investigations are required in this matter [27].

### 25-Hydroxy Vitamin D Deficiency

An increasing body of evidence linking vitamin D3 levels and oral health status has been emerging during the past few decades [28]. A positive effect of vitamin D on periodontal health status was noted in both clinical and in-vitro research [13,29,30]. Recent investigations suggest that elevated serum 25-hydroxy vitamin D (25OHD- vitamin D3) might be associated with a reduction in the risk of gingival inflammation [31], periodontitis [32], dental caries [33] and eventually tooth loss [13]. In the same context, the intake of vitamin D supplements has been noted to prevent the progression of periodontal diseases (Figure 1) [34]. That being said, the aforementioned reports were hardly suitable to assess the causality of such a relationship [28].

In this regard, Zhan, *et al.* [28] conducted a study among 1904 participants to explore the correlation between serum 25-OHD and the incidence of tooth loss, the progression of periodontal disease, and carious status in a follow-up period of 5 years. The authors noted a significant increase in the incidence rates of tooth loss in patients with reduced serum vitamin D3, even though the incidence rates of dental caries were comparably similar across assessed quintiles of serum vitamin D3. Moreover, increased serum D3 levels were correlated



**Figure 1:** The pathogenesis of Periodontal disease and its association with vitamin D deficiency. Source: Khammissa RA, Ballyram R, Jadwat Y, Fourie J, Lemmer J, Feller L. Vitamin D deficiency as it relates to oral immunity and chronic periodontitis. *International journal of dentistry*; 2018 [36].

with reduced risk of tooth loss in all models. Also, individuals with normal D3 levels had a significantly lower risk of tooth loss compared to vitamin D3-deficient participants.

This is comparable to the results reported by the Health Professionals Follow-up Study, the largest study with the longest follow-up duration, where a 14% reduction in the risk of self-reported tooth loss was noted in those with the highest quintile of vitamin D3 compared to those in the lowest quintiles [13]. Moreover, the administration of vitamin D supplementations has been linked with beneficial outcomes in terms of tooth loss [14]. Consistently, a meta-analysis concluded that D3 supplementation may lower the risk of caries in the pediatric population [35].

**Minerals**

**Calcium and phosphorus**

A very limited body of evidence has investigated the effects of calcium supplementation on alveolar bone loss in patients with periodontal disease, showing contradictory results [37-39]. It is unknown if this will delay the progression of periodontal disease and eventually tooth loss. That being said, a recent 3-year, randomized placebo-controlled clinical trial was conducted to estimate the incidence of tooth loss in patients taking calcium and vitamin D supplementations [14]. It was reported that 13% of people taking supplementation had tooth loss, while 27% of participants in the placebo group had tooth loss. Moreover, during the follow-up period, 40% of patients taking calcium (> 1000 mg/day) had tooth loss, while 59% of patients who consumed less calcium had tooth loss (OR = 0.5; 95% CI: 0.2 - 0.9).

Meanwhile, these aforementioned observations need to be confirmed by clinical trials in which tooth loss is a primary outcome of interest, where additional risk factors are also examined throughout the trials. If these findings are confirmed, then such inexpensive and easy, accessible measures could have a major beneficial impact on the public oral health.

### Macronutrients

To the best of our knowledge, there has been no study conducted to assess the correlation between fat, carbohydrate, and protein malnutrition and the incidence or the risk of tooth loss in such populations. Therefore, more investigations are in need to reach a conclusion in this matter.

### Summary of the strengths and limitations of the current evidence

The strength of the current evidence linking nutritional deficiencies to the risk of developing tooth loss lies in the multiplicity of the studies rather than the individual power of each study. The prospective design of the majority of studies might help reduce the possible reverse causation. The tooth-specific analysis on the incidence of tooth loss may minimize reverse causation as well, especially putting in mind that nutrients, such as vitamin B 12, are positively correlated with tooth number at baselines [16]. Moreover, some studies controlled for risk factors, which would have cofounded the correlation between nutrient deficiency and tooth loss [16].

That being said, there are many limitations and weaknesses in the current literature, the most important of which is the limited body of evidence investigating the association between tooth loss and the deficiency of each nutritional factors, as well as the lack of evidence assessing the correlation between macronutrient deficiency and tooth loss. Moreover, given the apparent nature of periodontal disease and tooth loss, follow-up durations of at least several years might be required to reach a significant beneficial impact of nutrient intake on oral bone and tooth retention.

### Conclusion

Vitamins, minerals, and other nutritional factors are essential for the growth, development, and maintenance of adequate oral health status. Nutritional factors deficiency is correlated with the progression of periodontal diseases as well as dental caries with subsequent tooth loss. Various nutrients deficiencies, such as vitamin B12, vitamin C, vitamin D3 and calcium deficiencies have been associated with either an increase in the risk/incidence of tooth loss, clinical attachment loss, or periodontal diseases.

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### Conflicts of Interest

No conflicts related to this work.

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