

Vitamin D and Chronic Obstructive Pulmonary Disease

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Chronic obstructive pulmonary disease (COPD) is one of the most prevalent diseases of the respiratory system in the elderly, and it poses a grave threat to the survival and quality of life. Examining the pathogenesis of COPD is extremely important for COPD prevention and treatment. To date, however, there is no medication for chronic obstructive pulmonary disease that can delay the lung function decline over time. According to studies, vitamin D offers new hope for the treatment of COPD. A deficiency in vitamin D can exacerbate the progression of COPD, whereas adequate vitamin D has a therapeutic effect on COPD. This paper summarizes the relevant domestic and international research, discusses the possible mechanism of vitamin D's effect on COPD, and investigates the role of vitamin D, particularly in COPD patients.

Keywords: Vitamin D; Obstructive Pulmonary Disease; Chronicity; Pulmonary Function

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IN chronic obstructive pulmonary disease (COPD), aberrant airway inflammation brought on by hazardous gases or particles is linked to airflow limitation that is not entirely reversible (1). Patients may experience respiratory failure, pulmonary encephalopathy, and even death in severe cases during the acute aggravation of the illness, which poses a substantial threat to the patient's quality of life (2). By 2030, according to some academics, COPD will be one of the top five chronic diseases worldwide in terms of morbidity and mortality (3). The significance of vitamin D and its active form, 1,25-dihydroxyvitamin D₃ (1,25-(OH)₂D₃), in respiratory immune defense has come to light in recent years (4), and the percentage of COPD patients who are vitamin D deficient has increased from 31% and 77% (5). In order to support the prevention and

treatment of COPD, we herein evaluated the connection between vitamin D and COPD and its impact on the disease's development.

The Relationship between Vitamin D Deficiency and COPD

Peripheral blood serum 1,25-(OH)₂D₃ levels are less than 20 ng/mL, and then vitamin D deficiency should be diagnosed, according to the clinical practice guidelines for the assessment, treatment, and prevention of vitamin D deficiency (6). Vitamin D deficiency is prevalent in COPD patients, according to a study comprising 12,041 COPD patients, and it may be brought on by a systemic inflammatory response, hormone use, nutritional inadequacies, smoking-induced skin aging, and a lower capacity

to synthesis vitamin D (7). Patients with COPD may be deficient in vitamin D because of inadequate sun exposure and other variables that influence vitamin D absorption, production, storage, and metabolism (8). In addition, COPD patients frequently have impaired renal function and decreased adipose tissue as a result of intake, which impairs the skin's capacity to produce vitamin D and results in vitamin D deficiency (9). In patients with COPD grades I–III, Yumrutepe et al. investigated the relationship between vitamin D and lung function, muscle strength, and balance (10), and the findings demonstrated that when COPD grades increased, the body's vitamin D level declined in patients, resulting in a decline in pulmonary function, muscle strength, and balance. Balance and muscular strength are both compromised. Furthermore, vitamin D insufficiency is also prevalent in COPD patients, and the severity of the condition is correlated with the severity of the illness (FEV1 decrease) (11).

Vitamin D-Binding Protein (VDBP) Gene Polymorphisms and COPD

VDBP is a hepatocyte-secreted protein. It has the ability to bind vitamin D and G-actin, boost the chemotactic activity of C5 polypeptide on inflammatory cells such as neutrophils, and stimulate macrophages to remove extracellular G-actin from necrotic tissue (12). Results indicated that the genotype of VDBP may be associated with race. The GC1F genotype is the most prevalent in the Asian population, accounting for approximately 50% of the overall population (13), whereas the GC1S genotype is the most prevalent in the Caucasian population (14). Homozygous GC1F may be a high-risk factor for COPD, whereas allele 2 (GC2) may be a protective factor that reduces the incidence of COPD (15). GC gene polymorphism is associated with the content and function of vitamin D-binding protein, including the affinity of vitamin D-binding protein to 1,25-(OH)2D3, the rate of conversion into macrophage activating factor and levels, and the ability to promote neutrophil chemotaxis (12, 16). By influencing vitamin D level and function, GC gene polymorphism may influence the prevalence and progression of COPD.

Vitamin D and Lung Function

The most reliable data on the connection between vitamin D and lung function can be found in the third National Health and Nutrition Examination Survey conducted in the United States (17). In 14,091 patients, 1,25-(OH)2D3 concentrations ranged from the greatest (> 85.7 nmol/L) to the lowest (40.4 nmol/L). The difference in mean vital capacity (FVC) was 172 mL, while the mean difference in forced expiratory volume per second (FEV1) was 126 mL. The individuals received vitamin D supplements, milk, and plasma antioxidant levels. In the greatest and lowest 1,25-(OH)2D3 groups, the mean difference in FEV1 was 106 mL, while the mean difference in FVC was 142 mL. The researchers further altered the parameters of physical activity and showed the connection between vitamin D and lung health. After adjusting for variables like age, sex, body mass, and season, the two-year Korean Health and Nutrition Survey in South Korea revealed that the mean difference in FEV1 between the highest and lowest 1,25-(OH)2D3 was 51 mL, the mean difference in FVC was 58 mL, and the mean difference in FEV1 in

patients with a history of pulmonary tuberculosis was as high as 229 mL (18). Additionally, the findings thoroughly supported the link between vitamin D status and lung health, particularly in tuberculosis patients. Furthermore, vitamin D deficiency worsens COPD symptoms in patients, which is directly associated to skeletal muscle weakness and an increased risk of fractures from osteoporosis (19, 20). Kyphosis, vertebral body, and rib fractures are all brought on by osteoporosis. The decrease in respiratory dynamism causes insufficient pulmonary ventilation and sputum obstruction, which exacerbates the disease, deteriorates lung function, and influences the occurrence and development of COPD. On the one hand, it can restrict respiratory movement and respiratory muscle dysfunction, resulting in a decrease in FEV1 and FVC. In a study of Canadian adults, a strong correlation was found between vitamin D insufficiency and lung function in overweight individuals, but not in normal-weight individuals (21).

Vitamin D and Immune Regulation

Recent study has demonstrated an imbalance between Th1 and Th2 cells in the T lymphocytes invading COPD. Th17 is a subpopulation of T cells that is significant in autoimmune illnesses like rheumatoid arthritis and psoriasis as well as chronic inflammatory cells (22). The main function of Th17 cells is interleukin (IL)-17 secretion. Accordingly, 1,25-(OH)2D3 can effectively prevent Th17 cells from secreting IL-17 (23). In stable COPD patients, IL-17 was expressed in the bronchial mucosa at a higher level than in the control group, and Th17 was crucial to the emergence and progression of chronic inflammation in COPD (24). 1,25-(OH)2D3 can greatly reduce Th17 generation, which is advantageous for disorders caused by T cell-mediated immunity (25). These investigations demonstrated that 1,25-(OH)2D3 can block the development and occurrence of illnesses that are mediated by Th1/Th17 cells. Vitamin D is advantageous in inflammatory bowel disease, multiple sclerosis, and other disorders because it can reduce the release of IL-17 and IFN- by increasing IL-4 and IL-10 (26). IL-10 possesses anti-inflammatory properties and can inhibit both the Th1 and Th2 immune responses as well as the generation and release of nearly all inflammatory mediators and cytokines (27).

The Relationship between Vitamin D and Acute Exacerbations of COPD

Acute COPD exacerbations (AECOPD) are most frequently brought on by bacterial, viral, or a combination of the two (28). Patients with vitamin D deficiency have reduced hCAP-18 antimicrobial peptide expression and impaired function of these cells, which increases their risk of developing or exacerbating respiratory tract infections (29). Increasing the concentration of 1,25-(OH)2D3 in patients with COPD to an ideal value can reduce the bacterial load and help prevent the disease (30). Insufficient vitamin D has been linked to chronic respiratory tract infections and bacterial colonization of the airways and the progression of COPD is slowed down and made worse by complications (31). In 973 COPD patients, Kunisaki et al. did not find a connection between the serum vitamin D level and the risk of an acute aggravation of the disease (32). However, Ginde and coworkers in their extensive cross-sectional investigation found

that serum vitamin D levels were strongly correlated with the exacerbation of COPD infection and inversely correlated with the prevalence of upper respiratory tract infections (33). Acute COPD exacerbations are more common in the winter, which may be associated to a lack of vitamin D (32, 34). Lack of vitamin D impairs immune cell function by weakening the expression of the antimicrobial peptide hCAP-18, which increases the risk of lower respiratory tract infections (35, 36).

Conclusion

In conclusion, people with COPD frequently lack vitamin D. AECOPD is closely associated to vitamin D insufficiency, which also has a significant role in the inflammation, immunological control, regulation of lung function, and occurrence and progression of COPD. In order to enhance the health and prognosis of COPD patients, it is advised that they take the proper amount of vitamin D supplements. ■

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