International Journal of Medical Science and Clinical Research Studies

ISSN(print): 2767-8326, ISSN(online): 2767-8342

Volume 05 Issue 02 February 2025

Page No: 275-278

DOI: https://doi.org/10.47191/ijmscrs/v5-i02-14, Impact Factor: 8.188

The Impact of Vitamin D Supplementation on Patients with Essential Hypertension and Vitamin D Deficiency

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ABSTRACT

Background: The maintenance of calcium homeostasis and bone mineralization are two important functions of vitamin D in bone health. Vitamin D deficiency is known to cause cardiovascular, musculoskeletal, and other body systems diseases.

Objective: To examine how vitamin D affects hypertension in those who are deficient in it.

Methods: The PubMed and Google Scholar databases are used in this investigation to conduct a literature review utilizing a narrative methodology that looks at and analyzes research findings in regional or global literature.

Results: Blood pressure levels after taking vitamin D are dramatically reduced.

Conclusion: Patients who are vitamin D deficient can benefit from vitamin D to treat their essential hypertension.

KEYWORDS: deficiency, Vitamin D, hypertension

ARTICLE DETAILS

Published On:
13 February 2025

Available on:
https://ijmscr.org/

INTRODUCTION

Hypertension is a significant public health problem, with essential hypertension being the most common type, accounting for approximately 90-95% of all cases of hypertension. (Goudarzi et al., 2020). Vitamin D deficiency has been identified as a potential risk factor for the development of hypertension, with several studies showing an association between low vitamin D levels and an increased risk of essential hypertension (Dahma et al., 2023) (Petimani et al., 2020).

Vitamin D is a fat-soluble vitamin that plays an important role in various physiological processes, including blood pressure regulation. The active form of vitamin D, calcitriol, has been shown to have a direct effect on the regulation of the renin-angiotensin-aldosterone system, which is a key regulator of blood pressure. In addition, vitamin D has been found to have anti-inflammatory and anti-proliferative effects on vascular smooth muscle cells, which may help reduce the risk of hypertension. (An et al., 2024)

Calciferol, another name for vitamin D, consists of vitamin D3 and vitamin D2. Most foods are fortified with vitamin D2 because it is a nutritional substance for humans. When the sun's UV rays hit the skin and cause vitamin D synthesis, vitamin D3 is made endogenously in human skin. It is also available in animal foods (Benedik, 2022).

Vitamin D2 and D3 are commercially produced and available as dietary supplements. Currently from available scientific data it appears that how vitamin D is required to maintain calcium homeostasis and influence bone health, including bone mineralization. Thus, vitamin D deficiency causes disorders involving the musculoskeletal system, cardiovascular and bone metabolism and provides a strong basis for dietary intake reference (Ramasamy, 2020). Animal studies provide strong evidence that vitamin D levels are inversely related to Renin-Angiotensin-Aldosterone system (RAAS) activity (McMullan et al., 2017). Furthermore, endothelial vasodilator dysfunction is associated with vitamin D deficiency (Kim et al., 2020). Thus, it is likely that vitamin D activity in animals contributes to blood pressure lowering (Dziedzic et al., 2017).

Based on epidemiological studies, there is growing evidence that vitamin D deficiency plays a role in the incidence of metabolic syndrome and cardiovascular disease. Risks have been associated with low vitamin D

levels that make it easier to develop certain diseases, including myocardial infarction, abnormal vascular endothelial function, vascular smooth muscle proliferation, vascular calcification, increased RAS activity, and hypertension. According to some studies, it has been suggested that the combination of vitamin D intake and antihypertensive drugs has a positive effect (Legarth et al., 2018). Therefore, this article will analyze the impact of vitamin D supplementation in patients with essential hypertension.

RESEARCH METHODS

This study used PubMed and Google Scholar databases to conduct a literature review with a narrative methodology that analyzed and assessed research on vitamin D and hypertension. The initial stage involved searching between 2017 and 2022, using the keywords "vitamin d deficiency, hypertension, supplementation". After sorting, 4 research articles were obtained that were considered relevant. Qualitative and quantitative analysis of these studies was selected based on research findings that vitamin D deficiency causes hypertension.

RESEARCH RESULT

Tabel 1. Research on vitamin D - hypertension

Study, year	Title	Result
Karadeniz, 2021	Vitamin D Deficiency Is a Potential Risk for Blood Pressure Elevation and the Development of Hypertension	Low levels of vitamin D were significantly associated with both normal and hypertensive blood pressure. Low levels of vitamin D were also associated with the development of hypertension in an 8-year study.
Dziedzic, 2017	Association of Vitamin D Deficiency and Degree of Coronary Artery Disease in Cardiac Patients with Type 2 Diabetes	A group of diabetic male cardiac patients with significant stenosis of the coronary arteries, inpatient treatment for acute coronary syndrome, with a previous history of MI (Myocardial Infarction) and hyperlipidemia showed low vitamin D levels.
Kim, 2020	Vitamin D and Endothelial Function	Vitamin D deficiency causes disturbances in the regulation of NO (Nitric oxide) bioavailability and endothelial function leading to atherosclerosis.
Lactic, 2020	Vitamin D and Cardiovascular Disease, with Emphasis on Hypertension, Atherosclerosis, and Heart Failure	Vitamin D deficiency disrupts vitamin D receptor (VDR) and 1α-hydroxylase signaling processes in cardiomyocytes as well as endothelial and vascular smooth muscle cells

DISCUSSION

Vitamin D supplementation, besides being safe and well tolerated by patients, is thought to have a significant positive effect on the heart. Systolic and diastolic blood pressure measurements were taken in one study in the intervention and control groups. In the control group with antihypertensive drug treatment without vitamin D intake, the systolic pressure decreased slightly, but in the group with additional vitamin D intake, the systolic blood pressure decreased lower. The benefits of the combination of antihypertensives and vitamin D can be attributed to the suppression of RAAS (Renin Angiotensin Aldosterone System), a positive effect on the heart including endothelial cells and cardiac myocytes. (McMullan et al., 2017). There was an association between those with normal blood pressure and hypertension and this supplement intervention as described in the study in patients aged 26-84 years with essential hypertension from March 2017 to April 2019. Inclusion in the study was patients who had to have serum vitamin D levels between 20 and 30 ng/ml or 20 ng/ml as a sign that they had vitamin D deficiency. Patients were randomized to receive vitamin D supplementation or placebo, medical measures included checking cardiac vital signs before the intervention and one and two months later. Of the 208 patients enrolled, 171 patients remained for analysis. Results showed a reduction in systolic and diastolic blood pressure compared to placebo, suggesting that vitamin D supplementation showed a more significant reduction in systolic blood pressure. Research shows that 25(OH)D has an inverse relationship with the risk of hypertension (Sheikh et al., 2020).

Based on a study, it was found that vitamin D signaling is essential for cardiovascular integrity, especially for the regulation of vascular tone and as an antifibrotic and antihypertrophic signaling pathway in the heart. Observations were made on blood pressure changes and

identification of vitamin D receptor (VDR) and 1α-hydroxylase in cardiomyocytes, as well as endothelial and vascular smooth muscle cells. This implicates the role of vitamin D in the cardiovascular system, providing strong evidence that vitamin D receptor signaling is critical for cardiovascular integrity, especially for regulation of vascular tone and as an antifibrotic and antihypertrophic signaling pathway in the heart (Latic and Erben, 2020).

Research (Kim et al., 2020) found that there are various mechanisms of vitamin D in regulating nitric oxide (NO) bioavailability and endothelial function. Vitamin D is known to induce vasoprotective effects while vitamin D deficiency is a risk factor for endothelial dysfunction (ED). ED is characterized by reduced bioavailability of the endothelium-dependent vasodilator, nitric oxide (NO), and is an early event in the development of atherosclerosis. In endothelial cells, vitamin D regulates NO synthesis by mediating endothelial NO synthase (eNOS) activity. Under pathogenic conditions, oxidative stress caused by excessive production of reactive oxygen species (ROS) facilitates NO degradation and suppresses NO synthesis, consequently reducing NO bioavailability. Vitamin D counteracts the activity of nicotinamide adenine dinucleotide phosphate (NADPH) oxidase that generates ROS, and enhances antioxidant capacity by increasing the activity of antioxidant enzymes such as superoxide dismutase. In addition to ROS, proinflammatory mediators such as TNF-α and IL-6 are risk factors for ED, through the nuclear factor kappa-light-chain-enhancer of the activated B-cell pathway (NF-kB), limiting the bioactivity of NO and eNOS and increasing the production of different atherosclerotic factors. These proinflammatory activities are inhibited by vitamin D by suppressing NF-kB signaling and proinflammatory cytokine production. It is proven that there is a relationship that vitamin D deficiency can impair endothelial cell function (Kim et al., 2020).

Several studies have investigated the potential benefits of vitamin D supplementation in the management of essential hypertension. A meta-analysis of randomized controlled trials found that vitamin D supplementation was associated with a significant reduction in systolic blood pressure, especially in individuals with vitamin D deficiency (Chiu et al., 2021). Another study found that vitamin D supplementation was effective in reducing both systolic and diastolic blood pressure in patients with essential hypertension and vitamin D deficiency.

CONCLUSIONS

The results of this trial show that vitamin D can reduce blood pressure. The use of vitamin D supplements is able to have a positive effect on the treatment of essential hypertension in hypertensive patients who are vitamin D deficient.

ADVICE

As knowledge progresses, further research is needed to find solutions to vitamin D deficiency and its effects on the endothelium and the incidence of atherosclerosis.

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