



# Vitamin D and its role in health; A review of mechanisms, risk factors, sources, and health benefits

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## Abstract

Vitamin D is crucial for maintaining optimal health. This review study evaluates health problems related to deficiency and ways to maintain sufficient levels. We conducted a review of the association between vitamin D inadequacy and various diseases, explored the various sources of vitamin D and the risk factors associated with vitamin D insufficiency, examined the consequences of insufficient vitamin D levels, and assessed the potential benefits of taking vitamin D supplements for promoting good health. A literature review demonstrated that maintaining sufficient levels of vitamin D is essential for improving health and preventing various diseases. Vitamin D deficiency is a common condition, and it can be addressed by consuming a balanced diet, getting regular exposure to sunlight, or taking supplements as necessary.

**Keywords:** Vitamin D, Vitamin D source, Vitamin D deficiency, Health problems

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## Introduction

Vitamin D is a fat-soluble substance that helps maintain bones by helping the body absorb calcium, magnesium, and phosphate (1). It also contributes to bodily processes like supporting our immune system, improving cell growth, and aiding in neuromuscular function (2). This vitamin is naturally occurring in certain foods, added to others, and exists in supplement form (3). When sunlight touches the skin, it triggers a process that produces vitamin D. Vitamin D is synthesized in response to exposure to ultraviolet (UV) rays (2, 3). We can obtain vitamin D from food sources like fish and fortified foods or produce it naturally when exposed to sunlight (2). However, most people worldwide don't get vitamin D, which causes the incidence of vitamin D insufficiency and is correlated with disorders like infections, type 2 diabetes, and COVID-19 (4).

## Objective

We investigate how vitamin D is correlated to diseases, what are its different sources and risk factors of its inadequacy, the implications of lacking sufficient vitamin D, and the main advantages of taking vitamin D

supplements for health.

## Mechanisms of vitamin D action

Vitamin D mechanisms are quite complex as they involve a series of steps, including synthesis, metabolism, and activation. Vitamin D can be obtained from the food we eat or synthesized by our bodies when exposed to sunlight. Once we acquire vitamin D, it goes through two hydroxylation processes, including in the liver and kidneys, causing the production of a form called 1,25 dihydroxy-vitamin D (1,25(OH)<sub>2</sub>D). This active form binds with receptors in tissues, such as the intestine, bones, and immune cells. Its role is regulation of calcium, phosphate balance, bone health control, and metabolism as a support immune functions (5). In addition to its classical functions, vitamin D is known for regulating cell proliferation, differentiation, and apoptosis (5).

## Sources of vitamin D

Vitamin D can be produced by the body through sunlight or taken from supplements and food sources. The two common types of vitamin D, including cholecalciferol (D<sub>3</sub>) and ergocalciferol (D<sub>2</sub>), are available in both food

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### ■ Implication for health policy/practice/research/medical education

Vitamin D insufficiency is common with various health problems, such as osteoporosis, autoimmune diseases, infection, cardiovascular disease, diabetes, and depression. Therefore, maintaining a sufficient vitamin D level with a balanced diet and regular exposure to sunlight can prevent this common disease and improve health and quality of life.

sources and supplements. The best food sources include fatty fish, eggs, sun-exposed mushrooms, liver, and other organ meats (6,7). Other sources are yogurt, eggs, cheese, fortified milk, beef, liver, dark chocolate, fat spreads, breakfast grains, orange juice, and plant-based beverages (8). There are limited food sources that provide a significant amount of vitamin D. However, there are a few examples including fish liver oils, Reindeer lichen, and mushrooms (7). The main dietary sources of vitamin D vary by country and depend on factors like sex, age, body composition, vitamin D levels, and income. Ensuring a sufficient intake of vitamin D is crucial for maintaining good health, and it is recommended by the European Food Safety Authority (EFSA) to consume 15 µg/d on a daily basis (7).

### Deficiency of vitamin D

Many individuals struggle with vitamin D insufficiency worldwide due to severe health issues caused by it (1,9). The most important cause of vitamin D deficiency is insufficient sun exposure, which is the primary source. There are not many foods that are naturally rich in vitamin D, and the ones that are fortified with it often don't meet human requirements (9). Both developed and developing countries have a worldwide prevalence of up to 1 billion individuals with subclinical vitamin D deficiency (1). An analyzed data from the National Health and Nutrition Examination Survey (2005 to 2006) regarding vitamin D levels in adults showed that the prevalence of vitamin D deficiency is 41.6%, and the highest rates are 82.1% and 69.2% in black and Hispanic races respectively (10).

### Prevalence of vitamin D insufficiency

The following studies show the prevalence rates of worldwide vitamin D insufficiency:

- 24% of the US population has vitamin D levels below 50 nmol/L (or 20 ng/ml), and 5.9% have a severe deficiency (25(OH)D <30 nmol/L or 12 ng/mL) (11).
- 14.8% of individuals over 65 in the US have a vitamin D deficiency (12).
- 2.6% of Americans have severe vitamin D inadequacy (25(OH)D <20 nmol/L), while 22.0% have moderate deficiency (25(OH)D <50 nmol/L) (13).
- According to recent studies, 40% of people in Europe have a deficiency of vitamin D, with 13% experiencing

severe deficiency (11).

- 50% to 60% of nursing home residents and hospitalized patients in the US are lack in vitamin D (1).
- 47% of African American and 56% of Caucasian infants in the US have vitamin D deficiency, while over 90% of infants in India, Turkey, and Iran are deficient (1).
- Vitamin D deficiency among hospitalized patients was 52.1% with a serum 25(OH)D level below 50 nmol/L (14).

### Symptoms of vitamin D deficiency

It is crucial to be aware that a lack of vitamin D in the body can lead to various symptoms, which may not necessarily be specific to vitamin D deficiency and could be caused by other medical conditions. It is crucial to be aware that a lack of vitamin D in the body can lead to various symptoms, which may not necessarily be specific to vitamin D deficiency and could be caused by other medical conditions. Some of the most common related symptoms to vitamin D deficiency are muscle pain and weakness, reduced performance speed, bone pain and deformities, increasing risk of falling, hypocalcemia, and Dental abnormalities (4, 15-18).

### Risk factors for vitamin D deficiency

Maintaining good bone health and overall health is essential, and vitamin D is an important nutrient that helps in achieving this. Unfortunately, many people suffer from vitamin D deficiency, which can lead to various health issues. According to previous studies, the following are some risk factors for vitamin D deficiency:

- *Insufficient sunlight exposure:* When the skin is exposed to sunlight, it produces vitamin D. This means that individuals who spend the majority of their time indoors, wear clothing that conceals most of their skin, or reside in regions with limited sunlight are at a greater risk of developing (4, 17).
- *Inadequate dietary intake:* Some foods contain vitamin D, including egg yolks, fortified foods, and fatty fish. If someone does not eat enough of these foods or follows a vegetarian diet, they may be at risk of developing this disease (4, 12).
- *Decreased endogenous synthesis:* With older age, our skin becomes less effective at generating vitamin D. This can result in a deficiency of this important nutrient (1).
- *Increased hepatic catabolism:* Medical disorders, including liver disease, can cause vitamin D deficiency by impairing its activation in the liver (1).
- *Limited oral intake:* People with malabsorption disorders like celiac or inflammatory bowel disease may not absorb sufficient vitamin D through diets, leading to a deficiency (4).

- **Lifestyle factors:** Sedentary behavior and physical inactivity, poor environmental conditions, low economic status, lower educational level, smoking, obesity, and Malabsorption syndrome are the most common lifestyle risk factors for vitamin D deficiency (19, 20).

It is worth noting that certain individuals may have a greater likelihood of experiencing a shortage of vitamin D compared to others. These may include seniors, those with darker skin tones, and individuals who are overweight (17). As a result, it's advisable to undergo testing for vitamin D deficiency and consider taking supplements if needed.

### Prevention of vitamin D deficiency

Some behavior and lifestyle changes can reduce the risk of vitamin D deficiency, including being exposed to sunlight (17, 21), consuming rich vitamin D foods and supplements (20, 22), being physically active (22), avoiding smoking and opium, maintaining a healthy weight, and Improving the economic status, educational level, and environmental conditions (20).

### Health-related problems of vitamin D deficiency and health benefits of its supplementation

Vitamin D inadequacy can cause softening of bones (Osteomalacia) in both children and adults and rickets in children (1,9), and also is correlated with osteoporosis, risk of falling, and older age fractures. Recent studies show an association between vitamin D deficiency and cardiovascular and cancer disease, autoimmune diseases, diabetes mellitus, and depression (1). On the other hand, vitamin D deficiency, due to its role in immune function, can lead to various diseases such as infections, type 2 diabetes, and COVID-19 (2), and its supplementation can improve bone health and reduce falls in seniors (6).

### Conclusion

Vitamin D deficiency is a prevalent condition associated with various health issues. It is crucial to maintain a sufficient level of vitamin D through a balanced diet and regular exposure to sunlight or supplements if needed.

### Authors' contribution

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### Conflicts of interest

The authors declare that they have no competing interests.

### Ethical issues

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

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