An Investigation of Vitamin C and Chronic Diseases with Inflammatory/Autoimmune Components: A Literature Review

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Abstract

Vitamin C has been studied for decades in cardiovascular, immune system, and musculoskeletal diseases. It is a water-soluble vitamin that can only be obtained from the diet where a consistent supply is necessary to maintain normal body functions. Multifaceted, Vitamin C includes properties such as free radical scavenging and antioxidation. Despite knowledge of the importance of this vitamin, routine assessment is lacking in the general population. Current standards of parameter monitoring include only the identification of deficiency. It is unknown the prevalence of optimal (plasma levels <70 μmol/L), sub-optimal (plasma levels <50 μmol/L), and marginal (plasma levels <28 μmol/L) Vitamin C plasma levels that exist within the country. Dietary labels have also made Vitamin C an 'optional' inclusion on food packaging, implying there is little need for increased awareness and research. Yet, suboptimal levels may partly explain increased diagnoses of chronic diseases and must be more clearly substantiated. Residents of food deserts, recently identified as areas within the country where people have little to no access to nutritious food, are at increased risk of diminished levels plasma Vitamin C and the associations with inflammatory diseases. An examination of research, including emerging science, might better explain the need for further exploration of suboptimal and marginal Vitamin C status. The purpose of this review is to inform of the most relevant state of the science regarding the role of Vitamin C in multiple diseases, to provide evidence for re-evaluation of Vitamin C deficiency labeling and increased efforts of public health awareness.

A PUBMED/Medline database search was conducted exploring studies of associations between Vitamin C and diseases with known inflammatory and/or autoimmune components in articles published from 1994 to 2018. Keywords used included: ascorbic acid, Vitamin C, and Vitamin C hypovitaminosis. This literature review explored the multiple known properties of Vitamin C and how they related to chronic diseases that possess inflammatory components. Results identified decreased Vitamin C levels (whether plasma or leukocytic) associated with multiple disease processes such as cardiovascular disease, diabetes, Alzheimer's disease, dementia, asthma, and others. Diseases with known inflammatory and autoimmune components were more likely to be associated with low levels of Vitamin C. Mechanisms of action varied depending on the nature of the specific disease. Inconsistent or non-existent baseline Vitamin C levels were common across multiple studies, leading to unclear benefits of supplementation.

These findings suggest both that current recommended guidelines for dietary intake may still be too low and sub-optimal/deficient people are not adequately identified prior to diagnosis. Healthcare practitioners may be better equipped to prevent disease by assessing and correcting sub-optimal levels of Vitamin C. A recommended revision to the definition of Vitamin C deficiency should include not only scurvy, but the decreased levels at which the body's immune system may be compromised and natural defense subverted. These include the addition of identifying marginal and sub-optimal plasma Vitamin C levels as routine assessments. Recommended dietary guidelines and deficiency-state guidelines need revision to reflect the important role of this vitamin that can only be obtained from diet or supplementation. Increased public health awareness would benefit both the general population and residents identified as living in or near food deserts, where nutrition may play a significant role in disease prevention and treatment.

Title:

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Keywords:
Vitamin C, chronic inflammation and hypovitaminosis

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Abstract Summary:

This literature review combines emerging and established research regarding the multifaceted functions of Vitamin C in chronic inflammatory and autoimmune diseases. The importance of assessment of sub-optimal and marginal plasma Vitamin C status will be identified.

Content Outline:

1. Introduction
    1. Vitamin C is a diet-dependent vitamin that provides anti-inflammatory and antioxidant properties, among other uses within the body. Currently, it is not routinely assessed unless in cases of identifying deficiency. It is unclear how much of the population holds optimal (plasma levels <70 µmol/L), sub-optimal (plasma levels <50 µmol/L), and marginal (plasma levels <28 µmol/L) statuses of Vitamin C and how these decreasing levels are associated with diseases with known inflammatory and auto-immune components.
    2. Literature was reviewed for identification of properties of Vitamin C within the body.
    3. Studies of diseases associated with chronic inflammation or autoimmunity that included Vitamin C were examined.
    4. Lack of Vitamin C assessment, monitoring, and education of the importance of this diet-dependent vitamin may miss prevention in people at risk of developing diseases with inflammatory and/or autoimmune components. Populations most at risk are those living in or near food deserts, identified as locations where residents have little to no access to

quality nutrition. Future research should consider increased surveillance of plasma Vitamin C in the population.
2. Properties of Vitamin C
    1. Vitamin C has been extensively studied on its significance within the immune system (Uchio, Hirose, Murosaki, Yamamoto, & Ishigam, 2017). Possessing antioxidant and anti-inflammatory properties, Vitamin C also provides support for growth and development of healthy immune cells:
        1. In the gut microbiota, (Bengmark, 2013);
        2. In neutrophil motility, (Elste, Troesch, Eggersdorfer, & Weber, 2017; Gorkom et. al, 2018);
        3. In proliferation of natural killer cells, (Huijskens, et. al, 2015).
    2. Vitamin C allows the body to reuse Vitamin E, theoretically doubling the impact of the functions of Vitamin E within the body (Bruno et. al, 2006).
    3. By enhancing the bio-availability of iron, Vitamin C plays a significant role in maintenance of healthy cells (Heffernan, Evans, Holmes, & Moore, 2017).
3. Studies of Vitamin C in diseases with inflammatory and/or autoimmune processes
    1. Vitamin C has been long researched within the realm of cancer. However, new evidence is emerging on its specific roles within the immune system that may better explain the benefit it contains within this disease, (Finn, 2012; Fortmann, Burda, Senger, Lin, & Whitlock, 2013; Rodríguez et. al, 2017; Wang et. al, 2014).
    2. Due to the anti-inflammatory properties Vitamin C exerts, cardiovascular disease may be associated with Vitamin C plasma levels, (Fortmann, Burda, Senger, Lin, & Whitlock, 2013; Mahmoodi, Kimiagar, & Mehrabi, 2014).
    3. Diabetes has long been understood to contain auto-immune processes, of which Vitamin C may provide benefit as well, (Harding et. al, 2008; Juhl, Lauszus, & Lykkesfeldt, 2017; Mahmoodi, Kimiagar, & Mehrabi, 2014).
    4. Asthma and allergies may also benefit from Vitamin C due to its anti-inflammatory properties, (Brunelli et. al, 2014; Harik-Khan, Muller, & Wise, 2004; McCabe, Lockwood, & Colbeck, 2017).
    5. Severe infections in critically ill patients have shown promising results with Vitamin C supplementation, (Laurent et. al, 2015; van Zanten et. al, 2014).
4. Conclusion
    1. This literature review provides contributions to the field by examining past and present studies to expose the importance of Vitamin C properties and the inflammatory influence on chronic diseases. Vitamin C has multi-faceted roles within many cellular activities including anti-oxidation, anti-inflammation, re-uptake of Vitamin E, and increasing the bio-availability of iron absorption. Many disease processes are caused or influenced by chronic inflammation, of which Vitamin C can play a significant role in prevention. Present assessment of Vitamin C plasma status within the population is limited to identifying deficiency. For maximum prevention potential, future research would benefit from increased surveillance and public health education of the importance of this water-soluble vitamin that can only be obtained through the diet.
    2. Overall strengths of this review include providing a 'big picture' approach to a relatively disregarded vitamin through review of its current known mechanisms of actions and applicability to chronic disease processes. Overall weaknesses of this review result from conflicting study reports and inconsistency of baseline Vitamin C plasma status at study onset.
    3. Future considerations for research include identifying prevalence of optimal, sub-optimal, marginal and deficiency Vitamin C levels within the population as well as identifying plasma levels prior to study initiation to better identify the benefits (or lack of) of Vitamin C supplementation in disease.

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