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THE ROLE OF VITAMIN D IN MILITARY PERSONNEL INFECTED WITH HUMAN IMMUNODEFICIENCY VIRUS (LITERATURE REVIEW)

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Abstract

HIV infection is considered a serious global threat to human health. Particularly among military personnel, the prevention, diagnosis, and treatment of this disease are of strategic importance. High physical and psychological stress, exposure to diverse climatic conditions, and nutritional problems negatively affect the immune system of military service members. Therefore, the course and complications of HIV infection in this group may have unique characteristics compared to the civilian population.

Keywords

Human immunodeficiency virus, acquired immunodeficiency syndrome, people living with HIV/AIDS, military personnel, immune system, vitamin D, antiretroviral therapy, supplements.

Although HIV infection has been regarded globally as a life-threatening disease, over the past two decades, medical professionals and researchers have significantly expanded their knowledge of HIV infection, including its diagnosis and treatment options. Today, HIV infection is no longer viewed as a disease inevitably ending in death. Currently, HIV infection is recognized as a viral, chronic (long-term) condition that can be fully controlled (viral suppression) with medications. This also makes it possible to completely prevent transmission of the virus to others [4, 5].

The global AIDS epidemic continues to affect all countries and regions of the world, remaining a global emergency and one of the most serious challenges in healthcare, social and economic development, as well as human rights [1]. Large-scale studies on life expectancy among people living with HIV have shown that over the past twenty years, their lifespan has significantly increased and is nearly comparable to the general population. For example, between 1996–1997 and 2011, the projected life expectancy at age 20 among people living with HIV increased

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from 19 years to 53 years. Meanwhile, among HIV-negative cohorts, life expectancy increased from 63 years to 65 years. This improvement is linked to early diagnosis and immediate initiation of ART regardless of CD4+ lymphocyte counts [10]. Looking back at the history of AIDS, since the start of the global epidemic, more than 75 million people have contracted HIV, and over 32 million people have died from AIDS-related illnesses [6]. At present, 39 million people are living with HIV worldwide, and as of 2022, more than 1.3 million new cases of HIV infection were recorded [7].

According to official data, as of January 1, 2024, a total of 49,152 people living with HIV were registered in Uzbekistan. Among them, 23.2% were in Tashkent city, 15.3% in Andijan region, 14.5% in Tashkent region, 9.7% in Samarkand region, and 8.2% in Fergana region. At present, the HIV epidemic in Uzbekistan is in a concentrated stage. In 2023, the incidence of HIV in the general population was 10.46 per 100,000 people. Men accounted for 58.4% of cases, while women accounted for 41.6%. The gender distribution of HIV prevalence may be related to the higher occurrence of risk behaviors among men [8].

An analysis of the epidemic dynamics in Uzbekistan shows that HIV infection had a sporadic nature between 1987 and 1999. Starting from 2000, the number of HIV-infected individuals began to increase sharply (Fig 1.). According to data from the Republican AIDS Prevention Center, this was caused by the spread of HIV among people who use injectable drugs. In 2002, the number of newly detected HIV cases was 981, whereas by 2009, this figure had reached 4,016. Between 2009 and 2018, the number of newly diagnosed HIV cases averaged around 3,500 per year [9].

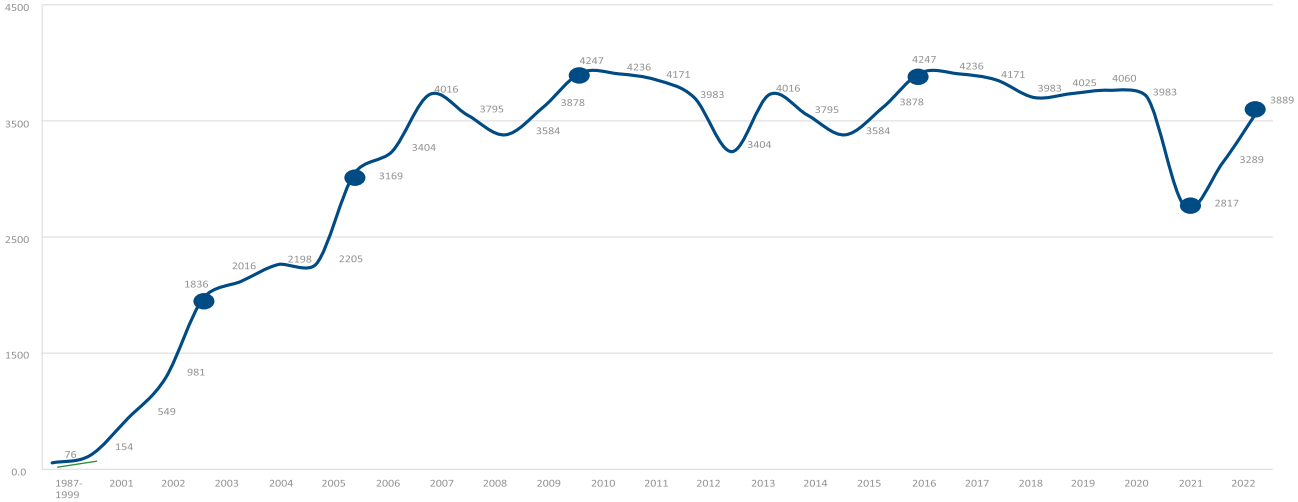

Fig 1. The dynamics of HIV cases in Uzbekistan.

Analysis of available data on HIV transmission routes shows that the proportion of parenteral transmission has been decreasing year by year, while the number of sexually transmitted cases has been increasing. In 2022, 79% of HIV

transmissions occurred through sexual contact, 12.7% through parenteral routes, and in 7.7% of cases, the transmission factors could not be determined [9].

If we consider the age distribution of HIV cases in Uzbekistan, in 2022 the majority of newly diagnosed cases occurred in the 30–39 age group, accounting for almost 29% of all new HIV cases [9].

Among military personnel, the course of the disease has unique features, as they are exposed to high physical and psychological stress, as well as climatic factors. Therefore, supporting the immune system and reducing complications in HIV-infected military personnel are considered key tasks. Vitamin D is seen as an important substance in this process. The role of vitamin D in HIV-infected military personnel has become the subject of many scientific studies. Vitamin D plays a significant role in the functioning of the immune system: it increases the number of CD4+ lymphocytes, reduces inflammatory responses, helps slow disease progression, and may enhance the effectiveness of antiretroviral therapy. Studies show that vitamin D deficiency is more common among HIV-positive military personnel, since their lifestyle often limits exposure to sunlight (for example, during long-term service at military bases or in interior regions). In combination with HIV, such deficiency may worsen the disease. Supplementation improves immune reactivation. Recent research has confirmed that vitamin D plays a crucial role in immune system functioning [2, 3].

Vitamin D is a fat-soluble vitamin available in two main forms: D_2 (ergocalciferol), obtained from food, and D_3 (cholecalciferol), synthesized in the skin under ultraviolet radiation (Fig. 2). Beyond its classical role in regulating calcium-phosphorus metabolism and maintaining bone health, vitamin D also has immunomodulatory, anti-inflammatory, and antiproliferative properties. These functions are particularly important in the context of chronic diseases, including HIV infection and AIDS. Vitamin D receptors (VDR) are present in many immune cells in the human body: T-lymphocytes, B-lymphocytes, macrophages, and dendritic cells. This ensures its involvement at every stage of the immune response. Vitamin D's role in innate immunity is part of the body's first line of defense: it activates macrophages and monocytes, enhancing their ability to destroy bacteria. It stimulates the production of antimicrobial proteins (such as cathelicidin and defensins), which directly kill bacteria and viruses. In mucosal surfaces (lungs, intestines, urinary tract), protective capacity against infections is strengthened [9].

Vitamin D is also involved in the development of adaptive (acquired) immunity, where lymphocytes (T-cells) play a central role. Vitamin D regulates Th1 and Th17 cells that promote inflammation, thereby reducing excessive immune responses and lowering the risk of autoimmune diseases. It increases the number of

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regulatory T-cells (Treg), which maintain immune balance and help prevent autoimmune disorders. In B-cells, vitamin D influences antibody production, making the body's response to specific infections more effective [10].

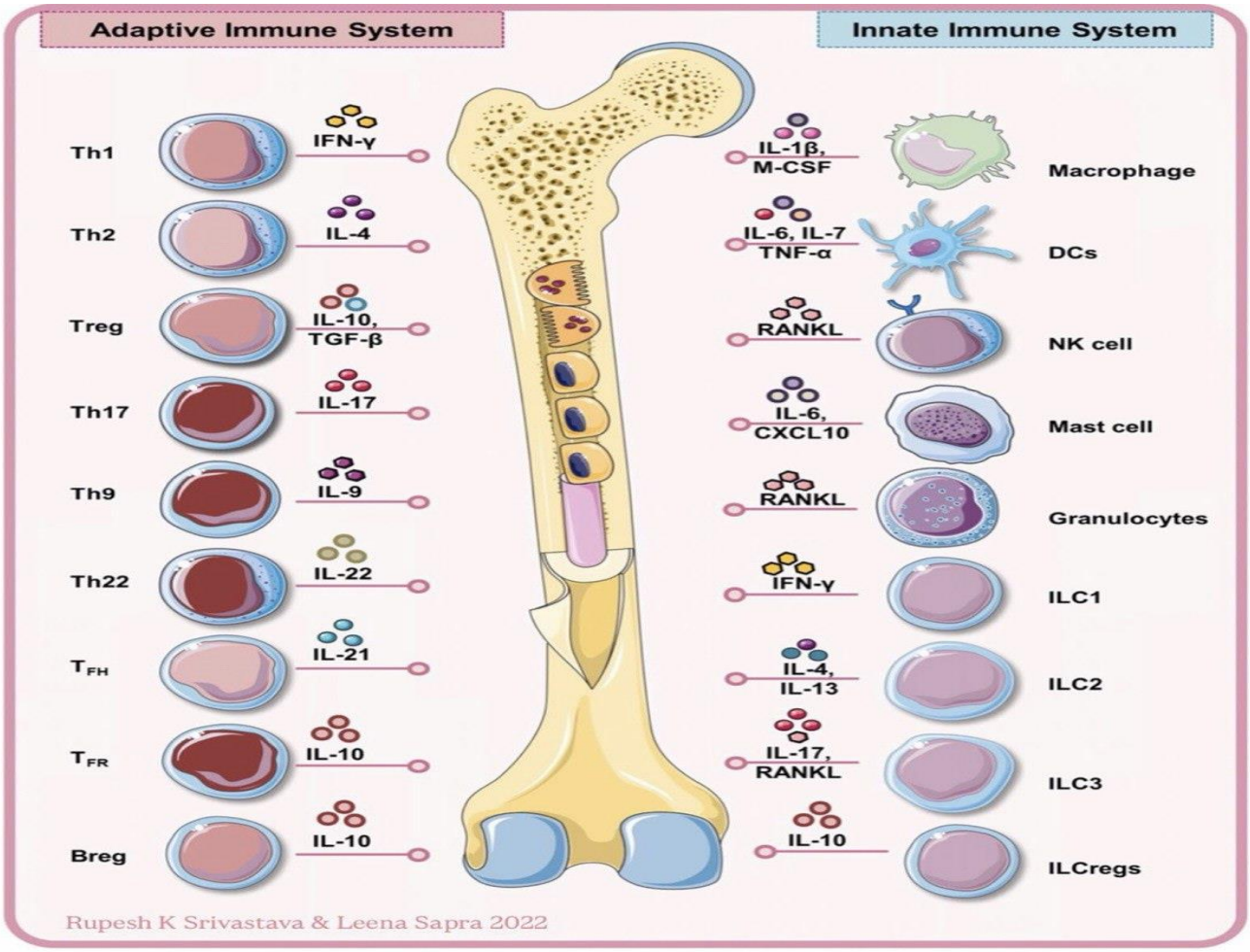

Fig 2. Innate and Adaptive Immune System (Rupesh K., Srivastava & Leena Sapra, 2022)

HIV primarily weakens immunity by destroying CD4+ T-lymphocytes. Vitamin D helps preserve the number and function of CD4+ cells (Fig. 3). Some studies show that sufficient vitamin D levels accelerate CD4 recovery and improve ART effectiveness. Vitamin D deficiency is widespread among people with HIV, occurring in 60–80% of patients. Causes include the impact of the virus on the immune system, ART (especially drugs like efavirenz that disrupt vitamin D metabolism), lack of sunlight exposure, and dietary restrictions [11].

Vitamin D deficiency is highly prevalent among people living with HIV. This is associated with lifestyle, liver diseases, ART effects, and chronic inflammation characteristic of HIV infection. Deficiency accelerates HIV progression, negatively affects both innate and adaptive immunity, contributes to immune system

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hyperactivation and chronic inflammation, and consequently increases the risk of non-AIDS-related diseases and mortality [12].

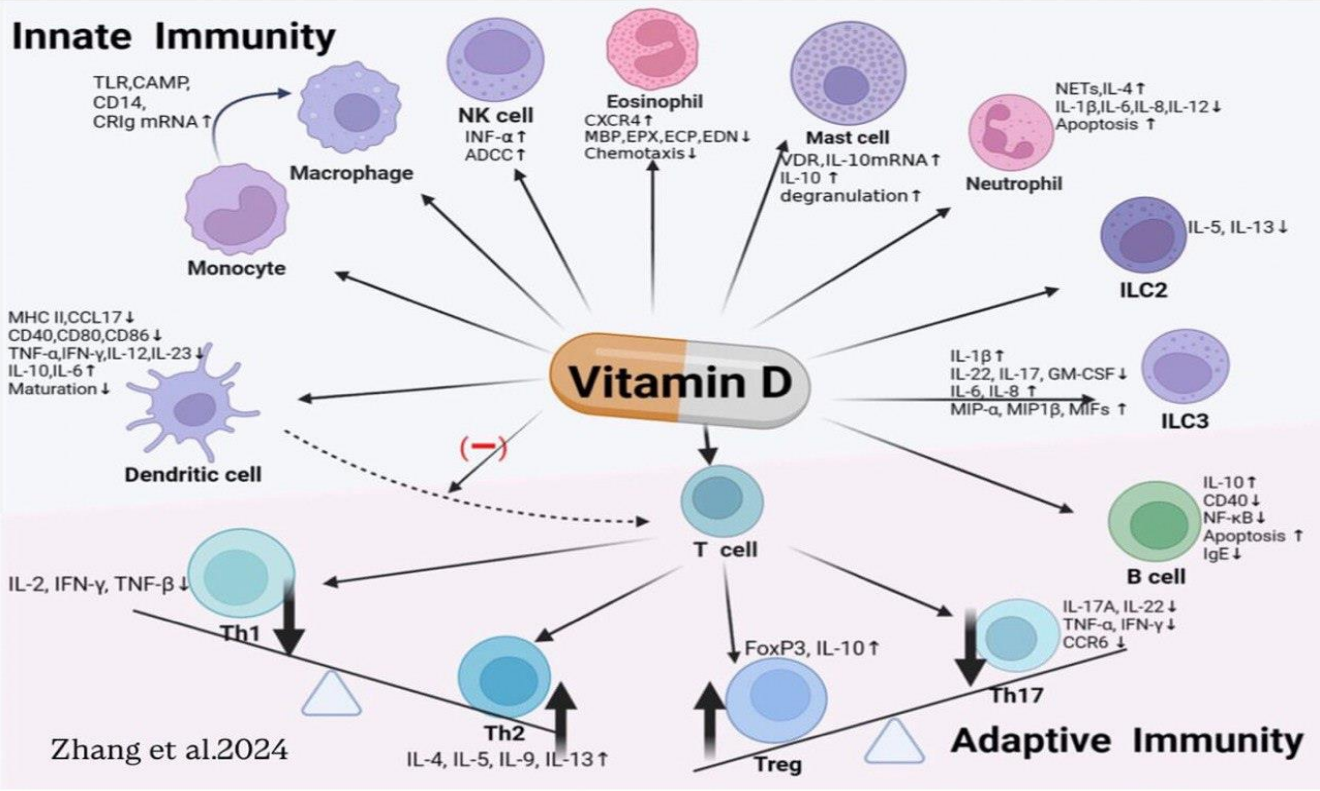

Fig 3. Effect of Vitamin D on the Immune System (Zhang et al. 2024)

Scientific studies show that vitamin D deficiency intensifies immune activation and inflammation in HIV infection. Another feature of vitamin D is its protective effect on bone and muscle health, which is important since many patients develop osteopenia or osteoporosis due to HIV and ART. Adequate vitamin D prevents bone fractures by improving calcium metabolism [13].

Clinical observations indicate that HIV patients receiving vitamin D supplementation experience slower CD4 decline or faster CD4 recovery; if viral load is controlled, immune reconstitution is faster; and when combined with ART, the risk of bone weakening is reduced [14].

Thus, vitamin D supplementation in HIV-infected patients supports the immune system, increases or stabilizes CD4+ counts, reduces pro-inflammatory cytokines (IL-6, TNF-α), and mitigates chronic inflammation. It lowers the risk of infections, strengthens natural defenses against opportunistic infections (such as tuberculosis, pneumonia, and fungal infections), and helps reduce severe complications of HIV infection during ART. It also stimulates the production of antimicrobial proteins (cathelicidin) [15].

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