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## **Benefits and risks of vitamin D supplementation**

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### **Summary**

Vitamin D deficiency is a common problem not only in Poland but also in the world. Studies from previous years indicate its pleiotropic effect and indicate the need for supplementation both in individual risk groups and in the general population. The main sources of cholecalciferol are skin synthesis and intestinal absorption. Vitamin D deficiency

adversely affects the cardiovascular, immune and nervous systems. It is also associated with gastrointestinal, metabolic, cancer and autoimmune diseases. Through the immune system, it also affects the respiratory system. Prophylactic doses should depend on age, body weight, seasonal insolation and sun exposure, as well as individual factors such as diet and lifestyle. Excessive supply of vitamin D can lead to hypercalcemia and hypercalciuria, although it is not known how high doses cause toxic effects. Monitoring the exponents of calcium and phosphate metabolism is the basic method of preventing vitamin D toxicity.

**Keywords:** vitamin D, supplementation, deficiency, calcitriol

## Introduction and purpose

Vitamin D is defined as vitamin D<sub>3</sub> - cholecalciferol, found in food of animal origin and vitamin D<sub>2</sub> - ergocalciferol present in plant tissues, yeast and fungi, and supplements. [1] Calcitriol has a structure similar to steroid hormones and has hormone-like effects. There are two sources of vitamin D - endogenous, the most efficient, formed in the skin as a result of exposure to sunlight, and the second poorer source is food containing vitamin D. [2] Considering the low consumption of foods rich in vitamin D in Poland, its primary source is skin synthesis under the influence of sunlight, which is effective only from April to September. [3-5] A significant part of the Polish population is deficient in vitamin D throughout the year, and about 85% of adults are deficient in the autumn and winter months. [6,7] The synthesis of vitamin D in the skin is affected by many factors: the degree of insolation, season, time of day, latitude, skin complexion, body weight, exposed body surface, cloud cover, air pollution, age, use of sunscreens. It has been shown that the use of sunscreen reduces skin vitamin D synthesis by 99.9% [8]. In addition, the ability to synthesize vitamin D decreases with age.

Under the influence of UVB radiation (219-315 nm), 7-dehydrocholesterol, which is a precursor of vitamin D, is formed in the skin from cholesterol. Its greatest production occurs at the radiation wavelength of 297 nm. On the other hand, at 320 nm, production is zero. In the next step, 7-dehydrocholesterol is isomerized to stable cholecalciferol (vitamin D<sub>3</sub>). This reductase-mediated transformation takes approximately 30 minutes. The resulting vitamin D from cell membranes goes to the intercellular spaces, and then to the bloodstream. [9,10]

Exogenous sources are eggs, dairy products, fatty fish or tuna or whale liver oil. Additional sources of vitamin D are supplements and fortified foods. [11,12]

The marker of vitamin D content is the measurement of the concentration of the 25(OH)D metabolite. The half-life of circulating 25(OH)D is about three weeks and is the best indicator of the total vitamin D content in the body. However, the diagnostic standard should be the simultaneous determination of 25(OH)D<sub>2</sub> and 25(OH)D<sub>3</sub>, i.e. total 25(OH)D [13, 14]. According to the current recommendations, there are no significant indications for the determination of calcidiol in the general population.

The correct concentration is currently 30-50 ng/ml 25(OH)D. Vitamin D deficiency below 30 ng/ml can be conventionally divided into: mild: 20-30 ng/ml, medium: 10-20 ng/ml, severe: 0-10 ng/ml.

There is no doubt that vitamin D deficiency is a serious global problem, affecting people of all races, genders and ages. According to epidemiological studies, vitamin D

deficiency in the European population may affect 50-70% of the population, and in Poland even about 90% [15, 16]. Optimally, the therapy should last 3 months to saturate all body compartments. The purpose of treatment is to achieve a serum 25-hydroxycholecalciferol concentration above 30 ng/ml. The following are recommended: concentration control every 1-3 months and tests of alkaline phosphatase concentration, serum Ca and P levels [17].

There are both over-the-counter (OTC) medications and vitamin D supplements on the market. In pharmacies you can buy vitamin D both in the form of a drug and a supplement in the following doses: 400 IU, 600 IU, 1000 IU, 2000 IU, 4000 IU. Below are the principles of vitamin D supplementation.

### **NEWBORNS AND INFANTS**

- 0-6 months: 400 IU/day from the first days of life, regardless of the method of feeding
- 6.-12. months of age - a dose of 400-600 IU/day, depending on the daily dose of vitamin D supplied with food.

### **KIDS (1-10 YEARS)**

In the period from May to September, in healthy children (1-10 years old) staying in the sun with uncovered forearms and lower legs for at least 15 minutes from 10.00 a.m. to 3.00 p.m., without using sunscreen, vitamin D supplementation is not necessary although it is recommended and safe.

If the above conditions are not met, supplementation is recommended at a dose of 600-1000 IU/day, depending on body weight and vitamin D supply in the diet, throughout the year.

### **YOUTH (11-18 YEARS OLD) AND ADULTS (19-65 YEARS OLD)**

In the period from May to September, in healthy person staying in the sun with uncovered forearms and lower legs for at least 15 minutes from 10.00 a.m. to 3.00 p.m., without using sunscreen, vitamin D supplementation is not necessary although it is recommended and safe.

If the above conditions are not met, supplementation is recommended at a dose of 800-2000 IU/day, depending on body weight and vitamin D supply in the diet, throughout the year.

### **SENIORS**

- 65-75 years: 800-2000 IU (20-50 µg) daily throughout the year (depending on body weight and vitamin D supply in the diet)
- >75 years: 2000-4000 IU (50-100 µg) daily throughout the year (depending on body weight and vitamin D supply in the diet) [18]

A breastfeeding woman should supplement her baby with vitamin D, because breast milk contains a very small amount of vitamin D (approx. 40 IU/litre). [19]

In most cases, vitamin D should be taken with a meal to ensure optimal absorption. It is also possible to recommend the use of complex preparations containing calcium and vitamin D, but care should be taken that they contain the recommended dose of vitamin D. Prescription preparations and dietary supplements present on the Polish market come in various forms.

## **State of knowledge**

The main task of calcitriol is to maintain calcium and phosphate homeostasis by affecting parathyroid hormone (PTH), calcium absorption and bone metabolism. Vitamin D plays an important role in the absorption of calcium in the small intestine. Its deficiency leads to rickets, osteomalacia (equivalent to rickets in adults) and osteoporosis. In the small intestine, it leads to increased absorption of calcium and phosphate, and in the kidneys, it increases the reabsorption of the  $\text{Ca}^{2+}$  ion. It promotes bone formation by stimulating osteoblasts to produce alkaline phosphatase and osteocalcin, which reduces the risk of fractures. Moreover, it inhibits the secretion of parathyroid hormone [20].

The effect of vitamin D on both innate and humoral immunity has been demonstrated. In addition, vitamin D reduces the amount of pro-inflammatory cytokines such as: IL-1, IL-6, IL-8 and controls the balance between Th1 and Th2 lymphocytes [21]. Scientific research suggests that vitamin D deficiency may contribute to the formation of autoimmune diseases such as type 1 diabetes, inflammatory bowel disease, rheumatoid arthritis, and its supplementation may be a protective factor [22, 23].

Vitamin D, by increasing the concentration of intercellular calcium, reduces the activity of renin, which affects the regulation of blood pressure. [24] Vitamin D supplementation reduces cardiovascular risk through various mechanisms. It regulates the function of the vascular endothelium, improves its functioning. It has a cardioprotective effect.

A number of epidemiological studies have shown that the occurrence of the most common forms of cancer, such as: breast cancer, colorectal cancer, rectal cancer, uterine cancer and prostate cancer shows a negative correlation with the level of vitamin D in the blood serum. It has been noticed that vitamin D has an anti-carcinogenic effect and significantly reduces the incidence of cancer. [25]

The effect of vitamin D deficiency on the nervous system and mental state of patients has also been demonstrated. These deficiencies can contribute to depression, bipolar disorder, and chronic fatigue.

An excess of vitamin D, called hypervitaminosis or vitamin D intoxication, is observed very rarely. Clinical signs of vitamin D excess are associated with increased serum calcium levels; include, among others: weakness, difficulty concentrating, drowsiness, vomiting, constipation and polyuria. The consequence of persistent hypercalcemia may be urolithiasis, calcification of organs, neurological disorders, teratogenic effect on the fetus, arterial hypertension, and cardiac arrhythmias.

## **Conclusion**

Currently, vitamin D deficiency is a major challenge in the practice of a physician. There is no doubt that vitamin D deficiency is a serious global problem, affecting people of all races, genders and ages. Therefore, emphasis should be placed on increasing public awareness of the importance of adequate vitamin D supplementation. According to the recommendation, it is recommended to take vitamin D from the first days of life until death. Special attention should be paid to children, pregnant women and the elderly. Both deficiency and excess of the vitamin are dangerous to health, therefore supplementation should be carried out under the supervision of a doctor.

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