Medical Science

Awareness of the population about vitamin D function, deficiency, and its impact on health, supported by survey results

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ABSTRACT

Background: Vitamin D plays an important role in the human body, and its deficiency may result in serious consequences such as rickets, osteoporosis, and cause an increased risk of autoimmune diseases, or cancer. In countries with limited exposure to the sun, deficiencies are more common, so supplementation is necessary. *Aim:* The aim of the study was to assess the knowledge of adult women and men about the function of vitamin D, supplementation, and the consequences of its deficiency. *Material and Methods:* The study material was collected using an anonymous questionnaire. The results were carefully reviewed and validated against the scientific literature available in online databases such as PubMed, Google Scholar, and Medline. Additionally, they were statistically analyzed using Microsoft Office Excel. *Results:* The study involved 155 participants. The largest group of whom were women aged 41-64 years. Almost 66.9% of the respondents declared that they take vitamin D supplements, of which 62.8% take it once a day at a dose of 2000 IU (International units). Furthermore, most respondents take the preparations only in autumn and winter. Respondents mainly associated the function of vitamin D with the skeletal system, but also with immunity, thyroid function, and positive effects on the skin. 78.6% of those surveyed also know the consequences of deficiency. *Conclusions:* Most adults have adequate knowledge of vitamin D and its effects on health, but some people do not supplement or do not know the consequences of deficiency. It is worthwhile to introduce educational programmes, and advertising spots to increase awareness of vitamin D.

Keywords: Vitamin D, vitamin D supplementation, vitamin D deficiency, vitamin D functions

1. INTRODUCTION

The topic of vitamin D is now one of the most frequently discussed in research, clinical practice, and in everyday life. Over the past decades, ample evidence has accumulated which indicates that the widespread worldwide deficiency of this vitamin promotes the development and progression of many diseases of civilisation, such as cardiovascular diseases, diabetes, autoimmune diseases, and cancer (Zmijewski, 2019). Vitamin D is fat-soluble. About 90% of the body's vitamin D is produced in the skin through exposure to UVB radiation (Young et al., 2022). Aging skin has decreased capacity to synthesize this important nutrient, so older adults are at greater risk of vitamin D deficiency (Chalcraft et al., 2020).

Two forms of vitamin D are found in foods and dietary supplements: D2 (ergocalciferol) and D3 (cholecalciferol). The key difference among these forms is in the structures of their side chains. D2 and D3 are absorbed from the small intestine via simple passive diffusion and via a specific carrier protein mechanism. Moreover, dietary fat increases the absorption of vitamin D, and in contrast to many other vitamins, the absorption process of this vitamin is not compromised by aging and obesity (Silva and Furlanetto, 2018). Cholecalciferol is derived from animal sources and ergocalciferol from plants. The synthesis of calcitriol, the hormonally active form of vitamin D, is a multi-step process.

The precursor is formed as a result of exposure of the skin to UV radiation and then hydroxylated in the liver to form 25-hydroxyvitamin D. The following step takes place in the proximal tubule of the kidney through the enzyme 1-α-hydroxylase (encoded by CYP27B1), thereby generating 1,25-dihydroxyvitamin D, also known as calcitriol (Young et al., 2022). The active variant of vitamin D (1,25(OH)2D3), called calcitriol, engages with the vitamin D receptor (VDR) to regulate calcium-phosphate balance. Its impact is important for the functioning of the musculoskeletal, immune, nervous and cardiovascular systems. Global vitamin D deficiency is aggravated by a sedentary lifestyle, a diet rich in highly processed foods, and limited sun exposure.

Consequently, low levels of this vitamin lead to calcium deficiencies, poor bone mineralization, increases the risk of deformities, falls fractures, rickets in children, or osteoporosis in adults (Zmijewski, 2019). Rickets in children can cause stunted growth, developmental delay, tetanic spasms, cardiomyopathy, and dental abnormalities. In adults and adolescents, vitamin D deficiency can lead to osteomalacia, which causes weakened bones (Munns et al., 2016; Uday and Hogler, 2017). Therefore, maintaining the appropriate level of vitamin D through supplementation in accordance with current recommendations is necessary to maintain body homeostasis (Zmijewski, 2019).

Increasing evidence suggests a correlation between vitamin D deficiency, and an increased risk of cardiovascular disease. The active hormone 1,25(OH)2D3 has a multidirectional effect. It influences the regulation of the renin-angiotensin-aldosterone axis (RAAS) to control blood pressure, and also inhibits the proliferation of vascular myocytes and cardiomyocytes, reducing left ventricular hypertrophy. The importance of vitamin D3 in regulating blood pressure is emphasized by its receptors in key organs such as the central nervous system, kidneys, adrenal glands, vascular walls, and the heart. Moreover, vitamin D deficiency leads to an excess of parathyroid hormone, which promotes vascular calcification.

Numerous epidemiological and genetic studies have demonstrated a connection between multiple sclerosis (SM) and low 25(OH)D levels before and after disease onset (Jagannath et al., 2018). Observational studies suggest that adequate vitamin D levels may reduce the risk of developing SM and, if SM does occur, reduce the risk of relapse and slow its progression (Sintzel et al., 2018). Numerous studies confirm the huge impact of vitamin D on mental health. Its appropriate level can prevent the occurrence of depression and anxiety. Furthermore, supplementation during pregnancy reduces the risk of postpartum depression (Kozyra et al., 2020).

Measurement of serum 25(OH)D levels is complicated by the wide variability of available tests, the two most commonly used being antibody, or chromatography (Sempos et al., 2018; LeFevre, 2015). Consequently, the result may be falsely low or falsely high, depending on the test and laboratory used. The International Vitamin D Standardisation Programme has developed procedures to standardise laboratory measurements of 25(OH)D to improve clinical practice and public health (Sempos et al., 2018; Brooks and Sempos, 2017; Taylor et al., 2017; Sempos and Binkley, 2020).

Vitamin D deficiency

Most people consume vitamin D in amounts less than recommended. Deficiency of this vitamin can develop when daily intake is below recommended standards for an extended period, sun exposure is limited, the kidneys are incapable of converting 25(OH)D into the active form, or when absorption of vitamin D from the gastrointestinal tract is insufficient. Diets deficient in vitamin D are more common in people with milk allergies or lactose intolerance and in people who follow a vegetarian or vegan diet (Institute of Medicine, Food and Nutrition Board, 2010).

Screening tests to detect vitamin D deficiency are becoming increasingly popular as part of standard blood laboratory analyses ordered by doctors, regardless of the indication for the test (Rockwell et al., 2018; Taylor et al., 2015; Taylor et al., 2019). There have been no studies examining whether such measures of vitamin D levels lead to improved quality of life over time. No national professional organization recommends their performance in the population (LeBlanc et al., 2014). Optimal serum 25(OH)D concentrations for bone and overall health are not established, as they are likely to vary according to life stage, race and ethnicity, and any physiological measurement used (Holick, 2007; Brown et al., 2018).

Recommended supplementation

In Poland, vitamin D supplementation is recommended throughout the year due to limited sun exposure, especially during autumn and winter. Although in summer, with adequate sun exposure, our body can synthesize vitamin D, between October and April, UVB radiation levels are too low to provide sufficient production of this vitamin. Therefore, supplementation becomes essential during these months. Recommendations regarding vitamin D supplementation in Poland are consistent with the opinion of experts such as the Polish Endocrine Society.

Adults, children and adolescents should take vitamin D all year round in doses depending on age, health condition and vitamin D level in the body. The usual recommended dose for adults is 800-2000 IU daily, depending on individual needs. It is also worth noting that people in risk groups, such as older people, people with dark skin, and pregnant women, may require higher doses of vitamin D during the year. It is worth consulting with a doctor to determine the appropriate amount to take before starting to supplement (Piotr et al., 2015).

Aim

This study aimed to assess the knowledge of people over 18 about vitamin D supplementation and its impact on health.

2. MATERIAL AND METHODS

The study involved 155 participants. Data were collected in August and September 2024 using an anonymous online version of the author's survey. The survey consisted of three sections. The first of which were general questions about age and gender. The second related to questions about vitamin D supplementation, dosage and timing of use. Third section related to knowledge of the function of vitamin D and the effects of vitamin D deficiency. Respondents were asked whether they had ever had their blood vitamin D levels tested and, if so, whether they were within normal limits. The survey included one-choice questions and questions which required from the respondent a short answer. The results were analyzed and verified based on the scientific literature and statistically processed using Microsoft Office Excel.

3. RESULTS

The survey was conducted among individuals over 18, with women representing 77.3% of the participants and men 22.7%. Considering age, the data are as follows (Figure 1). People aged 41-64 took part in the survey the most. These people accounted for 67.5% of all respondents. The next largest age group was 18-25 years (18.8%), followed by 26-40 years (13%), and the smallest group of respondents >65 years (0.7%). In the study group, 64.5% of the respondents had higher education, 33.6% had secondary education, and 1.9% had primary education. The majority of those with higher education did not have a medical qualification. Among those with medical education, the most common occupation was nurse practitioner (31.4%).

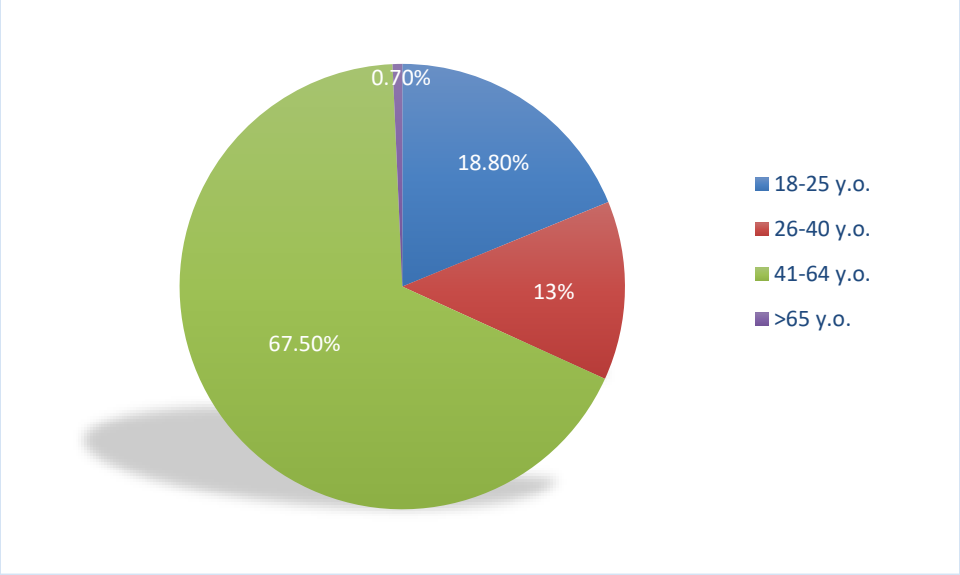

Figure 1 Characteristics of the group participating in the survey regarding age *(y.o: years old)*

Regarding taking vitamin D supplements, 66.9% of respondents answered in the affirmative. For these respondents, another open-ended question was asked: "In what doses do you take your vitamin D supplement (how many times a day, in what amounts - e.g., how many IU)?". Among people taking vitamin D, 62.8% take it once a day, at a dose of 2,000 IU, 19% take 4,000 IU once a day and 18.2% do not know the dose because they take the preparation by recommendation of others or based on advertising (Figure 2).

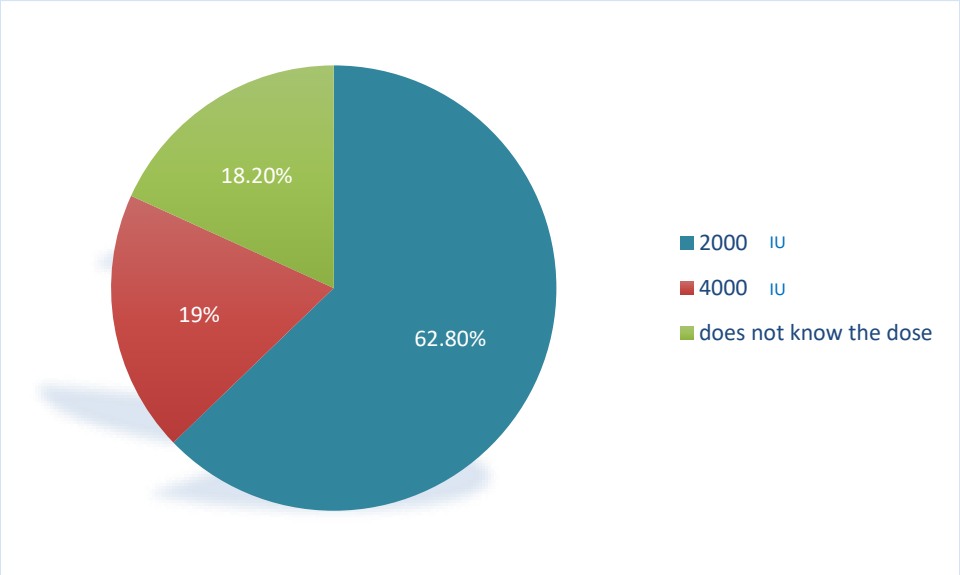

Figure 2 Vitamin D supplement doses taken by respondents. (IU - International units)

Another question asked about the timing of the use of vitamin D preparations (Figure 3). Most respondents only take the preparations in autumn and winter (32%). Then 23% of respondents take these more than one year, 21.20% less than 3 months, 15% since 3-6 months, and 8,80% since 6-12 months.

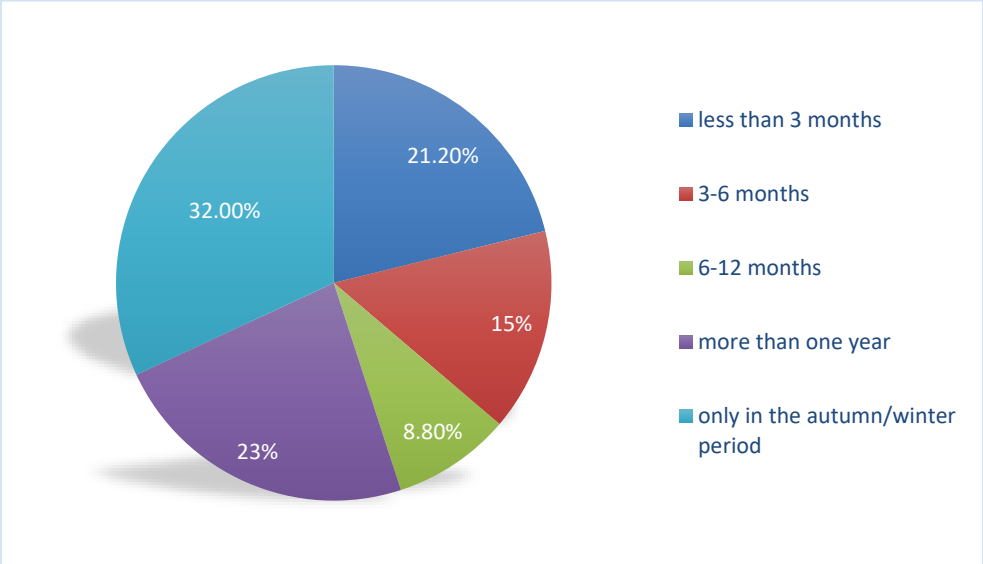

Figure 3 Timing of intake of vitamin D preparations.

To the question "Have you ever had your blood vitamin D levels tested? If yes, was the result within the acceptable range? " 42.8% of respondents answered that they had never had vitamin D levels tested, 29.6% had the test and the result was out of the norm, while 27.6% had their vitamin D levels tested and the result was within the norm (Figure 4).

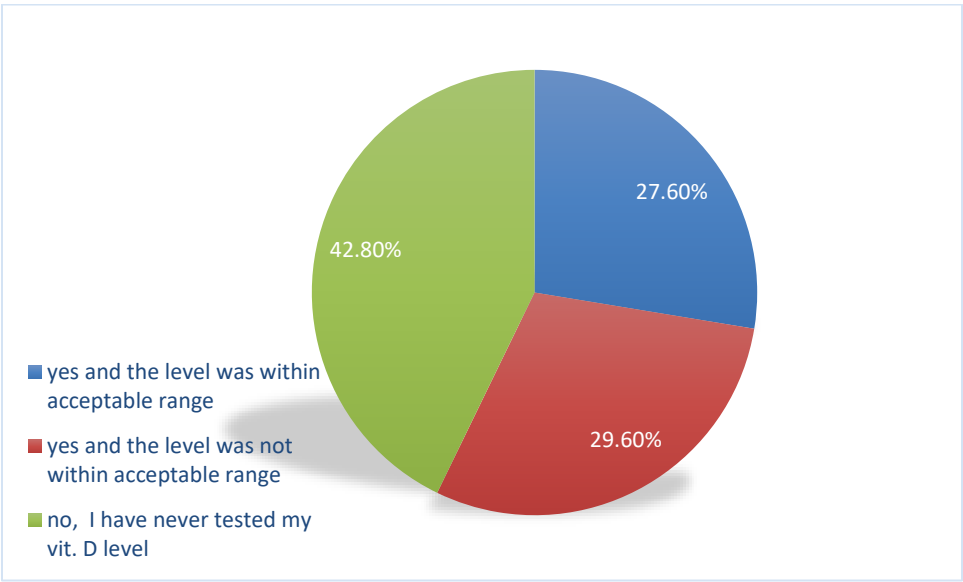

Figure 4 Distribution responses to the question about testing vitamin D blood levels.

The next question on the questionnaire was open-ended. It concerned the function of vitamin D. More than half of the respondents (63%) associate vitamin D with its effects on the skeletal system, reducing the risk of rickets in children and osteoporosis in adults. Even fewer (23%) identify the vitamin's immune function. The rest speak of antidepressant qualities, enhancing thyroid functions, and skin rejuvenation. The final question was "Do you know the consequences of vitamin D deficiency?" Respondents responded positively to the question at the rate of 78.6% of the time (Figure 5).

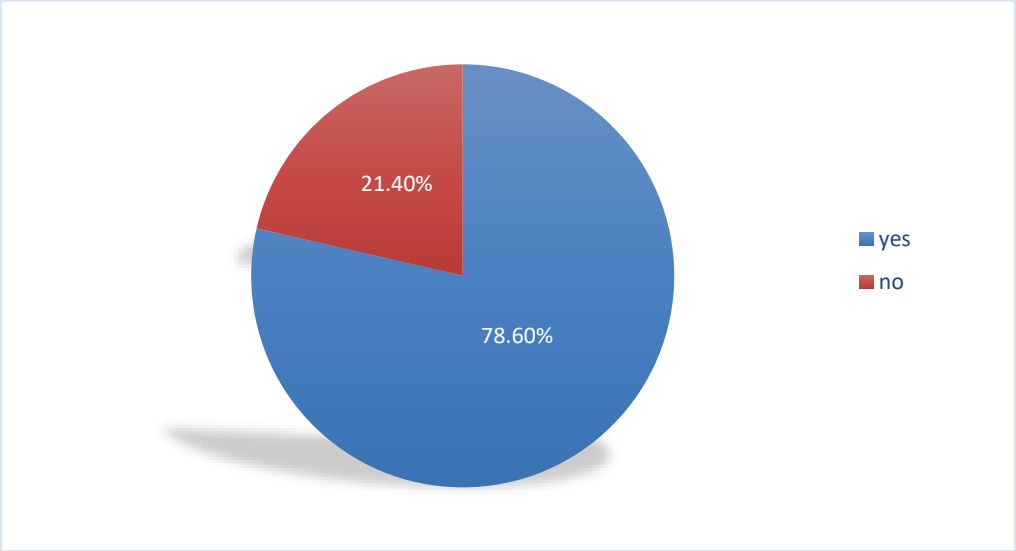

Figure 5 Assessment of knowledge about vitamin D deficiency and its adverse effect.

4. DISCUSSION

Analyzing the survey results, it can be concluded that most participants know the role of vitamin D in the body and use it to prevent deficiencies. People supplementing vitamin D most often declare taking a dose of 2,000 IU per day. Conducting a systematic review of articles in the PubMed database, one comes across information that the Institute of Medicine recommends 600 IU of vitamin D per day for most people aged one to 70 years. For those over 70, the recommended dose is 800 IU per day, assuming minimal sun exposure (Ross et al., 2011). In contrast, the Endocrine Society recommends a dose of 1500-2000 IU per day for adults and 1000 IU for children (Holick et al., 2011).

Therefore, a large proportion of respondents (62.8%) follow the Endocrine Society's recommendations, as they take 2000 IU of the vitamin daily. For all adults with vitamin D deficiency, treatment with a dose of 50,000 IU of vitamin D3 per week or 6,000 IU per day for 8 weeks is recommended to achieve a serum 25(OH)D concentration of 30 ng/ml. A vitamin D level below 30 ng/ml indicates a deficiency (Chung et al., 2011). Vitamin D deficiency was found in 29.6% of respondents based on laboratory tests (Figure 3). It is worth noting, however, that 42.8% of respondents had never had their vitamin D levels tested, so it is not known whether this would be in the normal range.

Treatment of the deficiency should be continued with a maintenance dose. The Endocrine Society guidelines support these recommendations but indicate that a maintenance dose of 1,000 IU per day may be necessary to maintain serum 25(OH)D levels above 30 ng/ml in patients aged 1 to 18 years, and even 1,500-2,000 IU per day in those aged 19 to 50 years. It is uncertain whether these treatment recommendations will be sufficient to provide all the potential health benefits of vitamin D (Chung et al., 2011). Maintenance doses in patients with malabsorption syndromes, obesity, or those taking medications that affect vitamin D metabolism can range from 3000 to 6000 IU per day.

For patients addressing vitamin D deficiency with supplements, routine laboratory testing to monitor 25(OH)D levels is not necessary, provided that the prescribed dosage remains within the recommended limits (American Geriatrics Society Workgroup on Vitamin D Supplementation for Older Adults, 2014). Survey results show that 78.6% of respondents know the effects of vitamin D deficiency (Figure 4). Despite this, the problem is global, affecting over one billion children and adults worldwide (Holick, 2017). Research indicates that vitamin D supplements could be advantageous throughout the year, not just in the autumn and winter. This incredibly significant in areas that receive minimal sunlight, where vitamin D levels in the body drop even in summer due to insufficient dermal synthesis.

One study confirmed that year-round supplementation (15-100 μg/day, or 600-4000 IU) was effective in maintaining adequate vitamin D levels in the body, with beneficial effects on health parameters such as parathormone (PTH) levels and general well-being of patients (Vieth et al., 2004). However, most respondents (31.9%) take vitamin D only in autumn and winter (Figure 2), although 15%,

8.8%, and 23% take it analogously 3-6 months, 6-12 months and more prolonged than one year, indicating that respondents also took the vitamin in summer and were therefore aware that skin synthesis is often insufficient.

5. CONCLUSIONS

Most adults surveyed have sufficient knowledge about vitamin D, its beneficial effects on health, supplementation, and the effects of deficiency. However, there are some areas need attention to be addressed in order to educate the public more effectively. Some respondents do not supplement vitamin D, do not know its function or have never heard of the risks of its deficiency. So, I think it is worth introducing programs and educational commercials that will inform citizens in an accessible and concise way about the importance of vitamin D, motivate them to test their levels, and show them how many diseases can be avoided in primary prevention. It is worth noting that vitamin D does not require a prescription and is therefore easy to purchase without seeing a doctor. Addressing these problems may lead to improved outcomes of the results obtained in the study. However, additional research and analyses are needed to better quantify the overall public awareness of the health-promoting effects of vitamin D.

Author's Contribution

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All authors have read and agreed with the published version of the manuscript.

Ethical approval

The ethical guidelines for Human Subjects are followed in the study.

Informed consent

Written & Oral informed consent was obtained from individual participants included in the study.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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