

Review Article**The Role of Vitamin C in Management of Hypertension: A systematic review****Rivani Sintia Suratman¹, Harnavi Harun², Drajad Priyono², Deka Viotra²**¹ Department of Internal Medicine, Faculty of Medicine, Universitas Andalas / Dr. M. Djamil General Hospital, Padang, Indonesia² Division of Nephrology and Hypertension, Department of Internal Medicine, Faculty of Medicine, Universitas Andalas / Dr. M. Djamil General Hospital, Padang, Indonesia

ARTICLE INFO	ABSTRACT
<i>Article history:</i> Received: April 14, 2025 Accepted: April 21, 2025 Published Online: April 24, 2025	Background: Vitamin C is an antioxidant that can reduce oxidative stress. Oxidative stress has been thought to play an important role in the pathophysiology of hypertension. Studies have looked at Vitamin C as a supplement to treat hypertension. Vitamin C's use as a complementary treatment for hypertension remains controversial, nevertheless. This study aims to evaluate vitamin C's contribution to the treatment of hypertension. Objective: To conduct a literature review that examines how vitamin C (VC) supplements affect hypertension. Methods: This research uses a systematic literature review (SLR) approach with sources obtained from various online databases, including PubMed, Cochrane Library, EBSCO, and Elsevier, using the keywords "vitamin C" and "Hypertension". The selected articles were in accordance with the inclusion and exclusion criteria and discussed the role of vitamin C in lowering blood pressure in hypertension. Results: All the articles displayed fair methodological quality and reported significant positive effects of vitamin C for lowering blood pressure. Conclusions: Vitamin C can help decrease blood pressure as a complementary treatment. Keywords: Vitamin C, Hypertension.
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Introduction

One of the leading causes of cardiovascular events and deaths globally is hypertension. Current estimates impact 1.28 billion adults within the 30 to 79 age range, with prevalence rates of 32% among men and 34% among women. Notably, approximately two-thirds reside in countries classified as low- to middle-income. It is estimated that 46% of people are thought to be unaware that they have this illness. Consequently, only 42% of those with hypertension receive a diagnosis and treatment. Essential hypertension, accounting for over 90%

of cases, is a multifactorial disease, resulting from a combination of environmental variables like stress, poor eating habits, and lack of exercise, as well as hereditary susceptibility. Elevated blood pressure in patients with essential hypertension is believed to result from oxidative stress, characterized by excessive production of reactive oxygen species (ROS) within the blood vessels.^{1,2} Several earlier investigations have demonstrated that endothelial dysfunction, intravascular oxidative stress, and decreased availability of nitric oxide (NO) are the pathophysiological factors of hypertension. Nitric oxide plays a

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significant part in controlling vascular tone by causing smooth vascular muscles to relax. It demonstrates the significance of antioxidants in reducing oxidative stress and enhancing vascular endothelial function.^{3,4}

Water-soluble vitamin C, also known as ascorbic acid or VC, is found naturally in fruits and vegetables. Vitamin C is a crucial dietary component as humans are unable to produce it on their own. As a potent antioxidant, VC reduces oxidative stress and improves endothelial function by scavenging intracellular superoxide, so it causes an activation of eNOS and smooth muscle guanylyl cyclase, thereby promoting increased NO production.^{5,6} As a free radical scavenger and potent antioxidant, vitamin C has several biological roles, including shielding cell components from oxidative stress caused by free radicals and ROS. Additionally, vitamin C plays a role in regenerating and maintaining other antioxidants, which include glutathione and tocopherol (vitamin E).^{7,8}

Collagen biosynthesis, procollagen, L-carnitine, norepinephrine, and other molecular syntheses are all influenced by vitamin C-mediated enzymatic processes. Additionally, by increasing the absorption of non-heme iron, vitamin C consumption through diet or supplementation can raise iron bioavailability. Although VC's anti-hypertensive effects have long been studied in people and animal models, a definitive conclusion about its therapeutic impact has not yet been made. To assist in offering recommendations about the possible application of vitamin C as a complementary anti-hypertension paradigm, this study was carried out to present the key findings of the effects of vitamin C on lowering blood pressure from the most recent published studies.^{9,10}

Methods

Study Design

The authors conducted a systematic review adhering to the Preferred Items for

Systematic Review and Meta-analysis (PRISMA) statement.

Eligibility Criteria

The selected studies had to meet the following inclusion criteria (1) investigate the relationship between serum vitamin C and blood pressure in hypertensive or normotensive subjects; (2) observational articles including case-control studies, cohort studies, cross-sectional studies, experimental interventions, and meta-analyses; (3) research publications from January 2019 to June 2023. The exclusion criteria: (1) duplicate entries or articles with substantially similar content; (2) articles not in English; (3) articles that cannot be accessed freely.

Quality Assessments

Studies that passed the eligibility criteria were further assessed for their quality. All studies were appraised with critical appraisal tools by the Oxford Center for Evidence-based Medicine for study quality.

Search Strategy

The literature search process was carried out on various databases (PubMed, Elsevier, EBSCO, and Cochrane Libraries) regarding the potential of vitamin C in lowering blood pressure. The search was carried out using the keywords: "Hypertension" and "vitamin C". The literature was limited to clinical studies and meta-analyses published in English from January 2019 to June 2023. Exclusion criteria were studies not related to hypertension, the effect of vitamin C for other conditions, the absence of a control group, and duplication of publications. This study follows a reporting system according to the systematic review protocol (PRISMA). The selected procedure is outlined in Figure 1.

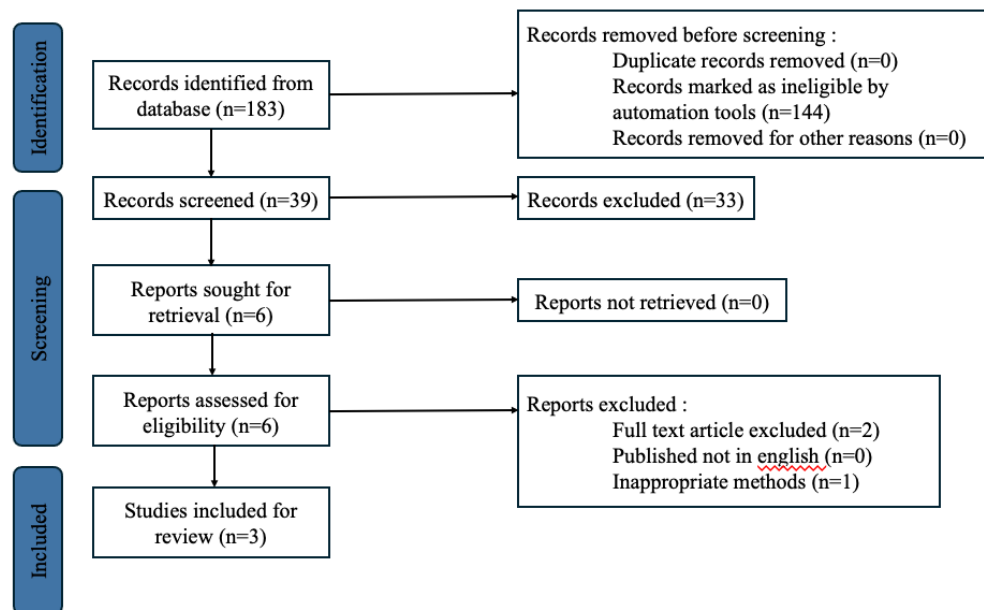


Figure 1. PRISMA Diagram

Data Extraction

Studies were extracted for further review. Extracted characteristics were: 1) Author and year of publication; 2) Study location; 3) Study design; 4) Vitamin C supplementation; 5) Blood pressure profile.

Result

A total of 183 articles were retrieved from various databases, including PubMed, Cochrane Library, EBSCO, and Elsevier, using relevant keywords. There were 144 articles released by filtering the title and abstract, and 3 articles that met the requirements were selected, as presented in Table 1.

Table 1. Research Characteristics

NUMBER	AUTHOR	LOCATION	METHOD	RESULTS
1.	Li ran, et al (2020)	China	Meta Analysis	Serum vitamin C has a significant inverse relationship with systolic blood pressure and diastolic blood pressure. ¹¹
2.	Yuanyuan Guan, et al (2020)	China	Meta-analysis	There was a significant difference in changes in SBP and DBP between groups with intervention of 500mg Vitamin C every day for more than 6 weeks. ¹²
3.	Chongchira boonthongkaew, et al (2023)	Thailand	Test	Significantly lower blood pressure in patients given vitamin C 1000mg over 6 weeks compared with placebo in T2DM patients on acute exercise. ¹³

The selected articles contained 2 literature reviews and meta-analyses, and 1 clinical study showing the effect of vitamin C supplementation on lowering blood pressure in patients with uncontrolled type 2 diabetes mellitus, with the results showing a positive relationship to reducing blood pressure.

Discussion

Previous studies have demonstrated that one of the pathophysiologies of hypertension is oxidative stress brought on by ROS. High levels of oxidative stress, resulting from an imbalance between free radical production and antioxidant defense, are also linked to endothelial dysfunction in hypertension. When nitric oxide is required to function as a vasodilator, oxidative stress reduces its bioavailability.¹³

Antioxidants can help lower blood pressure by reducing free radicals and increasing tolerance to oxidative stress, which protects cell membranes from oxidative damage. An early event in the pathogenesis of hypertension is endothelial impairment. Cells create nitric oxide, a vasodilator that relaxes the muscles of blood vessels. Cardiovascular risk factors, including hypertension, are linked to decreased nitric oxide and its bioavailability. Thus, nitric oxide levels and reduced endothelial function are linearly related. As an antioxidant, vitamin C helps prevent oxidative stress and preserves the blood vessel's ability to dilate.^{14,15}

Vitamin C is among the most effective water-soluble antioxidants in human plasma, which also helps prevent oxidative stress in hypertension. The researchers demonstrated that ascorbic-free radicals are initially generated, then transformed into dehydroascorbic acid and semidehydroascorbic acid, which have the ability to eliminate free radicals and highly reactive oxides, such as hydroxylradicals (OH \cdot), superoxide anions (O $_2$ $^{-\cdot}$), organic free radicals (R \cdot), and peroxy radicals (ROO \cdot). Consequently, vitamin C can diminish oxidatively damaged blood vessel endothelial cells to preserve blood vessel elasticity and restore their function.^{11,12}

The findings of this investigation support the current understanding that vitamin C concentrations are comparatively lower in people with hypertension. The study's findings demonstrated a substantial inverse relationship with vitamin C levels between hypertension and normotensive patients.

Our study has some limitations. The sample size of each trial was relatively small, and some factors contribute to variation in trial effect, such as differences in trial duration, vitamin C dose, and subject characteristics. There is potential publication bias, the major concern of most meta-analyses. Additional well-designed trials are needed to abstract high-quality blood pressure effects. In the future, there is a need for a greater diversity of research included in the analysis, such as multicenter studies, more rigorous clinical reports, and prospective studies.

Conclusion

Vitamin C has the potential to lower blood pressure due to its antioxidant qualities and ability to repair vascular endothelium. Hence, vitamin C administration typically has a good effect on lowering blood pressure in hypertensive patients. Additional trials are needed; large sample size trials should be conducted, with attention to the quality of blood pressure assessment.

Declarations

Competing interests

The authors declare no conflict of interest.

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