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The Effects of Vitamin C on Periodontal Diseases

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ABSTRACT

As life expectancy increases, the importance of dental health has been emphasized, but many people still suffer from periodontal disease (PD). PD not only affects oral health but also has implications for overall systemic health, making it crucial to effectively prevent and treat it. In this study, 28 papers on the effects of vitamin C on PD were comprehensively reviewed. It has been reported that inadequate vitamin C intake is associated with a higher prevalence and severity of PD. However, there are inconsistent results in some aspects, indicating the need for further research in this area. This study provides foundational data for cost-effective PD prevention and treatment by comprehensively reviewing the effects of vitamin C on PD.

Keywords: Vitamin C; ascorbic acid; Periodontal Diseases; Periodontitis

INTRODUCTION

As the average life expectancy increases, keeping one's teeth healthy has become a very important issue. However, one of the serious risk factors that hinders living while maintaining your teeth is Periodontal Disease (PD). 3.5 billion people worldwide suffer from PD (WHO, 2023) and the prevalence of PD increases as age increases, underscoring the prevention of periodontal diseases before old age (CDC, 2023). PD is an inflammatory disease caused by the destruction of connective tissue and bone tissue that supports teeth (Nishida et al., 2000). It is mainly caused by bacteria living in tartar (Putten et al., 2009). PD is a very important health problem because it threatens oral health as well as systemic health by increasing the risk of various systemic diseases such as cardiovascular disease, diabetes, and dementia (Liccardo et al., 2019; Nadim et al., 2020; Zardawi et al., 2021). Not only have various studies been conducted on the risk factors of PD, but also genetic factors, hormones, and PD-related health behaviors have been reported. Genetic factors and hormones are risk factors for PD, but since this is a difficult factor to change, several studies have been conducted on health behavior related to PD. As a result, stress, smoking, and nutrition were reported to be important. Specifically, nutrition was found to be very important in maintaining periodontal health. Among the various nutrients, vitamin C, in particular, is known to play a decisive role in preventing the progression of PD and slowing the progression rate (Yan et al., 2013). Therefore, numerous studies have been conducted on the effects of Vitamin C on periodontal disease (PD). However, the research methods, measurement variables, and results of these studies vary widely, necessitating a systematic review.

This study aims to comprehensively review research on the effect of vitamin C on periodontal disease (PD) published in English since 2000, in order to provide evidence for the utilization of readily available and affordable vitamin C in the prevention and treatment of periodontal disease (PD).

METHODOLOGY

Research Design

This study is a secondary data analysis that selected and analyzed relevant academic papers on the effects of Vitamin C on periodontal disease (PD) based on predetermined criteria.

Inclusion & Exclusion Criteria

To search for literature for this study, the key question was set as "What is the effect of vitamin C on periodontal disease?" The data search was conducted using Google Scholar; only academic papers published in English studying the relationship between periodontal disease (PD) and vitamin C, since the year 2000 were included for review. Books, master's or doctoral papers, review articles, case reports, and academic presentations were excluded from the selection

of target literature. In addition, only studies targeting humans and animals were included, while studies at the cellular level were excluded.

The search terms used were [vitamin C OR ascorbic acid] AND ['periodontal diseases' OR 'periodontitis']. After reading the abstracts of the papers, those that were not relevant to the key question and met the exclusion criteria were excluded. The final 28 articles were selected as the subject of analysis.

RESULTS

In this study, a total of 28 studies on the effects of vitamin C on periodontal disease (PD) were reviewed, of which 18 were non-experimental research papers and 10 were experimental research papers. The non-experimental studies involved self-reported vitamin C intake (Chapple et al., 2007; Europe PMC, 2012; Lee et al., 2017; Luo et al., 2018; Nishida et al., 2000; Park et al., 2016) or measurement of blood vitamin C levels (Chapple et al., 2007; Iwasaki et al., 2011; Munday et al., 2020; Yoshihara et al., 2022) in human subjects, investigating the relationship between these results and PD-related variables. Objective variables for measuring the severity of PD included community periodontal index (CPI), pocket depth (PD), probing pocket depth (PPD), attachment loss (AL), clinical attachment loss (CAL), and gingival bleeding tendency, as well as postclinical pictures.

Table 1 & Table 2 outlines the studies included in this review.
The participants in the studies came from nine different countries, with the highest number of studies from the United States (Chapple et al., 2007), followed by Japan (Nishida et al., 2000), South Korea (Luo et al., 2018), Germany (Mewes et al., 2022), and one study each from the Netherlands, Australia, India, Indonesia, and Pakistan. Some studies from the US and South Korea used data from large-scale national studies. While most of the studies targeted the general population, there were also studies focusing on patients diagnosed with PD (Mewes et al., 2022; Singh et al., 2023; Yang et al., 2020; Yoshihara et al., 2022) and elderly individuals (Iwasaki et al., 2012).

The results of the 18 non-experimental studies generally indicated that lower vitamin C intake or lower blood vitamin C levels were associated with higher risks and severity of PD (Alyami et al., 2023; Amarasena et al., 2005; Amaliya et al., 2007; Kuzmanova et al., 2012; Mushtaque et al., 2021; Singh et al., 2023). However, some studies reported opposite results, suggesting that higher blood vitamin C levels were associated with higher risks and severity of PD.

A total of 10 experimental studies were analyzed, comprising 8 studies involving human subjects and 2 studies involving Sprague-Dawley rats (Toraman et al., 2020; Aytekin et al., 2020). In all experimental groups, the intervention provided to the participants was vitamin C. Among the 8 studies involving human subjects, the methods of vitamin C administration were as follows: vitamin C supplementation was used in 6 studies, ascorbic acid solution was used in 1 study, and dentifrice was used in 1 study.

For the 2 studies involving Sprague Dawley rats, Vitamin C was administered directly into the gums through injection as a method of providing vitamin C. Most of the experimental studies reported a decrease in clinical indexes related to PD when vitamin C was provided to the participants in various forms. However, the results were not consistent across all studies.

Table 1. Non-experimental research about the Effect of vitamin C on periodontal disease

Reference	Study sample	Key results
Lee et al. (2017)	10,930 Korean adults (≥19 years) from the fourth Korean National Health and Nutrition Examination Survey data	Those with inadequate dietary vit C intake were more likely by 1.16 times to have periodontitis than those with adequate dietary vit C intake

Luo et al. (2018)	Data of 6415 NHANES (US National Health and Nutrition Examination Survey participants (≥30 years)	less intake of vitamin C (aOR = 1.401) was associated with increased severity of periodontal disease.
Park et al. (2016)	2049 young adults (19–39 years) from Korean National Health and Nutrition Examination Survey data	In young adults, periodontitis is significantly associated with lower intakes of niacin, vitamin C, and iron, especially in women and current non-smokers.
Nishida et al. (2000)	Data of 12,419 adults (20 to 90+ years) from NHANES III	reduced dietary vitamin C and increased risk for periodontal disease for the overall population. Current and former tobacco users who were taking less dietary vitamin C showed an increased risk of periodontal disease. Compared to individuals consuming over 180mg of Vitamin C per day, those who consumed 0-29mg had a 1.30 times higher prevalence of PD, while those consuming 100-179mg had a 1.16 times higher prevalence of PD.
Chapple et al. (2007)	11,480 NHANES III adult participants (>20 y of age).	Serum concentrations of vitamin C, bilirubin, and TAOC were inversely associated with periodontitis, the association being stronger in severe disease.
Amarasena et al. (2005)	413 Niigata (Japan) citizens aged 70 years	Serum vitamin C concentration was inversely related to CAL
Amaliya et al. (2007)	128 Indonesian citizens	The correlation coefficient between plasma vitamin C level and periodontal attachment loss was −0.199. Subjects with vitamin C deficiency had more attachment loss compared with those with depletion or normal plasma vitamin C values.
Kuzmanova et al.	21 untreated periodontal patients and 21	Plasma vitamin C was lower in periodontitis patients compared with controls. Only in the control group, a positive correlation was present between vitamin C intake and plasma values.

(2012)	healthy controls matched for age, gender, race and smoking habits were selected	
Europe PMC, n.d. (2012)	42 patients with chronic periodontitis and 38 healthy subjects (controls)	The mean vitamin C plasma levels were significantly lower in patients with periodontitis compared with healthy control subjects. 50% of patients experienced discomfort while eating.
Iwasaki et al. (2012)	264 Japanese elderly aged 75(retrospective cohort study, with a follow-up of 2 years)	A higher intake of dietary antioxidants was inversely associated with the number of teeth with periodontal disease progression, controlling for other variables
Iwasaki et al. (2011)	224 Japanese individuals (71 years)	The multivariate-adjusted relative risks in the highest, middle, and lowest tertiles were 1.00 (reference), 1.12 (1.01-1.26), and 1.30 (1.16-1.47) for ascorbic acid
Munday et al. (2020)	20 participants with periodontal disease	Low vitamin C was associated with higher periodontal disease stage. Elevated CRP was found in 2/3 of people with low vitamin C and CRP was negatively correlated with Vitamin C. Vitamin C did not correlate with patient-reported fruit or vegetable consumption
Yoshihara et al. (2022)	353 participants with periodontal disease	A negative tendency between the PRR of vitamin C tertiles for the PPD or CAL was seen for both groups (high or low serum cotinine levels). A bigger difference was observed in the group with high serum cotinine levels
Li et al. (2022)	8959 participants from the US NHANES	The risk of periodontitis was reduced with sufficient intake of the micronutrients; by contrast, a high intake of vitamin C and copper increased the risk
Mewes et al. (2022)	373 periodontitis patients—245 without and 128 with tooth loss	Periodontitis patients exhibited a significantly higher oral intake of vitamin C and Ω3FA Docosapentaenoic acid compared to controls.
Singh et al. (2023)	15 patients with chronic persistent gingival	Vitamin C injections improve the inflammation of the injected sites

	inflammation	
Mushtaque et al. (2021)	Pakistan 384 elderly patients (aged 60-85)	The participants who have taken dietary intake of vitamin C inadequately suffered from periodontitis by 1.16 times more than those participants who took adequate dietary intake of vitamin C
Hujoel et al. (2021)	1140 participants from NHANES III	Vitamin C supplementation reduced gingival bleeding tendency when estimated baseline AA plasma levels were < 28 μmol/L. Supplementation with Vitamin C did not unequivocally reduce gingival bleeding tendency when baseline estimated AA plasma levels were > 48 μmol/L or unknown.

Table 2. Experimental research about Effect of vitamin C on periodontal disease

Reference	Study sample Group assignment	Key results
Shimabukuro et al. (2015)	300 individuals with gingivitis (Half of the participants were given an APM-containing dentifrice and half were given a control dentifrice)	GI was significantly lower in the APM group
Gokhale et al. (2013)	120 subjects were categorized into four groups of 30 each as group 1: without periodontal disease; group 2: chronic gingivitis; group 3: chronic periodontitis, and group 4: chronic periodontitis and freshly diagnosed T2DM	A significant reduction in the SBI was seen in the subgroups that received dietary supplementation of vitamin C
Sulaiman &Shehadeh (2010)	60 subjects: 30 diagnosed with ChP and 30 matched controls. randomly allocated into ChP1 (15 patients received non-surgical treatment with an adjunctive dose of vitamin C) and ChP2 (15 patients received non-surgical periodontal treatment alone)	Plasma TAOC levels were significantly lower in ChP patients than controls. The periodontal therapy resulted in increasing plasma TAOC and improvements in clinical measures among both the ChP1 and ChP2 groups. However, the adjunctive dose of vitamin C did not offer additional effects.
Toraman et al.	35 male Sprague Dawley rats divided equally into five groups: 1) control (C), 2) experimental periodontitis (P), 3) experimental diabetes (D), 4)	Vitamin C treatment reduces serum CTX and gingival MMP-8 levels,

(2020)	experimental diabetes and experimental periodontitis (D + P), and 5) experimental diabetes–experimental periodontitis–locally applied vitamin C	oxidative stress, inflammation, and AGE accumulation in periodontal tissue.
Aytekin et al. (2020)	21 male Sprague-Dawley rats were divided into three groups with 7 animals in each group: (1) control, (2) experimental periodontitis, and 3) experimental periodontitis-local vitamin C treatment group.	Serum CTX levels, MMP-8-positive cells, Alveolar bone loss, and attachment loss were significantly lower in the vitamin C treatment group compared to the other group.
Vaziri et al. (2021)	72 patients with moderate and severe chronic periodontitis. They were randomly divided into four groups (n=18 per group). Group 1 was the control group that used 0.2% fluoride dentifrice after Scaling and Root Planing (SRP). Group 2 used 0.2% fluoride dentifrice + adjunctive use of atorvastatin 2% following SRP. Group 3 used 0.2% fluoride dentifrice and 250mg chewable ascorbic acid tablets after SRP. Group 4 used 0.2% fluoride dentifrice + adjunctive use of atorvastatin 2% and 250mg chewable ascorbic acid after SRP.	Combination treatment with SRP, 2% atorvastatin dentifrice, and ascorbic acid is more effective in improving periodontal parameters than SRP alone.
Nisha et al. (2023)	105 participants (70 with chronic PD and 35 periodontally healthy subjects), The ChP group was subdivided into the ChP1 group (n = 35) which received NSPT only and the ChP 2 group (n = 35) which received NSPT with vitamin C 500 mg once daily for 3 months.	Lower levels of serum and salivary TAOC levels were observed in ChP patients than in healthy subjects
Al-Abdaly et al. (2021)	150 moderate periodontitis patients (≥20 years) after conventional periodontal and prosthodontics therapy	Participants who received topical application of ascorbic acid solution showed improvements in all three parameters, PLI, GI, and CAL, compared to the control group, and the improvements in GI and CAL were maintained up to 6 weeks.
Penmetsa et al.	A total number of 40 patients with chronic periodontitis were randomly divided into two groups of 20 patients each. The test group patients (n = 20)	The mean CRP levels were reduced significantly in the test group before and after

(2020)	received 500 mg Orthoboon (glucosamine sulfate + Collagen + Vitamin C) three times daily for 45 days	administration of Orthoboon and there were statistically significant differences in the mean CRP levels at the end of 45 days between the test group and the control group.
Mahajani et al. (2021)	30 subjects with chronic periodontitis and 30 healthy controls. 15 patients in CGP1 were treated with nonsurgical therapy and 15 patients in CGP2 were administered 1500 mg of Vitamin C supplementation per day along with nonsurgical therapy	Vitamin C supplementation reduced only in gingival bleeding index score at 30 days and 60 days post-treatment

DISCUSSION

Among the 28 papers analyzed, 18 were non-experimental studies. These studies reported that inadequate vitamin C intake was associated with an increased risk and severity of PD. However, the estimation of vitamin C intake in these studies relied on self-reported methods, which may have limitations in accurately determining actual intake. Nevertheless, even in studies using objective measures like serum or plasma vitamin C levels, lower blood vitamin C levels consistently showed increased risk and severity of PD, suggesting that vitamin C deficiency may negatively impact PD.

This trend was particularly evident in non-smokers, former tobacco users, and those with high serum cotinine levels. The protective role of vitamin C in PD demonstrated in the literature, aligns with previous studies highlighting its strong antioxidant properties, reduction of bleeding tendency, and anti-inflammatory effects.

Conversely, some studies reported that higher blood vitamin C levels were associated with an increased risk of PD. However, explanations for these findings were not clear, warranting further research on the impact of elevated blood vitamin C levels on PD.

Studies on the relationship between vitamin C dosage and PD revealed a specific range of plasma vitamin C levels (28~48 μmol/L) associated with reduced gingival bleeding tendency, while levels above or below this range did not affect bleeding. However, further research is needed to support these results and determine the effective vitamin C dosage for PD prevention and treatment.

Among the 28 papers, 10 were experimental studies manipulating subjects. Various methods were used to provide vitamin C in human studies, such as supplementation, vitamin C-containing dentifrice, and vitamin C solution. Results regarding PD-related indicators varied across these studies, possibly due to limitations in increasing blood vitamin C concentration through supplementation. In Sprague Dawley rat experiments, direct injection of Vitamin C into the gums improved all PD-related clinical indicators.

This suggests that vitamin C administration through injection increases blood vitamin C levels, while methods like supplementation may not guarantee the same rise, limiting preventive and therapeutic effects on PD. Further research on enhancing vitamin C absorption is necessary.

CONCLUSION

Through this study, by reviewing 28 papers, it can be concluded that Vitamin C intake has a beneficial effect on reducing the prevalence and severity of PD. Additionally, areas for further research were identified. Lastly, clarifying

the role of vitamin C in the prevention and treatment of PD can help in developing strategies to maintain oral health and, consequently, enhance overall systemic health.

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