VITAMIN D YETISHMOVCHILIGI VA SURUNKALI KASALLIKLAR RIVOJLANISHI O‘RTASIDAGI BOG‘LIQLIK

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Annotatsiya. Mazkur maqolada vitamin D yetishmovchiligi va surunkali kasalliklar rivojlanishi o‘rtasidagi bog‘liqlik tahlil qilingan. Vitamin D ning suyak to‘qimasi metabolizmi bilan bir qatorda immun tizimi, yurak-qon tomir tizimi, endokrin tizim va modda almashinuvidagi muhim biologik funksiyalari yoritilgan. Shuningdek, vitamin D tanqisligining qandli diabet, arterial gipertenziya, yurak-qon tomir kasalliklari, osteoporoz hamda ayrim onkologik kasalliklarning rivojlanish xavfiga ta’siri ilmiy ma’lumotlar asosida baholangan. Tadqiqot natijalari vitamin D yetishmovchiligini erta aniqlash va o‘z vaqtida korreksiya qilish surunkali kasalliklarning oldini olish hamda aholi salomatligini yaxshilashda muhim ahamiyatga ega ekanligini ko‘rsatadi.[4,5]

Kalit so'zlar: vitamin D, vitamin D yetishmovchiligi, surunkali kasalliklar, osteoporoz, qandli diabet, yurak-qon tomir kasalliklari, immun tizimi.

ВЗАИМОСВЯЗЬ ДЕФИЦИТА ВИТАМИНА D И РАЗВИТИЯ ХРОНИЧЕСКИХ ЗАБОЛЕВАНИЙ

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Аннотация. В статье рассматривается взаимосвязь между дефицитом витамина D и развитием хронических заболеваний. Проанализирована роль витамина D не только в регуляции кальций-фосфорного обмена и здоровья костной ткани, но и в функционировании иммунной, сердечно-сосудистой и эндокринной систем. Особое внимание уделено влиянию дефицита витамина D на риск развития сахарного диабета, артериальной гипертензии, сердечно-сосудистых заболеваний, остеопороза и некоторых онкологических заболеваний. Результаты исследования свидетельствуют о том, что своевременное выявление и коррекция дефицита витамина D являются

важными факторами профилактики хронических заболеваний и укрепления общественного здоровья.[4,5]

Ключевые слова: витамин D, дефицит витамина D, хронические заболевания, остеопороз, сахарный диабет, сердечно-сосудистые заболевания, иммунная система.

THE RELATIONSHIP BETWEEN VITAMIN D DEFICIENCY AND THE DEVELOPMENT OF CHRONIC DISEASES

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Abstract. This article examines the relationship between vitamin D deficiency and the development of chronic diseases. It discusses the biological functions of vitamin D beyond bone metabolism, highlighting its essential role in immune regulation, cardiovascular health, endocrine function, and metabolic processes. Particular attention is given to the association between vitamin D deficiency and an increased risk of diabetes mellitus, hypertension, cardiovascular diseases, osteoporosis, and certain types of cancer. Based on current scientific evidence, the study emphasizes that early detection and appropriate correction of vitamin D deficiency may contribute to the prevention of chronic diseases, improve clinical outcomes, and enhance overall public health.[4,5]

Keywords: vitamin D, vitamin D deficiency, chronic diseases, osteoporosis, diabetes mellitus, cardiovascular diseases, immune system.

Relevance of the Study. Vitamin D deficiency has become a widespread public health problem affecting more than one billion people worldwide. Although vitamin D is traditionally recognized for its essential role in calcium and phosphorus metabolism and bone health, recent scientific evidence has demonstrated its significant involvement in immune regulation, cardiovascular function, metabolic homeostasis, and inflammatory processes. Growing evidence indicates that inadequate vitamin D levels are associated with an increased risk of developing several chronic diseases, including cardiovascular diseases, diabetes

mellitus, osteoporosis, chronic kidney disease, autoimmune disorders, and certain types of cancer.

The global increase in chronic diseases, together with the high prevalence of vitamin D deficiency, highlights the need for a better understanding of their relationship. Early identification and correction of vitamin D deficiency may contribute to reducing disease incidence, slowing disease progression, improving treatment outcomes, and enhancing patients' quality of life. Furthermore, regular assessment of serum vitamin D levels has become an important component of preventive healthcare and personalized medicine.[1,2]

Therefore, investigating the relationship between vitamin D deficiency and the development of chronic diseases is highly relevant. Understanding the biological mechanisms and clinical significance of vitamin D deficiency may support the development of evidence-based preventive strategies, improve disease management, and contribute to reducing the global burden of chronic diseases. The findings of this study may also provide valuable information for healthcare professionals in developing effective screening, prevention, and treatment programs.

Main Part. Vitamin D is a fat-soluble vitamin that plays a fundamental role in maintaining human health. Traditionally, it has been recognized for its importance in calcium and phosphorus metabolism and the maintenance of healthy bones and teeth. However, over the past two decades, numerous scientific studies have demonstrated that vitamin D exerts a wide range of biological effects beyond skeletal health. Vitamin D receptors (VDRs) are present in almost all tissues and organs, including the immune system, cardiovascular system, pancreas, muscles, kidneys, and brain. This widespread distribution suggests that vitamin D is involved in multiple physiological processes, and its deficiency may contribute to the development of various chronic diseases.

Vitamin D is synthesized in the skin through exposure to ultraviolet B (UVB) radiation from sunlight and can also be obtained from dietary sources such

as fatty fish, egg yolks, liver, fortified dairy products, and nutritional supplements. After synthesis or absorption, vitamin D undergoes hydroxylation in the liver to form 25-hydroxyvitamin D [25(OH)D], the primary circulating form used to assess vitamin D status. A second hydroxylation occurs in the kidneys, producing the biologically active form, 1,25-dihydroxyvitamin D, which regulates calcium absorption, bone mineralization, immune responses, and numerous cellular functions.

Vitamin D deficiency has become a global health concern affecting individuals of all age groups. Limited sun exposure, aging, obesity, darker skin pigmentation, poor dietary intake, chronic kidney disease, liver disorders, and gastrointestinal malabsorption are among the most common causes of vitamin D deficiency. Urbanization, indoor lifestyles, and environmental pollution have further reduced sunlight exposure, contributing to the increasing prevalence of deficiency worldwide.

One of the strongest associations between vitamin D deficiency and chronic disease involves cardiovascular disorders. Scientific evidence suggests that low serum vitamin D levels are associated with hypertension, coronary artery disease, heart failure, stroke, and endothelial dysfunction. Vitamin D contributes to cardiovascular health by regulating the renin-angiotensin-aldosterone system, reducing vascular inflammation, improving endothelial function, and modulating blood pressure. Deficiency may promote chronic inflammation, oxidative stress, and vascular calcification, thereby increasing the risk of cardiovascular complications. Although ongoing clinical trials continue to evaluate the benefits of vitamin D supplementation, maintaining adequate vitamin D status remains an important component of cardiovascular health.[1,3]

Vitamin D also plays an important role in glucose metabolism and insulin secretion. Pancreatic beta cells express vitamin D receptors, indicating that vitamin D influences insulin production and glucose homeostasis. Deficiency has been associated with insulin resistance, impaired glucose tolerance, metabolic

syndrome, and type 2 diabetes mellitus. Chronic inflammation resulting from vitamin D deficiency may further contribute to metabolic dysfunction. Several observational studies have demonstrated that individuals with lower serum vitamin D concentrations have a higher risk of developing diabetes, although the effectiveness of supplementation may vary depending on baseline vitamin D status and patient characteristics.

Bone disorders remain the most well-established consequences of vitamin D deficiency. Insufficient vitamin D reduces intestinal calcium absorption, leading to secondary hyperparathyroidism, bone demineralization, and increased fracture risk. In children, severe deficiency causes rickets, while in adults it contributes to osteomalacia and osteoporosis. Elderly individuals are particularly vulnerable because aging reduces the skin's capacity to synthesize vitamin D and decreases renal activation of the vitamin. Adequate vitamin D intake, together with sufficient calcium consumption, is therefore essential for maintaining bone strength and preventing skeletal complications.[2,5]

Recent research has highlighted the immunomodulatory effects of vitamin D. The active form of vitamin D regulates both innate and adaptive immune responses by influencing the activity of macrophages, dendritic cells, T lymphocytes, and B lymphocytes. Adequate vitamin D levels enhance antimicrobial defense while preventing excessive inflammatory responses. Vitamin D deficiency has been linked to autoimmune diseases such as multiple sclerosis, rheumatoid arthritis, systemic lupus erythematosus, inflammatory bowel disease, and type 1 diabetes mellitus. Although the exact mechanisms continue to be investigated, vitamin D appears to contribute to immune tolerance and regulation of inflammatory pathways.

Cancer prevention has also become an area of significant interest in vitamin D research. Experimental studies suggest that vitamin D regulates cell proliferation, differentiation, apoptosis, angiogenesis, and immune surveillance. Low vitamin D status has been associated with an increased risk of colorectal, breast, prostate, and

ovarian cancers in several epidemiological studies. While observational evidence is promising, randomized clinical trials have produced mixed findings regarding the protective effects of vitamin D supplementation. Nevertheless, maintaining sufficient vitamin D levels may contribute to overall cellular health and potentially reduce cancer risk in certain populations.

Vitamin D deficiency has also been associated with chronic kidney disease and chronic liver disease. Patients with kidney disease often have impaired conversion of 25(OH)D into its active form due to reduced renal function. Similarly, chronic liver disease affects the first hydroxylation step required for vitamin D metabolism. Deficiency in these patient groups may worsen mineral metabolism disorders, contribute to cardiovascular complications, and accelerate disease progression. Therefore, regular monitoring of vitamin D status is recommended in patients with chronic renal and hepatic disorders.

Diagnosis of vitamin D deficiency is primarily based on measuring serum 25-hydroxyvitamin D concentrations. This biomarker provides the most reliable assessment of vitamin D status because of its relatively long half-life and stable circulating levels. Laboratory methods such as immunoassays and liquid chromatography-tandem mass spectrometry (LC-MS/MS) are commonly used for quantitative analysis. Clinical evaluation should also include serum calcium, phosphorus, parathyroid hormone, and alkaline phosphatase measurements when disorders of bone metabolism are suspected.[3,6]

Prevention and management of vitamin D deficiency require a comprehensive approach. Regular exposure to sunlight, consumption of vitamin D-rich foods, food fortification, and supplementation are the most effective preventive strategies. Healthcare professionals should identify individuals at high risk, including older adults, pregnant women, infants, patients with chronic diseases, and individuals with limited sun exposure. Personalized supplementation based on laboratory findings and clinical guidelines can effectively restore normal vitamin D status while avoiding toxicity associated with excessive intake.

In summary, current scientific evidence demonstrates that vitamin D deficiency is closely associated with the development and progression of numerous chronic diseases. Although further large-scale clinical trials are needed to clarify causal relationships and optimize supplementation strategies, maintaining adequate vitamin D levels remains an important component of preventive medicine. Early diagnosis, appropriate laboratory monitoring, and timely correction of deficiency may significantly reduce the burden of chronic diseases, improve patient outcomes, and support healthier aging in the general population.

Materials and Methods

This study was conducted using a narrative literature review and comparative analytical approach to investigate the relationship between vitamin D deficiency and the development of chronic diseases. Relevant scientific publications published between 2019 and 2026 were identified through internationally recognized databases, including PubMed, Scopus, Web of Science, Google Scholar, and ScienceDirect. Original research articles, systematic reviews, meta-analyses, and international clinical guidelines related to vitamin D metabolism, deficiency, and chronic diseases were included in the analysis.[7,8]

The literature review focused on studies evaluating the association between serum vitamin D levels and the risk of developing major chronic diseases, including cardiovascular diseases, diabetes mellitus, osteoporosis, chronic kidney disease, autoimmune disorders, and cancer. Particular attention was given to research examining the biological mechanisms of vitamin D, laboratory assessment of vitamin D status, preventive strategies, and the clinical effectiveness of vitamin D supplementation.

The collected data were analyzed using descriptive and comparative methods. Scientific findings from different studies were systematically compared to evaluate the diagnostic significance of serum 25-hydroxyvitamin D [25(OH)D] concentration, the impact of vitamin D deficiency on disease development, and the effectiveness of preventive and therapeutic interventions. Priority was given to

peer-reviewed publications with high methodological quality and evidence-based conclusions.

Only full-text articles published in English with clearly described methodologies and reliable scientific evidence were included in the review. Duplicate publications, conference abstracts without complete data, and studies with insufficient methodological quality were excluded. The synthesized evidence provides a comprehensive overview of the current understanding of vitamin D deficiency and its relationship with chronic diseases, highlighting its importance in preventive medicine and clinical practice.[9,10]

Conclusion. Vitamin D deficiency is a significant factor associated with the development and progression of various chronic diseases. Numerous studies have demonstrated that inadequate vitamin D levels increase the risk of cardiovascular diseases, diabetes mellitus, osteoporosis, autoimmune disorders, and certain types of cancer. Therefore, regular assessment of vitamin D status, particularly among high-risk populations, along with timely diagnosis and evidence-based prevention and treatment strategies, is essential. Optimizing vitamin D levels may contribute to reducing the incidence and severity of chronic diseases, improving patient outcomes, and enhancing overall quality of life. Consequently, the implementation of comprehensive public health programs aimed at preventing and correcting vitamin D deficiency should be considered a priority in modern healthcare systems.

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