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ORIGINAL ARTICLE

Assessment of vitamin D levels in pediatric patients: A retrospective analysis from a tertiary hospital

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ABSTRACT

Objective: We aimed to assess the vitamin D levels in patients who visited the pediatric outpatient clinic for various reasons.

Material and Methods: The study was conducted retrospectively. Demographic information, vitamin D levels, place of residence (rural or urban), and vitamin D levels of 6939 patients, all obtained from the medical records of children aged 0–18 years who visited the outpatient pediatric clinic at Adıyaman Training and Research Hospital for any reason between January 1, 2022, and December 31, 2022, were meticulously recorded in an Excel file.

Results: Of the patients, 44.2% had adequate vitamin D levels. When examining these levels, it was observed that boys had a significantly higher proportion of sufficient vitamin D levels than girls ($p<0.001$). A significant difference in vitamin D levels was also observed among the 0–5 years, 6–11 years, and 12–18 years ($p<0.001$). Furthermore, vitamin D deficiency was notably more prevalent in children residing in urban areas than in rural areas.

Conclusion: It has been observed that vitamin D insufficiency/deficiency has a significant rate in childhood. To protect children against vitamin D insufficiency/deficiency, adopting a protective lifestyle that includes increasing sun exposure, gradually increasing vitamin D supplementation as they age, and periodically checking their vitamin D levels can be beneficial in preventing complications.

Keywords: Child nutrition, vitamin D, vitamin D deficiency, vitamin D insufficiency.

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INTRODUCTION

Vitamin D is a vitamin synthesized from our skin with the effect of ultraviolet B in sunlight and has biologically significant effects.[1] A vital component of bone-mineral metabolism, this vitamin is fat soluble. In studies conducted in the last two decades, the vitamin D receptor has been shown on many tissues, and it has been reported to be effective in general health and the protection of bone health.[2] The primary source of vitamin D is the synthesis that occurs in the skin when exposed to sunlight, although it can also be obtained through dietary intake. From a physiological perspective, approximately 90–95% of the vitamin D in the human body is produced through exposure to sunlight, whereas the remaining 5–10% is acquired through dietary means (milk, eggs, fish, animal fats, offal, etc.). Vitamin D, synthesized in our skin by diet and sunlight, is biologically inactive and must pass through several enzymatic pathways to be converted into active metabolites. The main factors affecting vitamin D levels are inadequate synthesis, intake, or absorption of vitamin D.[3,4] Vitamin D deficiency has been associated with various other diseases (autoimmune diseases, rheumatoid arthritis, cardiovascular diseases, etc.) as well as rickettsia, characterized by a deformity of bones and inadequate growth in children. Vitamin D deficiency and rickets continue to be insufficiently acknowledged clinical issues in numerous populations. Their significance goes beyond bone health, encompassing the non-classical functions of vitamin D, which include influencing various immune-related diseases. Compelling evidence supports the effectiveness of vitamin D supplementation in lowering infection rates among pediatric populations.[5] Reports indicate that vitamin D inadequacy or deficiency constitutes a significant global public health issue, affecting as many as 30% of children and 60% of adults.[4,6]

Epidemiological investigations have established that living in regions with higher latitudes and reduced sun exposure serve as indicators for the risk of having insufficient vitamin D levels. Furthermore, in various populations across the world, sun avoidance practices and conservative clothing in more southern areas contribute to vitamin D deficiency. The risk of vitamin D deficiency is prevalent at all life stages, including during pregnancy, infancy, childhood, and adulthood. In infants, this risk can be compounded by recommended sun avoidance practices, limited vitamin D stores, potential inadequacy of vitamin D in exclusively breastfed infants, and a lack of awareness regarding systematic vitamin D supplementation in certain cultural contexts. Epidemiological studies have shown that vitamin D levels are lower in children residing at higher latitudes because they are less exposed to the sun.[5] Türkiye is located between the 36th and 42nd latitudes in the northern hemisphere and is in a region where sun rays can be utilized at an optimum level. While vitamin D deficiency is expected to be less common in our country, studies have found that vitamin D insufficiency/deficiency is a severe public health problem.[1,7]

Since 2008, support programs covering all age groups have been carried out worldwide to prevent vitamin D deficiency/insufficiency. In their 2011 guideline publication, the Endocrine Society advised a vitamin D supplementation regimen of 400 IU per day for infants from the day of birth until their first year and 600 IU per day for children between the ages of 1 and 18, specifically for those without risk factors for vitamin D deficiency. For infants with risk factors for vitamin D deficiency, the recommended supplementation ranged from 400 to 1000 IU per day from birth to one year and 600 to 1000 IU per day for children aged 1 to 18.[8] Since 2005, in Türkiye, the "Prevention of Vitamin D Deficiency and Promotion of Bone Health" initiative has been carried out for all newborns to combat vitamin D insufficiency and deficiency. As part of this program, a daily oral vitamin D supplement of 400 IU (equivalent to 3 drops) is provided to all infants.[1] In this research, we aimed to assess the vitamin D levels of patients who presented to the pediatrics outpatient clinic for any reason and were examined for vitamin D.

Table 1: Descriptive characteristics and vitamin D status of the patients

	Number	Percent
Age		
0–5 years	2983	43.0
6–11 years	2180	31.4
12–18 years	1776	25.6
Gender		
Male	3273	47.2
Female	3666	52.8
Place of residence		
Urban	6153	88.7
Rural	786	11.3
Vitamin D status		
Severe deficiency	124	1.8
Deficiency	2306	33.2
Inadequate	1439	20.7
Normal	3070	44.2

MATERIAL AND METHODS

This retrospectively descriptive research was carried out in Adıyaman province, situated in the Southeastern Anatolia region of Türkiye. The demographic data, vitamin D levels, place of residence (rural, urban), and vitamin D levels of 6939 children aged 0–18 years who applied to the outpatient pediatrics clinic of Adıyaman Training and Research Hospital for any reason between 01.01.2022 and 31.12.2022 were investigated and recorded in an Excel file. It was planned to reach the entire universe without conducting a sample calculation that collects Hospital Information Management System (HIMS) data from the hospital. Patients with chronic diseases (epilepsy, congenital heart disease, chronic renal failure, etc.) and foreign patients were excluded from the study. The assessment of vitamin D levels in children, following the guidelines of the American Pediatric Endocrine Society, resulted in the following categories:

- Less than 5 ng/ml: Severe deficiency
- 5–15 ng/ml: Deficiency
- 15–20 ng/ml: Insufficiency
- Greater than 20 ng/ml: Normal.[9]

Table 2: Comparison of vitamin D status according to descriptive characteristics

	Vitamin D status								p
	Severe deficiency		Deficiency		Inadequate		Normal		
	Number	%	Number	%	Number	%	Number	%	
Gender									<0.001
Male	24	0.7	807	24.7	712	21.8	1730	52.9	
Female	100	2.7	1499	40.9	727	19.8	1340	36.6	
Age (years)									<0.001
0–5 years	24	0.8	659	22.1	536	18.0	1764	59.1	
6–11	18	0.8	703	32.2	547	25.1	912	41.8	
12–18	82	4.6	944	53.2	356	20.0	394	22.2	
Place of residence									0.011
Urban	117	1.9	2074	33.7	1257	20.4	2705	44.0	
Rural	7	0.9	232	29.5	182	23.2	365	46.4	

Statistical Analysis

The findings obtained from the files were evaluated with SPSS 26 package program. Descriptive statistics were expressed as numbers and percentages. The chi-square test was utilized to examine categorical variables among unrelated groups, with a significance level set at $p<0.05$.

Ethics Statement

Approval was obtained from the Ethics Committee for Non-Interventional Studies at Fırat University Faculty of Medicine (date: 08.06.2023, number: 2023/08-20). Institutional approval was obtained from Adıyaman University, Adıyaman Training and Research Hospital (date: 29.09.2023, number: 225654554). Since this is a retrospective study, obtaining any verbal or written consent from the participants was impossible. Helsinki Declaration rules were followed throughout the study.

RESULTS

The study included a total of 6939 participants. Among these individuals, 3666 (52.8%) were female, and 6153 (88.7%) resided in the city center. According to age groups, there were 2983 patients (43.0%) in the 0–5 age group, 2180 patients (31.4%) in the 6–11 age group, and 1776 patients (25.6%) in the 12–18 age group. According to vitamin D status, 124 (1.8%) were severely deficient, 2306 (33.2%) were deficient, 1439 (20.7%) were insufficient, and 3070 (44.2%) were at normal levels (Table 1).

In the analysis of vitamin D levels, it was observed that 1730 (52.9%) males and 1340 (36.6%) females had normal levels, and a significant difference was noted between the two groups ($p<0.001$). In the age analysis, it was determined that 1764 (59.1%) individuals were in the 0–5 years age group, 912 (41.8%) in the 6–11 years age group, and 944 (53.2%) in the 12–18 years age group, all of whom exhibited deficient levels of vitamin D. There was a significant difference observed among the age groups ($p<0.001$). Among urban residents, 2705 (44.0%) had normal vitamin D levels, whereas 365 (46.4%) of rural residents had normal vitamin D levels. A significant difference was observed between these two groups ($p=0.011$) (Table 2).

In subgroup analyses based on gender, a significant difference was identified in the vitamin D status of males concerning both age groups and place of residence ($p<0.001$ and $p=0.004$, respectively). Conversely, among females, a significant difference was observed among age groups in terms of vitamin D status ($p<0.001$), while no significant difference was noted based on place of residence ($p=0.148$) (Table 3).

DISCUSSION

Vitamin D deficiency/insufficiency is a prevalent health issue, especially in developing countries like Türkiye. Although it is located in the northern hemisphere and receives enough sunlight, vitamin D levels still need to be increased.[7] In this case, the importance of vitamin D-enriched foods or vitamin D supplementation therapy increases. No threshold 25-hydroxy D vitamin level is determined for vitamin D deficiency in children. Different threshold values have been taken as criteria in studies investigating vitamin D deficiency and insufficiency. The Endocrine Society published a report on this subject in 2016. In this report, a 25-OH D level was defined as vitamin D deficiency if <12 ng/ml, vitamin D insufficiency if 12–20 ng/ml, and normal vitamin D level if >20 ng/ml.[10] The American Pediatric Endocrinology Association defines a 25-OH D level as normal if it is >20 ng/ml, insufficiency if it is between 15–20 ng/ml, deficiency if it is between <5–15 ng/ml, and severe deficiency if it is <5 ng/ml.[11] In this study, the American Association of Pediatric Endocrinology's vitamin D ranges were considered.

In various epidemiological studies conducted across the globe, vitamin D deficiency has been documented with frequencies ranging from 7% to 68%, while vitamin D insufficiency has been observed with frequencies ranging from 19% to 61% among healthy children and

Table 3: Comparison of vitamin D status according to gender and descriptive characteristics

	Vitamin D status								p
	Severe deficiency		Deficiency		Inadequate		Normal		
	Number	%	Number	%	Number	%	Number	%	
Male									
Age (years)									<0.001
0–5	9	0.6	317	20.6	264	17.1	950	61.7	
6–11	7	0.7	265	25.0	273	25.7	517	48.7	
12–18	8	1.2	225	33.5	175	26.1	263	39.2	
Place of residence									0.004
Urban	23	0.8	732	25.6	615	21.5	1488	52.1	
Rural	1	0.2	75	18.1	97	23.4	242	58.3	
Female									
Age (years)									<0.001
0–5	15	1.0	342	23.7	272	18.8	814	56.4	
6–11	11	1.0	438	39.2	274	24.5	395	35.3	
12–18	74	6.7	719	65.1	181	16.4	131	11.9	
Place of residence									0.148
Urban	94	2.9	1342	40.7	642	19.5	1217	36.9	
Rural	6	1.6	157	42.3	85	22.9	123	33.2	

adolescents.[10] Many studies conducted and published in Türkiye reveal significant levels of vitamin D deficiency/insufficiency in children and adults. In Türkiye, the prevalence of vitamin D deficiency among children and adolescents ranges from 8% to 61%, and this prevalence varies depending on factors such as age, gender, and season.[11] In a study conducted by the Ministry of Health in 2011, involving 2504 children aged 6–17 months and their mothers in Türkiye, it was reported that vitamin D deficiency was present in 26.8% of the participants. Additionally, vitamin D insufficiency was found to affect 66.7% of the individuals. The study aimed to assess vitamin D levels and the status of iron deficiency anemia in this population and evaluate the programs conducted in 2011.[8] In a study conducted by Akman et al.[12] during the spring season in Ankara, vitamin D deficiency was observed in 8% of the 420 children aged 1–16 years, while vitamin D insufficiency was present in 25.5% of the participants. In a study conducted on children applied to the pediatric endocrine outpatient clinic, vitamin D deficiency was found to be 51.5%, and vitamin D insufficiency was found to be 35.1%.[13] A 2018 study conducted in the Erzincan province, involving 2346 children, revealed that severe vitamin D deficiency was detected in 8.36% of the participants.[14] Türe et al.,[15] in a study with 4153 children and adolescents, found vitamin D deficiency in 65.0% (n=2700) and vitamin D insufficiency in 23.1% (n=959) of the patients. In a study carried out in Ankara province, a significant prevalence of vitamin D deficiency (51.8%) and vitamin D insufficiency (20.7%) was observed.[16] Okan et al.[17] reported that 58.4% of children and adolescents had vitamin D deficiency. A study by Pearse et al.[18] in the UK revealed that vitamin D deficiency was prevalent in over 50% of the adult population during the winter and spring seasons, with severe vitamin D deficiency affecting 16%. A study conducted in Greece reported that 52.5% of 2386 school children aged 9–13 years had vitamin D deficiency.[19] Additionally, in an observational study conducted in Spain, 66% of children and adolescents aged 5–15 years were found to have vitamin D deficiency.[20] In the current study, among 6939 children, the prevalence of severe vitamin D deficiency was 1.8%, deficiency was observed in 33.2%, insufficiency in 20.7%, and normal levels in 44.2%. More than half (55.8%) had low vitamin D levels. This was considered to be compatible with the literature.

In a 2014 study conducted by Karagüzel et al.[21] in Trabzon, involving 746 healthy school-age children, it was observed that girls exhibited a higher prevalence of vitamin D deficiency compared to boys. Topal et al.'s[14] study revealed a significant difference (p<0.001) in vitamin D levels between boys and girls, with boys exhibiting higher levels. In Demiral et al.'s[13] study, it was observed that 25-OH D levels were significantly lower in girls compared to boys (p<0.001). In a study conducted by Badem et al.[22] involving 2672 adolescents, it was found that 84.9% of girls had vitamin D deficiency, while 12.1% had vitamin D insufficiency. In contrast, this rate was 59.5% and 31.4% in boys. In a study conducted on school children in Kuwait, it was observed that male students had significantly higher 25(OH) vitamin D levels compared to their female counterparts.[23] In a study conducted in Colombia, 25 hydroxy D vitamin levels were lower in female students than male students.[24] It is evident that research conducted both within Türkiye and internationally consistently indicates that girls tend to have lower levels of vitamin D. In our study, boys' low

vitamin D levels were 47.1%, whereas this rate was 63.4% in girls. It is evident that vitamin D deficiency was notably more prevalent in girls compared to boys (p<0.001). It was thought that this might be because girls dress more closed due to sociocultural or religious obligations and that girls spend less time in open areas, so their bodies are not sufficiently exposed to the sun and cannot synthesize vitamin D. Further studies are needed to make more precise interpretations about the cause. The current research aligns with existing literature, demonstrating a higher prevalence of vitamin D deficiency in girls.

The period of adolescence is a crucial phase for skeletal growth and development. The rapid increase in height during puberty necessitates a greater intake of calcium and vitamin D, both of which are often deficient during this time. As a result, it is standard practice to recommend calcium and vitamin D supplementation for adolescents during their pubertal years.[11] A research carried out in the Erzincan region of Türkiye revealed that vitamin D levels declined as individuals grew older.[14] In a study involving adolescent girls in Kocaeli, a vitamin D deficiency or insufficiency rate of 64.8% was documented.[25] In a study conducted by Okan et al.,[17] it was noted that 25(OH)-D vitamin D levels exhibited variations among different age groups, with the highest levels observed in the 1–6 age group and the lowest levels in the 7–17 age group (p<0.001). There exists an inverse correlation between age and vitamin D levels. The current study noted a significant decline in vitamin D levels among the older age groups. While the rate of children aged 0–5 years with low vitamin D levels was 40.9%, this rate was 77.8% in the 12–18 age group. This was consistent with the literature. It is considered that the free vitamin D support given to all babies from birth up to a certain age in Türkiye may also have an effect.

In some studies, spending more time at home, not taking children out of the house due to cultural reasons or screen addiction, having houses without balconies, or living in neighborhoods with dense apartment buildings that block sunlight cause people not to benefit from the sun sufficiently.[3] There is a scarcity of studies that assess vitamin D levels in children residing in both urban and rural areas. In a retrospective study conducted in the Tokat region of Türkiye, involving 5356 pediatric patients, it was observed that there was no significant difference in vitamin D levels between children residing in the city center and those living in rural areas (p=0.673).[17] In the current study, variations in vitamin D levels were noted based on the participants' places of residence. The vitamin D levels of children residing in the city center were markedly lower when compared to those living in rural areas (p=0.011). The reason for this was thought to be that children living in the city did not go out in the sun much and stayed in the buildings, whereas those living in the countryside benefited more from sunlight and thus had higher vitamin D levels.

The most important limitation of this study is that since it was a retrospective study, information such as living conditions, complaints, duration of contact with the sun, whether the skin color was dark or not, dietary characteristics, whether they used vitamin D supplements or not and sunscreen use could not be obtained. At the same time, the fact that the study was single-centered prevents the generalisability of the results. Most of the demographic characteristics of the study group could not be reached because the data were collected through hospital information systems, and the patients could not be interviewed one-on-one.

CONCLUSION

The study findings indicate a notable prevalence of vitamin D deficiency/insufficiency during childhood, with an increase in prevalence as age advances and a higher incidence among girls. Vitamin D deficiency was more prevalent among children residing in urban areas compared to those living in rural areas. Adopting a protective lifestyle against vitamin D deficiency/insufficiency in children, increasing exposure to the sun, increasing vitamin D supplementation with increasing age, and checking vitamin D levels from time to time may be helpful in terms of preventing complications.

Statement

Ethics Committee Approval: The Fırat University Non-Interventional Clinical Research Ethics Committee granted approval for this study (date: 08.06.2023, number: 2023/08-20).

Author Contributions: Concept – FEK, OK; Design – FEK, OK; Supervision – FEK, OK; Resource – FEK, OK; Materials – FEK, OK; Data Collection and/or Processing – FEK, OK; Analysis and/or Interpretation – FEK, OK; Literature Search – FEK, OK; Writing – FEK, OK; Critical Reviews – FEK, OK.

Conflict of Interest: The authors have no conflict of interest to declare.

Informed Consent: Written, informed consent was obtained from the patients' families for the publication of this case report and the accompanying images.

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