Dependence of the allergic status markers on the level of vitamin D in the serum

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SUMMARY

Introduction/Objective Recent researches show a link between low vitamin D serum levels and increased prevalence of allergic disease. The objective of this study was to show whether there is any dependence of the allergic status markers: skin prick test (SPT), total immunoglobulin E IgE (tIgE), and allergen-specific IgE (sIgE ≥ 3 class) in serum from the serum 25(OH)D (vitDs) level in children with allergic disease/s.

Methods A total of 150 children with allergic disease/s were enrolled into this study. The vitDs, tIgE, SPT, and sIgE ≥ 3 class for aeroallergens and common food allergens were simultaneously assessed.

Results We found a negative correlation between vitDs level and age groups and a statistically significant positive correlation between vitDs level and tIgE, sIgE ≥ 3 class for hen’s egg yolk and hen’s egg white. A statistically significant positive correlation was determined between vitDs level and SPT on Dermatophagoides pteronyssinus, and a negative correlation between tIgE and SPT on Dermatophagoides pteronyssinus, as well as between vitDs level and sIgE ≥ 3 class for Cladosporium and Alternaria molds. We confirmed the dependence of nettle rash and comorbidity asthma from the vitamin D insufficiency and vitamin D deficiency. We did not find any dependence of serum tIgE on vitDs level for the sample.

Conclusion In order to get an adequate insight into the allergic status in children, we must take into account the pleotropic effects of vitamin D, according to which we suggest that, in the future, vitDs level should be determined synchronously with known markers of allergic status.

Keywords: immunoglobulin E; vitamin D; child; allergen

INTRODUCTION

An allergy is a disorder caused by an abnormal reaction to a harmless substance called an allergen. An allergy may manifest itself as a food allergy, atopic dermatitis, allergic asthma, allergic rhinitis, allergic conjunctivitis, and urticaria. The prevalence of allergic disease has increased considerably during the last decades. About 30% of the population in Europe is “attacked by allergies;” the situation with children is alarming – every third child suffers from at least one allergic disease.

Considering the pleiotropic effects of vitamin D (especially on the development of immune system tolerance and of the integrity of the epithelial barrier), recent studies have hypothesized a correlation between vitamin D and the rising incidence of allergic disease.

Markers of allergic status – skin prick test, total and specific immunoglobulin E

Allergy skin prick test (SPT) is the gold standard for confirmation of immunoglobulin E (IgE)-mediated allergic diseases. SPT is well reproducible, easy to perform, reliable, very safe, and more sensitive than allergen-specific IgE (sIgE) [1]. SPT imperfections are many: it is difficult to compare results from different countries because they use different extracts, training of staff and parents is required, it takes a long time to perform, and in some countries SPT is considered less safe than sIgE for certain allergens. Serum sIgE emerges as an alternative test in the field of allergy diagnosis. In some countries, for reasons of conformity, it is resorted to an estimate of the atopic state in young children solely by measuring the level of sIgE (circulating IgE) for certain allergens in the serum [2].

A link between vitamin D serum levels and an increased prevalence of allergic diseases has been proposed. Results of the National Health and Nutrition Examination Survey for 2005–2006 determined a consistent association between 25(OH)D deficiency and higher levels of IgE sensitization in children and adolescents [3].

However, there are not many studies that evaluate the correlation between serum 25(OH)D level (vitDs) and the markers of allergic status (SPT, tIgE, sIgE) in children with allergic disease/s. Since tIgE is considered a good predictor of allergy in children, and SPT and allergen sIgE are the most widely used diagnostic tests in allergy, we observe the association, correlation, and dependence between them (SPT, tIgE, sIgE) and vitDs level.
Dependence of the allergic status markers on the level of vitamin D in the serum

**Vitamin D and immunomodulation related to allergy**

The potential role of vitamin D on the immune system is described after the discovery of VDR on macrophages, dendritic cells, activated B and T lymphocytes, as well as the ability of these cells to express 1-a-hydroxylase [4]. Up-regulation of 1-a-hydroxylase in DC is associated with the maturation process of these cells, suggesting that local production of 1,25(OH)D might serve as negative feedback to prevent inflammation. Vitamin D inhibits the expression of inflammatory cytokines and interferons in monocytes (IL-1, IL-6, IL-8, IL-12, TNF-α). Also, vitamin D affects the cells of the humoral immune response; it inhibits the proliferation and differentiation of B cells, thereby indirectly affecting the synthesis of immunoglobulins [5, 6, 7].

The objective of this study was to show whether there is any dependence of the allergic status markers (SPT, tIgE, sIgE) on serum vitDs level in children with an allergic disease.

**METHODS**

A total of 150 children with allergic disease were included in the study to investigate the association and dependence between the vitDs level and the markers of allergic status (SPT, tIgE, sIgE). The study was conducted with permission of the institutional ethics committee (01-6917/23.05.2016), at the Clinic of Pediatrics (PC), Kragujevac Clinical Center, Serbia, from January 2014 to June 2016.

The main criteria for patients included in the study were as follows: 1) age: 0–18 years; 2) suffering from at least one of the following diseases: asthma, allergic rhinitis, atopic dermatitis, urticaria, food allergies; the diagnosis was made according to the criteria defined by the protocols of Global Initiative for Asthma and Allergic Rhinitis and its Impact on Asthma [9], and of the World Allergy Organization [8, 9, 10]; for the classification of children, we used the diagnosis with which the children were discharged; 3) tIgE; 4) vitDs; 5) SPT; 6) sIgE with cut-off class three (sIgE ≥ 3 class).

**Allergy skin prick test**

We used allergen extract solutions manufactured by Torkla (Belgrade, Serbia) for seven aeroallergens (animal hair – cat’s and dog’s hair, molds, mix of tree pollens, mix of ragweed pollens, house dust mites, cockroach) and six food allergens (hen’s egg yolk, hen’s egg white, cow’s milk, wheat flour, soybean, peanut). The test was performed according to the European standard for SPT to inhaled and nutritive allergens and positive/negative control [histamine dihydrochloride (10 mg/ml) / physiological sodium chloride (9 mg/ml)] [11]. Positive SPT was defined as a wheal diameter ≥ 2 mm above the negative control for children aged 0–3 years, and wheal diameter ≥ 3 mm for the children aged four years or older.

**Specific immunoglobulin E in serum**

The sIgE level was determined by using the AlleisaScreen (Mediwick Analytic GmbH, Moers, Germany) screening method that is an immunoblot quantitative assessment of circulating allergen-specific IgE in serum. Tests were performed for matched panel of 17 aeroallergens (cat and dog hair E1–E5, Cladosporium and Alternaria M2–M6, Penicillium–Aspergillus M1–M3, maple pollen T1–T11, poplar T14, alder T2, birch T3, beech T5, ash T15, ragweed pollen W1–W2, Dermat. pteronyssinus D1, and cockroach I6) and eight food allergens (hen’s egg yolk F75, hen’s egg white F1, wheat flour F4, soybean F14, peanuts F13, lactalbumin alpha F76, lactalbumin beta F77, casein F78). The sIgE level ≥ 3.5 IU/ml or ≥ 3 class for certain allergens was adopted as an indicator of convincing allergic sensitization.

**Serum measurements of total IgE and vitamin D**

Total serum IgE was determined by using the electrochemiluminescence immunoassay (Cobas E 411) and was constituted in IU/ml. Measurements of vitamin D level was performed using electro-chemiluminescence binding assay (ECLA) for the in-vitro determination of total 25(OH)D on Cobas® e 601 analyzer (Roche Diagnostics, Mannheim, Germany). VitDs were categorized into three vitamin D statuses: sufficient (≥ 30 ng/ml), insufficient (20–30 ng/ml), and deficient (< 20 ng/ml) [12].

**Statistical analysis**

Statistical data processing was performed using IBM SPSS Statistics, Version 20.0 (IBM Corp., Armonk, NY, USA). We used descriptive statistical methods for continuous variables: mean, standard deviation. The correlations were assessed by Spearman’s rank correlation test. In order to test the hypothesis of the mean values, we used nonparametric tests, Mann–Whitney U test for comparisons between two groups, and Kruskal–Wallis test for comparing three or more groups, followed by Bonferroni post-hoc test for multiple comparisons between subgroups. P-values < 0.05 were considered statistically significant.

**RESULTS**

Out of 150 patients enrolled in this study, 86 were male (56%) and 66 (44%) were female. The age groups ranged from one month to 17 years, with the mean age being 7.11 ± 3.8 years. Forty-seven (31.7%) patients had medical history positive for allergic disease in the mother and 33 (22%) in the father; 122 patients (81.3%) had positive SPT; 86 (57.3%) patients had increased serum sIgE ≥ 3 class for at least one of the tested allergens. The mean value of total serum IgE was 327.42 ± 533.56 IU/ml. The mean level of vitDs was 20.44 ± 8.26 ng/ml. Established vitamin D statuses were deficiency (< 20 ng/ml) in 56% of the patients with the mean value of 14.46 ± 3.5, followed by insufficiency (20–30 ng/ml) in 31.3% of the patients with the mean value...
being 24.88 ± 2.9, and sufficiency (> 30 ng/ml) in 12.7% of the patients, with the mean value being 35.87 ± 4.

Table 1 represents the mean value of tIgE and vitDs according to the age groups. We found a statistically significant difference in vitDs level between the age groups (p = 0.009). Also, there was a statistically significant difference in tIgE between the age groups (p = 0.004).

Table 1. Mean value of total immunoglobulin E (IgE) and vitamin D according to age groups

| Age group (years) | Total IgE (IU/ml) | Vitamin D (ng/ml) |
|------------------|-------------------|------------------|
| 0–12 months (n = 7; 4.7%) | 71.09 ± 96.8 | 35.38 ± 10.3 |
| 13–24 months (n = 18; 12%) | 131.89 ± 314.6 | 23.24 ± 10.5 |
| 3–5 years (n = 26; 17.3%) | 199.64 ± 263.2 | 20.10 ± 8.1 |
| 6–11 years (n = 79; 52.7%) | 399.64 ± 64 | 18.94 ± 6.7 |
| 12–18 years (n = 20; 13.3%) | 473.97 ± 520.2 | 19.02 ± 5.6 |

Table 2 shows the correlation between the age groups, tIgE, and vitDs level. We found significant positive correlation between the age groups of the participants and tIgE (p = 0.000). Also, we found a negative correlation between the vitDs level and age groups of the participants (p = 0.030).

Table 2. Correlation between age groups (years), total immunoglobulin E (IgE) and serum 25(OH)D level

| Parameter | total IgE (IU/ml) | Correlation between age in years and total IgE | Vitamin D (ng/ml) | Correlation between age in years and vitamin D |
|-----------|------------------|---------------------------------------------|------------------|---------------------------------------------|
| Age, years | 327.42 ± 533.56 | 0.314**                                      | 20.44 ± 8.2      | -0.178*                                      |

*p < 0.05; **p < 0.001

Table 3 represents the correlation between vitamin D status in patients with allergic disease and one of the markers of allergic status. There we can see that there is a significant positive correlation between vitamin D status and SPT to aeroallergens (p = 0.016). Also, we found significant positive correlation between vitamin D status and sIgE ≥ 3 class to aeroallergens (p = 0.004).

In consideration of immunomodulatory effects of vitamin D in allergic disease, we observed the correlation between tIgE and vitDs level in patients with allergic disease. In our study we found a significant negative correlation between tIgE and vitDs level in patients with nettle rash (p = 0.000) and in patients with comorbidity asthma with atopic dermatitis (p = 0.000). Results of correlation between vitDs level and tIgE level in allergic diseases are shown in Table 4.

Table 4. Correlation between serum 25(OH)D level and total immunoglobulin E (IgE) in allergic disease

| Allergic disease | Parameters | Total IgE (IU/ml) | Vitamin D (ng/ml) | Spearman’s correlation | p |
|------------------|------------|------------------|-------------------|------------------------|---|
| Asthma           |            | 27.95 ± 14.2     | 26.17 ± 10.7      | 0.700                  | 0.188 |
| Allergic rhinitis|            | 127.99 ± 305.2   | 22.16 ± 8.6       | -0.277                 | 0.251 |
| Atopic dermatitis|            | 45.53 ± 75.1     | 31.16 ± 11.6      | 0.607                  | 0.148 |
| Nettle-rash     |            | 181.37 ± 279.7   | 20.0 ± 3.6        | -1.000**               | 0.000 |
| Food allergy    |            | 55.85 ± 78.2     | 22.06 ± 6.7       | 0.100                  | 0.873 |
| Asthma + comorbidities |       | 253.99 ± 461.4   | 18.70 ± 6.7       | -0.009                 | 0.951 |
| Atopic dermatitis + comorbidities |       | 267.76 ± 333.4   | 21.55 ± 14.1      | -1.000**               | 0.000 |
| Allergic rhinitis + atopic dermatitis |       | 466.16 ± 560.9   | 21.10 ± 10.3      | 0.273                  | 0.446 |
| Rhinitis allergic + food allergy |       | 538.0 ± 665.1    | 19.05 ± 7.3       | -0.067                 | 0.643 |

*p < 0.001
### Table 5. Features and findings in children suffering from allergic disease/s

| Allergic disease/s | Sex | Total IgE (IU/ml) | Vitamin D (ng/ml) | Aeroallergens | Food allergens | Skin Prick Test |
|--------------------|-----|------------------|-------------------|---------------|---------------|----------------|
|                    |     |                  |                   |               |               |                |
| Asthma             | M/F | 27.95 ± 14.2     | 26.17 ± 10.7      |               |               |                |
|                    |     | 0.03 ± 0.06      | 0.00              | E1–E5         |               |                |
|                    |     | 0.00             | 0.00              | M2–M6, M1–M3  |               |                |
|                    |     | 0.00             | 0.00              | 0.00          |               |                |
|                    |     | 0.01 ± 0.0       | 0.00              | 0.00          |               |                |
|                    |     | 0.00             | 0.00              | 0.00          |               |                |
|                    |     | 0.00             | 0.00              | 0.00          |               |                |
|                    |     | 0.00             | 0.00              | 0.00          |               |                |
|                    |     | 3/2              | 3/2               |               |               |                |
| Allergic rhinitis  | 11/8 | 127.99 ± 305.2   | 22.16 ± 8.6       |               |               |                |
|                    |     | 1.47 ± 5.9       | 0.45 ± 15         | 0.87 ± 3.2    | 2.49 ± 10.4   |                |
|                    |     | 0.52 ± 2.0       | 0.15 ± 0.2        | 0.02 ± 0.0    | 0.05 ± 0.1    | 0.79 ± 3.2     |
|                    |     | 0.27 ± 1.0       | 0.62 ± 2.2        |              |               |                |
| Atopic dermatitis  | 3/4  | 45.53 ± 75.1     | 31.16 ± 11.6      |               |               |                |
|                    |     | 0.00             | 0.00              | 0.05 ± 0.1    | 0.02 ± 0.0    | 0.42 ± 0.9     |
|                    |     | 0.10 ± 0.1       | 0.62 ± 2.2        |              |               |                |
| Nettle rash        | 2/1  | 181.37 ± 279.7   | 20.00 ± 3.6       |               |               |                |
|                    |     | 0.05 ± 0.0       | 0.09 ± 0.1        | 0.15 ± 0.2    | 0.06 ± 0.1    | 0.36 ± 0.7     |
|                    |     | 0.01 ± 0.0       | 0.95 ± 1.5        | 0.03 ± 0.0    | 4.5 ± 7.9     | 0.62 ± 1.0     |
| Food allergy       | 1/4  | 55.85 ± 78.2     | 22.06 ± 6.7       |               |               |                |
|                    |     | 0.43 ± 0.6       | 0.11 ± 0.2        | 0.23 ± 0.2    | 0.04 ± 0.0    | 0.11 ± 0.2     |
|                    |     | 0.02 ± 0.0       | 2.86 ± 0.8        | 0.58 ± 1.3    | 1.97 ± 4.3    | 0.38 ± 0.5     |
| Asthma comorbidities | 25/21 | 253.99 ± 461.4 | 18.70 ± 6.7       |               |               |                |
|                    |     | 6.39 ± 14.0      | 0.15 ± 0.7        | 0.99 ± 4.3    | 1.04 ± 4.4    |                |
|                    |     | 0.26 ± 1.0       | 0.26 ± 0.4        | 0.41 ± 2.6    | 0.17 ± 0.4    |                |
|                    |     | 0.49 ± 1.9       | 0.39 ± 1.9        | 4.43 ± 20.6   | 33/13         | 21/25          |
|                    |     | 0.70 ± 0.0       | 2.0 ± 1/1         |               |               |                |
| Nettle rash        | 6/4  | 466.16 ± 560.9   | 21.10 ± 10.3      |               |               |                |
|                    |     | 5.90 ± 7.4       | 2.12 ± 6.0        | 1.34 ± 3.3    | 0.08 ± 0.2    | 0.00           |
|                    |     | 0.27 ± 0.4       | 0.01 ± 0.0        | 10.02 ± 3.6   | 0.02 ± 0.0    | 0.74 ± 2.3     |
| Food allergy       | 31/22| 538.0 ± 665.1    | 19.05 ± 7.3       |               |               |                |
|                    |     | 11.65 ± 2.9      | 0.48 ± 1.9        | 1.19 ± 3.9    | 1.05 ± 2.9    |                |
|                    |     | 0.16 ± 0.4       | 0.31 ± 1.0        | 0.44 ± 2.5    | 0.63 ± 2.7    | 0.42 ± 1.2     |
|                    |     | 2.43 ± 8.4       | 44/9              | 31/22         |               |                |

Aeroallergens: Derm. pteronyssinus – D1, animal hair (dog, cat) – E1–E5, mold (Cladosporium–Alternaria – M2–M6, Penicillium–Aspergillus – M1–M3), tree pollen – TP, insect (cockroach) – I6; food allergens: milk – F2 (F76, F77, F78), hen’s egg yolk – F75, hen’s egg white – F1, wheat flour – F4, soybean – F14, peanuts – F13.

IgE – immunoglobulin E.
According to these Norwegian authors, it is necessary to use an SPT and allergen sIgE. Schoos et al. [14] determined their study showed that the serum total IgE level is a good predictor of allergy in children. Several papers indicated a problem of discrepancy between the results obtained with an SPT and allergen sIgE. Consequently, it is necessary to use complementary SPT and allergen sIgE, but not interchangeably, especially in young children (0–2 years) [14]. Regarding the role of vitamin D in the regulation of the immune system, vitamin D status can be one of the effective factors in the reactivity of a certain allergen. Studies conducted by Kolokotroni et al. indicated that serum level of vitamin D is positively associated with tIgE level and sIgE on Dermatophagoides farinae in Cyprus children [15]. In our study, we found a negative correlation between vitDs level and tIgE and sIgE ≥ 3 class to aeroallergens, as well as between vitDs level and sIgE ≥ 3 class on mold Cladosporium–Alternaria, and, finally, a statistically significant positive correlation between vitDs level and sIgE ≥ 3 class to animal hair (cat and dog), which we consider to be interdependence.

Likewise, related to food allergens, we found a statistically significant positive correlation between vitDs level and tIgE, and sIgE ≥ 3 class on hen's egg white (p = 0.006), which we consider to be interdependence.

### DISCUSSION

An increasing incidence of allergic disease during the past 30 years sets the need to seek laboratory parameters that are useful in diagnosing allergic disease. Park et al. [13] in their study showed that the serum total IgE level is a good predictor of allergy in children. Several papers indicated a problem of discrepancy between the results obtained with an SPT and allergen sIgE. Schoos et al. [14] determined poor or moderate degree of agreement between the results obtained from SPT and sIgE for a certain allergen, which shows that this ratio deteriorates with age of the child. According to these Norwegian authors, it is necessary to use a decreasing ratio of SPT and aero- and food allergens from vitDs level (p = 0.050) and we did not find the correlation and dependence of other SPT to aero- and food allergens from vitDs level.

### Table 6. Correlation between total and allergen-specific immunoglobulin E (IgE) > 3 class on certain aeroallergens and serum 25(OH)D level

| Aeroallergens          | logE (IU/ml) > 3 class | Serum total IgE (IU/ml) level | Correlation total IgE vs. logE | Vitamin D (ng/ml) | Correlation vitamin D vs. logE > 3 class |
|------------------------|------------------------|------------------------------|-------------------------------|-------------------|----------------------------------------|
|                        | *rho        | p       | *rho          | p-value          |                          |                                      |
| Dermatophagoides pteronyssinus (n = 38) | 24.91 ± 20.8 | 674.40 ± 765.48 | 0.813** | 0.004     | 18.33 ± 6.8 | -0.104 | 0.527                          |
| Animal (n = 6)         | 9.03 ± 5.7    | 948.45 ± 631.62 | 0.353     | 0.493     | 16.57 ± 5.1 | 0.884** | 0.008                          |
| Cladosporium–Alternaria (n = 14) | 16.01 ± 15.5 | 618.31 ± 690.7 | -0.103     | 0.725     | 18.39 ± 8.8 | -0.699** | 0.001                          |
| Penicillium–Aspergillus (n = 2) | 8.65 ± 6.3    | 581.07 ± 807.6  | 1.000**   | 0.001     | 24.85 ± 3.8 | -1.000 | /                             |
| Tree pollen            |                        |                              |                          |                      |                                      |
| Maple (n = 8)          | 22.23 ± 27     | 629.48 ± 470.6     | -0.253     | 0.545     | 19.39 ± 6.5 | 0.157 | 0.711                          |
| Poplar (n = 3)         | 8.23 ± 5.7     | 529.09 ± 514.5     | 1.000     | /         | 16.89 ± 4.9 | 0.500 | 0.667                          |
| Alder (n = 9)          | 14.82 ± 11     | 644.54 ± 463.16    | -0.193     | 0.618     | 21.23 ± 8.2 | 0.059 | 0.881                          |
| Birch (n = 11)         | 11.46 ± 7.1    | 571.90 ± 445.9     | 0.78     | 0.821     | 19.52 ± 8.3 | 0.196 | 0.563                          |
| Hazel bush (n = 12)    | 7.20 ± 10      | 760.52 ± 487.6     | -0.310     | 0.327     | 21.41 ± 10 | 0.014 | 0.965                          |
| Beech (n = 11)         | 25.79 ± 28     | 608.14 ± 434.2     | 0.132     | 0.689     | 17.25 ± 6.6 | 0.562 | 0.072                          |
| Mix of ragweed (n = 7) | 32.41 ± 23.4   | 681.98 ± 538       | 0.429     | 0.337     | 19.40 ± 6.3 | -0.714 | 0.071                          |
| Ash tree (n = 2)       | 5.95 ± 2.7     | 601.41 ± 705.8     | 1.000**   | 0.001     | 19.57 ± 2.5 | -1.000 | /                             |
| Cockroach (n = 3)      | 6.53 ± 2.2     | 529.09 ± 514.58    | 0.727*     | 0.041     | 16.89 ± 4.9 | 0.500 | 0.667                          |

sIgE – allergen-specific IgE;
*p < 0.05;
**p < 0.001

### Table 7. Correlation between total and allergen-specific immunoglobulin E (IgE) > 3 class on certain food allergen, allergen-specific immunoglobulin > 3 class on certain food allergen and serum 25(OH)D level

| Food allergens | logE (IU/ml) > 3 class | Serum total IgE (IU/ml) level | Correlation total IgE vs. logE | Vitamin D (ng/ml) | Correlation vitamin D vs. logE > 3 class |
|----------------|------------------------|------------------------------|-------------------------------|-------------------|----------------------------------------|
|                | *rho        | p       | *rho          | p-value          |                          |                                      |
| Milk (n = 0)   | /           | /       | /              | /                | /                       | /                                     |
| Alfa-lactoglobulin (n = 6) | 5.35 ± 5.6 | 275.87 ± 343.6 | 0.993** | 0.007     | 18.76 ± 5.6 | 0.029 | 0.957                           |
| Beta-lactoglobulin (n = 0) | /           | /       | /              | /                | /                       | /                                     |
| Casein (n = 2) | 10.12 ± 9    | 579.41 ± 809.9 | 1.000** | 0.000     | 15.50 ± 5 | 1.000** | 0.000                          |
| Hen's egg yolk (n = 2) | 18.20 ± 0.5 | 579.41 ± 809.9 | 1.000** | 0.000     | 15.50 ± 5 | 1.000** | 0.000                          |
| Hen's egg white (n = 4) | 32.50 ± 45.4 | 869.55 ± 552   | 0.949*  | 0.048     | 24.94 ± 10.7 | 0.949* | 0.050                          |
| Wheat flour (n = 5) | 9.28 ± 3.3  | 552.83 ± 365.31 | 0.053    | 0.933     | 20.50 ± 6 | -0.684 | 0.203                          |
| Soybean (n = 4)  | 10.33 ± 4.1  | 344.91 ± 512.8  | -0.800   | 0.200     | 20.24 ± 3 | 0.400  | 0.600                          |
| Peanuts (n = 9)  | 36.07 ± 39.3 | 923.99 ± 896.9  | -0.33    | 0.932     | 20.91 ± 8.4 | -0.435 | 0.242                          |

sIgE – allergen-specific IgE;
*p < 0.05;
**p < 0.001

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Several studies investigated the relationship between vitamin D deficiency and allergic diseases and concluded that low level of vitamin D is associated with increased incidence of allergies and asthma [16, 17, 18]. Poole et al. [19] in their study conducted on infants showed that vitamin D insufficiency is associated with an increased risk of a challenge-proven peanut/egg allergy. Quirk et al. [20] suggest that vitamin D deficiency increases the risk of sensitization to food allergens, particularly to milk and wheat. In our study, we found a statistically significant correlation between nettle rash and comorbidity asthma (with one or more allergic diseases) and lower mean vitD level (p = 0.005), which we consider to be interdependence. We found a statistically significant difference in serum vitD level according to SPT in children with allergic disease (p = 0.050). The mean value of 25(OH)D level in children with positive SPT was 19.77 ± 7.91 ng/ml in serum. The children with negative SPT had a mean value of 9.28 ± 9.2 ng/ml in serum 25(OH)D. From this result, we can remark that the high frequency of positive SPT (81.3%) in children with allergic disease means high frequency of vitamin D insufficiency and vitamin D deficiency, which leads us to conclude that there is a dependence between these two variables.

In our study we did not find any correlation between serum tIgE and vitDs level (rho = -0.126, p = 0.126).

However, there is a trend that the mean value of vitDs level decreased with age, while the serum concentration of total IgE increased with age. When we investigated separate correlations between serum tIgE and vitDs in individual allergic diseases, we noticed a significant negative correlation between them in children who had nettle rash (p = 0.000) and asthma comorbidity with atopic dermatitis (p = 0.000).

We found statistically significant differences in serum tIgE between boys and girls (p = 0.004). The mean total serum IgE in boys was higher (383.35 ± 519.91 IU/ml) than in girls (256.23 ± 546.11 IU/ml). Simultaneously, there is a statistically significant difference in serum 25(OH)D level between boys and girls (p = 0.020) so they maintain the same parity (21.98 ± 8.9 vs. 18.47 ± 6.9 ng/ml).

There was a statistically significant difference between child’s age and positive/negative SPT (p = 0.004). The mean age of children who had positive SPT was 7.5 ± 3.8 years and of children who had negative SPT it was 5.1 ± 3.1 years. Also, we found a statistically significant difference between a child’s age and increased slgE ≥ 3 class (p = 0.004) (7.8 ± 3.3 vs. 6 ± 4.2 years).

CONCLUSION

We found a significant dependence of positive SPT and high serum slgE ≥ 3 class to certain allergens from the low serum 25(OH)D level (insufficiency or deficiency), which means that vitD contributes to reactivity to a certain allergen. We noted the correlation of increased tendency to allergies and, simultaneously, low level of vitamin D with a child’s age. Also, we confirmed the dependence of comorbidity asthma from hypovitaminosis D. We noticed a significant dependence of serum tIgE from the vitDs in children who had nettle rash or with comorbidity of asthma and atopic dermatitis. We did not find the correlation between serum tIgE level and vitD level for the whole group of participants. Children with hypovitaminosis D exhibited a more pronounced tendency to one or more allergic diseases.

Our findings suggest that the vitDs level could be determined synchronously with known markers of allergic status with the goal of precisely determining the child’s allergic status. Perhaps correction of hypovitaminosis D would affect the decrease in the prevalence of allergic diseases. In order to gain full insight into the allergic status of children in the future, we need to conduct further investigations of the relationship between serum 25(OH)D level, tIgE level, slgE ≥ 3 class, and SPT.

Conflict of interest: None declared.
Зависност маркера алергијског статуса од концентрације витамина Д у се럼у

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САЖЕТАК
Увод/Циљ Недавне студије су доказале везу између ниске серемске концентрације витамина Д и пораста преваленције алергијских болести.

Циљ овог рада је да покаже да ли постоји зависност маркера алергијског статуса: кожног (prick) алерготеста (KAT), концентрације укупног имуноглобулина Е (уИгЕ) и концентрације ИгЕ специфичног за алерген (класа сИгЕ ≥ 3) у серему од серемске концентрације 25(ОН)D (витДс) код деце обилење од алергијских болести.

Методе У ову студију је било укључено 150 деце са алергијским болестима. Проценети су, истовремено, ВитДс, уИгЕ, КАТ и сИгЕ ≥ 3 класе на ихалаторним и нутритивним алергенама. Резултати Утврдили су своју негативну корелацију између нивоа витДс и старосних група и статистички значајну по-

Зетивну корелацију између витДс и, с друге стране, уИгЕ, сИгЕ ≥ 3 класе на кошошке жуначке и беланке. Статистички значајна позитивна корелација утврђена је између витДс и КАТ на кућну грињу, као и између витДс и сИгЕ ≥ 3 класе на гљивице Cladosporium и Alternaria. Потврдили су своју зависност копринење и коморбидитетне астме од инсуфицијенције витамина Д и дефицијенције витамина D. Нисмо наšли за-

вишност уИгЕ од витДс за цео узорак.

Закључак Да би смо добили адекватан увид у алергијски статус деце, морамо уважити плетне ефekte витамина D, сходно чему предлажемо да се, убудуће, одређује витДс и свој зависност од уИгЕ и сИгЕ.

Кључне речи: имуноглобулина Е; витамин Д; деца; алерген

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