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ORIGINAL ARTICLE

Evaluation of Vitamin D Levels in Children by Seasons, Gender and Age

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Abstract

Introduction: Vitamin D is significantly effective in bone and mineral metabolism. Low levels of vitamin D has been associated with rickets, susceptibility to infections, obesity, diabetes mellitus, muscle weakness, depression, and development of autoimmune diseases in children. On the other hand, elevated levels may cause hypercalcemia, polyuria, hypertension, nephrolithiasis, and renal failure. In this study, we aimed to examine serum 25-hydroxyvitamin D3 [25(OH)D] levels of children in the risk group for low vitamin D levels.
Methods: A total of 1259 patients who applied to our pediatric outpatient clinic for routine examination between January and December 2015 were evaluated retrospectively; age, gender, [25(OH)D] levels were grouped according to seasons.
Results: Our study included 711 (56.4%) girls and 548(43.6%) boys between the ages of 0 and 18. The mean vitamin D levels of the patients were found as 21.69±11.23 ng/mL. The vitamin D level of 50% of the children was below 20 ng/mL and at the level of deficiency and insufficiency. A statistically significant difference was found between age groups according to vitamin D levels ($p<0.05$). While the number of children with vitamin D level above 20 ng/mL was significantly higher in the 0-2 age group, the number of children with vitamin D level below 20 ng/mL in the 12-18 age group was higher. In our study, vitamin D levels of girls were significantly lower than boys ($p<0.05$). In addition, the rate of the season being spring was 28.2%, while the rate of being winter was 25.2% in children with a vitamin D level below 12 ng/mL.
Discussion and Conclusion: When vitamin D levels were evaluated according to age, gender and season, the levels were found to be significantly lower in the 12-18 age range, in girls, and in the spring/winter seasons, compared to other groups.
Keywords: Age; gender; season; vitamin D deficiency.

The main function of vitamin D is to provide calcium and phosphorus levels necessary for the mineralization of growing bone tissue in children. There are 2 types of vitamin D that are different in their sources but similar in structure and formation. Calciferol (vitamin D2) is taken in the form of the provitamin ergosterol, found in plants; and is accumulated in the skin. The provitamin of cholecalciferol (Vit D3) is 7-dehydrocholesterol. It is synthesized in the body. Therefore, it is not a true vitamin but a hormone precursor. It can also be taken in foods of animal origin (fish; especially sardine meat and fish oil). After being activated by ultra violet effect, it undergoes hydroxylation in

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the liver (25-hydroxylase) and kidney (1-α hydroxylase), respectively, and functions in target organs. Its low level has been associated with malaise, growth retardation, rickets, tendency to infections, obesity, diabetes mellitus, muscle weakness, depression, development of autoimmune diseases in children. High levels can cause hypercalcemia, polyuria, hypertension, nephrolithiasis, renal failure. Its level measurement is often made with serum 25(OH)D3 level[1-2].

Materials and Methods

A total of 1259 patients who applied to our pediatric outpatient clinic for routine examination between January and December 2015 were evaluated retrospectively and were divided into 4 age groups according to their childhood periods: 0-2 years old (infancy), 3-6 years old (early childhood), 7-11 years old (middle childhood), 12-18 years old (adolescence). Their genders and in which season the sample was taken were noted. Serum 25(OH)D3 levels were evaluated as follows: >20 ng/ml: sufficient, 12-20 ng/ml: vitamin D insufficiency, <12 ng/ml: vitamin D deficiency[3]. While evaluating the findings obtained in the study, IBM SPSS Statistics 22 (IBM SPSS, Turkey) program was used for statistical analysis. In the study, the conformity of the parameters to the normal distribution was evaluated with the Shapiro–Wilk test. In addition to descriptive statistical methods (mean, standard deviation, frequency), Chi-square test was used to compare qualitative data. Significance was evaluated at the $p<0.05$ level.

Results

The distribution of children by gender, age, vitamin D levels and seasons is given in Table 1. Of 1259 cases, 711 were girls and 548 were boys. There were 360 cases in the 0-2 age group, 274 cases in the 3-6 age group, 243 cases in the 7-11 age group, and 382 cases in the 12-18 age group. The mean vitamin D level was 21.69 ng/ml. Vitamin D deficiency was observed in 18.3% of the cases, and vitamin D insufficiency was observed in 31.7%. Vitamin D level was found to be normal in 50% of the cases.

There was a statistically significant difference between gender groups in terms of vitamin D levels ($p<0.05$). While the mean vitamin D level of girls was 20.78 ng/ml, it was 20.78 ng/ml for boys. In addition, the rate of girls (55.4%) with vitamin D levels below 20 ng/ml was found to be significantly higher ($p<0.05$). There was a statistically significant difference between age groups according to vitamin D levels ($p<0.05$). It was observed that the rate of children with a vitamin D level above 20 ng/ml in the 0-2 age group was 79.4%, and the rate of children in the 12-18 age group with a vitamin D level below 20 ng/ml was 70.7%. The number of cases according to the seasons is given in Table 2. There is a statistically significant difference between seasonal distributions according to vitamin D levels ($p<0.05$). In children with a vitamin D level below 12 ng/ml, the rate of the season being spring is 28.2%, the rate of being winter is 25.4%, and the rate of being summer is 7.9% (Table 3). It was observed that vitamin D levels were above 20 ng/ml at a rate of 64.6% and 60.5%, respectively, measured in the summer and autumn seasons.

Vitamin D levels in individual age groups with distribution according to gender, there was no significant difference in the other 3 groups, but there was a statistically significant difference between the gender distributions according to vitamin D levels in the 12-18 age group ($p<0.05$). The rate of girls with vitamin D levels below 20ng/mL was (55.4%). There was no significant difference between other vitamin D levels in different genders ($p>0.05$).

Table 1. General distributions

	n	%
Gender		
Male	548	43.6
Female	711	56.4
Age		
0-2	360	28.6
3-6	274	21.8
7-11	243	19.3
12-18	382	30.3
Vitamin D ng/ml		
<12	230	18.3
12-20	399	31.7
>20	630	50
Season		
Spring	294	23.4
Summer	302	24.0
Autumn	344	27.3
Winter	319	25.3

Table 2. Number of cases received by season

	n	%
Season		
Spring	294	(23.4)
Summer	302	(23.9)
Autumn	344	(27.3)
Winter	319	(25.4)

Table 3. Gender, age and season evaluation according to vitamin D levels

	Vitamin D ng/mL			p
	<12 n (%)	12-20 n (%)	>20 n (%)	
Gender				
Male	73 (13.3)	162 (29.6)	313 (57.1)	0.001*
Female	157 (22.1)	237 (33.3)	317 (44.6)	
Age				
0-2	18 (5)	56 (15.6)	286 (79.4)	0.001*
3-6	33 (12)	105 (38.3)	136 (49.6)	
7-11	43 (17.7)	104 (42.8)	96 (39.5)	
12-18	136 (35.6)	134 (35.1)	112 (29.3)	
Mevsim				
Spring	83 (28.2)	97 (33)	114 (38.8)	0.001*
Summer	24 (7.9)	83 (27.5)	195 (64.6)	
Autumn	42 (12.2)	94 (27.3)	208 (60.5)	
Winter	81 (25.4)	125 (39.2)	113 (35.4)	

Chi-square test; * p<0.05.

There was no significant difference between genders according to vitamin D levels in the 0-2, 3-6, 7-11 age groups and in the seasons separately (p>0.05). When evaluated according to age groups, the frequency of vitamin D insufficiency and deficiency (25(OH)D level <20 ng/mL) in 0-2, 3-6, 7-11 and 12-18 age groups was detected as 20.6%, 50.3%, 60.5% and 70.7%, respectively. Therefore, the incidence increases with increasing age. In the 12-18 age group, 70.7% of the girls whose values were measured in the autumn season had a vitamin D level below 20 ng/ml, which was significantly higher than the other age groups and seasons (p<0.05).

Discussion

Vitamin D deficiency is thought to be endemic in many regions of the world. Studies have shown that more than 1 billion people are affected by this condition[14]. Vitamin D deficiency and insufficiency in the pediatric population have been reported with varying frequencies in studies conducted in many countries[15,16].

In the study of Akman et al.[4] in healthy children aged 1-16 years in Turkey, when cutoff value was calculated as 20 ng/mL, 8% vitamin D deficiency and 25.5% vitamin D insufficiency were detected. It has been found that daily calcium intake is low, especially in children over the age of 8. In the study of Lapatsanis et al.,[15] vitamin D deficiency was found to be 14% in children aged 3-18 years. In a study conducted with Andiran et al.[18] in 2002, vitamin D deficiency was found to be 25% and vitamin D insufficiency to be 15% in breastfed infants. The higher rate of vitamin D deficiency and insufficiency in our study compared to many other studies may be due to geographical, sociocultural and other environmental differences in the studied groups. In the study of Gordon et al.,[17] 12% of 133 infants aged 8-24 months were found to have vitamin D deficiency and 40% to have vitamin D insufficiency. In a study by Yoon et al.[5] in Korea, the frequency of vitamin D insufficiency was found to be 29.8% in children under the age of 2 when they took 30 ng/ml as a cut-off value. The difference in the cut-off value may have played a role in the fact that vitamin D insufficiency was detected at a rate of 5% in cases under 2 years of age in our study. In large population-based studies conducted in the United States, the prevalence of vitamin D insufficiency (defined as 25(OH)D <20 ng/mL) and deficiency (defined as 25(OH)D <10 ng/mL) in the pediatric age group was 15% and 1-2%, respectively[6,7]. These variations between countries in terms of prevalence may be due to geographical, nutritional and climatic differences, and differences arising from the regular and adequate dose of vitamin D supplement used in childhood.

In our study, vitamin D levels were found to be lower at higher rates in winter and spring. In winter, the frequency of vitamin D deficiency was 25.4%, insufficiency was 39.2%, and in spring, these rates were 28.2% and 33%, respectively. This situation shows the importance of exposure to sunlight in cutaneous vitamin D synthesis. Similarly, in studies conducted in Iowa, USA and Canada, vitamin D insufficiency or deficiency was found to be significantly higher in winter and early spring periods compared to other seasons. In a study conducted in the USA, it was reported that while 25(OH)D levels were <11 ng/ml at a rate of 78% in winter months, this rate decreased to 1% in summer months in infants who received breast milk and did not receive vitamin D supplementation[8]. In a study conducted in Canada, it was reported that 25(OH)D levels were found to be <16 ng/mL in 34% of patients admitted to the hospital at the end of winter, and to be <10 ng/mL in 6%[9].

Vitamin D levels of 70.7% of girls in the 12-18 age group in the autumn season were found to be below 20 ng/ml, and significantly higher than other age groups and seasons. In a study conducted by Hatun et al.[10] in Kocaeli, Turkey (vitamin D insufficiency was accepted as 25(OH)D: 25-50 nmol/L and deficiency as 25(OH)D <25 nmol/L) in adolescent girls aged 13-17, Vitamin D deficiency was found to be 21.3%, and insufficiency was found to be 43.8%. In the studies, vitamin D insufficiency or deficiency is seen more frequently in the late winter and early spring periods, but

this frequency decreases significantly in the summer and autumn periods. However, in parallel with the results of our study, vitamin D deficiency or insufficiency can be seen frequently in also summer and autumn periods, depending on the way women dress, lifestyle and nutritional differences, especially in Muslim societies[11,12].

While the rate of children aged 0-2 years with a vitamin D level above 20 ng/ml was 79.4%, this rate decreased to 29.3% in the 12-18 age group. This situation shows the importance of vitamin D supplementation program in newborn and infancy period. In older children and adolescents, factors such as nutritional deficiency and insufficient exposure to sunlight may play a role in the development of vitamin D insufficiency or deficiency[11-13]. Vitamin D supplementation programs can be considered for children in the 12-18 age group.

Conclusion

Vitamin D deficiency or insufficiency has been observed frequently in all age groups in parallel with other large-scale prevalence studies conducted in our country, and it is more common especially in puberty period and in girls. Again, vitamin D deficiency and insufficiency were observed more frequently in winter and spring periods.

In addition, although the success of the vitamin D supplementation program in the newborn and infancy period has been observed, it may be considered to increase its effectiveness.

In order to prevent vitamin D insufficiency in children, measures such as recommending vitamin D supplements to mothers during pregnancy and breastfeeding, not interrupting vitamin D prophylactic treatment in children, recommending products rich and enriched with vitamin D in terms of nutrition for older ages, recommending adequate sunlight, checking the 25(OH)D serum levels at certain periods in healthy child follow-up and treating it if necessary, can be taken.

The main factors limiting our study were the inability to evaluate the sociocultural and socioeconomic status of the children and lack of evaluation of information about diet, breastfeeding and demographic information about the perinatal period, which may play a role in vitamin D insufficiency or deficiency.

Considering its incidence in the population, since vitamin D insufficiency or deficiency is an important public health problem, more comprehensive and detailed studies in terms of sample and examined variables, together with existing studies on the subject, may guide future applications.

Ethics Committee Approval: Retrospective study.

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