

Investigation of Vitamin D Deficiency in Pre-School Children During Summer Season

Esra Ulgen Temel¹, Kenan Kocabay², Aybars Ozkan³

¹Department of Child Neurology, Faculty of Medicine, Gazi University, Ankara, Turkey. ORCID iD: 0000-0002-0841-5935 ulgenesra@yahoo.com (Corresponding Author)

²Department of Child Health and Diseases, Faculty of Medicine, Düzce University, Düzce, Turkey. ORCID iD: 0000-0002-4030-1145

³Department of Pediatric Surgery, Sakarya University Medical Faculty Training and Research Hospital, Sakarya, Turkey. ORCID iD: 0000-0003-0214-4203

ABSTRACT

Aim: Vitamin D deficiency is an important public health problem, especially affecting children. The aim of our study is to evaluate the serum 25 (OH) vitamin D levels of children during the summer and to determine some features such as exposure to the sun, oral vitamin D supplementation, and to examine the parameters that affect serum vitamin D levels.

Methods: In our study, children aged between 12 and 83 months were included. A questionnaire was answered by families. In this cross-sectional study, serum 25 (OH) vitamin D levels of children and biochemical parameters were examined.

Results: The mean serum 25 (OH) vitamin D level was 27.0±12.4 ng/ml. Vitamin D deficiency was found 17%, and vitamin D insufficiency was 6%. The children that taking daycare indoors and body mass index <5th percentile had lower serum 25 (OH) vitamin D levels. Children between the ages of 12-36 months and children with chronic diseases were found to have a shorter time to benefit from sunlight.

Conclusion: The rate of vitamin D deficiency and insufficiency (<20 ng/ml) in children were found at 23% in summer season. Families and caregivers should be informed about vitamin D and should be aware of safe sun exposure.

Keywords: Vitamin D, sunlight, summer, children, vitamin D deficiency

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The study is part of the thesis called 'Düzce Üniversitesi Tıp Fakültesi Hastanesi Pediatri Kliniğine Başvuran Okul Öncesi Çocuklarda Serum 25 (OH) Vitamin D Düzeylerinin Araştırılması' which was written by Esra Ülgen Temel.

Introduction

Vitamin D (25 (OH) D) is a fat-soluble vitamin. Very few foods naturally contain vitamin D; dermal synthesis is the primary source of vitamin D. Some countries have vitamin D-fortified milk, fruit juice, yogurt, bread, and cheese (1). Vitamin D plays a significant role in growth and development by providing calcium absorption from the intestines and bone mineralization (2).

Sun exposure of a fair-skinned adult for 10-15 minutes during the summer months produces 10000 – 20000 IU of vitamin D within 24 hours. Factors such as skin colour, high altitude, air pollution, fog, body mass index, clothing style, and protective creams affect vitamin D synthesis in the skin (3-8).

Normal serum vitamin D levels are defined as which can keep the serum PTH level within the normal range and preventing the development of rickets or osteomalacia, by providing optimal absorption of dietary calcium from the intestines (5). As a result of the studies about nutritional rickets, vitamin D level 20 ng/ml and above was accepted as sufficient. However, the exact limits for deficiency term in children could not be determined. Some groups accept deficiency below 12 ng/ml, while other groups accept it as less than 15 ng/ml (6,7).

In order to keep the vitamin D levels within adequate limits, it is recommended that infants should take orally 400 IU/day vitamin D. The recommended dose for children and adolescents is 600 IU/day orally (8,9). In our country, the Ministry of Health has granted free vitamin D supplements for children under one-year-old since May 2005. Free vitamin D supplementation is provided to at least 1 million children each year. In addition to oral support, adequate and correct contact with sunlight plays a determinant role for serum vitamin D levels. Our country has made significant strides in terms of vitamin D support program. However, children are sometimes prevented from spending time outdoors due to chronic diseases, some medications used continuously, and frequent illnesses. Therefore, endogenous vitamin D production cannot be achieved

at a sufficient level.

Our study purposed to evaluate vitamin D levels in children and examined the factors that could affect vitamin D levels and identify children who had a risk for vitamin D deficiency.

Methods

Toddlers and preschool-age children were included in this prospective study to examine their risk status in vitamin D deficiency. The study was conducted in a city of approximately 360,000 inhabitants located between approximately 40 ° - 42 ° north latitude and 30 ° - 33 ° east longitude. The sample of the study was planned to reach the entire population according to the age group. As an observational cross-sectional design, we included all children aged 12-84 months followed in pediatric and pediatric surgery inpatient clinics between June 1, 2014, and August 31, 2014, in the study group. Patients not suitable for this age group, whose family consent to participate in the study could not be obtained and who used oral vitamin D during the study were excluded. One hundred children participated in this cross-sectional study. Informed consent forms were obtained from all families. A questionnaire form was applied to the families, and information about the children was collected. Height and weight measurements of the children were made. Serum calcium (Ca), phosphorus (P), and alkaline phosphatase (ALP) values measured with the Hitachi Cobas C501 analyzer (Roche, Mannheim, Germany) device. 25 (OH) D levels were studied by Radioimmunoassay (RIA) method and results are given as 'ng/ml'. In the statistical evaluation of the data, independent samples t-test and one-way ANOVA were used to compare groups in terms of continuous variables. Chi-square or Fisher's Exact test was used to compare categorical variables, depending on the expected value rule. Results were considered significant if the p-value is under 0.05 ($p < 0.05$).

Serum 25 (OH) D values were accepted as a severe deficiency when <5 ng/ml, deficiency ≤ 15 ng/ml, insufficiency 15-20 ng/ml, normal values 20-100 ng/ml (6,10). Approval was obtained from the Faculty of Medicine Ethics Committee.

Results

One hundred cases aged 12-83 months, participated in the study. 42% (n=42) of them were girls and 58% (n=58) were boys. The average age was 50.5±23.3 months. The serum 25 (OH) D level was an average of 27.0±12.4 ng/ml. The rate of used to take oral vitamin D supplements was 94%, and the rate of used as 400 IU/day for the first 12 months was 36% (Table 1).

Table 1. General information about the subjects included in the study*

Age groups	Total n(%)	100 (100)
12-36 months	31 (31)	
37-83 months	69 (69)	
Sex (girl) n (%)	42 (42)	
Age (month)	50.5 ± 23.3 (12 - 83)	
BMI (kg/m ²)	16.1±1.8 (11.6-24.4)	
BMI (percentile) n (%)	<5p	9 (9.0)
	5-85p	74 (74.0)
	85-95p	11 (11.0)
	>95p	6 (6.0)
Mother age (year)	30.9 ± 5.7 (20 - 47)	
Duration of oral vitamin D supplementation (month)	10.6 ± 4.9 (1 - 36)	
Mean duration of sun exposure (hour)	2.4 ± 1.5 (0.2 - 6.0)	
Number of cases with chronic diseases (%)	35 (35)	

*Continuous variables are summarized as mean ± standard deviation (min-max), categorical variables as n (%).

According to the vitamin D levels, severe deficiency was detected in 6% (n=6), deficiency in 17% (n=17), and insufficiency in 6% (n=6) of participants. Vitamin D values of 77% (n=77) of children were within the normal range.

When the cases were compared according to age groups, it was observed that the duration of exposure to sunlight was significantly shorter (p=0.036) in the 12 - 36-month-old group compared to the 37-83-month-old group. Vitamin D levels were significantly lower in the 37-83 months old group than the 12-36 months old group (p=0.013), but the average values were above 20 ng/ml in both groups (Table 2).

Table 2. Comparison of the vitamin D levels, duration of sun exposure, and chronic disease states of the cases included in the study by age groups*

	12-36 months (n=31)	37-83 months (n=69)	p
Cases with chronic disease n (%)	11 (35.5)	24 (34.8)	0.946
Duration of sun exposure (hour)	1.9 ± 1.5	2.6 ± 1.5	0.036
Vitamin D level (ng/ml)	31.5 ± 10.6	24.9 ± 12.6	0.013

*Mann-Whitney's test was used for statistical analysis in accordance with the distribution.

The participants were divided into four groups to body mass index (BMI, kgm). Vitamin D level was lowest in underweight (BMI <5p) group and highest in overweight (BMI=85-95p) group. Also, these groups differed significantly from each other and the other groups (Table 3).

Table 3. Comparison of serum vitamin D, ALP, calcium, and phosphorus values according to BMI*, percentiles**

	< 5p (n: 9)	5-85p (n: 74)	85-95p (n: 11)	> 95p (n: 6)	p
Vitamin D (ng/ml)	15.8 ± 11.2	27.0 ± 11.0	37.0 ± 15.0	24.7 ± 13.5	< 0.001
ALP (U/L)	199.0 ± 60.7	208.8 ± 80.7	224.1 ± 80.8	231.0 ± 37.1	0.874
Ca (mg/dl)	9.9 ± 0.3	9.9 ± 0.7	9.9 ± 0.5	10.3 ± 1.1	0.520
P (mg/dl)	4.8 ± 0.4	4.9 ± 0.7	4.9 ± 1.6	5.1 ± 0.5	0.920

* Bodyweight, height, head circumference, and body mass index were calculated according to the Turkish children reference values. **Oneway ANOVA test was used for statistical analysis. Post hoc tests were conducted for intergroup evaluation.

A comparison was made according to daytime care, sixteen (16%) of the cases were receiving day care in places such as kindergarten. Vitamin D level was the lowest in this group than the groups that were caretaken by the mother or nursemaid (p=0.009) (Table 4).

Table 4. Comparison of serum vitamin D, ALP, calcium, and phosphorus values according to daycare status*

	Mother (n: 71)	Nursemaid (n: 13)	Kindergarten (n: 16)	p
Vitamin D (ng/ml)	27.9±11.8	31.8±7.8	18.9±14.9	0.009
ALP (U/L)	213.5±73.3	186.5±55.9	214.2±94.9	0.712
Ca (mg/dl)	9.9±0.7	9.8±0.7	9.9±0.8	0.874
P (mg/dl)	4.9±0.8	5.2±1.3	4.9±0.6	0.521

* Oneway ANOVA test was used for statistical analysis. Post-hoc tests were conducted for intergroup evaluation

The cases were compared to with or without have chronic disease. There were 35 patients with one or more chronic diseases: 16 neurological/metabolic diseases (nine epilepsy, two hydrocephalus, one cerebral palsy, one Tay Sachs, two metachromatic leukodystrophies, one nonketotic hyperglycinemia), seven type-1-diabetes mellitus, two asthma, ten hypothyroidism, two nephrotic syndromes, two dermatological diseases (one vitiligo, one eczema), one short stature, one thalassemia, one heart failure, one gastroesophageal reflux, one congenital adrenal hyperplasia, one immune deficiency. These patients were statistically significantly less exposed to sunlight than those without chronic disease (1.9 ± 1.5 hours - 2.6 ± 1.5 hours, respectively, $p=0.19$). There was no statistically significant difference between the vitamin D levels of those with or without the chronic diseases (25.6 ± 9.6 ng/dl - 29.5 ± 16.2 ng/dl, $p=0.201$).

There was no significant difference between vitamin D levels in terms of the number of siblings, education level of the mother, and place of residence.

Discussion

Vitamin D is an essential pro-hormone for calcium absorption from the intestines. Although vitamin D deficiency mainly causes rickets in children, it has also been associated with increased risk of many cancers, autoimmune diseases, hypertension, and infectious diseases (6). The primary source of vitamin D for humans is sunlight. Factors that reduce ultraviolet B (UVB) rays reaching the earth or affect the contact of UVB rays with the skin inhibit vitamin D synthesis from the skin (1). Although our country is rich in sun, vitamin D deficiency is common. As an effect of 'Vitamin D supplementation for infants during first-year' project, rickets' frequency due to vitamin D deficiency was detected below 1% in 2007. However, in 1998, a study conducted in the same region, and vitamin D deficiency was 6.09% (11). This study is very significant as it shows the necessity of oral Vitamin D supplementation. The fact that vitamin D levels in our study were lower in the 37-83 months old group than the younger age group suggested that vitamin D levels were negatively affected after the

cessation of oral vitamin D supplementation in the first year.

There are many studies in the literature proving that vitamin D levels are low in winter months. Our study was carried out by selecting three months (June, July, August) when the study area temperatures were above 25°C, and the insolation duration is the longest. It was aimed to determine whether children who spend cold days at their homes benefit from the sun sufficiently on hot days.

Many studies have been conducted in our country and the world to determine the causes, frequency, and impacts of vitamin D deficiency. In our study, the average vitamin D level was found to be 27.0 ± 12.4 ng/ml, and no rickets patients were detected. Vitamin D deficiency was 14%, while severe vitamin D deficiency was 6%. These results are like other studies in the literature (9-12).

In our study, the average duration of exposure to sunlight in children aged between 12 and 36 months old was significantly lower than between 37 and 83 months old ($p=0.36$). Since this age group (12-36 months old) is more dependent on maternal care, it was thought that it might be similar to the insolation duration of their mothers. In our study group, the average duration of the children staying under the sun during daylight was 2.4 hours. 68.4% of the children who spent time outside during the day were staying more than an hour. A study showed that if mothers' vitamin D levels are normal, sunbathing for 10 minutes with only diapers on the baby and 30 minutes with only the head uncovered is sufficient for normal vitamin D synthesis (13). In our study two of children were not taken out of the house during the day; these two children had chronic neurological diseases and were bedridden. It was observed that children with chronic diseases were exposed to less sunlight than the other group ($p=0.019$). However, there was no statistically significant difference between serum vitamin D levels ($p=0.20$). Families may not want to take their children out with chronic diseases, may be thinking that their children will be infected outside or because of their social reservations. A study conducted with 1351 children with chronic diseases showed

vitamin D levels of children younger than six years did not differ seasonally. The researchers have argued that vitamin D levels do not show seasonal changes because children with chronic diseases are not exposed to sunlight as much as healthy children (14). In particular, children who use antiepileptics, steroids, etc., which are known to effect vitamin D levels, should definitely receive vitamin D supplements to prevent complications that may occur.

It will be beneficial for children to spend time in open areas without being damaged by the sun in terms of improving vitamin D levels. For example, it has been shown that wearing a hat for sun protection does not negatively affect vitamin D levels in children and adults (15,16). People who care for children, such as mothers, nursemaids, and teachers, should be informed about benefiting from the sun. In this study, vitamin D levels of children who spent the daytime in indoors like kindergartens were significantly lower than in other groups ($p=0.009$). In a study conducted in China, vitamin D levels of school children between the ages of 6 and 11 were lower than those of preschool children (17).

On the contrary, another study conducted in Israel, 247 children between the ages of 1.5 and 6 were evaluated. Vitamin D levels of children who attend full-day daycare were higher than those who attend half-day daycare and those who are caretaken at home (18). The fact that there are different results on this subject indicates that going to school is not a risk factor alone.

Obesity and vitamin D deficiency are common conditions in almost all populations separately. The relationship between increased body fat mass and serum vitamin D is complex and controversial. It is not clear which one causes which and how it provides it (19). In most studies, an inverse proportion was found between body mass index (BMI) and serum vitamin D levels (14,20,21). In our study, the participants' body mass indexes were calculated and grouped according to percentile values developed for Turkish children (22). Below 5th percentile ($n=9$) was considered as underweight, between 5th and 85th percentile ($n=74$) as normal weight, between 85th and 95th percentile

($n=11$) as overweight, over 95th percentile ($n=6$) as obese. Serum vitamin D levels were significantly lower in the group whose BMI percentile was below the 5th percentile compared to the other groups ($p<0.01$). The mean serum vitamin D value (15.8 ± 11.2 ng/ml) was at the vitamin D deficiency level in this group. Only one of these children had a chronic illness; he was followed up with a diagnosis of short stature and hypothyroidism and received growth hormone and thyroid hormone replacement. Others had no known illness. There was no difference in Ca, P, ALP levels among all groups. Normal calcium and phosphorus levels and no difference between groups suggested that underweight children were not malnourished. Although the relationship between low vitamin D levels in obese patients is well known, there are also studies suggesting that low body weight and vitamin D deficiency coexistence, and this may cause short stature (23). In addition, it has been shown that correction of vitamin D deficiency provides height and weight gain (24).

Several different conclusions have been made in the literature about how the education and socioeconomic levels of mothers affect the vitamin D levels of children. In many studies conducted in our country, it has been shown that the low socioeconomic level of the family affects the serum vitamin D levels of children (11,25). Again, in other studies conducted in our country, no relationship was found between the mother's education level and the vitamin D levels of the children (26-28). Similarly, in a study with 247 participants in Israel, no relationship was found between the mothers' education status and their children's serum vitamin D levels (18). In our study, 37% of the mothers were high school and above graduates. Although vitamin D levels (29.3 ± 10.4 ng/ml) of the mothers' children in this group were found to be higher than the other groups, there was no statistically significant difference between them ($p=0.311$). In our study, no relationship was found between the mothers' education status and the serum vitamin D levels of the children.

The study's limitations are the small number of cases and the lack of follow-up of the change in the

same population during the year. Our study was executed with children between 12 and 83 months, which is significant for evaluating this population regarding vitamin D deficiency. Our study conducted during the summer months will be a guide to determine whether children benefit from sunlight sufficiently.

Conclusion

Vitamin D deficiency and insufficiency still

maintains its importance in our country. It is noteworthy that the rate of vitamin D insufficiency and the deficiency (<20 ng/ml) in children was 23% in this study, administered during exposure to sunlight more. It will be beneficial for new generations to draw attention to the necessity of continuing vitamin D supplements in advanced ages.

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