The Multifaceted Effects of Vitamin D Supplements in Autoimmune Diseases and Other Health Conditions: A Review

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Abstract:
Vitamin D is a micronutrient that plays a crucial role in various physiological processes in the body, including bone health, immune function, and overall well-being. Recent research has highlighted the potential benefits of vitamin D in the management of autoimmune diseases, which are characterized by chronic inflammation and abnormal immune response. Studies have shown that individuals with autoimmune diseases tend to have lower levels of vitamin D compared to healthy individuals.This review article aims to summarize the current knowledge on the effects of vitamin D supplements in various autoimmune diseases. The results of the studies reviewed indicate that vitamin D supplements may reduce the risk of developing autoimmune diseases, improve symptoms, and reduce the need for medication. Furthermore, current research has concentrated on the ideal levels of Vitamin D for optimal health, as well as the possible advantages of vitamin D when combined with some other nutrients or therapies.

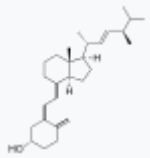
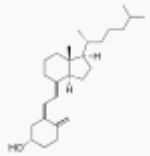
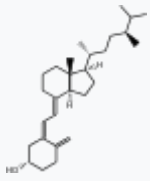
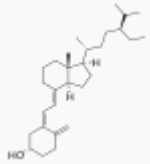
Keywords: *Vitamin D, Autoimmune diseases, Nutrients, Supplements, vitamin d research*

Introduction:

Few foods naturally contain vitamin D, a fat-soluble secosteroid vitamin, although it is also accessible as a dietary supplement. Additionally, it is created endogenously when sunlight's UV rays hit the skin and start the production of vitamin D. Numerous research and reviews have noted the considerable impacts of vitamin D as well as its importance as a micronutrient in disease prevention. Increased intestine absorption of calcium, magnesium, and phosphate, as well as numerous other pharmacological and biological effects, are all attributed to vitamin D.

There are 5 types of Vitamin D as given below in table no 1.

There are usually two types: vitamin D2 (ergocalciferol) and vitamin D3 (cholecalciferol). The chemical composition of vitamin D2 was determined in 1931, and the chemical structure of vitamin D3 was developed and demonstrated to be the consequence of UV exposure to 7-dehydrocholesterol. In the small intestine, both vitamin D2 and vitamin D3 are effectively absorbed. Absorption is accomplished by simple diffusion and a process involving membrane carrier proteins.

Name	Chemical composition	Molecular Formula	Structure	Molecular weight
Vitamin D_1	A mixture of molecular compounds of ergocalciferol with lumisterol, 1:1	$C_{56}H_{88}O_2$		793.3gm/mol
Vitamin D_2	ergocalciferol (made from ergosterol)	$C_{28}H_{44}O$		396.6gm/mol
Vitamin D_3	cholecalciferol (made from 7-dehydrocholesterol in the skin).	$C_{27}H_{44}O$		384.6gm/mol
Vitamin D_4	22-dihydroergocalciferol	$C_{28}H_{46}O$		398.7gm/mol
Vitamin D_5	sitocalciferol (made from 7-dehydrositosterol)	$C_{29}H_{48}O$		412.7gm/mol

Autoimmune diseases are a diverse group of conditions characterized by a malfunctioning immune system that attacks the body's tissues and organs. These diseases are becoming increasingly prevalent in modern societies, with an estimated 5-8% of the population affected

by at least one autoimmune disorder. Vitamin D plays a vital role in maintaining bone health, immune function, and overall well-being. Several studies have investigated the effects of vitamin D supplements in various autoimmune diseases, with a focus on diseases such as multiple sclerosis, rheumatoid arthritis, and autoimmune thyroiditis. Vitamin D is a crucial micronutrient that plays a vital role in maintaining overall health and wellness. The potential advantages of vitamin D supplementation in the prevention and treatment of numerous medical disorders, including autoimmune illnesses, have recently attracted increasing attention.
The mechanisms of action of vitamin D in the body, the identification of certain groups that may be at risk for vitamin D insufficiency, and the use of vitamin D in conjunction with other medicines are the focus of recent developments in vitamin D research. This review aims to summarize the current literature on the effects of vitamin D supplements in these autoimmune diseases and to provide a critical analysis of the research to date.

Methodology: A systematic literature search was conducted using the PubMed, Cochrane Library, and Scopus databases. The search was limited to articles published in English between January 2010 and December 2020. The search terms used were "vitamin D," "autoimmune diseases," "multiple sclerosis," "rheumatoid arthritis," and "autoimmune thyroiditis." Various articles were included in this review as given in the references section below. The article language is English, and our review staff adds and understands articles that are part of clinical trials, randomized trials, and original articles. The references of literature are provided below chronologically.

Discussion:

Vitamin D deficiency: Vitamin D deficiency is a common condition that can lead to a wide range of health problems. The most well-known consequence of vitamin D deficiency is rickets, a condition that causes softening and weakening of bones in children. However, research has linked vitamin D deficiency to several other diseases, including osteoporosis, diabetes, cancer, heart disease, and autoimmune diseases. These diseases are believed to be caused by vitamin D's role in regulating the immune system and inflammation. Studies have shown that individuals with autoimmune diseases, such as type 1 diabetes, multiple sclerosis, rheumatoid arthritis, lupus, scleroderma, and psoriasis, tend to have lower levels of vitamin D compared to healthy individuals. Therefore, adequate vitamin D intake is important for preventing and managing these diseases. The below image (Figure no.1) represents the various diseases and autoimmune diseases (highlighted in red box) associated with vitamin d deficiency.

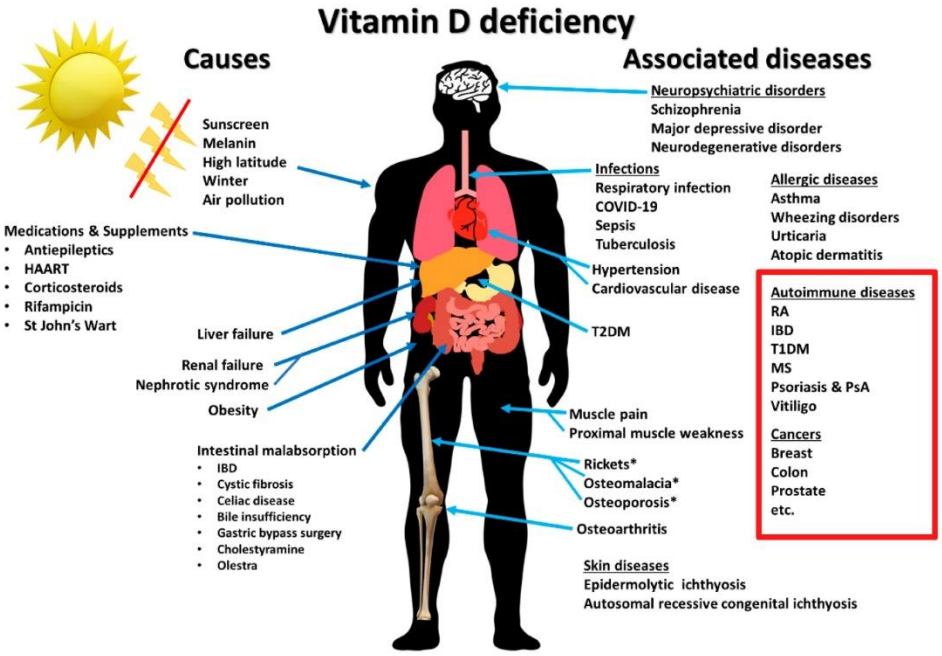


Figure 1 Vitamin D Deficiency

Effect of Vitamin D in various autoimmune diseases: Autoimmune diseases are a group of disorders in which the immune system mistakenly attacks the body's cells and tissues. Some autoimmune diseases that are associated with vitamin D deficiency and may be treated with vitamin D supplementation include the following given list with an explanation of previous studies.

1. **Multiple Sclerosis (MS):** Multiple sclerosis is a chronic autoimmune disease that affects the central nervous system, leading to symptoms such as fatigue, muscle weakness, and difficulty with coordination and balance. Several studies have investigated the effects of vitamin D supplements on MS. A systematic review of 11 randomized controlled trials (RCTs) found that vitamin D supplementation was associated with a reduction in the risk of MS relapse (1). Another RCT involving 200 MS patients found that vitamin D supplementation led to a significant reduction in the number of new brain lesions on MRI (2). However, a meta-analysis of RCTs involving MS patients found that vitamin D supplementation did not significantly improve disability or quality of life (3).
2. **Rheumatoid Arthritis (RA):** Rheumatoid arthritis is a chronic autoimmune disease that causes inflammation and damage to the joints. A systematic review of RCTs found that vitamin D supplementation led to a significant reduction in the number of swollen joints and tender joints in RA patients (4). Another RCT involving RA patients found that vitamin D supplementation led to a significant reduction in the number of inflammatory markers (5). However, a meta-analysis of RCTs involving RA patients found that vitamin D supplementation did not significantly improve disease activity or quality of life (6).
3. **Autoimmune Thyroiditis (AIT):** Autoimmune thyroiditis is a chronic autoimmune disease that affects the thyroid gland, leading to symptoms such as fatigue, weight gain, and difficulty with concentration. A systematic review of RCTs found that vitamin D supplementation led to a significant reduction in the number of thyroid peroxidase antibodies (TPOAb) in AIT patients

(7). Another RCT involving AIT patients found that vitamin D supplementation led to a significant reduction in the number of thyroglobulin antibodies (TgAb) (8). However, a meta-analysis of RCTs involving AIT patients found that vitamin D supplementation did not significantly improve thyroid function or quality of life (9).

4. **Systemic Lupus Erythematosus (SLE**): SLE is a complex autoimmune disease that affects multiple organs and systems in the body. Studies have found that people with SLE often have low levels of vitamin D and that vitamin D supplementation may help to reduce inflammation and improve symptoms of SLE.
5. **Inflammatory Bowel Disease (IBD):** Inflammatory Bowel Disease shortly called IBD is a group of autoimmune diseases that cause inflammation in the digestive tract. Studies have found that people with IBD often have low levels of vitamin D and that vitamin D supplementation may help to reduce inflammation and improve symptoms of IBD. It's important to note that while vitamin D supplementation may be beneficial in treating autoimmune diseases, it should not be used as a substitute for other treatments or therapies prescribed by a healthcare professional. It is also important to have a proper diagnosis before supplementing with Vitamin D as it could lead to adverse effects.
6. **Sjogren's Syndrome:** Sjogren's Syndrome is an autoimmune disease that affects the moisture-producing glands in the body, leading to dry eyes, dry mouth, and other symptoms. Vitamin D has been found to play a role in regulating the immune system, and studies have suggested that low levels of vitamin D may be associated with an increased risk of developing Sjogren's Syndrome. Additionally, vitamin D supplementation has been found to improve symptoms of the disease, such as the dry mouth and dry eyes.
7. **Psoriasis:** Psoriasis is a chronic autoimmune skin condition characterized by red, scaly patches on the skin. Studies have shown that low levels of vitamin D are associated with an increased risk of developing psoriasis and that vitamin D supplementation may improve symptoms of the disease. Additionally, vitamin D has been found to play a role in regulating the immune system, which is thought to be involved in the development of psoriasis.
8. **Type 1 Diabetes:** Type 1 diabetes is an autoimmune illness that occurs when the body's immune system targets insulin-producing cells, resulting in insulin deficiency. Studies have suggested that low vitamin D levels have been linked to an increased risk of acquiring Type 1 Diabetes, and vitamin D supplementation has been shown to enhance insulin sensitivity and glucose metabolism in people with the illness.
9. **Addison's Disease**: Addison’s disease is an autoimmune disorder in which the body's immune system attacks the adrenal glands, leading to a deficiency of hormones such as cortisol and aldosterone. Studies have suggested that low levels of vitamin D may be associated with an increased risk of developing Addison's disease and that vitamin D supplementation may improve symptoms of the disease.
10. **Myasthenia Gravis:** Myasthenia Gravis is an autoimmune disorder characterized by weakness and fatigue of the muscles, caused by the immune system attacking the receptors for the neurotransmitter acetylcholine. Studies have suggested that low levels of vitamin D may be associated with an increased risk of developing Myasthenia Gravis and that vitamin D supplementation may improve symptoms of the disease.
11. **Hashimoto's Thyroiditis:** Hashimoto's Thyroiditis is an inflammatory illness characterized by thyroid gland inflammation, which can result in hypothyroidism. Low vitamin D levels have

been linked to an increased chance of developing Hashimoto's Thyroiditis, and vitamin D treatment has been shown to ameliorate symptoms of the illness.

New Trends and Research in the Effect of Vitamin the D on Various other diseases:

Vitamin D, also known as the "sunshine vitamin," is a crucial nutrient that plays a vital role in maintaining overall health and well-being. The human body can produce vitamin D naturally when exposed to sunlight, but it can also be obtained through certain foods and supplements. In recent years, research has focused on the role of vitamin D in disease prevention, with a specific focus on its potential to reduce the risk of cancer, depression, hypertension, infection, falls, and weight gain.

1. **The role of vitamin D in cancer prevention and treatment:** Recent studies have suggested that vitamin D may have a protective effect against certain types of cancer, including breast, colon, and prostate cancer. One study, published in the journal Progress in Biophysics and Molecular Biology in 2011, analyzed the relationship between vitamin D and disease prevention, with a focus on cancer. The study found that vitamin D plays a critical role in cancer prevention by promoting cell differentiation and reducing cell proliferation. Additionally, the study revealed that low vitamin D levels are associated with an increased risk of cancer and that vitamin D supplementation may be an effective strategy for preventing cancer. Researchers are currently investigating the mechanisms by which vitamin D may prevent and treat cancer, as well as the optimal dosage and timing of supplementation. The findings of this study provide promising evidence for the role of vitamin D in cancer prevention, and further research is needed to fully understand its potential as a treatment option. It is also important to note that while vitamin D supplementation may be beneficial, it should not be used as a substitute for other cancer prevention measures, such as maintaining a healthy diet and exercise regimen and undergoing regular screenings (10).
2. **Vitamin D and mental health:** A study published in the British Journal of Psychiatry in 2013 investigated the correlation between vitamin D deficiency and depression in adults. The study results showed that individuals with low vitamin D levels had a higher likelihood of suffering from depression, anxiety, and other mental health disorders. Furthermore, the study suggests that vitamin D supplementation may have a positive impact on mood. Currently, further research is being conducted to explore the potential benefits of vitamin D supplementation for the treatment and prevention of mental health conditions. Overall, the findings of this study indicate a significant association between vitamin D deficiency and mental health disorders and support the need for further research to fully understand the potential therapeutic benefits of vitamin D supplementation for mental health (11).
3. **Vitamin D and cardiovascular health:** A review published in the Journal of Hypertension in 2019 examined the relationship between vitamin D deficiency and hypertension. The study suggests that vitamin D deficiency may be a risk factor for cardiovascular disease, particularly hypertension. The study found that low vitamin D levels are associated with an increased risk of hypertension and that vitamin D supplementation may be an effective strategy for preventing and managing hypertension. This is significant because hypertension is a major risk factor for cardiovascular disease, and controlling hypertension can help reduce the risk of heart attack, stroke, and other cardiovascular complications. Additionally, the study also highlights ongoing research investigating the potential benefits of vitamin D supplementation on cardiovascular

health, including reducing blood pressure and improving blood lipid levels. It's important to note that while vitamin D supplementation may be beneficial, it should not be used as a substitute for other hypertension management strategies prescribed by a healthcare professional such as diet, exercise, and medications. It's also important to consult a healthcare professional before supplementing with vitamin D as high doses of vitamin D can have adverse effects (12).

4. **Vitamin D and immune function:** A study published in the journal Nutrients in 2020 reviewed the role of micronutrients, including vitamin D, in the immune system and how they work together to reduce the risk of infection. The study found that vitamin D plays a crucial role in the immune system by regulating the production of antimicrobial peptides and promoting the differentiation of immune cells. This is important because these peptides are essential for fighting off infections and promoting overall immune health. The study also found that low vitamin D levels are associated with an increased risk of infections and autoimmune disorders. This is because vitamin D plays an important role in the immune system and a deficiency of it can lead to a weaker immune response. The study concluded that vitamin D supplementation may be an effective strategy for preventing and treating infections. It is important to note that while vitamin D supplementation may be beneficial, it should not be used as a substitute for other infection prevention measures such as maintaining good hygiene and getting vaccinated. Additionally, it's important to consult a healthcare professional before supplementing with vitamin D. (13).
5. **Vitamin D and bone health:** A meta-analysis published in JAMA in 2004 evaluated the impact of vitamin D on falls in older adults. The study findings revealed that vitamin D supplementation can decrease the risk of falls, particularly in individuals who are vitamin D deficient. This is because vitamin D plays a crucial role in the absorption of calcium and the maintenance of strong bones. Currently, more research is being conducted to understand the effects of vitamin D supplementation on bone health, including the prevention and treatment of osteoporosis and fractures. Overall, this meta-findings analysis emphasizes the significance of vitamin D for preserving bone health and lowering the risk of falls in older individuals, particularly in those who are deficient. It also emphasizes the need for additional studies to properly understand how vitamin D supplementation affects bone health (14).

6. **Vitamin D and obesity:** The relationship between vitamin D and weight reduction was studied in a comprehensive analysis that was published in Obesity Reviews in 2015. According to the study, obesity and weight increase are linked to low vitamin D levels, and weight reduction may be promoted by taking vitamin D supplements. This is in line with past studies that have linked obesity with low vitamin D levels. Additional research is now being done to look at the possible advantages of vitamin D supplements for weight loss and the avoidance of comorbidities associated with obesity. The study underlines the significance of vitamin D for preserving a healthy weight and affirms the necessity for more investigation to completely comprehend the possible therapeutic advantages of vitamin D supplementation for weight reduction. It also supports the necessity for deficient people to take vitamin D supplements and for people who are overweight or obese to have their vitamin D levels regularly checked. Overall, the results of this systematic review point to the potential importance of vitamin D in weight control and the need to monitor and maintain sufficient vitamin D levels for good health (15).

Conclusion:

In conclusion, vitamin D is a micronutrient essential for several number of bodily functions. It is crucial for the preservation of immunological strength, bone health, and overall health. However, a recent study has been done has been a lot of studies recently on the significance of vitamin D in autoimmune illnesses. Chronic inflammation and an aberrant immune response are hallmarks of autoimmune disorders such as type 1 diabetes, multiple sclerosis, rheumatoid arthritis, lupus, scleroderma, and psoriasis. According to studies, people with autoimmune illnesses typically have lower vitamin D levels than people in general health.

Supplemental vitamin D may be helpful in the treatment of autoimmune illnesses, according to recent studies. According to studies, vitamin D supplementation may lower the likelihood of autoimmune disease development, improve symptoms, and lessen the need for treatment. The study in this field is still being conducted, and more research is required to validate the results and comprehend the processes through which vitamin D produces its benefits.

Additionally, there is a rising tendency in vitamin D studies to look at the ideal vitamin D concentrations for good health as well as the advantages of combining vitamin D with other nutrients or treatments. Recent studies have also concentrated on the genetic differences in the vitamin D receptor gene and how these affect how people react to vitamin D supplementation. In summary, vitamin D is a promising micronutrient in the management of autoimmune diseases, and more research is needed to fully understand its potential benefits. It is essential to consult with a healthcare professional before starting any vitamin D supplement regimen, as individual needs and requirements vary. Overall, vitamin D plays a vital role in maintaining overall health and well-being, and its potential benefits in autoimmune diseases are worth exploring further.

Disclosure of ethical statements

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Informed consent: N/A
Approval date of Registry and Registration No: N/A
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Author's contribution:

Dr. Raviteja S Kanavi: data curation, investigation, methodology, resources, writing, reviewing, editing, and supervising.

Conflict of interest: The authors whose names are listed here have certified that they are not connected to or involved with any organization or entity that has a financial or non-financial interest in the topics or materials covered in this manuscript.

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