BIŁOGRAS, Jan, KARAMUS, Kornelia, REJMAK, Rafał, BOROWSKA-ŁYGAN, Martyna, TOMASZEWSKI, Jakub, STRUŻEK, Konrad and URBAN, Wojciech. Effect of vitamin D supplementation. Journal of Education, Health and Sport. 2024;76:56537. eISSN 2391-8306.
https://dx.doi.org/10.12775/JEHS.2024.76.56537
https://apcz.umk.pl/JEHS/article/view/56537

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences).
Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).© The Authors 2024;
This article is published with open access at Licensee Open Journal Systems of Nicolaus Copernicus University in Torun, Poland

The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 01.11.2024. Revised: 05.12.2024. Accepted: 08.12.2024. Published: 08.12.2024.

Effect of vitamin D supplementation

Jan Biłogras[1]

https://orcid.org/0009-0002-6038-9217; janbilogras@gmail.com

Kornelia Karamus[2]

https://orcid.org/0000-0001-7453-1427; kornelia.karamus@interia.pl;

Rafał Rejmak[2]

https://orcid.org/0009-0002-9422-8550; rrejmak@gmail.com;

Martyna Borowska-Łygan[3]

https://orcid.org/0009-0001-9402-7444; borowskamartyna123@gmail.com;

Jakub Tomaszewski[2]

https://orcid.org/0009-0009-9384-4643; jakub.t.tomaszewski@gmail.com

Konrad Strużek[4]

https://orcid.org/0009-0000-3146-5132; konradstruzek@gmail.com

Wojciech Urban[4]

https://orcid.org/0009-0009-1565-0595; wojtekurban17@gmail.com

1- 1 Wojskowy Szpital Kliniczny z Polikliniką SPZOZ w Lublinie
2- Uniwersytecki Szpital Kliniczny nr 4 w Lublinie
3- Mazowiecki Szpital Specjalistyczny w Radomiu
4- Wojewódzki Szpital Specjalistyczny im. Stefana Kardynała Wyszyńskiego SPZOZ w Lublinie

Abstract

Introduction

Vitamin D is one of the most important vitamins in affecting the human body. It turns out that its influence is not limited to its health-promoting effect on the skeletal system, but may also play an important role in the immune system. In our study, we focused precisely on this aspect of vitamin D's action.

Review method

We used materials from PubMed for this purpose. We focused on articles and research papers published between 2019 and 2024. We reviewed the publications in terms of vitamin D supplementation and its effects on immunity, disease processes, patient recovery, COVID-19 patients, and some autoimmune diseases.

Results

Some studies show that vitamin D supplementation significantly improves immune function. It also improves prognosis and reduces mortality in COVID-19. The number of complications and severity of the course also decreases. Vitamin D supplementation also has a positive effect on the course of autoimmune diseases, allowing a reduction in the incidence and improving the outcome of some of them. Unfortunately, not all studies prove such beneficial effects of vitamin D. What is important, however, is that vitamin D may have a beneficial effect on the course of diseases, and the low cost of its use and high availability may prove to be the key to medical development.

Conclusions

Based on the accumulated studies, it can be concluded that vitamin D contributes to the improvement of immune system function. Some studies prove the beneficial effect of vitamin D supplementation on the course of some autoimmune diseases. The potential benefits of vitamin D supplementation, as well as its low cost, should be a key argument for further research and knowledge on this topic.

Keywords: vitamin D, supplementation, immune system, immunity, COVID-19, autoimmune disease.

Introduction

Vitamin D is one of the most important vitamins affecting the human body. It is found in numerous foods, such as fatty fish and egg yolks. Unfortunately, we are not always able to get enough vitamin D from food, so it needs to be supplemented [1]. Its role has been studied for years, and scientists have yet to discover its true potential. Widely available research points to a growing array of benefits of vitamin D supplementation. It turns out that the benefits of vitamin D supplementation go far beyond supporting the skeletal system. It can affect immune system function, fight certain diseases, including COVID-19, and even help prevent autoimmune diseases. In our article, we focused on the impact of vitamin D the immune system and the validity of supplementation.

Search strategy

We used materials from PubMed to write our paper. In our work, we focused on articles and research papers published between 2019 and 2024. We reviewed the publications in terms of vitamin D supplementation and its impact on immunity, disease processes, and patient recovery. We also took a look at the impact of vitamin D supplementation on patients suffering from COVID-19, as well as some autoimmune diseases.

Effect of vitamin D on the immune system

According to an article on the effects of vitamin D on the immune system, there has been a significant increase in evidence of a correlation between vitamin D and immune function. The link to vitamin D is the production of cytokines, antimicrobial proteins and pattern recognition receptors. A growing number of studies also indicate a beneficial effect of vitamin D supplementation in bacterial infections. In addition, vitamin D supplementation is also proving beneficial in viral infections, including COVID-19 [2].

A study conducted in 2020 focused on the immunological effects of vitamin D on human health. It showed that vitamin D can modulate immune function in a non-genoviral manner by stabilizing the endothelium thereby reducing inflammation [3]. This implies that vitamin D supplementation may play an important role in immune processes. The authors suggest, based on their research, that to achieve optimal health benefits, it is best to maintain serum vitamin D levels between 40-60 ng/ml (100-150 nmol/L) [4].

Another study examined the effect of vitamin D supplementation on clinical outcomes in older adults. Vitamin D supplementation was compared with Omega 3 fatty acid supplementation and an exercise program. For this purpose, a group of more than 2,000 participants aged 70 years or older was collected. They were divided into different groups comparing different combinations of supplementation and exercise. The study found no significant differences between any particular type of supplementation or exercise on improvements in systolic or diastolic blood pressure, non-vertebral fractures, physical performance, infection rates or cognitive function [5].

Another article focused on the conclusions of randomized trials on the health effects of vitamin D supplementation. There was a lot of data showing that vitamin D supplementation may benefit prediabetic subjects or have a small effect on cancer mortality. Additional studies are needed to confirm these data. However, there is a strong possibility that supplementation will benefit infectious diseases, multiple sclerosis and autoimmune diseases [6].

A 2022 article examined the effects of vitamin D on the regulation of immune function. It shows that vitamin D, through its active metabolite $1,25(OH)_2D$, can regulate adaptive immunity. This occurs by limiting the maturation of DCs (dendritic cells), limiting the ability to present antigen to T cells and shifting the T cell profile to Th2 subsets in Treg, which inhibit pro-inflammatory processes [7].

In 2020, the effect of a multivitamin and mineral supplement on immune function in healthy older adults was studied. MVM-containing supplements, which included Vitamin C, Vitamin D and zinc, were used. A group of participants ranging in age from 55 to 75 were collected and divided into different groups. The study lasted 12 weeks, and during this time the patients were examined several times and their parameters were evaluated. At the end of the

experiment, tests showed significantly higher levels of zinc and vitamin C in the participants. Vitamin D levels were not determined, but a marked decrease in the reported length and severity of illnesses in the MVM supplement group compared to the placebo group was noted. This may suggest a real effect of a multivitamin supplement containing vitamin D on boosting immunity and improving immune function in the elderly [8].

Another study looked at the role of vitamin D supplementation in patients infected with tuberculosis and HIV (co-infection). Based on the data collected, the researchers showed that vitamin D supplementation inhibits the growth and replication of Mtb (Mycobacterium tuberculosis) and HIV through cathelicidin production. Vitamin D deficiency may be associated with an increased risk of active tuberculosis and progression and susceptibility to HIV infection. The study conducted and the conclusions drawn may be a prelude to future research on the effects of vitamin D supplementation in other infectious diseases [9].

Effects on children and lactation

Studies focusing on the effect of vitamin D on immunity in children and infants have also been conducted. Various data and analyses have been collected for this purpose, from which some conclusions have been drawn. It turns out that vitamin D supplementation can reduce infection rates among children. There is also evidence that vitamin D supplementation may be beneficial in preventing autoimmune disorders and even asthma or other allergic diseases. For definitive confirmation of these conclusions, however, the research conducted needs to be deepened [10].

A 2022 study examined whether vitamin D supplementation and exclusive breastfeeding could have an impact on preventing infections among children. To this end, the researchers collected materials on the issue and conducted an analysis. They show that there is an association between vitamin D levels and the severity or incidence of various infectious diseases in children. Long-term vitamin D deficiency can not only negatively affect bone health, but also increase the risk of developing severe infectious diseases such as COVID-19 and MIS-C (multisystem inflammatory syndrome in children). Studies show that supplementation at a constant level appropriate for age, rather than intermittent or high doses of vitamin D, has the best effect. However, no clear evidence has been found for a positive correlation between exclusive breastfeeding and vitamin D supplementation in the context of

preventing infections in children. This is a topic worthy of future attention and deeper research [11].

Vitamin D vs. COVID-19

Researchers tested vitamin D supplementation for the 2019 pandemic caused by the SARS-CoV-2 virus, and found that ACE2 plays an important role in the development of infection symptoms. This is the receptor through which the virus attaches to the cell. An active form of vitamin D can induce the expression of this receptor and control the mechanisms of the immune system. Vitamin D can also reduce replication of some respiratory viruses. This suggests that vitamin D may have a major effect in preventing COVID-19 complications. This has not been conclusively confirmed so far, so more research needs to be done on this topic [12].

In 2021-2022, the researchers conducted a randomized controlled trial to determine the relationship between vitamin D supplementation and clinical outcomes of COVID-019 patients. COVID-19 patients were screened and qualified, and their vitamin D levels were examined. Patients with low vitamin D levels were qualified for further study. Patients were randomly divided into two groups: intervention and placebo. The intervention group received vitamin D supplementation at a dose of 10,000 IU orally or through a gastric tube for at least 14 days. Vitamin D levels were measured on days 7 and 14. The number of days on respiratory support was not reduced. There were also no differences in the length of ICU stay or hospital stay. The results also showed no differences in 14-, 28- or 60-day survival rates between the groups.

The overall result of the study suggests no significant difference between the groups, which may lead to the conclusion that vitamin D supplementation does not improve clinical outcomes in patients with severe COVID-19. Perhaps the benefit would be greater in patients with less severe COVID-19. A study would need to be conducted on a larger study group for this purpose [13].

Researchers examined the role of certain vitamins and micronutrients, including vitamin D, in the fight against COVID-19. To this end, they collected 39 articles showing that vitamin D helps reduce the incidence and severity of viral infections. The effect of vitamin D on SARS-CoV-2 infection has not been conclusively demonstrated, but it has been suggested that it

could potentially reduce levels of pro-inflammatory cytokines, helping to reduce mortality among patients. The accumulated research provides a positive outlook for the future [14].

Another article gathered evidence on the effect of vitamin D supplementation on COVID-19 patients, showing that vitamin D can have a positive impact on patients' clinical outcomes by enhancing the innate antiviral immune response and facilitating the induction of antimicrobial peptides/autophagy. In addition to this, the study found that people who had previously supplemented with vitamin D were less likely to become severely ill during infections. Some researchers also suggest that vitamin D supplementation may help with “Long COVID,” but this needs to be confirmed in further studies [15].

Another study focused on the overall benefits of vitamin D supplementation. A 2022 article compiled and summarized the clinical studies on which the analysis was based. They show that vitamin D supplementation is associated with reduced ICU admissions, reduced need for mechanical ventilation and decreased mortality among patients hospitalized for COVID-19. There is no conclusive evidence to claim that vitamin D supplementation reduces the incidence of COVID-19 [16].

According to a systematic review of the effects of vitamin D supplementation in patients with COVID-19, significant differences in some of the parameters analyzed and improvements in clinical status were observed. The review leads us to believe that vitamin D supplementation on a continuous basis may be of clinical benefit to patients with COVID-19. However, the study group needs to be expanded and the current research needs to be deepened [17].

Another article shows that retrospective studies have shown an association between vitamin D and the cases and outcomes of patients with COVID-19. However, insufficient evidence has been collected for a correlation between vitamin D levels and mortality in COVID-19. It appears that vitamin D may affect the lungs, kidneys and also the heart by reducing inflammation and fibrosis in these organs [18].

Another article shows that vitamin D significantly affects immune responses and immune responses, but there is no clear evidence of its beneficial effects in COVID-19 infection.

Moreover, the researchers suggest that hypovitaminosis D should not affect the development of severe COVID-19 [19].

A study on the relationship between vitamin D supplementation and COVID-19 infection and mortality was published in 2022, with a retrospective cohort study comparing the outcomes of patients supplementing with vitamin D during the per-pandemic period. The results of the study support the claim that vitamin D3 and D2 supplementation reduced the risk of COVID-19 infection, as well as infections ending in patient death. In addition, patients with initially lower serum vitamin D levels benefited more from the inclusion of supplementation than patients with high serum levels. Since the majority of the population is serum vitamin D deficient, the inclusion of supplementation may prove to be the key to reducing the spread of many infections, not just COVID 19, at low cost [20].

Another article dealt exclusively with the prophylactic role of vitamin D supplementation on COVID-19 infections, focusing on individuals not previously affected by COVID-19 infection. The results suggest that the use of vitamin D, especially in deficient individuals, may prevent COVID-19 infections and related complications [21].

Another source focused on examining the impact of vitamin D supplementation in the post-pandemic era. The researchers suggest that vitamin D deficiencies increase the risk of acute respiratory distress syndrome, lung damage, as well as cardiovascular events, diabetes which can lead to many of the clinical complications of COVID-19. The implication here leads us to believe that maintaining adequate levels of vitamin D in the blood may contribute to a milder outbreak without additional complications [22].

2023 examined the effect of vitamin D supplementation on length of hospitalization, need for ICU admission and mortality in COVID-19. The study suggests that high-dose vitamin D supplementation can significantly shorten hospital stays, as well as the need for ICU admission. However, it should be remembered that this research is only a prelude to further studies that need to be conducted to delve deeper into the topic [23].

Vitamin D in other cases

One study set out to evaluate the effects of supplementation with vitamin D and marine omega 3 fatty acids on autoimmune diseases. For this purpose, a group of more than 25,000 participants was collected on which a randomized trial was conducted. The study included men and women over the age of 50. They were divided into two groups: placebo and vitamin D supplementation. The results show that five years of vitamin D supplementation reduces the incidence of autoimmune diseases by up to 22%. The greatest effects are seen after about two years. In the future, it would be worthwhile to deepen this topic, especially with a younger research group [24].

Another study examined the effect of vitamin D on autoimmune thyroiditis (Hashimoto's disease). Based on the collected studies, it was concluded that vitamin D has a role in the immune system, which may contribute to the inhibition of the immunopathological process in Hashimoto's disease. The exact mechanisms are still unknown. Some researchers claim that in the future, vitamin D may play an auxiliary role in the treatment of autoimmune thyroid diseases. Confirmation of the accumulated information requires deeper research and expanded study groups [25].

The 2023 review looked at the effect of vitamin D on cancer. It looked at the literature on breast cancer, ovarian cancer, glioma, multiple myeloma, prostate cancer, squamous cell carcinoma of the head and neck, bladder cancer, bone cancer, colorectal cancer, and melanoma. Most results have shown an association between vitamin D supplementation and cancer inhibition. The properties of vitamin D may have long-term effects on human life, disease incidence, as well as aging and the development of injuries. However, more research needs to be done to understand the exact mechanisms involved in these cases [26].

Vitamin D has also been considered from another angle, namely as an anti-aging supplement. Researchers have concluded that low levels of vitamin D strongly affect the aging process. This suggests that the fight against this phenomenon should begin with supplementation and restoring vitamin D concentrations to appropriate levels. Food alone is not enough to meet the need for vitamin D, so it should be supplemented separately. Keep in mind that the cited review is only a prelude to further research opportunities [27].

Another article examined whether vitamin D can affect rheumatic diseases. Scientists report that vitamin D plays a key role in maintaining a healthy skeleton, and also has important functions in the immune system, as mentioned earlier. Some studies claim that vitamin D supplementation may benefit diseases like RA and SLE. Interestingly, genetic studies conducted suggest that some people may benefit more from vitamin D supplementation than others. However, it is worth remembering that it is not only vitamin D supplementation that is important, but also adequate sun exposure. This is especially important for patients with rheumatic diseases with corticosteroid therapy. This is to avoid osteomalacia, secondary osteoporosis and fractures [28].

Conclusions

In our work, we have collected articles, based on which it can be concluded that vitamin D significantly contributes to the improvement of immune function. It is important to remember that only adequate serum vitamin D levels can improve patient outcomes, so vitamin D should be monitored and supplemented if necessary. Some studies report on the benefits of vitamin D supplementation by mothers during lactation. It turns out that in breastfed children, vitamin D deficiency can lead to a more severe course of infectious diseases, as well as increase the risk of certain autoimmune diseases.

A number of publications examining the relationship between serum vitamin D levels and the incidence and illness of COVID-19 suggest that vitamin D influences the course of the disease. Maintaining adequate vitamin D levels appears to increase resistance to COVID-19, prevent severe courses, allow shorter hospitalizations, reduce the need to transfer patients to the ICU, and, most importantly, reduce patient mortality. However, the results of the studies are not conclusive on this issue. Some of them do not prove the benefits presented in other publications. Nonetheless, it is worth continuing to explore the topic and expand our knowledge, as the benefits of the results can contribute significantly to the development of current medicine. The universality, easy access and low cost of vitamin D supplementation may prove to be the key to improving the health of many patients on a large scale.

In addition, some sources report that vitamin D may be helpful in the fight against some autoimmune diseases, such as Hashimoto's disease, for example. Moreover, vitamin D may also have a beneficial effect on diseases like RA and SLE.

However, it is important to remember that the results presented here are only signposts for further research. Research groups need to be broadened, existing studies need to be deepened and definitive conclusions need to be drawn. The best is yet to come.

References

1. Benedik, E. Sources of Vitamin D for Humans. *International Journal for Vitamin and Nutrition Research 2022, 92(2), 118-125* **2021**, *92*, 118–125, doi:10.1024/0300-9831/A000733.
2. Ismailova, A.; White, J.H. Vitamin D, Infections and Immunity. *Rev Endocr Metab Disord* **2021**, *23*, 265, doi:10.1007/S11154-021-09679-5.
3. Cantorna, M.T.; Zhao, J.; Yang, L. Symposium 3: Vitamin D and Immune Function: From Pregnancy to Adolescence: Vitamin D, Invariant Natural Killer T-Cells and Experimental Autoimmune Disease. *Proc Nutr Soc* **2012**, *71*, 62, doi:10.1017/S0029665111003193.
4. Charoenngam, N.; Holick, M.F. Immunologic Effects of Vitamin D on Human Health and Disease. *Nutrients* **2020**, *12*, 2097, doi:10.3390/NU12072097.
5. Bischoff-Ferrari, H.A.; Vellas, B.; Rizzoli, R.; Kressig, R.W.; Da Silva, J.A.P.; Blauth, M.; Felson, D.T.; McCloskey, E. V.; Watzl, B.; Hofbauer, L.C.; et al. Effect of Vitamin D Supplementation, Omega-3 Fatty Acid Supplementation, or a Strength-Training Exercise Program on Clinical Outcomes in Older Adults: The DO-HEALTH Randomized Clinical Trial. *JAMA* **2020**, *324*, 1855, doi:10.1001/JAMA.2020.16909.
6. Bouillon, R.; LeBoff, M.S.; Neale, R.E. Health Effects of Vitamin D Supplementation: Lessons Learned from Randomized Controlled Trials and Mendelian Randomization Studies. *J Bone Miner Res* **2023**, *38*, 1391, doi:10.1002/JBMR.4888.
7. Bikle, D.D. Vitamin D Regulation of Immune Function. *Curr Osteoporos Rep* **2022**, *20*, 186, doi:10.1007/S11914-022-00732-Z.
8. Fantacone, M.L.; Lowry, M.B.; Uesugi, S.L.; Michels, A.J.; Choi, J.; Leonard, S.W.; Gombart, S.K.; Gombart, J.S.; Bobe, G.; Gombart, A.F. The Effect of a Multivitamin and Mineral Supplement on Immune Function in Healthy Older Adults: A Double-Blind, Randomized, Controlled Trial. *Nutrients* **2020**, *12*, 2447, doi:10.3390/NU12082447.
9. Ayelign, B.; Workneh, M.; Molla, M.D.; Dessie, G. Role Of Vitamin-D Supplementation In TB/HIV Co-Infected Patients. *Infect Drug Resist* **2020**, *13*, 111, doi:10.2147/IDR.S228336.
10. Mailhot, G.; White, J.H. Vitamin D and Immunity in Infants and Children. *Nutrients* **2020**, *12*, 1233, doi:10.3390/NU12051233.
11. Domenici, R.; Vierucci, F. Exclusive Breastfeeding and Vitamin D Supplementation: A Positive Synergistic Effect on Prevention of Childhood Infections? *Int J Environ Res Public Health* **2022**, *19*, 2973, doi:10.3390/IJERPH19052973.
12. Hadizadeh, F. Supplementation with Vitamin D in the COVID-19 Pandemic? *Nutr Rev* **2020**, *79*, nuaa081, doi:10.1093/NUTRIT/NUAA081.
13. Domazet Bugarin, J.; Dosenovic, S.; Ilic, D.; Delic, N.; Saric, I.; Ugrina, I.; Stojanovic Stipic, S.; Duplancic, B.; Saric, L. Vitamin D Supplementation and Clinical Outcomes in Severe COVID-19 Patients—Randomized Controlled Trial. *Nutrients* **2023**, *15*, 1234, doi:10.3390/NU15051234.
14. Shakoor, H.; Feehan, J.; Al Dhaheri, A.S.; Ali, H.I.; Platat, C.; Ismail, L.C.; Apostolopoulos, V.; Stojanovska, L. Immune-Boosting Role of Vitamins D, C, E, Zinc, Selenium and Omega-3 Fatty Acids: Could They Help against COVID-19? *Maturitas* **2020**, *143*, 1, doi:10.1016/J.MATURITAS.2020.08.003.

15. Cicero, A.F.G.; Fogacci, F.; Borghi, C. Vitamin D Supplementation and COVID-19 Outcomes: Mounting Evidence and Fewer Doubts. *Nutrients* **2022**, *14*, 3584, doi:10.3390/NU14173584.
16. Stafford, A.; White, N.D. Potential Benefit of Vitamin D Supplementation in COVID-19. *Am J Lifestyle Med* **2022**, *17*, 202, doi:10.1177/15598276221140864.
17. Feiner Solís, Á.; Avedillo Salas, A.; Luesma Bartolomé, M.J.; Santander Ballestín, S. The Effects of Vitamin D Supplementation in COVID-19 Patients: A Systematic Review. *Int J Mol Sci* **2022**, *23*, 12424, doi:10.3390/IJMS232012424.
18. Farid, N.; Rola, N.; Koch, E.A.T.; Nakhoul, N. Active Vitamin D Supplementation and COVID-19 Infections: Review. *Ir J Med Sci* **2021**, *190*, 1271, doi:10.1007/S11845-020-02452-8.
19. Feentved Ødum, S.L.; Kongsbak-Wismann, M. Vitamin D and SARS-CoV-2. *Basic Clin Pharmacol Toxicol* **2023**, *133*, 6–15, doi:10.1111/BCPT.13872.
20. Gibbons, J.B.; Norton, E.C.; McCullough, J.S.; Meltzer, D.O.; Lavigne, J.; Fiedler, V.C.; Gibbons, R.D. Association between Vitamin D Supplementation and COVID-19 Infection and Mortality. *Sci Rep* **2022**, *12*, 19397, doi:10.1038/S41598-022-24053-4.
21. Sartini, M.; Del Puente, F.; Oliva, M.; Carbone, A.; Bobbio, N.; Schinca, E.; Giribone, L.; Cristina, M.L. Preventive Vitamin D Supplementation and Risk for COVID-19 Infection: A Systematic Review and Meta-Analysis. *Nutrients* **2024**, *16*, 679, doi:10.3390/NU16050679.
22. Bopape, P.G.; Wagenaar, C.; Poka, M.; Bronkhorst, E. Vitamin D Supplementation in a Post-Pandemic Era: A Narrative Review. *South African Family Practice* **2023**, *65*, 5752, doi:10.4102/SAFP.V65I1.5752.
23. Sîrbu, A.C.; Sabin, O.; Bocşan, I.C.; Vesa, Ştefan C.; Buzoianu, A.D. The Effect of Vitamin D Supplementation on the Length of Hospitalisation, Intensive Care Unit Admission, and Mortality in COVID-19—A Systematic Review and Meta-Analysis. *Nutrients* **2023**, *15*, 3470, doi:10.3390/NU15153470.
24. Hahn, J.; Cook, N.R.; Alexander, E.K.; Friedman, S.; Walter, J.; Bubes, V.; Kotler, G.; Lee, I.M.; Manson, J.A.E.; Costenbader, K.H. Vitamin D and Marine Omega 3 Fatty Acid Supplementation and Incident Autoimmune Disease: VITAL Randomized Controlled Trial. *The BMJ* **2022**, *376*, e066452, doi:10.1136/BMJ-2021-066452.
25. Durá-Travé, T.; Gallinas-Victoriano, F. Autoimmune Thyroiditis and Vitamin D. *Int J Mol Sci* **2024**, *25*, 3154, doi:10.3390/IJMS25063154.
26. Seraphin, G.; Rieger, S.; Hewison, M.; Capobianco, E.; Lisse, T.S. The Impact of Vitamin D on Cancer: A Mini Review. *J Steroid Biochem Mol Biol* **2023**, *231*, 106308, doi:10.1016/J.JSBMB.2023.106308.
27. Fantini, C.; Corinaldesi, C.; Lenzi, A.; Migliaccio, S.; Crescioli, C. Vitamin D as a Shield against Aging. *Int J Mol Sci* **2023**, *24*, 4546, doi:10.3390/IJMS24054546.
28. Charoenngam, N. Vitamin D and Rheumatic Diseases: A Review of Clinical Evidence. *Int J Mol Sci* **2021**, *22*, 10659, doi:10.3390/IJMS221910659.