MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
FACULTY OF ENVIRONMENTAL SAFETY,
ENGINEERING AND TECHNOLOGIES
DEPARTMENT OF ENVIRONMENTAL SCIENCE

APPROVED TO DEFENCE
Head of the Graduate Department
_____ T. V. Dudar
«_____» _____ 2022

BACHELOR THESIS

(EXPLANATORY NOTE)

SPECIALTY 101 "ECOLOGY",
EDUCATIONAL AND PROFESSIONAL PROGRAM:
"ECOLOGY AND ENVIRONMENT PROTECTION"

Theme: « Provision oh the population of Ukraine with vitamin D3 as an environmental factor of healts impact »

Done by: student of EK-411 group, Polina S. Tremasova
(student, group, surname, name, patronymic)

Supervisor: Ph. D. in Biol. Sc., Associate Professor of the Ecology Department, Tetiana I. Bilyk
(academic degree, academic rank, surname, name, patronymic)

Standards Inspector: _____ Andrian A. Iavniuk
(signature) (S.N.P)

KYIV 2022

МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ
ФАКУЛЬТЕТ ЕКОЛОГІЧНОЇ БЕЗПЕКИ, ІНЖЕНЕРІЇ ТА ТЕХНОЛОГІЙ
КАФЕДРА ЕКОЛОГІЇ

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач випускової кафедри
_____ Т. В. Дудар
«_____» _____ 2022 р.

ДИПЛОМНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)

ВИПУСКНИКА ОСВІТНЬОГО СТУПЕНЯ БАКАЛАВРА

ЗА СПЕЦІАЛЬНІСТЮ 101 «ЕКОЛОГІЯ»
ОПП «ЕКОЛОГІЯ ТА ОХОРОНА НАВКОЛИШНЬОГО СЕРЕДОВИЩА»

Тема: «Забезпеченість населення України вітаміном Д3 як екологічний чинник впливу на здоров'я»

Виконавець: студентка групи ЕК-411, Поліна С. Тремасова
(студент, група, прізвище, ім'я, по батькові)

Керівник: кандидат біологічних наук., доцент кафедри екології Білик Тетяна Іванівна
(науковий ступінь, вчене звання, прізвище, ім'я, по батькові)

Нормоконтролер: _____ Явнюк А. А.
(підпис) (П.І.Б.)

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NATIONAL AVIATION UNIVERSITY

Faculty of Environmental Safety, Engineering and Technologies

Department of Environmental Science

Specialty, Educational and Professional Program: specialty 101 "Ecology", Educational and Professional Program: "Ecology and Environment Protection"

(code, name)

APPROVED
Head of the Department
_____ Dudar T.V.
«____» _____ 2022

BACHELOR THESIS ASSIGNMENT

Polina S. Tremasova

1. Theme: « Provision oh the population of Ukraine with vitamin D3 as an environmental factor of healts impact » approved by the Rector on April 18, 2022, № 388/ст.

2. Duration of work: from 23.05.2022 to 19.06.2022

3. Output work (project): scientific literature on vitamins of group D, international and domestic data on the analysis and methods of determining the daily norm of vitamin, ways of obtaining and basic functions, literature sources on the use of vitamins, dosage and treatment of beriberi.

4. Content of explanatory note: (list of issues): analysis of scientific literature on the topic of work, conducting research on the basis of a private medical clinic, processing and analysis of the results, preparation for the implementation of research results..

5. The list of mandatory graphic (illustrated materials): tables, figures, charts, graphs.

6. Schedule of thesis fulfillment

№ з/п	Task	Term	Advisor's signature
1	Getting the topic of the task, searching for literary sources	08.04.2022	
2	Preparing the main part (Chapter I)	23.05-29.05.2022	
3	Preparing the main part (Chapter II)	30.06-01.06.2022	
4	Preparing the main part (Chapter III)	02.06-04.06.2022	
5	Formulating conclusions and recommendations of the thesis	05.06.2022	
6	Making an explanatory note to the previous presentation of the department, consultation with the norms controller	05.06 - 07.06.2022	
7	Presentation of work at the department	08.06.2022	
8	Taking into account comments, recommendations and preparation for defense	09.06 - 13.06.2022	
9	Thesis defense at the department	14.06.2022	

7. Date of task issue: «08» April 2022

Diploma (project) advisor: _____ Bilyk T.I.____

(advisor's signature) (S.N.P.)

Task is taken to perform: _____ Tremasova P.S_____

(graduate's signature) (S.N.P.)

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Факультет екологічної безпеки, інженерії та технологій

Кафедра екології

Спеціальність, освітньо-професійна програма: спеціальність 101 «Екологія», ОПП «Екологія та охорона навколишнього середовища»

(шифр, найменування)

ЗАТВЕРДЖУЮ
Завідувач кафедри
_____Дудар Т. В.
«____» _____ 2022 р.

ЗАВДАННЯ
на виконання дипломної роботи

Тремасова Поліна Сергіївна

1. Тема роботи «Забезпеченість населення України вітаміном Д3 як екологічний чинник впливу на здоров'я» затверджена наказом ректора від «18» квітня 2022 р. № 388/ст

2. Термін виконання роботи: з 23.05.2022 по 19.06.2022 р.

3. Вихідні дані роботи: наукова література про вітаміни групи Д , міжнародні і вітчизняні данні щодо аналізу та методики визначення добової норми вітаміну,шляхи отримання та основні функції, літературні джерела про використання вітаміну, дозування та лікування авітамінозу.

4. Зміст пояснювальної записки: аналіз наукової літератури за темою роботи, проведення досліджень на базі приватної медичної клініки, опрацювання та аналіз отриманих результатів, підготовка до впровадження результатів дослідження.

5. Перелік обов'язкового графічного (ілюстративного) матеріалу: таблиці,рисунки,діаграми.

6. Календарний план-графік

№ з/п	Завдання	Термін виконання	Підпис керівника
1.	Отримання теми завдання, пошук літературних джерел та законодавчої бази	08.04.2022	
2.	Підготовка основної частини (Розділ І)	23.05-29.05.2022	
3.	Підготовка основної частини (Розділ ІІ)	30.06-01.06.2022	
4.	Підготовка основної частини (Розділ ІІІ)	02.06-04.06.2022	
5.	Формулювання висновків та рекомендацій дипломної роботи	05.06.2022	
6.	Оформлення пояснювальної записки до попереднього представлення на кафедрі, консультація з нормоконтролером	05.06 - 07.06.2022	
7.	Представлення роботи на кафедрі	08.06.2022	
8.	Урахування зауважень, рекомендацій та підготовка до захисту	09.06 - 13.06.2022	
9.	Захист диплому	14.06.2022	

7. Дата видачі завдання: «08» квітня 2022 р.

Керівник дипломної роботи (проекту): _____ Білик Т. І.
(підпис керівника) (П.І.Б.)

Завдання прийняв до виконання: _____ Тремасова П.С._____
(підпис випускника) (П.І.Б.)

ABSTRACT

Explanatory note to the thesis on the topic « Provision oh the population of Ukraine with vitamin D3 as an environmental factor of healts impact »: 42 pages, 5 figures, 3 tables, 24 references.

Object of research the vitamin D supply of the population of Ukraine

Aim of work – research of the supply of vitamin D to the population of Ukraine and analysis of its impact on health.

Mehods of research: analytical, biochemical, statistical methods of data processing.

An analysis of the impact of environmental factors on the supply of vitamin D, the causes and consequences of its deficiency in humans in Ukraine, the impact on health and ways to correct D-hypovitaminosis. Improving the health of the population of Ukraine by implementing recommendations to ensure the required level of vitamin D.

VITAMIN D, HEALTH OF THE POPULATION OF UKRAINE, INSOLATION, AIR POLLUTION, IMMUNITY, COVID - 19, CORRECTION OF D-HYPOVITAMINOSIS

CONTENT

INTRODUCTION

Relevance of the work. Nowadays, the problem of vitamin D deficiency has been underestimated for many years and has been associated mainly with impaired calcium and phosphorus metabolism. The discovery of the role of vitamin D in the prevention of many diseases, including infectious, cardiovascular, autoimmune disorders, various cancers, has made it an urgent task to study the causes of D-hypovitaminosis and their correction. It is important for the population of Ukraine to analyze the supply of vitamin D and make recommendations for improving health, taking into account the effects of environmental factors.

Aim and tasks of the diploma work

Aim of the work – improving the health of the population of Ukraine by implementing recommendations to ensure the required level of vitamin D.

Tasks of the work:

1. Analysis of vitamin D3 in the body
2. Investigate the effectiveness and availability of the vitamin in Ukraine
3. Study the need for vitamins in different age categories
4. Draw conclusions about the importance of vitamin D3 in different age categories, its importance and necessity in a pandemic

Object of research vitamin D supply of the population of Ukraine.

Subject of research determining the causes and consequences of vitamin D deficiency as an environmental factor affecting health and ways to correct it.

Methods of research – analytical, chemical, statistical methods of data processing, toxicological.

Personal contribution of the graduate: analysis of scientific literature on the topic of work, conducting research on the basis of a private medical clinic, processing and analysis of the results, preparation for the implementation of research results.

CHAPTER 1
VALUE OF VITAMIN D IN METABOLISM AND FUNCTIONS OH HUMAN ORGANISM

Speaking about vitamin D3 we always mean the regulation of calcium and phosphorus exchange. It is precisely this vitamin that is necessary for the normal functioning of all organs and systems of the person. Ways of obtaining vitamins are quite curious. They can be obtained both with food and because of solar radiation, the influence of which is synthesized in each person, like a sunburn. After that it is transferred to the kidneys and liver, where it is again transformed into the necessary substance to provide for the whole organism. Vitamin D3 also plays a major role in the prevention of children from the development of rickets. Adults need it at lower doses, but it remains no less important in the life of every person. In its absence, it is impossible to have healthy and firm bones.

The maintenance of vitamin D3 at a normal level contributes to the development of cancer, as well as autoimmune diseases such as multiple sclerosis, asthma, and autism, and also infectious and viral ones, such as influenza virus, and cardiovascular diseases, such as stroke and heart attack.

Cholecalciferol, or vitamin D3 in active form, is a steroid hormone. It is well soluble and can also be well stored in the body for some time. Sometimes doctors assign analysis to the content of calcitriol. But with the help of this analysis, it is impossible to accurately assess the level of vitamin D. Calcitriol in the blood falls from the kidneys and does not reflect how much vitamin D is in other organs. At the moment, it is most adequate estimation whether vitamin D is sufficient for the concentration of 25-hydroxy-cholecalciferol (calcidiol) in the blood raw material. We can get enough vitamin D from several sources:

- from the sun;
- from food or vitamin supplements.

1.1. Value of vitamin D supply into organism

Vitamin D refers to fat-soluble compounds. Its main function is to regulate the metabolism of calcium and phosphates required for adequate bone mineralization. It is not synthesized from cholesterol and an exclusive metabolic pathway distinguishes it from steroid hormones and provides important functions. The two main inert forms, the precursors of the active form of vitamin D, are ergocalciferol (vitamin D2) and cholecalciferol (vitamin D3). The first is produced by the body under the influence of ultraviolet light, and also comes with food, the second is contained only in food. The biological role of calciferol is associated with the activity of calcium metabolism (Ca2 +), stimulating the absorption of this macronutrient, its deposition in bone, and increased reabsorption of Ca2 + in the kidneys and intestines [7].

They enter the body with food (in small quantities) and by the synthesis in the skin (the main source). From the sun, two types of ultraviolet radiation pass through the ozone layer of the earth - UVA and UVB. UVA (UV-A) or distant ultraviolet does not cause sunburn but contributes to premature aging and the appearance of wrinkles. UVA rays are active at any time of a day and throughout a year, but do not stimulate our skin to produce vitamin D.

- UV -B or medium ultraviolet is important for two reasons:

- Firstly, UVB rays are responsible for skin redness, causing sunburn.
- Secondly, when UVB rays get into the skin, they also cause the skin to produce vitamin D.

In contrast to UVA rays, UVB does not penetrate through clothes, and even through windows, thus a person can hide from it in the shade under trees, or sunscreen. Paradoxically, however, vitamin protects against the appearance of such a disease as cancer, but at the same time, a prolonged stay in the sun increases the risk of skin cancer. And this is the paradox of the situation, staying in the sun is both good and bad; the main thing is to know the measure and refrain from an overdose.

In addition, it affects neurotropic and neuroprotective processes in the brain, cognitive functions, helps with nervous and psychological disorders, facilitates the course of autoimmune diseases (psoriasis), and prevents the growth of cancer cells. It can also affect neurotransmission and synaptic plasticity. The name "vitamin D" means a group of substances - ergocalciferol (D 2), cholecalciferol (D 3), 25-hydroxycholecalciferol - (25- (OH) D) - calcidiol , 1,25 - dihydroxycholecalciferol - (1,25 (OH) 2 D) - calcitriol , the active form of the vitamin.

Vitamin D is called the Sun's vitamin because the body forms it during the action of direct sunlight from substances-predecessors. Thus, the main environmental factor that affects the provision of the population is the radiation of the sun. Insolation leads to the formation in the skin greater parts necessary organism vitamin D (80-90%). The entire UV range of the solar radiation is divided into three areas, in particular, the D-vitamin-forming effect is in the range of 270-315 nm, with a maximum in the range of 280-297 nm. If light redness of the skin appears under the influence of the appropriate UV-wave, it is equal to 1 minimum erythematous dose (MED), which corresponds formation of 20,000 IU of vitamin [10].

Air pollution is a factor that determines the degree of solar ultraviolet radiation reaching the Earth's surface. Scientific data of populations that live in different geographical latitudes indicate that atmospheric pollution (fine dust, volatile organic substances, tropospheric ozone) plays a significant independent role in the development of vitamin D deficiency [3,5].

Vitamin D is found in milk, butter, cheese, eggs, liver (especially fatty fish liver), and fish oil, which was previously given to children to prevent rickets (Table 1.1).

Some experts in the field of health protection and nutrition argue that we can get enough vitamin D when eating products that are rich in this vitamin. According to research, the amount of vitamin D in products is unstable. Therefore it is not necessary to focus on products as the main or the only source of vitamin D.

Table 1.1

Food’s high in vitamin D

Product name	The content of vitamin D in 100 g	**Percentage of daily requirement**
Fish oil (from cod liver)	250 mcg	2500%
Fatty herring	30 mcg	300%
Chum salmon	16.3 mcg	163%
Mackerel	16.1 mcg	161%
Atlantic salmon (salmon)	11 mcg	110%
Humpback whale	10.9 mcg	109%
Grainy black caviar	8 mcg	80%
Chicken egg yolk	7.7 mcg	77%
Tuna	5.7 mcg	57%
Chanterelle mushrooms	5.3 mcg	53%
Morel mushroom	5.1 mcg	51%
Egg powder	5 mcg	50%
River perch	3 mcg	30%
Red granular caviar	2.9 mcg	29%
Flounder	2.8 mcg	28%
Pike	2.5 mcg	25%
Sea bass	2.3 mcg	23%
Chicken egg	2.2 mcg	22%
Butter fried	1.8 mcg	18%
Unsalted sweet and sour butter	1.5 mcg	15%
Quail egg	1.4 mcg	14%
Butter	1.3 mcg	13%
Goat's milk	1.3 mcg	13%
Pollock	1 mcg	10%
Cheddar cheese 50%	1 mcg	10%
Swiss cheese 50%	1 mcg	10%

And if you take fish fat in the dosage, sufficient to provide for the need for vitamin D, then ultimately it is possible to get an overdose on vitamin A. And this already can be toxic.

Vitamin D in the form of supplements is the only reliable source that remains if there is no possibility of regularly staying in the sun or the wintertime. However, before admission, there are other sources of vitamin D to consider. Vitamin D3 is a hormone that formed in the skin under influence of ultraviolet irradiation of 7-dehydrocholesterol. It is biologically inert and must be metabolized to 25-hydroxyvitamin D3 in the liver and then to 1alpha, 25-dihydroxyvitamin D3 in the kidneys before to functioning. The hormonal form of vitamin D3, i.e. 1alpha, 25-dihydroxyvitamin D3, acts through the nuclear receptor to perform many features including absorption of calcium, phosphate in the intestine, mobilization of calcium in the bones, and reabsorption of calcium in the kidneys. It also performs sprat non-calcium functions in the body. This review contains a brief description of the physiological, endocrinological, and molecular biological characteristics of vitamin D. It also provides information about new selective analogs of 1alpha, 25-dihydrovitamin D3 for therapy [1].

Vitamin D, obtained from food or by the synthesis in the skin, is biologically inactive and requires enzymatic conversion into active metabolites (Fig. 1.1.).

1,25-dihydroxyvitamin D3 is classified as a hormone because it is synthesized in one part of the body and acts in other parts. Only about 1% of the calcium in the body exists outside the bones, but regulating the concentration of calcium ions in the blood is crucial because they are involved in many physiological processes – from blood clotting to muscle contraction [7]. When the level of calcium in the blood is low, calcitriol stimulates its absorption from the intestine and transport into the blood. In the kidneys, this hormone together with parathyroid hormone stimulates the reabsorption of calcium so that it is not lost in the urine. If the level of calcium in the blood is too low, calcitriol even stimulates its removal from the bones. This, of course, leads to their weakening, which can cause osteomalacia – decalcification and fragility. Excess vitamin D can lead to hypervitaminosis with symptoms such as renal failure, weight loss, and soft tissue calcification.

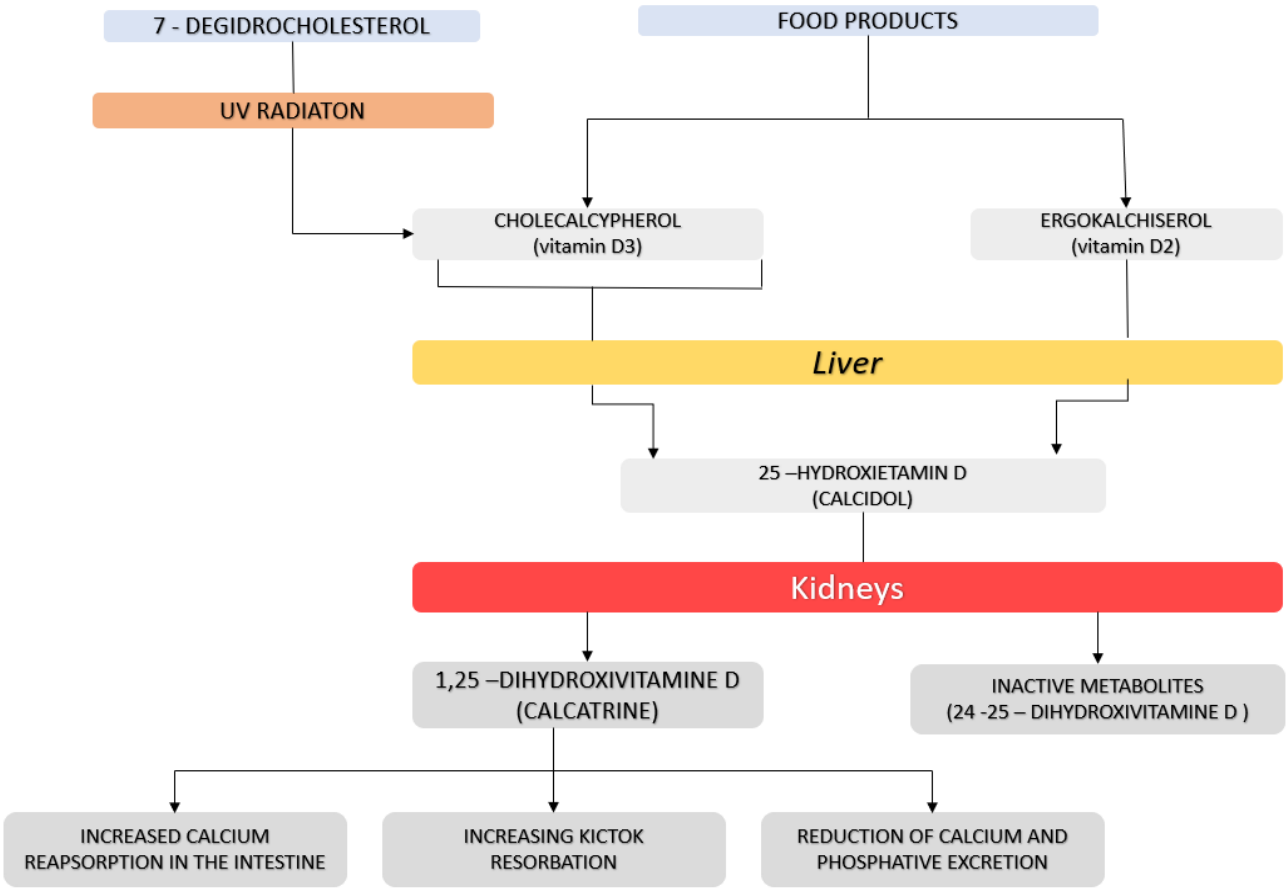

Fig. 1.1. Ways of formation of the active form of vitamin D in the human body

Vitamin D influences the organs and tissues of the human body too. In the intestine, this vitamin increases the absorption of calcium and phosphates through cell membranes. In addition, there is the process of creating calbidin. It is responsible for regulating the transport of calcium through the cells. Another process of vitamin D performs detoxification functions in the intestine by enhancing the catabolism of toxic bile acids. These acids are produced in the liver and are primarily a major metabolite of cholesterol. They are excreted in the bile and reabsorbed in the intestine, and those acids that are not reabsorbed are converted directly into secondary bile acids by intestinal microflora (cholesterol → henodioxycholic acid → lithocholic acid (LHC) (ligand to vitamin D receptor) → formed under the action of intestinal bacteria → activation of the expression of antibacterial peptide gene). Secondary bile acids are toxic and must pass detoxification in the body. The excretion of bile acids leads to magnification of bacterial growth in thin intestines, mucosa damage, and violation of protective

barriers and promotes systemic infection. FHR plays a key role in protecting the intestines. Side products in the intestines play important role in the expression of the cathelicidin gene (antimicrobial peptide). It can be important when creating a barrier to prevent contact between the infection intestine and mucus.

In the kidneys, the mechanism is similar to that absorbed in the intestinal, namely increased reabsorption of calcium and phosphorus. There is also a direct inhibition of renin secretion which causes a decrease in blood pressure.

In bones, vitamin D activates osteoclastogenesis by augmentation RANKL products (ligand that connects with the receptors on osteoclasts and activates them). It also increases bone calcium and absorption. The final differentiation hypertrophied chondrocytes and subsequent calcification matrix markedly are broken at deficit vitamin D that leads to soldering end long tubular bones and rickets garland on the edge-cartilage connection of ribs, classical lynx rickets. In the bones metabolites vitamin D can change the expression and/or secretion of large quantity substances, including insulin-like growth factor-1 (IGF-I) and its receptor and binders proteins, transforming growth factor β (TGF-β), endothelial growth factor vascular (VEGF), interleukin-6 (IL-6), IL-4, and receptors endothelin. They all can affect the bones as well as modulate action metabolites vitamin D on bones. Osteoblasts differ in their responses to 1.25 (OH) 2D depending on the degree of their maturation. In the early stages of differentiation of osteoblasts, the reaction to 1.25 (OH) 2D is manifested by inhibition of alkaline phosphatase and type I collagen, stimulation selection osteopontin, and lack of magnification quantity osteocalcin. At a later date stages differentiation osteoblasts respond to 1.25 (OH) 2D by magnification production osteocalcin, alkaline phosphatase and collagen type I, but less selection osteopontin [3].

Osteoclastogenesis is activated by the augmentation of RANKL products (ligand that binds to receptors on osteoclasts and activates them). It was found that first, it reduces the number of osteoprotegerins, and then increases. It shows that vitamin D has a more catabolic effect, but is also anabolic (stimulation of osteopontin and alkaline phosphatases). It was also

found that there is a connection between low-level vitamin D and increase expression of RANKL and others cytokines (IL-6, TNF-α).

In the parathyroid gland by induction production by osteocytes of fibroblast growth factor-23 activates the mitogen-activated protein kinase pathway and thus reduces expression of the PTH gene as well as by acting on the RVD, which are on the parathyroid glands reduces the synthesis and secretion of parathyroid hormone. It regulates the activity of calcium and chloride channels, activation of protein kinase C, and its distribution as well as activity of phospholipase C in many cells, including osteoblasts, cells liver, muscles, and intestines.

It increases the expression of 25-hydroxyvitamin D-24-hydroxylase (24-OHase) – an enzyme that catalyzes further metabolism of vitamin D that leads to the formation of water-soluble biologically inactive calcitroic acid that is released from bile [2].

Vitamin D, which comes from food, will be concentrated mainly in the twelve-pals intestine and the small intestine in the presence of salts of bile acids. It enters the lymph in the form hilomi crowns cholecalciferol oxalate, which is formed when interacting vitamin D3 with taurocholic acid. Vitamin D3 absorbed circulates in the blood in the form of a complex with a protein that has a molecular mass of 53,000 D and belongs to alpha2 globulins. Vitamin D3 protein complex is also seized by Kupffer cells of the liver and is reserved in fatty tissue and muscles.

Thus, in adipose and muscle tissues fabric depot with indefinite term existence can be created. In the liver, D3 (cholecalciferol) is hydroxylated under the action of liver enzyme microsomal monooxygenase 25hydroxylase and requires the presence of molecular oxygen, flavoprotein, and cytochrome P450. At the same time form is 25hydroxycholecalciferol, or calcidiol (25 (OH) D3), which is 1.5 times more active than vitamin D3. Hydroxylation in the liver is carried out without any extrahepatic regulator influences. The liver accumulates a sufficient number of vitamins to meet the need for it within one year (in adults) [4, 7, 8].

Vitamin D is a fat-soluble compound. Its main function is the regulation of the metabolism of calcium and phosphates required for adequate bones mineralization. It is not synthesized from cholesterol, and its exclusive metabolic pathway differs from steroid

hormones and provides important functions. Two basic inert forms, predecessors of active forms of vitamin D, are ergocalciferol (vitamin D 2) and cholecalciferol (vitamin D 3). The first is produced organism under the influence of ultraviolet, and also comes with food, the second contained only in products food. The biological role of calciferol is associated with activity exchange of calcium (Ca 2+), stimulation of mastering of this macroelement, its delay in bones, and strengthening reabsorption of Ca 2+ in the kidneys and intestines [9].

Vitamin D is a hormone that not only regulates the exchange of calcium and phosphate supporting their required level in the blood but also affects the organs and tissues, performing diverse features that provide normal operation of the organism and warn the emergence of many diseases. Therefore the support of a sufficient level of Vitamin D metabolites in the blood is an important task. Periodontal disease is also associated with insufficiency of vitamin D [2].

1.2. Consequences of hypovitaminosis D for human

Vitamin D is formed in the body under action solar light and incoming with food. The daily dose of the vitamin for people aged 18 to 50 is 600-800 IU per day. After 50 years the daily dose should be at least 800-1000 IU, and for pregnant and breastfeeding women – 800-1200 IU. High doses of VD are toxic to the body. Appearance large VD dose is due to:

- increased individual sensitivity ;
- overdose of vitamin D drugs;
- reception high doses of VD in combination with high insolation ;
- a combination of VD and fish oil;
- artificial breastfeeding.

Previously, hypervitaminosis was met in children aged the first year of life, who were treated for rickets with shock doses of vitamin D. With the review of the therapy technique anomaly occurs very rarely. Children, whose mothers took supplements with vitamin D during pregnancy, may have increased sensitivity to it.

Intoxication leads to:

- hypercalcemia;
- acute and chronic hypervitaminosis;
- urolithiasis diseases;
- renal insufficiency, etc.

The reception of vitamin drugs without determining equal nutrients in the blood most often leads to pathology.

Appearance large VD dose is due to:

- increased individual sensitivity ;
- overdose of vitamin D drugs;
- reception high doses of VD in combination with high insolation ;
- a combination of VD and fish oil;
- artificial breastfeeding.

Taking excessive amounts of vitamin D in history can be the only key that allows differentiation of vitamin D toxicity from other causes of hypocalcification. Increasing calcium in the blood raw material to 12-16 mg/dL (3-4 mmol/L) is a good sign of symptoms of intoxication. Vitamin 25(ON)D levels in the blood raw material are usually increased by more than 150 ng/mL when intoxicating with vitamin D (>375 nmol/L). Levels of 1,25-dihydroxyvitamin D, which do not need to be measured to confirm a diagnosis, may be normal. The level of calcium in the raw material should be measured frequently (first weekly, later monthly) in all patients who receive high doses of vitamin D, in particular strong 1,25 dihydroxyvitamin D [16].

During hypervitaminosis D, the processes of expression of L-type tension of sensitive CA-channels, which influences the process of sexual maturation (Lee HS. et al., 2014), can be disturbed. Thus, already at the stage of sexual maturity deficiency of vitamin D can lead to serious violations and the formation of the pathology of the reproductive system [16].

Equally important is the status of vitamin D on the reproductive function of a woman, starting from the moment of the transplantation and during the entire pregnancy period, which usually affects the fetal status and the formation of a variety of pathology in the child [17,18].

Vitamin D also plays an important role in pregnancy. Its deficiency affects the development of the fetus and the health of the mother, including dental. A lot of scientists admit that there is vitamin D deficiency during pregnancy. For example, Javaid M. with co-authors studied the status of vitamin D in pregnant women in the UK. It turned out that 31% of mothers had a deficiency, and 18% of a concentration deficit of 25(OH) D during pregnancy. In 9-year-old children of these women found that the content of mineral substances in the transverse section of the ridge was reduced. The authors concluded that taking vitamin D preparations by pregnant women, especially during the winter period, could reduce the risk of osteoporotic fractures in their children [15].

As noted, there is a large number of evidence that indicates the activation of VDR on monocytes, macrophages, dendritic cells, and lymphocytes that has value for control of both congenital and acquired immunity. Considering the influence of vitamin D on the function of T-lymphocytes and antigen-producing cells, there is a thought that Vitamin D acts as an immune modulator during implantation. In the early deadlines, pregnancy trophoblast synthesizes and responds to the impact of vitamin D, which provides local anti-inflammatory action and induces growth decidual fabrics for a successful pregnancy. The results of the number of studies indicate increased synthesis of active forms of vitamin D by decidual tissue in the 1st trimester of pregnancy, in which paracrine modulates immune relationships between organism mother and embryo. Work is underway to study the influence of vitamin D on the results of fertilization in the application of auxiliary reproductive technologies, which are widely used in the present conditions. Women with a high output level of 25(ON)D have a 4 times higher chance of successful extracorporal fertilization compared to the group with a low level of the said metabolite. Some authors suggest using level 25(ON)D in the follicular fluid as an independent predictor of the success of the ekstracorporeal fertilization cycle. During pregnancy, the regulation of calcium homeostasis and vitamin D metabolisms are subject to

changes in the supply of calcium of the embryo. During the whole pregnancy, the need for calcium is 30 g, this explains the reason for the increase of activity of 1α-hydroxylase by the kidneys of pregnant and the placenta, which leads to an increase of production calcitriol. Therefore, in pregnant women with a normal level of vitamin D to pregnancy, the level of calcitriol increases compared to pregnancy. Increased level of calcitriol leads to elevated absorption of calcium in the gastrointestinal tract, at the same time parathyroid hormone levels decrease. Received calcium gets out of the body from mother to child through the placenta. It is worth to note that in this case insufficient quantity of vitamin D, a precursor of calcitriol, or reduced hit calcium with food, the mechanism is ineffective. In this case, the only source of Calcium is the bone tissue of the mother which can lead to demineralization and the development of osteoporosis in pregnant women and other complications associated with hypocalcemia. Possible complications of pregnancy with deficiency vitamin D are preeclampsia, gestational diabetes (DM), premature birth, etc. Although these conditions are quite well known, the connection with vitamin D is a new direction for studying their pathogenetic chains. It has been proved that the implementation of vitamin D during pregnancy reduces the likelihood of these complications, which in turn reduces the proportion of the birth by cesarean solution (Hollis BW et al., 2011). Based on the structure of pathological conditions that cause maternal and infant mortality (Fig. 4, 5), consider it expedient to dwell in more detail on the role of vitamin D in the formation of preeclampsia, DG, and preterm birth for understanding and prevention of occurrence of these states [17,18].

Taking into account the participation of hypovitaminosis D in the formation of the pathology of pregnancy and the severe consequences for the future generation, special attention is to the timely detection of deficiency of vitamin D needs to be pregnant. Based on the structure of maternal and infant mortality pathologic conditions, that lead to maternal and infant mortality, it is important to identificate and eliminate the reasons that may cause preeclampsia, PGD, and premature birth, resulting from vitamin D deficiency in time. Even against the background of reception of multivitamin complexes with the content of vitamin D (up to 400 MO/day), a high frequency of hypovitaminosis D. According to the data of M.F. Holick (2007),

in the indicated category of women in 73% of cases, the level of vitamin D is <20 ng/mL, and in newborns from these women, vitamin D deficiency is noted in 83% of cases. Understanding this problem makes it necessary to take medical and preventive measures to eliminate vitamin D deficiency both at the stage of preparation and during pregnancy and breastfeeding [17,18].

1.3. Effect of vitamin D on the state of the immune system during the COVID-19 pandemic

Today's world has met the realities of a new disease manifested by coronavirus-induced respiratory syndrome (SARS-CoV-2). There are currently many studies on the role of VD in immunity and immunomodulation.

Immune cells can synthesize and secrete vitamin D in both autocrine and paracrine ways, indicating that it plays an important role in the immune system, and affects antigen presentation, innate immunity, and T-cell activation [10]. Vitamin D is an immunomodulatory hormone with proven effectiveness against various infections of the upper respiratory tract. It can suppress hyperinflammatory reactions, reduce the risk of cytokine storms and accelerate the healing process in the affected areas, especially in the lung tissue (Fig. 1.4.)

The possibility of reducing the risk of cytokine storm has been shown.

In addition, vitamin deficiency is associated with severity and mortality, high prevalence of hypovitaminosis D in patients with COVID-19, and acute respiratory failure. The researchers conducted a retrospective study of the effects of vitamin D deficiency on the condition of patients in one part of England. VD deficiency has been shown to cause more severe diseases [10, 19].

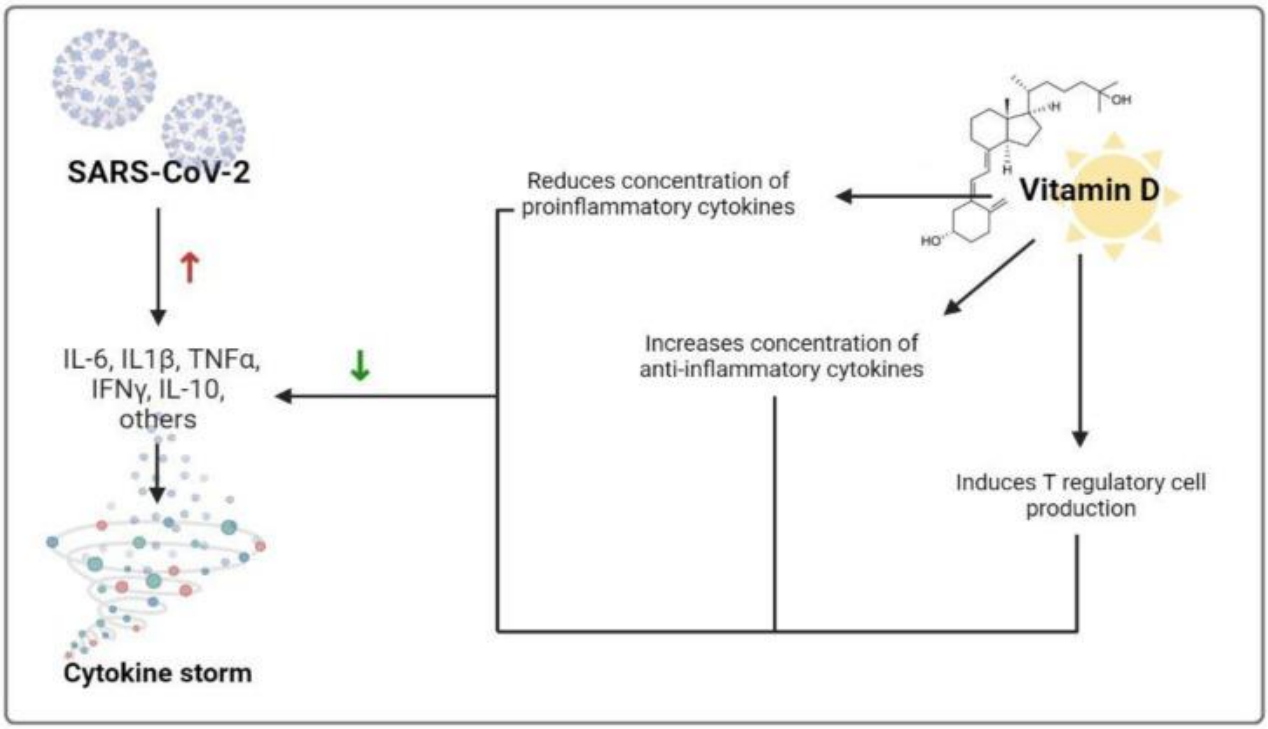

Fig.1.4. The mechanism of action of vitamin D on the human immune system

At the same time, there are promising studies of the effect of vitamin D supplements on the rate of recovery in patients with COVID-19. Vitamin D deficiency and deficiency are recognized by doctors as risk factors for various respiratory infections. They affect the expression of many genes that are well established in the functions of the immune system. Vitamin deficiency has recently been shown to be a risk factor for COVID-19 infection, and its correction is a safe and inexpensive way to modulate the severity of the disease. Vitamin D-induced epidermal antimicrobial low-molecular-weight peptides cathelicidin and defensin with broad-spectrum activity against bacteria, viruses, and fungi are induced in immune cells [22,10].

Thus, vitamin D plays an important role in reducing the impact of viral lung disease. Its deficiency is a recognized threat to public health that requires action by the entire population to reduce morbidity and mortality from COVID-19. D-hypovitaminosis is common in people over the age of 60, many of whom have comorbidities, as well as people with skin pigmentation sufficient to reduce vitamin D synthesis. Fine air pollution is also associated with the worse

effects of COVID-19. Action is needed to address the risks associated with COVID-19 as well as air pollution from industry, transport, domestic sources, and primary and secondary tobacco smoke.

1.4. Conclusions to chapter

From the data written earlier, we can say that vitamin D belongs to the family of steroid compounds along with sex hormones and is involved in the regulation of many important functions of the human body. Its important role has been proven not only in the homeostasis of calcium, phosphorus, and bone metabolism, from calcium and phosphate metabolism to ensure adequate reactivity of the immune system, but also in the regulation of immune responses, hormonal and metabolic processes. It should be noted that the vitamin affects neurotropic and neuroprotective processes in the brain, and cognitive functions, helps with nervous and psychological disorders, facilitates the course of autoimmune diseases (psoriasis), inhibits the growth of cancer cells. and may affect neurotransmission and synaptic plasticity.

CHAPTER 2
MATERIALS AND METHODS OF RESEARCH

An analysis of the impact of environmental factors on the supply of vitamin D, the causes and consequences of its deficiency in humans in Ukraine, the impact on health and ways to correct D-hypovitaminosis.

2.1. Methods of research of vitamin D provision of Ukrainian population

Scientific work was performed in the private medical clinic "Verum" (Kyiv) based on agreements on cooperation with higher education institutions.

It is generally accepted that the determination of the concentration of calcidiol - 25 (OH) D in the blood is the best indicator of the body's security VD. It includes vitamin D, which is produced in the skin, as well as obtained with food and supplements, and has a fairly long half-life (15 days). At the same time, it does not indicate the number of vitamins stored in the body's tissue depots.

It should be noted that calcitriol - 1.25 (OH) 2D is usually not an adequate indicator of vitamin D status, as it has a short half-life (15 hours), and its concentrations in the blood are closely regulated by parathyroid hormone, calcium, and phosphate levels. Plasma levels of 1.25 (OH) 2D do not usually decrease until vitamin D deficiency is critical.

25 (OH) D was determined by a competitive enzyme-linked immunosorbent assay using a luminescent reagent. Atellika IM1600 analyzer (Germany), Siemens Healthcare Diagnostics reagents were used. All determinations were made in one laboratory.

According to international and European clinical guidelines adopted by the International Committee of Endocrinologists, the following interpretation of the results of the definition of 25 (OH) D as an indicator of the body's security:

- less than 10 ng / ml (less than 25 nmol / l) - severe deficiency, characterized by an increased risk of rickets, osteomalacia, secondary hyperparathyroidism, myopathy, falls and fractures;
- less than 20 ng / ml (less than 50 nmol / l) - deficiency that causes an increased risk of bone loss, secondary hyperparathyroidism, falls and fractures;
- from 20 to 30 ng / ml (from 50 to 75 nmol / l) - vitamin deficiency associated with a low risk of bone loss and secondary hyperparathyroidism, a neutral effect on falls and fractures;
- from 30 ng / ml (from 75 nmol / l) - adequate VD level, optimal suppression of parathyroid hormone and bone loss, reduction of falls and fractures by 20%;
- above 100 ng / ml (over 250 nmol / l) - levels with possible toxicity of vitamin D, which can cause hypercalcemia, hypercalciuria, nephrocalcinosis, calcification.

It should be noted that the measurement results of 25 (OH) D in Ukraine are usually expressed in ng / ml, and in foreign publications more often in nmol / l.

In Ukraine deficit and insufficiency vitamin D make up the serious problem that was noted in some of scientific works [22,23]. According to our results research determined that 25, 37% of the general quantity surveyed (a total of 158 people) have a deficit of vitamin D; 23, 88% have an indicator of 20-30 ng / ml that meets insufficiency vitamin;

- 50.75% have sufficient level, indicators whose meet interval from

30 ng / ml to 100 ng / ml. These data indicate that insufficient security among adults is very distributed and composed about 50%.

Comparing received data published in the scientific literature and the results of others authors, it should be noted that it is quite a normal level of the VD providing for the population. It may be explained that the research was conducted in autumn when there are still vitamin reserves accumulated in the summer as well all surveyed small sufficient financial conditions for a full-fledged food.

It is mentioned in other works that with increased age and decline in motor activity interest in patients from VD deficiency is significant increases. In particular, in Australia (Sydney area) among people who were in nursing homes, it was diagnosed in 68% of men and 86% of women (average level - 17 nmol / l) [21].

There is a reverse connection between serum level 25 (OH) D and index tables body (BMI) over 30 kg / m 2, and thus obesity is associated with deficit vitamin D. It has also been shown that in patients with the syndrome malabsorption fats are often fat-soluble vitamin D is not absorbed [21].

What about the comparison of Ukraine with data on Europe, the results of a large study conducted in 2016 in Cork center research vitamin D and nutrition University Cork College (Ireland) showed that 40.4% of the population of European countries is noted deficit vitamin D in serum blood, and 13% of people face from expressed of this micronutrient deficiency that carries high risks of clinical manifestations. Since most European people are in the zone of low insolation, higher-level life allows full-fledged nutrition [20].

Ukraine applies also to countries with insufficient level insolation, especially in the west and north regions. One of the significant factors of risk insufficiency and deficit vitamin D among the population in Ukraine is climatic. For the geographical location in most parts of our country, a short summer and often cloudy weather are characteristic that determines and insufficient level of insolation population. The synthesis of the vitamin by organism may be achieved just by being in the sun on average for 20 minutes in the open clothes.

2.2. Characteristics of the studied population groups

Based on the Verum Clinic, a study was conducted on adult patients who applied for a preventive examination within the medical insurance program of their company. This is a large consulting firm, where employees have the same work schedule, being on the premises during the working day. From the total number of subjects, five groups (equal to men and women) were formed, which were distributed by age: the first group consisted of 32 patients - aged 20-

29 years; the second group consisted of 30 patients aged 30-39 years; the third group consisted of 34 patients aged 40-49 years; the fourth group consisted of 30 patients aged 50-59 years; the fifth group consisted of 32 patients aged 60-69 years (Table 2.1.).

Table 2.1

Groups of examined patients (distribution by age)

Droups	I	II	III	IV	V
Age (years)	20-29	30-39	40-49	50-59	60-69
Number surveyed (n), % of the total	32 20	30 19	34 22	30 19	32 20

A total of 158 patients were examined, and all of them are residents of Kyiv.

It should be noted that the study groups included patients who have not taken vitamin D and calcium in the last 4 months as part of pharmaceuticals or in the form of supplements.

Since, according to the literature, the highest values of VD in the blood are observed in summer, and in winter and spring - the lowest, with significant fluctuations, the period of the relative stability of this indicator was chosen, namely autumn. Therefore, the study was conducted in October 2021.

2.3. Conclusions to chapter

In the study of this topic we can say that the saturation of the vitamin depends on the season, namely to get the most D3 is possible with the period from mid-spring to mid-autumn (equinox days). The most difficult thing is to find an individual norm of vitamins for the elderly and pregnant women. The supply of the vitamin itself also does not cause the problems; the only thing that can create a problem is a vitamin overdose. It is necessary to remember, the dosage and understanding of the importance of the content of other vitamins and before taking them it is better to consult a doctor and get tested.

CHAPTER 3
PROVISION OF UKRAINIAN POPULATION WITH VITAMIN D3 AS ECOLOGICALFACTOR OF INFLUENCE ON HEALTH

The deficit of vitamin D indicates one of the problems with the system, which is the data of organizations. It is estimated that 1 billion people in 2008 left a small deficit or deficit in vitamin D. In Europe, the tax rate is 57.7%. The problem with the current situation is level of vitamin D for Ukrainians. The normal range of vitamin D in plasma blood slightly exceeds 4.6%, deficit - 13.6%, deficit - 81.8%. The average amount of normal vitamin D is increased.

The reasons for low levels of vitamin D are excessive use of creams with high protection from ultraviolet light, urbanization associated with reduced exposure to nature, environmental problems (smog in cities), short world time (in our latitudes - 5 months of an adequate global wave), violations diet, age (over 70 years), acute and especially chronic liver and kidney disease, medication (corticosteroids, anticonvulsants) (Fig. 3.1.).

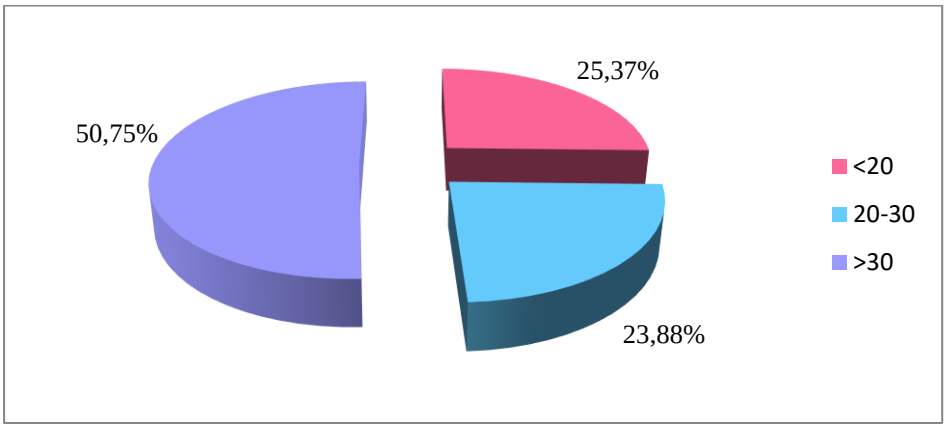

Fig.3.1. Provision of examined patients with vitamin D. Different colors indicate different levels of VD in serum (ng / ml)

3.1. Causes and consequences of vitamin D3 deficiency in different age groups of Ukrainian population

For comparison, conducted by Povoroznyuk V.V. with the staff of the Institute of Gerontology in 2011 large-scale studies of the population of different regions of Ukraine (surveyed 1575 people aged 20-95 years) found that only 4.6% of Ukrainians have a level of 25 (OH) D within normal limits, 13.6% had insufficiency, and 81.8 % - were deficient in vitamin D. In this work, it is shown that probably higher values of 25 (OH) D were registered in young people aged 20–29 years compared to those of other age groups. It is noted that in summer, especially in August, the average 25 (OH) D is the highest [12].

In this study, we also tried to establish differences between age groups within a 10-year interval in selected groups (Fig. 3.2.). It can be stated that patients in the older age group (60-69 years) generally had lower rates starting at 61 years than in other groups. At the same time, we could not establish identified patterns within the selected age intervals. This may be due to the small number of respondents and the lack of sample homogeneity for each year. So this requires further research.

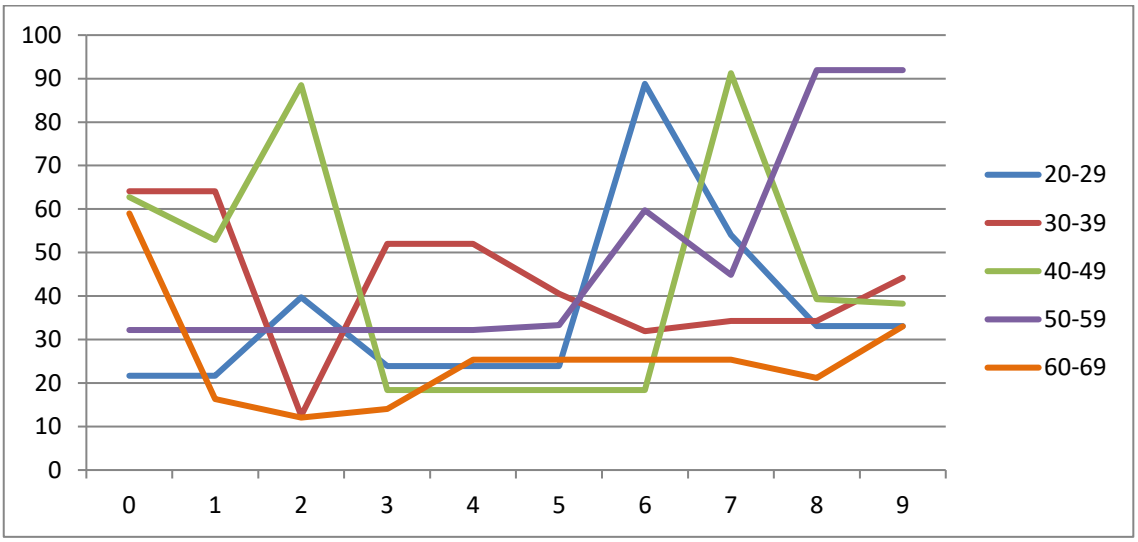

Fig.3.2. The content of vitamin D (nmol / ml) in the serum of different age groups of the population of Ukraine (within 10 years of age)

It was noted in other studies that with increasing age and decreased motor activity, the percentage of patients with VD deficiency increases significantly. In particular, in Australia (Sydney area), 68% of men and 86% of women (mean 17 nmol / l) were diagnosed in nursing homes [13].

There is an inverse relationship between serum 25 (OH) D and body mass index (BMI) over 30 kg / m2, and thus obesity is associated with vitamin D deficiency. It has also been shown that patients with fat malabsorption syndrome are often fat-soluble vitamin D is not absorbed [13].

Other significant factors in vitamin D deficiency in Ukraine are insufficient food intake, impaired absorption from the digestive tract, as well as dietary reasons related to milk allergy, lactose intolerance, vegetarianism and veganism.

3.2. Ways of correction of hypovitaminosis D3

Significant risk factors for vitamin D deficiency:

- insufficient exposure to the sun; ambient air pollution;
- wearing clothing that leaves almost no skin exposed;
- dark skin pigmentation; excessive use of sunscreen;
- unbalanced diet; long-term diets of low-fat foods;
- old age;
- adiposity;
- breastfeeding without vitamin supplements;
- several pregnancies with a small interval between them;
- taking drugs that reduce the bioavailability of the vitamin;
- chronic diseases that reduce the body's absorption of all vitamins (cholecystitis, gallstone disease, biliary dyskinesia, kidney disease and thyroid disease).

For correction of hypovitaminosis D medicines of vitamin D, which are currently presented in the form of alcohol, oil and aqueous solutions are used. Due to a number of restrictions on the use of alcohol and oil solutions vitamin D, which appointed for a long time even in paediatrics practice, more broadly application acquired water-soluble form of drugs vitamin D, an example of which is the water-soluble form of cholecalciferol - the drug Aquadetrim ® Vitamin D_3, 1 ml of which (30 drops) contains 15 thousand IU of active substances (1 drop - 500 IU). Exactly this form of vitamin D is the most acceptable for use during the period of pregnancy and in pediatric practice. The advantages of the drug are [18]:

- good absorption in the digestive tract (absorption of aqueous solution 5 times rather, his concentration in the liver 7 times higher);
- less tension on enzymatic systems of the intestine during absorption;
- the more long effect, compared to the oil form (lasts up to 3 months);
- fast onset clinical effect (after 5-7 days after the beginning of application);
- convenience and safety medicinal forms.

Individual adjustment of doses of vitamin D helps to minimize the risk of side effects and at the same time from warning new fractures, pain control and improve mobility, retaining quality of life for patients, including rheumatic diseases (Table 3.1.)

Table 3.1

Recommended daily intake of vitamin D

Age group	Recommended daily dose, MO	Maximum allowable level consumption, MO
Baby, 0 - 6 months	400	1000
Baby, 7 - 12 months	400	1500
Children 1 - 3 years	600	2500
Children 4 - 8 years	600	3000
Children 9 - 17 years	600	4000
Adults 18 - 70 years	600	4000
Adults over 70 years	800	4000
Pregnancy and lactation	800	4000

It is worth noting that the specified above doses and terms reception vitamin D is more preventive, whereas available deficit or deficit vitamin D should be appointed higher doses of the latter.

This includes the introduction of "basic" antiosteoporotic agents such as bisphosphonates since the recommendation for patients of the doses of vitamin D can increase at times.

Is important that the recommendations on the onset of antiosteoporotic treatment long-term GC defined groups patients in whom optimization consumption of calcium and vitamin D and lifestyle changes have advantages over bisphosphonate, teriparatide, denosumab or raloxifene. There are adults ≥40 years from low-risk fractures, which is significant for part of patients with rheumatism, especially at the beginning of the disease.

To prevent vitamin D deficiency, it is recommended to take pharmaceuticals or dietary supplements containing a therapeutic dose. For children under 3 years of age today it is 500 IU, from 3 to 12 years - 1000 IU, over 12 years and adults - 2000 IU. During viral infections, at risk of cancer and autoimmune diseases, as well as in the fight against overweight, the dosage should be higher and determined by the doctor. The fat-soluble form is very popular for many vitamins, in which the active substance is dissolved in oil. However, the bioavailability of such vitamin D directly depends on the state of the gastrointestinal tract of the person taking it. For example, chronic disease of the pancreas significantly reduces the digestibility of micronutrients (Fig. 3.3.). An alternative to the oil form is water. This is a ready-made micellar solution of vitamin D, which is easily absorbed in the intestine and is the best in terms of resource and energy expenditure.

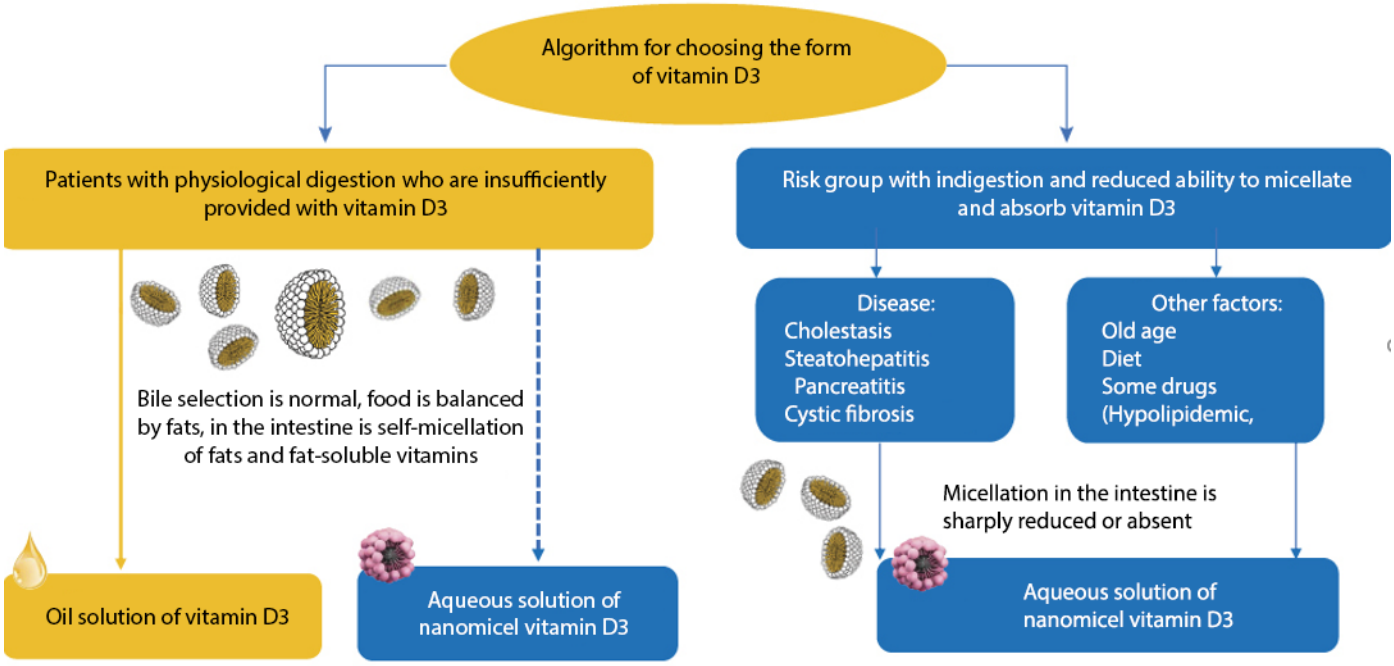

Fig.3.3 The choice of the form of vitamin D3 depending on the state of the gastrointestinal tract

It should be noted that taking more than 100 mcg of vitamin D per day can have toxic effects. It is necessary to take into account how much of it a person gets from food.

Recommendations for obtaining the optimal level of vitamin D for the population of Ukraine:

1. Periodically monitor the levels of "solar" vitamin D with a blood test. Measurement of 25-OH D is a criterion for assessing the condition.

2. Not only low vitamin levels (less than 30 ng/ml) but also high levels (more than 100 ng/ml) are dangerous to health. Overdose leads to the accumulation of excess calcium, which is deposited in blood vessels, heart, kidneys and lungs and leads to blockage of arteries.

3. Stay in the sun for 20 minutes. in places with clean air (recreation areas, parks, in nature) with open areas of the body (arms, legs, neck) daily, in the period from 11 to 15 hours, gives up to 90% of the required daily dose of vitamin.

4. Eat foods that contain vitamin D regularly.

5. Lead an active lifestyle.

6. Quit smoking.

7. If necessary, take corrective drugs or dietary supplements in doses prescribed by your doctor.

8. Monitor the normal functioning of the digestive system and weight.

3.3. Conclusions to chapter

We now need to understand that all the availability and illiteracy in the use of vitamins, and walruses lead to major health problems. Be sure to get tested and consult a doctor before using the medication. Also keep in mind the ways of obtaining a vitamin, namely to take into account the main sources of natural vitamins, namely vitamin D. Some of the tips are to walk more on the street and sunbathe, eat products containing this vitamin, and also choose a more comfortable way to get a vitamin with the help of consultation with experts.

CONCLUSIONS

1. D3 (cholecalciferol) is called "solar", as it is formed in the skin due to exposure to ultraviolet radiation. In addition, the natural absorption of the vitamin decreases over the years, and people with dark skin absorb it more slowly. Negative aspects of the perception of beneficial sunlight are sunscreens and unfavorable ecology, for example, air pollution. Therefore, even in the summer months, not always and not everyone can stock up on cholecalciferol. Prevention of vitamin D deficiency is one of the important tasks of public health. Among the vitamins valuable for a woman's health, of course, a special role is played by vitamin D (calciferol), which exists in two forms - D2 and D3, the activation of which occurs in the liver and kidneys.

2. D3 enters the body along with the usual food. However, few foods of animal origin are known to be enriched with vitamin D: fish, lamb, eggs, butter, cream, sour cream, hard cheese, beef liver, seafood, cod liver, red caviar, and fish oil. In a limited amount, the vitamin is present in plant foods: chanterelle mushrooms, oatmeal, potatoes, oranges, parsley, broccoli, nuts, and vegetable oils. It is important to follow the rules of cooking so that the useful vitamin is not destroyed.

3. Vitamin D is essential, as it is responsible for the blood levels of minerals such as calcium and phosphorus, which contribute to the preservation and strengthening of musculoskeletal tissue, and it also controls the functioning of the immune, cardiovascular, endocrine, hormonal, and nervous systems. In particular, it supports the level of innate immunity and has a good effect on vision, concentration and memory.

4. Vitamin deficiency also has serious consequences for the human body:

- The state of immunity and metabolism worsens.
- Complications during and after pregnancy.
- changes in the bone tissue begin, which leads to osteomalacia and then to osteoporosis, which is fraught with fractures and injuries
- gaining excess weight

Also, an excess of vitamin D3 has a very detrimental effect on the body. First, the consequences of intoxication are such manifestations as nausea, thirst, headaches, lack of appetite, weight loss, constipation or diarrhoea, frequent urination, dehydration, weakness, fever, convulsions, irritability, muscle and joint pain. Then there are deposits of calcium in the soft tissues, atherosclerosis may develop. Severe cases are considered loss of consciousness and coma. It is worth mentioning that an increased content of calciferol is fraught with infertility and the onset of early menopause, frequent colds, arrhythmias, hypertension, and liver enlargement. Therefore, the dosage of the vitamin should be prescribed by the doctor after receiving the results of the blood test. In case of long-term use, regular testing is necessary.

5. You can get information about how much the body is saturated with vitamin D by doing a blood test. Typically, this laboratory test is performed if osteoporosis is suspected, during pregnancy, if the woman is very little in the sun, lives in the northern regions, refused food of animal origin, has chronic diseases or hereditary disorders of the metabolism of this vitamin.

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