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Association between serum 25-hydroxyvitamin D concentration and severity of seasonal allergic rhinitis in Karaganda region (Kazakhstan)

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Abstract

Background: Vitamin D deficiency (VDD) is the one of the major public health problem affecting approximately one billion people all over the world. In recent years, the relationship of allergic diseases with a low concentration of vitamin D has been studied worldwide. An association has been found between small count of serum vitamin D and the development of immune disorders. Patients with allergic disorders and, in particular, with respiratory allergy are susceptible for VDD.

Objective: The study was aimed to assess the levels of serum 25-hydroxyvitamin D (25(OH)D) and their associations with the severity of seasonal allergic rhinitis in the Karaganda region (Kazakhstan).

Material and methods: This cross-sectional study included 416 patients with seasonal allergic rhinitis aged 18-65 years (mean age 39±8 years), 267 of whom were females. VDD was defined as serum concentrations of 25(OH)D below 20 ng/ml.

Results: The median concentration of 25(OH)D in blood serum was below the reference threshold (20 ng/ml) and amounted to 16.1 ng/ml. 75% of patients with seasonal allergic rhinitis had VDD and this was common in all age categories. VDD was more prevalent in female patients (82.8%) as compared with the male patients (61.1%) (p<0,01). Of interest is the fact that low serum 25(OH)D concentration correlated with the severity of symptoms (r =-0.94 and r =-0.67).

Conclusion: According to our study, the significant part of patients with allergic rhinitis residing in Karaganda region (Kazakhstan) had deficient status of 25(OH)D and this correlated with the severity of symptoms.

Key words: adults, vitamin D deficiency, Karaganda region, Kazakhstan

Introduction

Vitamin D deficiency (VDD) is the one of the major public health problem affecting approximately one billion people all over the world. In recent years, the relationship of allergic diseases with a low concentration of vitamin D has been studied worldwide. An association has been found between small count of serum vitamin D and the development of immune disorders [1]. Patients with allergic disorders and, in particular, with respiratory allergy are susceptible for VDD [2].

It is known, that the participation of vitamin D is related to development of allergic processes. Vitamin D is considered as an immunomodulatory [3, 4] acting on dendritic cells (DC), macrophages, T-cells and B-cells [1, 5, 6]. Activated B-lymphocytes, T-lymphocytes and myeloid APCs can synthesize biologically active calcitriol from 25-hydroxyvitamine D3 (inactive precursor) [7]. Vitamin D suppresses dendritic cell differentiation, maturation, and immunostimulation by inhibiting the expression of class II MHC molecules [8]. Thus, physiological quantities of vitamin D maintain the level of tolerogenic dendritic cells producing Interleukin-10 (IL-10) [1].

Vitamin D contributes to maintaining a balance between T-helpers type 1 (Th1) and type 2 (Th2) [4]. Several researches have shown that vitamin D deficiency can be the reason to increased Th2 and decreased Treg and IL-10 [9, 10]. Adequate quantity of vitamin D in the blood contribute to the suppression of IgE formation, as well as enhance the secretion of IL-10 by B-lymphocytes [6, 7].

Karaganda region (Kazakhstan) is characterized by long winter, with decreased insolation and high levels of pollutants in the atmospheric air, exceeding the maximum permissible concentrations that might further deteriorate VDD [11].

The aim of this study was to assess the serum 25-hydroxyvitamin D levels (25(OH)D) and their associations with the severity of seasonal allergic rhinitis in Karaganda region (Kazakhstan).

Material and methods

Study design

We conducted a cross-sectional trial. It was carried out from July 1, 2019 to September 31, 2019 at Divera Allergy Center in Karaganda (Kazakhstan).

Study object

The study included 416 patients aged 18-65 years (mean age 39±8 years, 267 of whom were females) with a diagnosis of seasonal allergic rhinitis. Population distribution by age groups: 18-39 years – 223, 40-59 years – 136, >60 years – 57. Verification of the seasonal allergic rhinitis diagnosis was performed on the basis of the anamneses and complaints of patients, an objective examination, and the collection of an allergy anamnesis. Confirmation of diagnosis was performed by skin test. Two weeks prior to the study, patients were excluded from taking all medications for allergic rhinitis.

The exclusion criteria were: presence of any acute or chronic severe somatic pathology, including hepatic or renal disease, metabolic bone disease, type 1 diabetes, malignancy, history of recent immobility for a period of more than one week, pregnancy and lactation, current dieting or consumption of multivitamin supplements containing vitamin D or its combinations.

Questionnaire

A questionnaire was employed to assess the severity of symptoms of seasonal allergic rhinitis. Self-assessment was based on an adapted questionnaire described by Pfaar et al. [12]. The questionnaire included evaluating nose itch, nasal congestion, watery/mucous nasal discharge, sneezing, itchy eyes, and watery eyes. An assessment of each symptom was expressed on a 3-point scale depending on the severity of the manifestation: 0 – no symptoms; 1 – mild degree (the symptom is minimally pronounced, occurs 1-3 times a week; the state of health is of no concern); 2 – moderate degree (the symptom is pronounced, has a frequency of manifestation 4-5 times a week, moderately affects well-being and sleep); 3 – severe degree (the symptom is very pronounced, has a systematic and persistent character on a daily basis, imposes a pronounced impact on sleep and labor activity). The maximum score constitutes 18 points, which is interpreted as a severe degree of manifestations. A severity score of 1 to 6 suggests mild severity, 7-12 corresponds to a moderate severity, and ≥13 points suggest severe degree of manifestation (Author's Certificate for Invention No. 14535 of January 19, 2021).

Laboratory analyses

Blood sampling for the vitamin D content was conducted from 8:00 am to 12:00 pm (noon) at a network of government-licensed laboratories (Olymp). The content of vitamin D in blood serum was determined via the chemiluminescence method on Beckman Coulter DxI automatic modular analyzer (USA). The normal range for serum vitamin D levels was at least 30 ng/mL [4,11]. The results in the range of 21-29 ng/mL were regarded as vitamin D insufficiency, and below 20 ng/mL as vitamin D deficiency [12].

Statistical analysis

Statistical analyses were carried out in Statistica 13 for Windows. At the first stage, the type of data distribution was determined and descriptive statistics of numerical variables were carried out. Since the data distribution was different from normal, descriptive statistics were generated by calculating the median and corresponding boundaries of the 25th and 75th percentiles. Mann-Whitney test was applied for qualitative variables to find differences in comparison groups. Spearman coefficient of correlation was applied to determine the correlation between the groups. The critical level was established on the probability of error of the first type not more than 5% ($\alpha < 0.05$)

Ethics

All the study participants signed voluntary informed consent before participation. The study protocol was approved by the Ethics Committee of the Non-Profit Joint-Stock Company Karaganda Medical University (Protocol No 14, March 11th, 2019).

Results

The median quantities of 25(OH)D in blood serum in Karaganda was less than the reference limit (20 ng/ml) and amounted to 16.1 ng/ml (Figure 1).

Figure 1 - Vitamin D concentration in blood in patients with seasonal allergic rhinitis

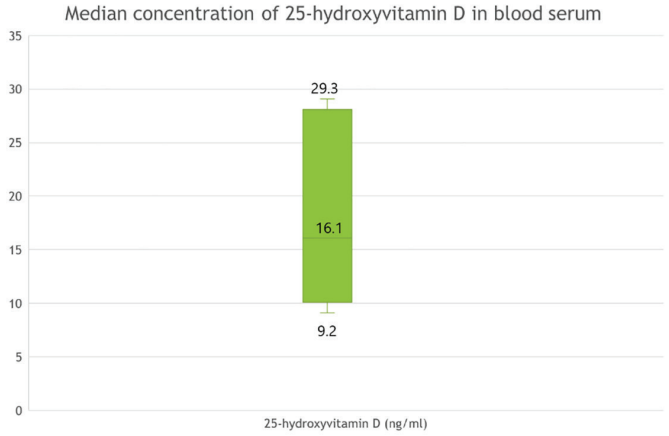


Figure 2 - Prevalence of vitamin D deficiency among patients with seasonal allergic rhinitis

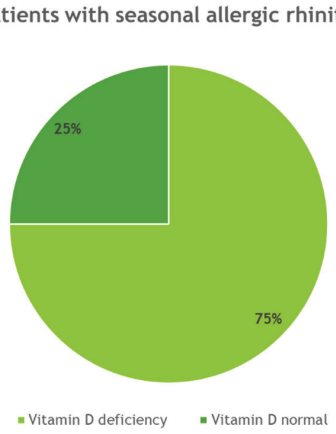


Figure 3 - Prevalence of vitamin D deficiency among different age categories

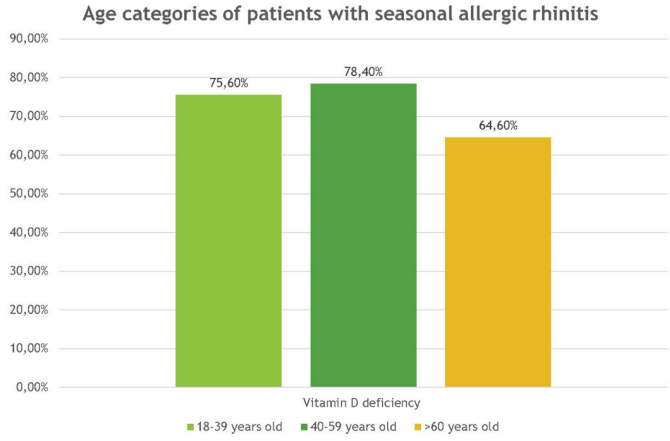
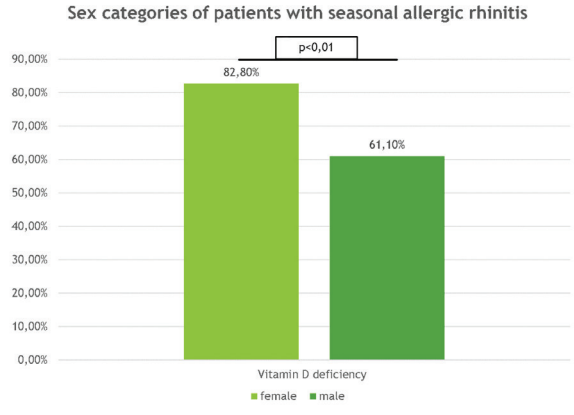


Figure 4 - Prevalence of vitamin D deficiency among men and women with seasonal allergic rhinitis



Most people in our study (75% of patients with seasonal allergic rhinitis) had VDD and this was common in all age categories: 75.6 % of 18-39 years old, 78.4 % of 40-59 years old, and 64.6 % of >60 years old (Figure 2, 3). There were no particular differences in concentrations of 25(OH)D in the age groups in blood serum at the cut-offs of <20 ng/mL.

In addition, VDD was more prevalent in female patients with seasonal allergic rhinitis (82.8 %) as compared with the male patients (61.1 %) (p<0,01) (Figure 4). Females had deficient vitamin D status a quarter more often than males.

Of interest is the fact that low serum 25(OH)D concentration correlated with the severity of symptoms: nasal congestion and nasal discharge (r =-0.94), sneezing, itchy nose and eyes, tearing (r =-0.67) (Figure 5 a, b, c, d, e, f).

Figure 5a - correlation the nasal congestion with vitamin D concentration

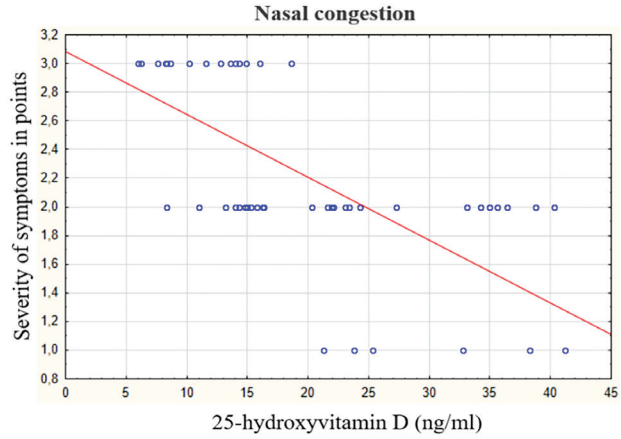


Figure 5b - correlation the nasal discharge with vitamin D concentration

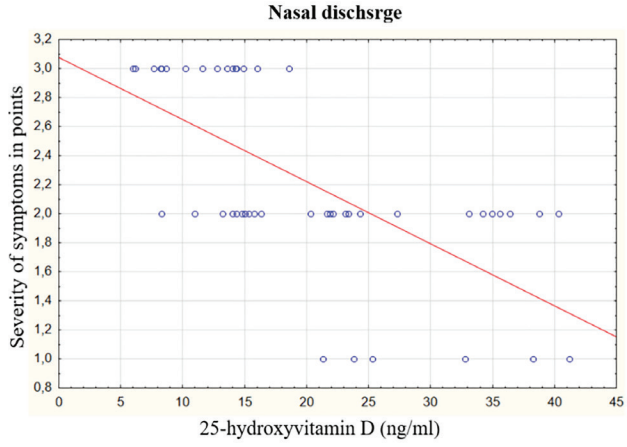


Figure 5c - correlation the sneezing with vitamin D concentration

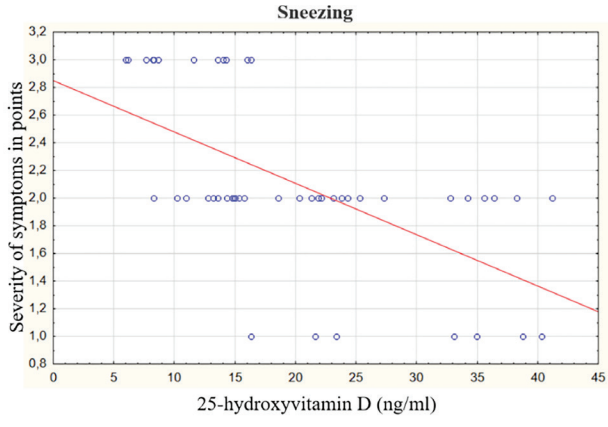


Figure 5d - correlation the itchy nose with vitamin D concentration

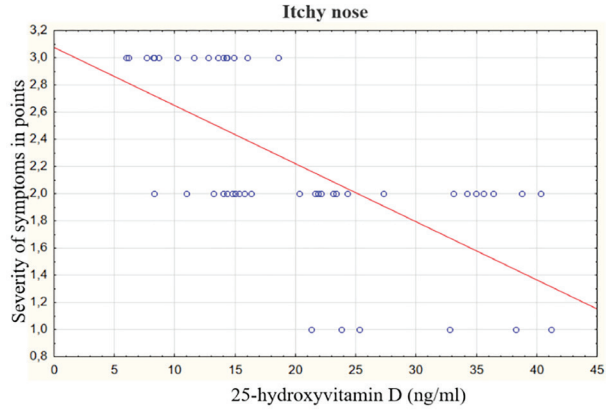


Figure 5e - correlation the itchy eyes with vitamin D concentration

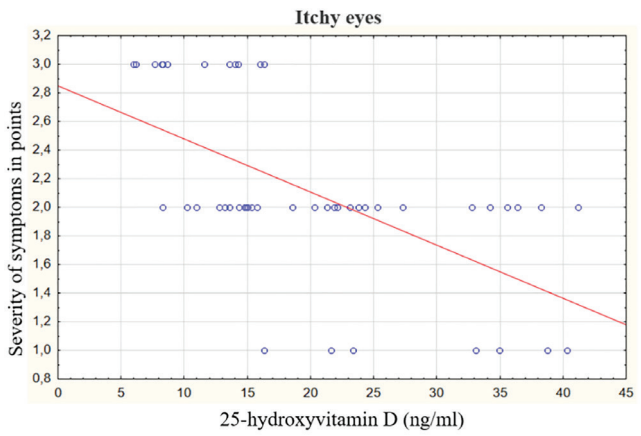
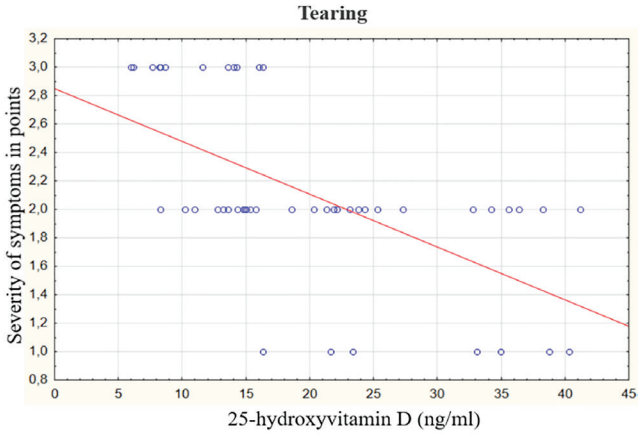


Figure 5f - correlation the tearing with vitamin D concentration



Discussion

This study aimed at evaluation the serum 25-hydroxyvitamin D levels (25(OH)D) and their associations with the severity of seasonal allergic rhinitis in Karaganda region (Kazakhstan). The major finding of this study was a high rate of VDD as three quarters of study participants had serum 25(OH)D concentrations below 20 ng/mL. It`s only 25 % of them had optimal levels of serum 25(OH)D defined as 30 ng/mL (75 nmol/L). Female gender was the major contributing factors for VDD.

In this study a connection was found to the vitamin D levels in the body and severity of the allergic rhinitis. The lower the vitamin D level in the serum, more severe were the symptoms. A study conducted by Arshi et al. (2012) showed that it was important to assess vitamin D levels in patients suffering from allergic rhinitis, whereas women were less likely to develop vitamin D deficiencies [13]. Bukhari et al. (2020) found that a lack of vitamin D is closely linked to a non-controlled allergic rhinitis [14].

In recent years, there has been a growing amount of researches on the interplay of vitamin D levels in the blood and the allergic diseases disease progression and severity [15–18]. The existence of a correlation between serum vitamin D concentration and allergic rhinitis status has been proven by various studies. Studies prove that allergic rhinitis is more common in patients with severe vitamin D deficiency in the blood [1, 10, 13, 19]. These studies suggest that vitamin D deficiency may cause eosinophil activation and release of high levels of eosinophilic cationic protein [20], which in turn has an effect on nasal mucosal inflammation in patients with allergic rhinitis [21].

Various clinical studies have shown that vitamin D supplementation is important in the prevention of allergic rhinitis, asthma and other allergic diseases [10]. The study of vitamin D as an additional treatment for allergic rhinitis in children with sensitization to grass pollen during the dusting season identified a significant reduce in the symptoms of the disease and a decrease in the use of drugs. These results are straight confirmation of the efficacy and safety of vitamin D 1000 IU as an additional therapy for grass pollen allergy in allergic rhinitis patient during pollen season [22, 23].

This study has some limitations, as we have only limited data in the Karaganda region. The results of the work can serve as a basis for further studies in the area of the study of the vitamin D levels of patients with allergic rhinitis in Kazakhstan and elsewhere. In addition, we have launched a project dedicated to the study of the effectiveness of allergen-specific immunotherapy in combination with vitamin D in patients with allergic rhinitis. Nevertheless, the results of this study can serve as recommendations for representatives of practical healthcare to diagnose all patients with allergic rhinitis for vitamin D status.

Conclusion

Nowadays, VDD remains an unresolved problem in Kazakhstani patients with seasonal allergic rhinitis. In fact, vitamin D is a prohormone with immunomodulating properties. According to our study, the significant part of patients with allergic rhinitis residing in Karaganda region of Kazakhstan had deficient status of 25(OH)D and this correlated with the severity of symptoms. The outcomes of our study could be of interest for both clinical physicians and public health professionals, who could envisage preventive strategies to tackle this problem.

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