Med. čas. 2022; 56(4): 158-160.
KRATKO SAOPŠTENJE
doi: 10.5937/mckg56-40957
COBISS.SR-ID 112694281
UDK. 615.356:577.161.2

VITAMIN D IN THE DIET AND ITS EFFECTS ON THE NERVOUS SYSTEM

Marko Koprivica[1], Jelena Bjelanovic[1,2]
[1]University of Novi Sad, Faculty of Medicine, Novi Sad, Serbia
[2]Institute of Public Health of Vojvodina, Novi Sad, Serbia

ВИТАМИН Д У ИСХРАНИ И ЊЕГОВА ДЕЈСТВА НА НЕРВНИ СИСТЕМ

Марко Копривица[1], Јелена Бјелановић[1,2]
[1]Универзитет у Новом Саду, Медицински факултет, Нови Сад
[2]Институт за јавно здравље Војводине, Нови Сад

ABSTRACT

Vitamin D is a liposoluble organic compound that, in addition to calcium metabolism and its effect on the skeletal system, also has numerous other effects on other organ systems, such as the cardiovascular, endocrine, skeletal and immune, but also on the central nervous system. The primary source of vitamin D is food of animal origin; however, vitamin D is synthesized in the skin upon its exposure to sunlight. In this paper, we will also present the studies corroborating the theory that numerous neurological and psychiatric manifestations are due to deficiency of vitamin D.

Key words: *vitamin D; vitamin D deficiency; nervous system diseases.*

САЖЕТАК

Витамин Д је липосолубилно органско једињење, које, осим што учествује у регулацији метаболизма калцијума и утиче на скелетни систем, има и бројне друге ефекте на друге органске системе, као што су кардиоваскуларни, ендокрини, коштани, имунски, али и централни нервни систем. Примарни извор витамина Д је храна животињског порекла. Међутим, витамин Д се синтетише у кожи након излагања сунчевој светлости. У овом раду представићемо студије које поткрепљују теорију да су бројне неуролошке и психијатријске манифестације последица недостатка витамина Д.

Кључне речи: *витамин Д; недостатак витамина Д; болести нервног система.*

INTRODUCTION

The most significant source of vitamin D for people is exposure to sunlight. Ultraviolent (UV) radiation provides the synthesis of 2/3 of the necessary concentrations of vitamin D. Food intake provides the remaining one-third of the vitamin D (1). Taking into account and the content of vitamin D in 100 grams of foods, research shows that the largest source of vitamin D is cod liver oil (2, 3). This oil contains, on average, 210-250 μg (2, 3). A smaller, but certainly significant, source is wild salmon, which contains from 5.9 to 24.7 μg/1 (2-4). Vitamin D can also be found in the meat of cod (5.7-15.4 μg) (5), hake (8 μg) (2), mackerel (8.8-16.1 μg) (2, 3), canned sardines (4.6 μg) (2), tuna (6.7 μg (3), and anchovies (2.6 μg) (2). Vitamin D-rich mushrooms are wild, edible Cantharellus tubaeformis mushrooms that contain 13.6-29.8 μg (5,6) as well as Agaricus bisporus mushrooms with 0.2 μg (3). Among dairy products, vitamin D is present in unfortified whole milk and yoghurt at a concentration of 0.1 μg (3), and in cheddar cheese that can have 0.3-0.6 μg (2,3). Among animal products, turkey meat is the most important source of vitamin D, 100 g of this meat contains 2.2 μg of vitamin (2). Slightly lower concentrations are present in pork bacon (1.6 μg) and beef liver (1.2 μg) (3), while of chicken contains only 0.1 μg (3). Higher concentrations of vitamin D are present in butter (1.5 μg) (3) and raw, whole egg (1.8 to 2.05 μg) (2, 3).

Research conducted around the world has shown that the dominant source of vitamin D varies from country to country. In Norway, the largest source of this vitamin is fish and fats (7). While in Finland it is milk and milk products (8). In the United Kingdom (UK), fish oil, meat and meat products, cereals and their products make the most significant contribution to maintaining adequate daily intake of vitamin D in the adult population (9). In Spain, fish is responsible for 65% of the daily intake of vitamin D (10). In contrast, fortified milk provides 39% - 58% of daily needs in the United States (11). In Japan, the most significant source of vitamin D is fish and eggs, while in Ireland it is meat, fish and spreads (12).

Apart from its natural form, vitamin D can be introduced into the organism through fortified foods. Foods that are enriched with vitamin D also vary among countries around the world. In practice, milk, margarine, mushrooms and cereals are most commonly enriched food. Enrichment can be made in several ways. One of them is the increased exposure of mushrooms to UV radiation. Concentrations of vitamins that are synthesized depend on the length of exposure and the dose of radiation delivered. The synthesized concentrations of vitamin D in mushrooms remain durable even after its treatment (drying, cooking, baking). In products of animal origin, an increase in the concentration of vitamin D is achieved by the rise in the concentration of vitamins in foods used in animal feeding (13).

Primljen/Received: 02.11.2022.
Prihvaćen/Accepted: 20.03.2023.

Marko Koprivica
Banatska 6A, 21000 Novi Sad, Serbia
Phone +381 63 7703238
E-mail: markokoprivica@uns.ac.rs

doi: 10.5937/mckg56-40957
COBISS.SR-ID 112694281
UDK. 615.356:577.161.2

THE EFFECT ON THE NERVOUS SYSTEM

Vitamin D in the nervous system works by activating receptors on neurons located in regions responsible for behavioural control. This vitamin stimulates neurotrophin release and protects the brain by preventing antioxidant and anti-inflammatory damage to the blood vessels. The mechanism by which vitamin D exerts its effect on the nervous system and affects mental status has not yet been fully elucidated. It is thought to primarily exert its influence through VDRs located in the hypothalamus, which subsequently exerts a neuroendocrine effect (14). Calcitriol has been shown to induce the expression of tryptophan hydroxylase 2, an enzyme that participates in serotonin biosynthesis (15).

Neurological and psychiatric disorders and vitamin D deficiency

One of the mechanisms that explain the impact of vitamin D deficiency on the onset of depression is a disturbance in calcium metabolism and a decrease in calcium receptors, which inhibits the function of numerous signaling pathways in the brain. Also, the decreased concentration of vitamin D leads to reduced synthesis of serotonin (15).

Vitamin D deficiency is linked to the onset of depression, schizophrenia, bipolar disorder, seasonal affective disorder, and impairment of cognitive function. Numerous studies show that vitamin D deficiency is associated with the onset of depression and that people with adequate vitamin D concentrations have a significantly lower risk of developing the disease. There is a risk of depression in people with hypovitaminosis D both in adolescents and in older adults (16).

In addition to depression, vitamin D deficiency has also been shown to affect anxiety (17). The exact mechanism of occurrence is not yet fully known. Animal studies have shown that defects in vitamin D receptors (VDR), as well as vitamin D deficiency, affect anxiety expression (18). Vitamin D has also shown to play a role in modulating the immune response and secretion of the cytokine TNF-α and C reactive protein (19). More recent evidence suggests that these proteins play a role in the onset of anxiety by affecting the modulation of neurotransmitter metabolism (dopamine, serotonin) (20). It should also be emphasized that 400 IU per day may be enough for healthy people to get Vitamin D regularly through food, sunlight or supplements. However, it should not be overlooked that the doses of vitamin D for therapeutic purposes are significantly higher (21). Vitamin D has a protective effect on certain dementias. Some studies have also shown that this vitamin prevents cognitive degradation (22). Some randomized studies have shown that high-dose vitamin D can reduce the severity of Parkinson's disease symptoms (23). An increasing number of studies show that vitamin D is one of the most responsible factors for the development of multiple sclerosis, as well as for the degree of expression of the symptoms of this disease (24). Also, recent studies show that some genes responsible for multiple sclerosis are close to genes responsible for creating enzymes that affect vitamin D and various enzymatic processes (25). It is undeniable that vitamin D deficiency plays a role in the development of multiple sclerosis (26). In the case of stroke, some studies have shown a correlation suggesting that people with vitamin D deficiency are more prone to stroke (27).

Headache and vitamin D

Vitamin D deficiency is associated with the development of chronic pain as well as several other neurological disorders (28). Although the way of occurrence has not yet been fully explained, it is noted that people with vitamin D deficiency have frequent and severe headaches (29). The role of vitamin D in the onset of pathogenesis involves the stimulation of painful sensations and the development of inflammation and immune dysfunction (30). At the molecular level, it has been recorded that polymorphism of a gene encoding VDR may increase the risk of migraine without aura. As people with migraines avoid sunlight due to photophobia and are less physically active and spend a lot of time indoors, the risk of deficiency is higher (31).

CONCLUSION

In addition to having effects on the above-mentioned organ systems, recent research emphasizes the role of vitamin D in the activation of certain receptors in the nervous tissue, causing neurological and psychiatric disorders unless it is present in optimal amounts. These studies show the extent to which vitamin D is present in this public health problem. Special attention should be paid to the primary sources of vitamin D.

REFERENCES

1. Naeem Z. Vitamin d deficiency-an ignored epidemic. Int J Health Sci (Qassim) 2010; 4: 5-6.
2. O′Mahony L, Stepien M, Gibney MJ, et al. The potential role of vitamin D enhanced foods in improving vitamin D status. Nutrients 2011; 3: 1023-41.
3. Food databases. Methods and Application of Food Composition Laboratory: Beltsville, MD. Washington DC: Agricultural Research Service, U.S. Department of Agriculture, 2022. (https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/methods-and-application-of-food-composition-laboratory/mafcl-site-pages/database-resources/).

doi: 10.5937/mckg56-40957
COBISS.SR-ID 112694281
UDK. 615.356:577.161.2

4. Lu Z, Chen TC, Zhang A, et al. An evaluation of the vitamin D3 content in fish: is the vitamin D content adequate to satisfy the dietary requirement for vitamin D? J Steroid Biochem Mol Biol 2007; 103: 642-4.
5. Mattila P, Ronkainen R, Lehikoinen K, et al. Effect of household cooking on the vitamin D content in fish, eggs, and wild mushrooms. J Food Compos Anal 1999; 12: 153-60.
6. Mattila PH, Piironen VI, Uusirauva EJ, et al. Vitamin-D contents in edible mushrooms. J Agric Food Chem 1994; 42: 2449-53.
7. Calvo MS, Whiting SJ, Barton CN. Vitamin D intake: a global perspective of current status. J Nutr 2005; 135: 310-6.
8. Pietinen P, Paturi M, Reinivuo H, Tapanainen H, Valsta LM. FINDIET 2007 Survey: energy and nutrient intakes. Public Health Nutr 2010; 13(6A): 920-4.
9. Henderson L, Irving K, Gregory J, et al. National Diet and Nutrition Survey: adults aged 19 to 64 years. Volume 3: Vitamin and mineral intake and urinary analytes. London: TSO, 2003.
10. Serra-Majem L, Ribas-Barba L, Salvador G, et al. Trends in energy and nutrient intake and risk of inadequate intakes in Catalonia, Spain (1992-2003). Public Health Nutr 2007; 10: 1354-67.
11. Park YK, Barton CN, Calvo MS. Dietary contributions to serum 25(OH) vitamin D levels [25(OH)D] differ in black and white adults in the United States: results from NHANES III. J Bone Miner Res 2001; 16: F281.
12. Irish Universities Nutrition Alliance. National Adult Nutrition Survey. Cork, Dublin: University College Cork, University College Dublin 2011. (https://irp-cdn.multiscreensite.com/46a7ad27/files/uploaded/The%20National%20Adult%20Nutrition%20Survey%20Summary%20Report%20March%202011.pdf).
13. Allen RE, Dangour AD, Tedstone AE, Chalabi Z. Does fortification of staple foods improve vitamin D intakes and status of groups at risk of deficiency? A United Kingdom modeling study. Am J Clin Nutr 2015; 102: 338-44.
14. Harms LR, Burne TH, Eyles DW, McGrath JJ. Vitamin D and the brain. Best Pract Res Clin Endocrinol Metab 2011; 25: 657-69.
15. Sabir MS, Haussler MR, Mallick S, et al. Optimal vitamin D spurs serotonin: 1,25-dihydroxyvitamin D represses serotonin reuptake transport (SERT) and degradation (MAO-A) gene expression in cultured rat serotonergic neuronal cell lines. Genes Nutr 2018; 13: 19.
16. Berridge MJ. Vitamin D and depression: cellular and regulatory mechanisms. Pharmacol Rev 2017; 69: 80-92.
17. Han B, Zhu FX, YuHF, et al. Low serum levels of vitamin D are associated with anxiety in children and adolescents with dialysis. Sci Rep 2018; 8: 5956.
18. Kalueff AV, Lou YR, Laaksi I, et al. Increased anxiety in mice lacking vitamin D receptor gene. Neuroreport 2004; 15: 1271-4.
19. Bellia A, Garcovich C, D Adamo M, et al. Serum 25-hydroxyvitamin D levels are inversely associated with systemic inflammation in severe obese subjects. Intern Emerg Med 2013; 8: 33-40.
20. Wrzosek M, Łukaszkiewicz J, Wrzosek M, et al. Vitamin D and the central nervous system. Pharmacol Rep 2013; 65: 271-8.
21. Burt LA, Billington EO, Rose MS, Raymond DA, Hanley DA, Boyd SK. Effect of high-dose vitamin d supplementation on volumetric bone density and bone strength: a randomized clinical trial. JAMA 2019; 322: 736-45.
22. Kang JH, Vyas CM, Okereke OI, et al. Effect of vitamin D on cognitive decline: results from two ancillary studies of the VITAL randomized trial. Sci Rep 2021; 11: 23253.
23. Hiller AL, Murchison CF, Lobb BM, O'Connor S, O'Connor M, Quinn JF. A randomized, controlled pilot study of the effects of vitamin D supplementation on balance in Parkinson's disease: Does age matter?. PLoS One 2018; 13: e0203637.
24. Kim D, Witt EE, Schubert S, et al. Peripheral T-cells, B-cells, and monocytes from multiple sclerosis patients supplemented with high-dose vitamin D show distinct changes in gene expression profiles. Nutrients 2022; 14: 4737.
25. Mimpen M, Rolf L, Poelmans G, et al. Vitamin D related genetic polymorphisms affect serological response to high-dose vitamin D supplementation in multiple sclerosis. PLoS One 2021; 16: e0261097.
26. Wesnes K, Myhr KM, Riise T, et al. Low vitamin D, but not tobacco use or high BMI, is associated with long-term disability progression in multiple sclerosis. Mult Scler Relat Disord 2021; 50: 102801.
27. Zhang H, Yang G, Dong A. Prediction model between serum vitamin D and neurological deficit in cerebral infarction patients based on machine learning. Comput Math Methods Med 2022; 2022: 2914484.
28. Wu Z, Malihi Z, Stewart AW, et al. The association between vitamin D concentration and pain: a systematic review and meta-analysis. Public Health Nutr 2018; 21: 2022-37.
29. Wheeler S. Vitamin D deficiency in chronic migraine. Headache 2008 ;48: S52-S53.
30. Lukacs M, Tajti J, Fulop F, et al. Migraine, neurogenic inflammation, drug development-pharmacochemical aspects. Curr Med Chem 2017; 24: 3649-65.
31. Sato K, Hayashino Y, Yamazaki S, et al. Headache prevalence and long working hours: the role of physical inactivity. Public Health 2012; 126: 587-93.