

The Potential Impact of Essential Nutrients Vitamins C and D upon Periodontal Disease Pathogenesis and Therapeutic Outcomes

Brock, Gareth; Chapple, Iain

DOI:

[10.1007/s40496-016-0116-9](https://doi.org/10.1007/s40496-016-0116-9)

License:

None: All rights reserved

Document Version

Peer reviewed version

Citation for published version (Harvard):

Brock, G & Chapple, I 2016, 'The Potential Impact of Essential Nutrients Vitamins C and D upon Periodontal Disease Pathogenesis and Therapeutic Outcomes', *Current Oral Health Reports*, vol. 3, no. 4, pp. 337-346. <https://doi.org/10.1007/s40496-016-0116-9>

[Link to publication on Research at Birmingham portal](#)

General rights

Unless a licence is specified above, all rights (including copyright and moral rights) in this document are retained by the authors and/or the copyright holders. The express permission of the copyright holder must be obtained for any use of this material other than for purposes permitted by law.

- Users may freely distribute the URL that is used to identify this publication.
- Users may download and/or print one copy of the publication from the University of Birmingham research portal for the purpose of private study or non-commercial research.
- User may use extracts from the document in line with the concept of 'fair dealing' under the Copyright, Designs and Patents Act 1988 (?)
- Users may not further distribute the material nor use it for the purposes of commercial gain.

Where a licence is displayed above, please note the terms and conditions of the licence govern your use of this document.

When citing, please reference the published version.

Take down policy

While the University of Birmingham exercises care and attention in making items available there are rare occasions when an item has been uploaded in error or has been deemed to be commercially or otherwise sensitive.

If you believe that this is the case for this document, please contact UBIRA@lists.bham.ac.uk providing details and we will remove access to the work immediately and investigate.

1. Chapple ILC, Matthews JB. The role of reactive oxygen and antioxidant species in periodontal tissue destruction. *Periodontol 2000*. 2007; 43:160-232.
2. Van Dyke TE. Proresolving lipid mediators: potential for prevention and treatment of periodontitis. *J Clin Periodontol*. 2011; 38 Suppl 11:119-25.
3. Van der Velden U, Kuzmanova D, Chapple ILC. Micronutritional approaches to periodontal therapy. *J Clin Periodontol*. 2011; 38 Suppl 11:142-158.
4. Sidi AD, Ashley FP. Influence of frequent sugar intakes on experimental gingivitis. *J Periodontol*. 1984; 55:419-423.
5. Baumgartner S, Imfeld T, Schicht O, Rath C, Persson RE, Persson GR. The impact of the stone age diet on gingival conditions in the absence of oral hygiene. *J Periodontol*. 2009; 80:759-768.
6. Sutton G. Putrid gums and 'Dead Men's Cloaths': James Lind aboard the *Salisbury*. *J Roy Soc Med*. 2003; 96:605-608
7. Health and Social Care Information Centre (2015). Provisional Monthly Hospital Episode Statistics for Admitted Patient Care, Outpatients and Accident and Emergency Data - April 2015 to July 2015; PDF available at: <http://www.digital.nhs.uk/seachcatalogue> [accessed 16 August 2016]
8. Fain O, Paries J, Jacquart B *et al*. Hypovitaminosis C in 37 hospitalized patients. *Eur J Intern Med*. 2003; 14: 419-425.
9. Heinecke JW. Pathways for oxidation of low density lipoprotein by myeloperoxidase: Tyrosyl radical, reactive aldehydes, hypochlorous acid and molecular chlorine. *BioFactors* 1997; 6:145-155.
10. Davies HE, Davies JE, Hughes RE, Jones E. Studies on the absorption of L-xyloascorbic acid (vitamin C) in young and elderly subjects. *Hum Nutr Clin Nutr*. 1984; 38:469-471
11. Carlo A, Roberto BC *et al*. Scientific opinion on dietary reference values for vitamin C. *EFSA J* 2013; 11:1-2.
12. Lykkesfeldt J, Christen S, Wallock LM, Change HH, Jacob RA, Ames BN. Ascorbate is depleted by smoking and repleted by moderate supplementation: A study in male smokers and nonsmokers with matched dietary antioxidant intakes. *Am J Clin Nutr*. 2000; 71:530-536.
13. Pecoraro RE, Chen MS. Ascorbic acid metabolism in diabetes mellitus. *Ann N Y Acad Sci*. 1987; 498:248-258.

14. Tu H, Li H, Wang Y, Niyyati M, Wang *et al.* Low Red Blood Cell Vitamin C Concentrations Induce Red Blood Cell Fragility: A Link to Diabetes Via Glucose, Glucose Transporters, and Dehydroascorbic Acid. 2015; 2:1735-1750.
15. Levine M, Conry-Cantilena C, Wang Y *et al.* Vitamin C pharmacokinetics in healthy volunteers: evidence for a recommended dietary allowance. Proc Natl Acad Sci USA. 1996; 93:3704–3709.
16. Graumlich JF, Ludden TM, Conry-Cantilena C, Cantilena LR Jr, Wang Y, Levine M. Pharmacokinetic model of ascorbic acid in healthy male volunteers during depletion and repletion. Pharm Res. 1997; 14:1133– 1139.
17. Bahal P, Djemal S. Dental Erosion from an Excess of Vitamin C. Case Rep Dent. 2014; 2014:485387. doi: 10.1155/2014/485387. Epub 2014 Aug 4.
18. Assimos DG. Vitamin C supplementation and urinary oxalate excretion. Rev Urol. 2004; 6:167.
19. Baker EM, Hodges RE, Hood J, Sauberlich HE, March SC, Canham JE. Metabolism of ¹⁴C- and ³H-labeled L-ascorbic acid in human scurvy. Am J Clin Nutr. 1971; 24:444–454.
20. Levine M, Wang Y, Katz A, Eck P *et al.* Ideal vitamin C intake. Biofactors 2001; 15:71-74.
21. Levine M, Rumsey SC, Daruwala R, Park JB, Wang Y. Criteria and recommendations for vitamin C intake. J Amer Med Assoc. 1999; 281: 1415-1423.
22. Eastwood MA. Interaction of dietary antioxidants in vivo: how fruit and vegetables prevent disease? QJM-Mon J Assoc Phys. 1999; 92:527-530.
23. Chapple ILC, Milward MR, Dietrich T. The prevalence of inflammatory periodontitis is negatively associated with serum antioxidant concentrations. J Nutr. 2007; 137:657–664.
24. Pushparani DS, Nirmala S, Theagarayan P. Low serum vitamin C and Zinc is associated with the development of oxidative stress in type 2 diabetes mellitus with periodontitis. Int J Pharm Sci Rev Res. 2013; 23: 259–264.
25. Kuzmanova D, Jansen ID, Schoenmaker T, Nazmi K, Teeuw WJ, Bizzarro S, Loos BG, van der Velden U. Vitamin C in plasma and leucocytes in relation to periodontitis. J Clin Periodontol. 2012; 39:905-912.
26. Dias IHK, Chapple ILC, Milward M, Grant MM, Hill E, Brown J, Griffiths HR. Sulforaphane Restores Cellular Glutathione Levels and Reduces Chronic Periodontitis Neutrophil Hyperactivity *In Vitro*. PLoS One. 2013; 8(6): e66407.

27. Amaliya, Timmerman MF, Abbas F, Loos BG, Van der Weijden GA, Van Winkelhoff AJ, Winkel EG, Van der Velden U. Java project on periodontal diseases: the relationship between vitamin C and the severity of periodontitis. *J Clin Periodontol.* 2007; 34: 299–304.
28. Amarasena N, Ogawa H, Yoshihara A, Hanada N, Miyazaki H. Serum vitamin C-periodontal relationship in community-dwelling elderly Japanese. *J Clin Periodontol.* 2005; 32:93–97.
29. Iwasaki M, Moynihan P, Manz MC, Taylor GW, Yoshihara A, Muramatsu K, Watanabe R, Miyazaki H. Dietary antioxidants and periodontal disease in community-based older Japanese: a 2-year follow-up study. *Public Health Nutr.* 2013; 16:330-8.
30. Levine M, Wang Y, Padayatty SJ, Morrow J. A new recommended dietary allowance of vitamin C for healthy young women. *P Natl Acad Sci USA.* 2001; 98:9842–9846.
31. Bates CJ, Hamer M, Mishra GD. Redox-modulatory vitamins and minerals that prospectively predict mortality in older British people: the National Diet and Nutrition Survey of people aged 65 years and over. *Br J Nutr.* 2011; 105:123–132.
32. Yoshihara A, Watanabe R, Hanada N *et al.* A longitudinal study of the relationship between diet intake and dental caries and periodontal disease in elderly Japanese subjects. *Gerodontology* 2009; 26:130–136.
33. Tanaka K, Miyake Y, Sasaki S *et al.* Relationship between intake of vegetables, fruit, and grains and the prevalence of tooth loss in Japanese women. *J Nutr Sci Vitaminol.* 2007; 53:522–528.
34. Zare Javid A, Seal CJ, Heasman P, Moynihan PJ. Impact of a customised dietary intervention on antioxidant status, dietary intakes and periodontal indices in patients with adult periodontitis. *J Hum Nutr Diet.* 2014; 27:523-32.
35. Carter P, Gray LJ, Troughton J, Khunti K, Davies MJ. Fruit and vegetable intake and incidence of type 2 diabetes mellitus: systematic review and meta-analysis. *BMJ* 2010; 341:c4229
36. Diet, nutrition, and the prevention of chronic diseases. Report of a WHO Study Group. *World Health Organ Tech Rep Ser.* 1990; 797:1-204.
37. Dodington DW, Fritz PC, Sullivan PJ, Ward WE. Higher Intakes of Fruits and Vegetables, β -Carotene, Vitamin C, α -Tocopherol, EPA, and DHA Are Positively Associated with Periodontal Healing after Nonsurgical Periodontal Therapy in Nonsmokers but Not in Smokers. *J Nutr.* 2015; 145:2512-2519.

38. Abou Sulaiman AE, Shehadeh RM. Assessment of total antioxidant capacity and the use of vitamin C in the treatment of non-smokers with chronic periodontitis. *J Periodontol*. 2010; 81:1547-1554.
39. Willershausen B, Ross A, Försch M, Willershausen I, Mohaupt P, Callaway A. The influence of micronutrients on oral and general health. *Eur J Med Res*. 2011; 16:514-518.
40. Harpenau LA, Cheema AT, Zingale JA, Chambers DW, Lundergan WP. Effects of nutritional supplementation on periodontal parameters, carotenoid antioxidant levels, and serum C-reactive protein. *J Calif Dent Assoc*. 2011; 39:309-12, 314-8.
41. Staufenbiel I, Weinspach K, Förster G, Geurtsen W, Günay H. Periodontal conditions in vegetarians: a clinical study. *Eur J Clin Nutr*. 2013; 67:836-840.
42. Jenzsch A, Eick S, Rassoul F, Purschwitz R, Jentsch H. Nutritional intervention in patients with periodontal disease: clinical, immunological and microbiological variables during 12 months. *Br J Nutr*. 2009; 101:879-885.
43. Glade MJ. Vitamin D: health panacea or false prophet? *Nutrition*. 2013; 29:37-41.
44. Holick MF. Vitamin D and Health: Evolution, Biologic Functions, and Recommended Dietary Intakes for Vitamin D. In: Holick MF, editor. *Vitamin D: Physiology, Molecular Biology, and Clinical Applications*. 2nd ed, Humana; 2010. pp. 3-33.
45. Jones G. Pharmacokinetics of vitamin D toxicity. *Am J Clin Nutr*. 2008; 88:582S-586S.
46. Dietary Reference Intakes for Calcium and Vitamin D. In: Ross AC, Taylor CL, Yaktine AL, Del Valle HB, editors. *Institute of Medicine (US) Committee to Review Dietary Reference Intakes for Vitamin D and Calcium; Washington (DC): National Academies Press (US); 2011.*
47. Hennig BJ, Parkhill JM, Chapple IL, Heasman PA, Taylor JJ. Association of a vitamin D receptor gene polymorphism with localized early-onset periodontal diseases. *J Periodontol*. 1999; 70:1032-1038.
48. Laine ML, Loos BG, Crielaard W. Gene polymorphisms in chronic periodontitis. *Int J Dent*. 2010; 324719. doi: 10.1155/2010/324719. Epub 2010 Feb 9.
49. Stein SH, Livada R, Tipton DA. Re-evaluating the role of vitamin D in the periodontium. *J Periodontal Res*. 2014; 49:545-553.

50. Dawson-Hughes B, Mithal A, Bonjour JP, Boonen S, Burckhardt P *et al.* IOF position statement: vitamin D recommendations for older adults. *Osteoporos Int.* 2010; 21:1151-4.
51. Garcia MN. Vitamin D May Reduce Periodontal Disease Prevalence in Older Men. *J Evid Base Dent Pract.* 2014; 14:39-41.
52. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, Heaney RP, Murad MH, Weaver CM; Endocrine Society. Evaluation, treatment, and prevention of vitamin D deficiency: an Endocrine Society clinical practice guideline. *J Clin Endocrinol Metab.* 2011; 96:1911-30. Erratum in: *J Clin Endocrinol Metab.* 2011; 96:3908.
53. Newberry SJ, Chung M, Shekelle PG, Booth MS, Liu JL, Maher AR, Motala A, Cui M, Perry T, Shanman R, Balk EM. Vitamin D and Calcium: A Systematic Review of Health Outcomes (Update). Evidence Reports/Technology Assessments, No. 217. Rockville (MD): Agency for Healthcare Research and Quality (US); 2014.
54. Theodoratou E, Tzoulaki I, Zgaga L, Ioannidis JP. Vitamin D and multiple health outcomes: umbrella review of systematic reviews and meta-analyses of observational studies and randomised trials. *BMJ.* 2014; doi:10.1136/bmj.g2035.
55. Bischoff-Ferrari HA, Dawson-Hughes B, Orav EJ, Staehelin HB, Meyer OW *et al.* Monthly High-Dose Vitamin D Treatment for the Prevention of Functional Decline: A Randomized Clinical Trial. *JAMA Intern Med.* 2016; 176:175-183.
56. Dietrich T, Joshipura KJ, Dawson-Hughes B, Bischoff-Ferrari HA. Association between serum concentrations of 25-hydroxyvitamin D3 and periodontal disease in the US population. *Am J Clin Nutr.* 2004; 80:108-113.
57. Lee HJ, Je DI, Won SJ, Paik DI, Bae KH. Association between vitamin D deficiency and periodontal status in current smokers. *Community Dent Oral Epidemiol.* 2015; 43:471-478.
58. Alshouibi EN, Kaye EK, Cabral HJ, Leone CW, Garcia RI. Vitamin D and periodontal health in older men. *J Dent Res.* 2013; 92:689-693.
59. Liu K, Meng H, Tang X, Xu L, Zhang L, Chen Z, Shi D, Feng X, Lu R. Elevated plasma calcifediol is associated with aggressive periodontitis. *J Periodontol.* 2009 Jul; 80:1114-1120.
60. Zhan Y, Samietz S, Holtfreter B, Hannemann A, Meisel P, Nauck M, Völzke H, Wallaschofski H, Dietrich T, Kocher T. Prospective Study of Serum 25-hydroxy Vitamin D and Tooth Loss. *J Dent Res.* 2014; 93: 639-644.
61. Millen A, *J Evid Base Dent Pract.* 2014; 14:197-199; article analysis and evaluation of Zhan Y, Samietz S, Holtfreter B, Hannemann A, Meisel P, Nauck M,

Volzke H, Wallaschofski H, Dietrich T, Kocher T. Prospective study of Serum 25-hydroxy Vitamin D and Tooth Loss. *J Dent Res* 2014; 93:639-644.

62. Jimenez M, Giovannucci E, Krall Kaye E, Joshipura KJ, Dietrich T. Predicted vitamin D status and incidence of tooth loss and periodontitis. *Public Health Nutr.* 2014; 17:844-852.

63. Millen AE, Andrews CA, LaMonte MJ, Hovey KM, Swanson M, Genco RJ, Wactawski-Wende J. Vitamin D status and 5-year changes in periodontal disease measures among postmenopausal women: the Buffalo OsteoPerio Study. *J Periodontol.* 2014; 85:1321-1332.

64. Millen AE, Hovey KM, LaMonte MJ, Swanson M, Andrews CA, Kluczynski MA, Genco RJ, Wactawski-Wende J. Plasma 25-hydroxyvitamin D concentrations and periodontal disease in postmenopausal women. *J Periodontol.* 2013; 84:1243-1256.

65. Schulze-Späte U, Turner R, Wang Y, Chao R, Schulze PC, Phipps K, Orwoll E, Dam TT. Relationship of Bone Metabolism Biomarkers and Periodontal Disease: The Osteoporotic Fractures in Men (MrOS) Study. *J Clin Endocrinol Metab.* 2015; 100:2425-2433.

66. Nathalia Garcia M, Hildebolt CF, Douglas Miley D, Dixon DA, Couture RA *et al.* One-year Effects of Vitamin D and Calcium Supplementation on Chronic Periodontitis. *J Periodontol.* 2011; 82: 25–32.

67. Antonoglou G, Knuuttila M, Niemelä O, Hiltunen L, Raunio T, Karttunen R, Vainio O, Ylöstalo P, Tervonen T. Serum 1,25(OH)D Level Increases After Elimination of Periodontal Inflammation in T1DM Subjects. *J Clin Endocrinol Metab.* 2013; 98:3999–4005.

68. Tang X, Pan Y, Zhao Y. Vitamin D inhibits the expression of interleukin-8 in human periodontal ligament cells stimulated with *Porphyromonas gingivalis*. *Arch Oral Biol.* 2013; 58:397-407.

69. McMahon L, Schwartz K, Yilmaz O, Brown E, Ryan LK, Diamond G. Vitamin D-mediated induction of innate immunity in gingival epithelial cells. *Infect Immun.* 2011; 79:2250-2256.

70. Woelber JP, Bremer K, Vach K, König D, Hellwig E, Ratka-Krüger P, Al-Ahmad A, Tennert C. An oral health optimized diet can reduce gingival and periodontal inflammation in humans - a randomized controlled pilot study. *BMC Oral Health.* 2016; 17:28. doi: 10.1186/s12903-016-0257-1.

