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Micronutrient Level Among Patients with Chronic Obstructive Pulmonary Disease

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Abstract:
Chronic obstructive pulmonary disease (COPD) is a serious health problem today. Every year there is an increase in the number of cases of COPD around the world, which is accompanied by a deterioration in the quality of life of patients, temporary loss of ability to work, and even death.
Deficiencies of macro- and microelements are currently recognized by world medicine as a global problem. These conditions have a significant impact on the body, presenting an urgent need for the development of effective health strategies to address them.
According to available data, nutritional deficiencies are quite common in patients with COPD. Numerous studies highlight the impact of micronutrient deficiencies on disease progression. Currently, the connection between bronchopulmonary diseases and low levels of vitamin D and magnesium in the body of patients is being actively studied. Insufficient outdoor activity, infrequent exposure to sunlight, poor diet, alcoholism, smoking, decreased ability of the skin to synthesize vitamin D in smokers, general exhaustion of the body, and the use of certain antibiotics can be the causes of low levels of vitamin D and magnesium. Many studies indicate that deficiencies of these elements may be associated with decreased lung function and increased exacerbations in COPD, which contributes to disease progression.
Deficiency conditions, which often remain undiagnosed, can negatively affect the prognosis of the disease. This study identifies the incidence of low blood levels of vitamin D and magnesium and demonstrates the relationship between low levels of these elements and the severity of COPD.
Key words: COPD, vitamin D, magnesium, frequency of occurrence, deficiency, deficiency, deficiency conditions, severity.

Today, chronic obstructive pulmonary disease (COPD) is a pressing problem in the healthcare system among the adult population. Despite significant advances in the diagnosis and treatment of this disease, COPD is still associated with serious complications and can be fatal. Every year there is a steady increase in the prevalence of this disease. The World Health Organization (WHO) estimates that more than 65 million people currently suffer from moderate to severe forms of COPD.
Based on the available evidence, micronutrient deficiencies are common in patients with COPD. Research conducted by V.I. Shevtsova indicates that micronutrient deficiency can influence the course and progression of this disease.
Currently, the relationship between bronchopulmonary diseases and vitamin D deficiency is being actively studied. Vitamin D deficiency is a global problem, especially common in developed countries, where the natural synthesis of vitamin D in the skin is possible only in the summer from 11:00 to 14:00 in the absence of smog, clouds and thick clothing. These countries are also experiencing a rapid increase in bronchopulmonary diseases. Various studies indicate a relationship between low levels of vitamin D in the body, impaired lung function and an increased risk of infectious and inflammatory diseases [2, 5, 7].
There is currently active research into the relationship between COPD and vitamin D levels. Reasons for low vitamin D levels may include insufficient outdoor physical activity, limited exposure to sunlight, poor diet, reduced ability of the skin to synthesize vitamin D in smokers, and general exhaustion of the body [12].
To date, scientists have found that vitamin D promotes the activation of protective and immune cells, including monocytes, macrophages, lymphocytes and epithelial cells. Vitamin D receptors (VDRs) have been found in these cells [6]. Vitamin D levels influence the normal functioning of innate and acquired immunity [26].
Vitamin D deficiency can impair the antibacterial function of macrophages, as well as the immune defense of the lungs, which can subsequently increase the risk of developing pathological respiratory infections [11, 17].

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Low vitamin D levels may increase susceptibility to recurrent infections, promote microbial colonization of the airways, and accelerate decline in lung function.

Therefore, active research is being conducted into the possible impact of vitamin D deficiency in patients with COPD on chronic inflammation, impaired immune response, and a decrease in the body's resistance to acute respiratory diseases [4, 5, 15]. Viral and bacterial infections are considered the main factors that contribute to exacerbations of COPD [13]. Frequent exacerbations, in turn, lead to a rapid deterioration in FEV1 and disease progression [16, 17, 18, 10], which may increase the risk of death from COPD [13].

Some studies highlight that vitamin D deficiency can maintain inflammation in the airways, increasing their reactivity and influencing the degree of obstruction, which, in turn, increases the frequency of exacerbations [19].

It was found that there is a relationship between vitamin D deficiency and the length of hospitalization of patients with chronic obstructive pulmonary disease during an exacerbation. According to a study by Mekov E. et al., the length of hospital stay in patients with vitamin D levels less than 25 nmol/L was longer compared to patients whose vitamin D levels exceeded 25 nmol/L [21].

Magnesium is also an essential biogenic element, found in significant quantities in the tissues of animals and plants. This macroelement ranks fourth in quantity in the body after sodium, potassium and calcium, and magnesium ions play an important role in the regulation of almost all organs and systems.

Magnesium deficiency is quite common. There are not enough foods containing magnesium in your daily diet. A lack of magnesium in the body is also caused by an unhealthy lifestyle, weight loss using a one-sided diet, consumption of fatty foods, unhealthy diet (excess of sweets and white flour products, fried and fatty foods), consumption of foods high in calcium or deficiency of vitamins B1, B2 and B6, alcoholism, smoking, excess phosphate, laxatives and diuretics, certain antibiotics, extreme sports, pregnancy, breastfeeding, chronic stress and environmental disasters (most of the body's magnesium reserves are spent fighting smog, smoke, stress , pesticides, etc.) [3].

The results of epidemiological studies indicate that magnesium deficiency actually plays an important role in the formation of various cardiovascular diseases, pathologies of the respiratory system, as well as neuropsychiatric disorders, especially those associated with age [8].

Magnesium deficiency is common in patients with COPD. Magnesium is a natural modulator of the relaxation of smooth muscles of the arteries and bronchi, and affects the activity of inflammation in the bronchi and lungs. Mainly magnesium has the properties of dilating the bronchi in the respiratory tract. Scientific studies indicate an association between magnesium, decreased lung function and increased exacerbations in COPD [22, 23, 9, 20]. It has been found that extremely low dietary magnesium intake may be a risk factor for the development of asthma and COPD [24], contributing to the progression of the disease.

Although existing studies provide valuable data on the relationship between vitamin D and magnesium deficiency and COPD, additional research is needed to better understand the mechanisms by which these deficiencies influence disease progression. Given the complexity of the relationships between micronutrients, the immune system, and respiratory function, further research may be key to developing more precise strategies for the prevention and treatment of COPD.

Aim: to assess the level of vitamin D and magnesium in the blood serum of patients with chronic obstructive pulmonary disease.

Material and methods: The study included 100 patients with a documented diagnosis of COPD (86% (86) men and 14% (14) women) who were hospitalized at the Russian National Research Medical Center for Phthisiology and Pulmonology. To confirm the diagnosis and determine the severity of the disease, spirometry was performed using the SMP-21/01-R-D device (Monitor, Russia). The average age of the patients was 66 ± 8 years. In total, the study included patients with severe stage III COPD - 15 people (15%) and patients with extremely severe stage IV COPD - 85 people (85%). According to the reference values, the presence of vitamin D deficiency was assessed - 25(OH)D <20 ng/ml; vitamin D deficiency - 25(OH)D 20–30 ng/ml; normal vitamin D content is >30 ng/ml (Holick M. F. et al., 2011).

Serum magnesium levels were measured in all patients with exacerbation of COPD on admission. Serum magnesium levels <0.66 mmol/l were considered hypomagnesemia, normal magnesium levels in the blood were 0.66-1.07 mmol/l (O. A. Gromova et al., 2014).

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Statistical analysis was carried out using the STATISTICA 13.3 program (developed by StatSoft.Inc). All values in the text are presented as the arithmetic mean of the variation series of the error of the mean (M±m). Values with $p<0.05$ (with a confidence level of 95%) were used as a statistical hypothesis.

Results and discussions: The average vitamin D level among all examined patients was 34.18 ± 17.41 ng/ml (95%CI 30.72 – 37.63).

36% of patients had a decreased level of vitamin D. At the same time, 11% of patients had vitamin D deficiency, and 25% of patients had vitamin D deficiency.

The study found that vitamin D levels vary depending on the stage of COPD. The difference in vitamin D levels depending on the stage of COPD is presented in Table 1.

Table 1

Vitamin D level depending on the stage of COPD

Index	Categories	Vitamin D in blood (ng/ml)		
		M ± SD	95% CI	n
COPD stage	COPD III	37,56 ± 18,59	27,27 – 47,86	15
	COPD IV	33,58 ± 17,24	29,86 – 37,30	85

Among patients with COPD III, vitamin D deficiency was detected in 13.3% (2) of cases, while vitamin D deficiency occurred in 20% (3) of patients. In patients with COPD IV, vitamin D deficiency was observed in 10.6% of cases (9), and vitamin D deficiency was detected in 25.9% (22) (Fig. 1).

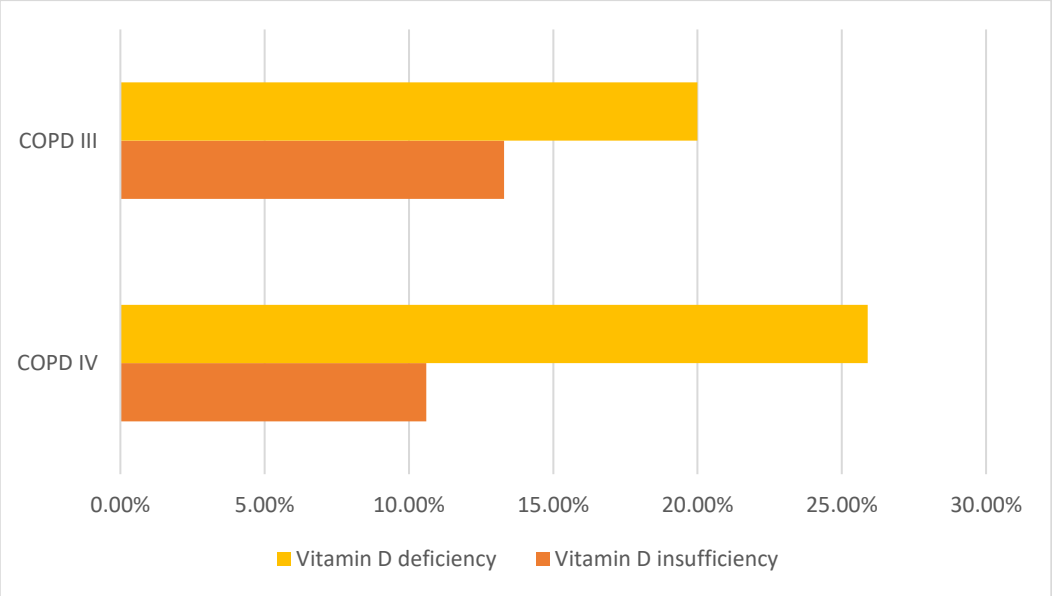

Fig. 1 Vitamin D levels among patients with COPD III and COPD IV

The average magnesium level among all examined patients was 0.65 ± 0.08 mmol/l (95% CI 0.64 – 0.67). Magnesium deficiency was detected in 46% of patients.

The study found that magnesium levels also vary depending on the stage of COPD. The difference in magnesium levels depending on the stage of COPD is presented in Table 2.

Table 2

Magnesium level depending on the stage of COPD

Index	Categories	Magnesium in blood (mmol/l)		
		M ± SD	95% CI	n
COPD stage	COPD III	0,67 ± 0,08	0,62 – 0,71	15
	COPD IV	0,65 ± 0,08	0,64 – 0,67	85

Among patients with COPD III, magnesium deficiency occurred in 26.7% (4) of patients. In patients with COPD IV, magnesium deficiency was detected in 49.4% (42) (Fig. 2).

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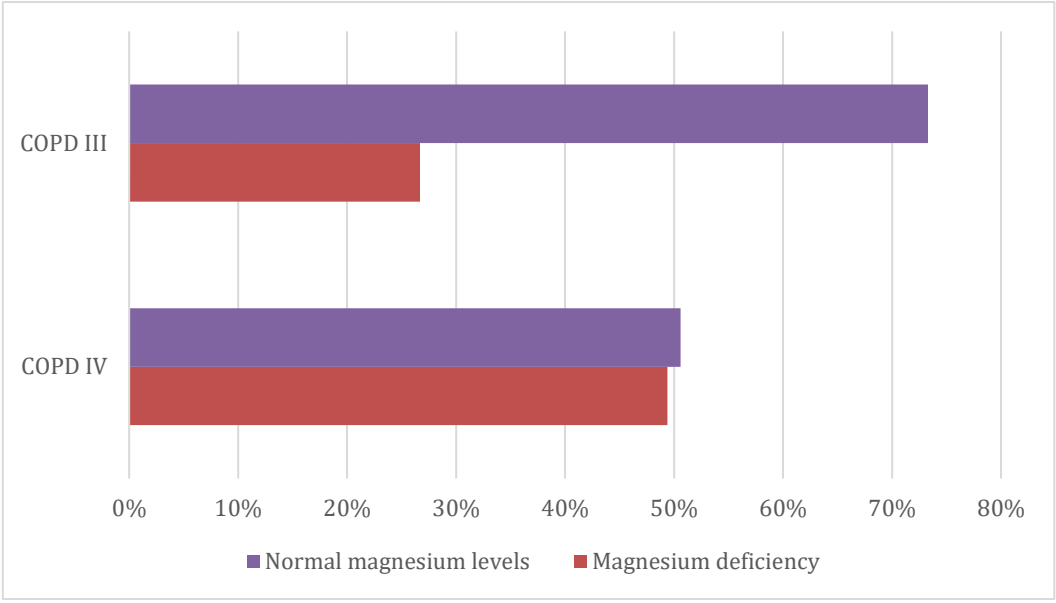

Fig. 2 Magnesium levels among patients with COPD III and COPD IV

The results of our study highlight the high incidence of vitamin D and magnesium deficiencies among patients suffering from chronic obstructive pulmonary disease, which is consistent with the findings of previous studies. According to the work of Janssens W., 33-77% of patients with COPD have vitamin D deficiency [14]. Other sources note that the proportion of patients with vitamin D deficiency can reach up to 83.6% [21]. A meta-analysis of five studies shows a statistically significant decrease in blood levels of vitamin D in patients with COPD compared to healthy controls [4]. Evidence suggests that vitamin D deficiency may nearly double the risk of developing COPD and triple the risk of severe disease. In addition, vitamin D levels correlate with the degree of obstruction in patients with COPD, with those with a lower FEV1 value and a higher annual decline in this indicator having lower vitamin D levels [1, 15, 17, 21, 25].

Magnesium deficiency is also common in patients with COPD. Many studies have noted an association between magnesium deficiency and deterioration of lung function, as well as an increase in the frequency of exacerbations in COPD [22, 23, 9, 20].

Our study also confirms these theories. We found that deficiency states are most common in patients with more severe COPD. All this indicates the need to pay more attention to this problem in clinical practice, including early diagnosis and an integrated approach to the treatment of these patients, including the normalization of deficit conditions.

Conclusions: Among COPD patients, there is a high incidence of low levels of vitamin D and magnesium in the blood. The lowest levels of vitamin D and magnesium are observed in patients with COPD IV.

The incidence of vitamin D deficiency increases depending on the stage of COPD. The incidence of vitamin D deficiency in patients with COPD IV exceeds the incidence of deficiency in patients with COPD III. In patients with COPD III, vitamin D deficiency occurred in 20% of patients, and in patients with COPD IV - in 25.9%.

The incidence of magnesium deficiency was also higher in patients with COPD IV. Among patients with COPD III, magnesium deficiency occurred in 26.7% of patients. In patients with COPD IV, magnesium deficiency was detected in 49.4%

Thus, deficiency states may be associated with the severity of COPD. That is why, for successful treatment and rehabilitation of patients with COPD, the content of these indicators should be diagnosed for early detection and assessment of the severity of low levels of vitamin D and magnesium in the blood, followed by correction of identified disorders. This can improve treatment outcomes, reduce the number of exacerbations, reduce disease progression and the risk of death.

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