DOI: https://doi.org/10.18621/eurj.1783317 *Clinical Chemistry*

Pediatric Vitamin D Status: Age, Gender, and Seasonal Determinants in a Comprehensive Retrospective Cohort

Ahmet Dundar[1], Songul Cetik Yildiz[1], Halit Irmak[2]

[1]Department of Medical Services and Techniques, Vocational Higher School of Health Services, Mardin Artuklu University, Mardin, Türkiye;
[2]Department of Computer Sciences, Faculty of Engineering and Architecture, Mardin Artuklu University, Mardin, Türkiye

Abstract:

Objective: Vitamin D plays a critical role in bone health, immune function, and overall growth and development in children. So, the study aimed to determine serum vitamin D levels in a large sample, examine their relationship to age groups, gender, seasonal and monthly, and identify risk groups by demonstrating the prevalence of vitamin D deficiency in the pediatric age group.

Methods: A retrospective study was conducted using serum vitamin D level data from pediatric patients presenting to the Pediatrics Outpatient Clinic. Children were divided into four age groups based on developmental stages: 1-4, 5-8, 9-12, and 13-17 years. Vitamin D levels were categorized as severe deficiency, deficiency, insufficiency, and normal. The data were analyzed for age, gender, seasonality, and monthly distribution, and the relationships between these variables were evaluated using comprehensive statistical methods.

Results: Only 6.5% of the average vitamin D levels were found to be normal. Deficiency, insufficiency, or severe deficiency was detected in 93.5%. A weak but significant negative correlation was observed between age and vitamin D levels. While levels were similar between genders, severe deficiency was higher in females. The highest values were observed in summer and the lowest in winter, with July-September being the peak and January-February the trough.

Conclusion: Our study revealed that vitamin D deficiency is common in children and a critical public health problem. Decreasing levels with age, seasonal cycles, and gender differences indicate that the risk becomes more pronounced. These findings highlight the need for supplementation plans and awareness-raising strategies, particularly during winter and spring.

Keywords: Vitamin D Status, Pediatric Population, Deficiency, Analytical Determinants

Vitamin D (Vit D) plays a vital role not only in bone health but also in immune and metabolic functions during childhood. As an illustration, rickets, one of the classic complications of Vit D deficiency in childhood, is characterized by the softening of developing bone resulting from impaired bone mineralization. It can cause serious health problems in children, such as growth retardation, motor delays, and bone deformities [1]. Furthermore, Vit D exerts regulatory effects on innate components of the immune system. The presence of Vit D receptors, particularly in immune cells such as monocytes, macrophages, and

Submitted: September 13, 2025 **Accepted:** November 2, 2025 **Published Online:** December 16, 2025

How to cite this article: Dundar A, Cetik Yildiz S, Irmak H. Pediatric Vitamin D Status: Age, Gender, and Seasonal Determinants in a Comprehensive Retrospective Cohort. Eur Res J. 2026;12(6):650-658. doi: 10.18621/eurj.1783317

Corresponding author: Songül Çetik Yıldız, PhD., Assist. Prof., Phone: +90 482 212 69 48 ext. 7270, E-mail: songulcetik@gmail.com songulcetik@artuklu.edu.tr

dendritic cells, suggests that this Vit D inhibits antimicrobial peptide synthesis and weakens the immune response when serum levels are low [2]. Vit D in steroid form is found in the human body in the forms of D_2 (ergocalciferol) and D_3 (cholecalciferol) [3]. More than 90% of Vit D is converted to previtamin D3 from 7-dehydrocholesterol in the skin during exposure to sunlight, which is thermally converted to Vit D3. Therefore, Vit D, D2, or D3, is hydroxylated first to 25(OH)D in the liver and then to 1,25(OH)2D in the kidneys. 25(OH)D is the main circulating form of Vit D and has a half-life of 2–3 weeks [4]. Since the 25(OH)D level in serum is considered the most reliable biological marker of Vit D status in the body, they have identified it as a strong and reliable indicator for monitoring Vit D status in infants and children [5]. Studies conducted in various geographic regions reveal that differences in sunlight exposure, lifestyle, dietary habits, and latitude also influence serum 25(OH)D levels. And age, gender, season have each been reported to have significant effects on Vit D levels, and the interaction effect between age and season is also significant [4]. It has also been noted that the high prevalence of Vit D deficiency in children is particularly related to nutritional status and seasonal factors [6]. Vit D levels have been reported to be low across age groups, particularly in the 7-18 age group. In gender-based assessments, males are frequently reported to have higher Vit D levels than females. It has also been reported that levels rise in the summer and drop significantly in the winter [7]. Beyond bone metabolism, emerging evidence indicates that Vit D also plays an important role in immune regulation. Accordingly, our study aims to assess vitamin D levels in children aged 0-17 based on age, gender, season, and month, expecting that these factors influence vitamin D status and reveal subgroups at increased risk for deficiency.

METHODS

Study Design and Data Collection

Our study included a total of 15.981 pediatric patients aged 1 to 17 who presented to the Pediatrics Outpatient Clinic of Mardin Training and Research Hospital between 01.01.2018-31.12.2018. The study was approved by the Mardin Artuklu University Non-Interventional Clinical Research Ethics Committee (number: 2025/1-4, date: 07.01.2025).

The study included retrospective and cross-sectional data on Vit D levels in children. Demographic information such as age and gender of the patients, month and season information regarding the application period, and laboratory results of Vit D (25-OH D) levels were obtained from the hospital automation system.

As part of the preliminary analysis, participants were divided into four age groups based on their developmental stages: 1-4, 5-8, 9-12, and 13-17 years. Vit D levels were classified into four categories: <10 ng/mL (severe deficiency), 10-19.99 ng/mL (deficiency), 20-29.99 ng/mL (insufficiency), and ≥30 ng/mL (normal). Additionally, seasonal and monthly data in text format were converted to numerical codes to facilitate statistical analyses (e.g., Winter = 1, Spring = 2...; January = 1, February = 2...). Vit D categories were based on established clinical cut-offs recommended by the Endocrine Society and other pediatric guidelines. Seasonal and monthly information was numerically coded solely to facilitate statistical analyses.

Study inclusion criteria: Pediatric age group between 1 and 17 years old were included in the study.

Study exclusion criteria: Conditions such as diabetes mellitus, pregnancy, cancer, rheumatic diseases, febrile illnesses, inflammatory diseases, renal dysfunction, vitamin D supplementation, autoimmune disease, liver and thyroid dysfunction, and acute and chronic infections were identified as exclusion criteria.

Statistical Analysis

Statistical analysis of the data was performed using SPSS 27.0. Descriptive statistics are given as mean±standard deviation (Mean±SD) for continuous variables and as number (n) and percentage (%). The Kolmogorov-Smirnov test was used to assess the data's conformity to a normal distribution, and since it was determined that the data were not normally distributed (P< .001), non-parametric tests were used for comparisons between groups. In group comparisons, the Mann-Whitney U test was used for two independent groups, and the Kruskal-Wallis H test was used for comparisons of more than two independent groups (seasons, months, age groups). If the Kruskal-Wallis H test was significant, post-hoc analysis was performed using the Mann-Whitney U test with Bonferroni correction to determine the source of the difference. Spearman correlation analysis was used to examine the relationship between variables. Statistical significance was set at P<0.05 in all analyses.

RESULTS

Demographic Characteristics and General Vitamin D Assessments

The mean age of the participants was 7.59±5.28 years. Females constituted 51.6% of the sample (n=8,251), while males constituted 48.4% (n=7,730). When the distribution by age group was examined, the largest group was children aged 1-4 (37.5%), followed by children aged 13-17 (23.7%) (n=3,786), those aged 5-8 (21.2%) (n=3,388), and those aged 9-12 (17.6%) (n=2,809) (Table 1).

The overall mean Vit D level in the study group was found to be 16.24±13.06 ng/mL. Classification based on Vit D sufficiency revealed that only 6.5% (n=1.035) of participants had normal Vit D levels (>30 ng/ml). 44.1% (n=7.047) of the individuals were classified as "Deficiency," 30.5% (n=4.872) as "Severe deficiency," and 18.9% (n=3.027) as "Insufficiency". In total, 93.5% of the individuals included in the study were found to have Vit D levels below the ideal level (Table 1).

Evaluation of Vitamin D Levels by Gender and Age Group

The relationship between Vit D status categories and gender was examined using the Chi-Square test. The analysis revealed a statistically significant difference in the distribution of Vit D status by gender (χ^2(3, N=15981) = 297.883, P<0.001). A detailed examination revealed that the rate of 'Severe Deficiency' was significantly higher in females (36.2%) than in males (24.4%). Conversely, the rates of 'Insufficient' (22.2% vs. 15.9%) and 'Normal' (7.4% vs. 5.6%) Vit D levels were higher in males than in females. General Vit D deficiency (<20 ng/mL) was detected in 78.6% of girls and 70.3% of males (Table 2).

Vitamin D Assessment by Age Groups

Chi-Square test analysis revealed a highly statistically significant association between Vit D status and age groups (χ^2(9, N=15981) = 1465.163, P<0.001). The findings show a strong trend towards an increase in both the prevalence and severity of Vit D deficiency with increasing age. While the rate of 'Severe Deficiency' (<10 ng/mL) was 18.8% in the 1-4 age group, this rate gradually increases with age, reaching 46.5% in the 13-17 age group (adolescence). In contrast, the rate of having 'Normal' Vit D status (>30 ng/mL) was highest at 12.0% in the 1-4 age group, while this rate

TABLE 1. Descriptive Statistics Regarding Demographics and Vitamin D Levels of Participants

Variable	Category	Value
Age (year)		7.59±5.28
Gender	Female	8,251 (51.6)
	Male	7,730 (48.4)
Age groups (years)	1-4	5,998 (37.5)
	5-8	3,388 (21.2)
	9-12	2,809 (17.6)
	13-17	3,786 (23.7)
Vitamin D (ng/mL)		16.24±13.06
Vitamin D (ng/mL)	Normal (≥30)	1,035 (6.5)
	Insufficiency (20-29.99)	3,027 (18.9)
	Deficiency (10-19.99)	7,047 44.1
	Severe deficiency (<10)	4,872 (30.5)
Total		15,981 (100.0)

Data are shown as mean±standard deviation or n (%).

TABLE 2. Distribution of Vitamin D Status by Gender

Vitamin D status	Male (n=7,730)	Female (n=8,251)	Total (n=15,981)
Severe deficiency	1,889 (24.4%)	2,983 (36.2%)	4,872 (30.5%)
Deficiency	3,547 (45.9%)	3,500 (42.4%)	7,047 (44.1%)
Insufficiency	1,719 (22.2%)	1,308 (15.9%)	3,027 (18.9%)
Normal	575 (7.4%)	460 (5.6%)	1,035 (6.5%)

Data are shown as n (%). Chi-square test result: P<0.001

decreases to 2.9% during adolescence. This trend towards worsening Vit D status with increasing age was also statistically supported by the linear association test (Linear-by-Linear Association, P<0.001), which was found to be significant (Table 3).

Changes in the Relationship Between Age and Vitamin D Levels According to Gender

The linear relationship between age and Vit D levels was examined using Spearman correlation analysis. The analysis revealed a statistically significant, weak, and negative correlation between age and serum Vit D levels (rho = -0.330, P<0.001). This negative relationship between age and Vit D was also visually confirmed in scatter plots stratified by gender. A similar trend toward a decrease in Vit D levels with increasing age was observed in both male and female participants (Figure 1).

Evaluation of Changes in Vitamin D Levels by Season

The Kruskal-Wallis H test, which was conducted to determine whether Vit D levels differed according to seasons, showed that there was a highly statistically significant difference between seasons (H(3)= 2542.287, P<0.001). In order to determine the seasons between which this general difference occurred, pairwise comparisons were made using Mann-Whitney U tests with Bonferroni correction (significance level was set at P<0.008). According to the mean rank values, Vit D levels are ranked as Summer > Autumn > Spring > Winter. The highest Vit D levels were detected in Summer (Mean Rank: 10122.90), while the lowest levels were observed in Winter (Mean Rank: 5386.13). Additionally, it was found that Autumn (Avg. Rank: 9366.04) levels were significantly higher than Spring (Avg. Rank: 7692.56) levels due to the effect of Vit D stored during the summer (Table 4).

Prevalence of Vitamin D Deficiency by Season

A chi-square test was performed to further examine the effect of seasonal variation on Vit D sufficiency status. The analysis confirmed a highly statistically significant relationship between the distribution of Vit D status categories and the seasons ($\chi^2(9, N=15981) = 2521.187$, P<0.001). Cross-tabulation analyses revealed a dramatic seasonal fluctuation in the prevalence of Vit D deficiency. While severe deficiency (<10 ng/mL) was detected in more than half of the participants (56.4%) in winter, this rate decreased to

TABLE 3. Distribution of Vitamin D Status by Age Groups

Vitamin D status	1-4 years (n=5,998)	5-8 years (n=3,388)	9-12 years (n=2,809)	13-17 years (n=3,786)
Severe deficiency	1,125 (18.8%)	991 (29.2%)	995 (35.4%)	1,761 (46.5%)
Deficiency	2,567 (42.8%)	1,620 (47.8%)	1,353 (48.2%)	1,507 (39.8%)
Insufficiency	1,584 (26.4%)	629 (18.6%)	405 (14.4%)	409 (10.8%)
Normal	722 (12.0%)	148 (4.4%)	56 (2.0%)	109 (2.9%)

Data are shown as n (%). Chi-Square: P<0.001

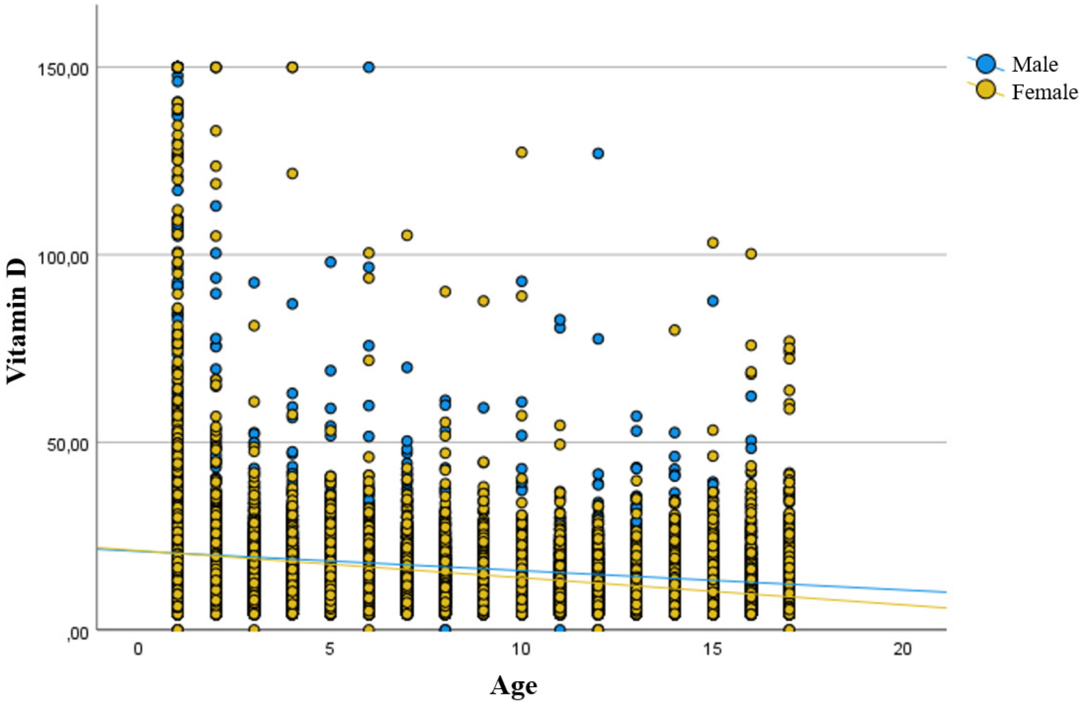

FIGURE 1. Scatter plot of the relationship between age and vitamin D levels by gender.

12.4% in summer. Vit D deficiency (<20 ng/mL) (sum of severe deficiency and deficiency groups) was observed to reach a significantly high rate of 87.3% in winter. This rate decreased to 61.3% in summer. Conversely, the proportion of individuals with 'Normal' Vit D levels (>30 ng/mL) is only 4.4% in winter, reaching its highest value in summer (8.6%) and autumn (8.5%) (Table 5).

Differences in Vitamin D Levels by Months

To conduct a more detailed analysis of seasonal effects, Vit D levels were compared over 12 months. The Kruskal-Wallis H test revealed a highly statistically significant difference in Vit D levels between months (H(11)= 3044.525, P<0.001). The monthly distribution of mean rank values indicates that Vit D levels exhibit a significant cycle throughout the year. Vit D levels were observed to reach their lowest levels in January (mean rank: 4828.42) and February (mean rank: 4939.42), to increase from March onward, and to reach their highest values in July (mean rank: 10454.35) and September (mean rank: 10369.80). A significant decrease was observed again from October onward (Table 6).

TABLE 4. Comparison of Vitamin D Levels by Season

Seasons	N	Mean Rank
Winter	4,386	5386.13[a]
Spring	4,492	7692.56[b]
Summer	3,962	10122.90[c]
Autumn	3,141	9366.04[d]

Kruskal-Wallis H Test result. Test statistic: H(3)= 2542.287, P<0.001. Different superscript letters (a, b, c, d) indicate that all groups are statistically significantly different from each other as a result of Bonferroni-corrected post-hoc tests (all P<0.008).

Prevalence of Vitamin D Deficiency by Months

The Kruskal-Wallis H test, performed to compare Vit D levels on a 12-month basis, revealed a highly statistically significant difference between months (H(11)= 3044.525, P<0.001). Chi-Square analysis, performed to evaluate the clinical reflection of this cycle, also confirmed a very strong relationship between the distribution of Vit D status and months ($\chi^2(33) = 3155.455$, P<0.001). According to monthly deficiency prevalences (Table 7):

•The 'Serious Deficiency' rate peaks in January

TABLE 5. Distribution of Vitamin D Status categories by Season

Vitamin D status	Winter (n=4,386)	Spring (n=4,492)	Summer (n=3,962)	Autum (n=3,141)
Severe deficiency	2,473 (56.4%)	1,384 (30.8%)	490 (12.4%)	525 (16.7%)
Deficiency	1,354 (30.9%)	2,181 (48.6%)	1,938 (48.9%)	1,574 (50.1%)
Insufficiency	366 (8.3%)	692 (15.4%)	1,194 (30.1%)	775 (24.7%)
Normal	193 (4.4%)	235 (5.2%)	340 (8.6%)	267 (8.5%)

Data are shown as n (%). Chi-square test result: $\chi^2(9)=2521.187$, P<0.001

(65.5%) and February (59.7%), falling to its lowest level of 9.3% in July.

•The prevalence of overall Vit D deficiency is most critical in late winter and early spring. This rate reached its highest point of the year in February, affecting 90.2% of participants.

•The lowest rate of 'normal' Vit D levels was observed in February with 3.2%, while the highest was observed in September with 11.9%.

DISCUSSION

In this large-scale study of 15,981 pediatric participants, we found that Vit D deficiency is highly prevalent across all age groups, with only a small proportion of children achieving normal serum levels. Our findings demonstrate the extent of the problem within a large hospital-based population, even if some of this pattern - especially the greater rates of deficiency in older children - is consistent with earlier reports. Despite regular supplementation regulations in many areas, the noticeably high early childhood insufficiency rate raises the possibility that present preventive measures are either inadequate or inconsistently applied. Studies involving children aged 0-18 have reported higher Vit D levels in the infant group, with levels tending to decline with age [8, 9].

TABLE 6. Comparison of Vitamin D Levels by Months

Months	N	Mean Rank
January	1,706	4828.42
February	1,453	4939.42
March	1,562	6588.70
April	1,761	7754.04
May	1,169	9074.88
June	1,088	9814.48
July	1,660	10454.35
August	1,214	9946.11
September	1,407	10369.80
October	1,390	8877.71
November	344	7233.69
December	1,227	6690.53

Kruskal-Wallis H Test results. Test statistic: $H(11) = 3044.525$, P<0.001

The average Vit D levels were found to be 16.24±13.06 ng/mL, with only 6.5% at normal levels and approximately 93.5% below the ideal level. This rate is quite high and demonstrates the prevalence of Vit D deficiency. One study reported that Vit D levels decrease with age, and the rate of deficiency increases [10]. It is noteworthy that the mean level in our data (approximately 16-17 ng/mL) was 30.5% in the severe deficiency group. While better levels were observed in areas where Vit D supplementation was administered, particularly during infancy (<1 year of age), a decline was observed during the school-age period and in adolescents due to factors such as supplementation, nutritional deficiencies, and lack of sun exposure. Furthermore, the gender gap is a frequently reported variable in the literature, with many studies [8, 11] showing that deficiency is more prevalent in females. In our study, overall Vit D levels and the rate of "Severe Deficiency" were found to be higher in girls. Contrary to our data, some reported studies have observed higher Vit D levels in males [8, 12].

Spearman correlation analysis showed a statistically significant, weak, but negative correlation between age and serum Vit D levels. This suggests a general trend toward a decrease in Vit D levels with increasing age. Furthermore, the similar decrease observed in both genders in scatterplots grouped by sex

TABLE 7. Distribution of Vitamin D Status Categories by Months (%)

Vitamin D status	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Severe deficiency	65.5	59.7	41.4	30.7	18.2	16.4	9.3	14.7	11.1	17.7	36.9	39.9
Deficiency	22.0	30.6	43.6	49.8	53.2	49.9	50.2	47.5	46.2	55.7	43.6	43.6
Insufficiency	7.7	6.6	11.4	15.3	21.0	28.3	31.5	30.0	20.9	13.3	14.0	11.5
Normal	4.9	3.2	3.6	4.2	7.6	7.3	9.9	7.9	11.9	3.3	5.5	5.0

Data are shown as percentage (%). Chi-square test result: $\chi^2(33) = 3155.455$, $P<0.001$

suggests that this age-related relationship is independent of gender. A study of 1,510 children found a significant negative correlation between Vit D levels and age [13]. According to our findings, the highest Vit D levels were seen in younger age groups, with levels decreasing significantly with age. One study reported that age, gender, and season all had significant main effects on Vit D levels, and that the combined effects of age and season were also significant [4]. Our findings of higher severe deficiency rates in girls may indicate behavioral, cultural, or physiological variables influencing sun exposure or supplementing adherence. Finding these sex-specific trends is therapeutically significant since it could direct more specialized public health initiatives.

Our findings demonstrate a highly statistically significant difference in Vit D levels across seasons. Pairwise comparisons using Mann-Whitney U tests with Bonferroni correction yielded a ranking of Summer > Autumn > Spring > Winter, with the highest levels observed in summer and the lowest in winter. One study observed seasonal variation in 25(OH)D concentrations in children and adolescents (aged 3-18), with the deficiency rate reaching as high as 80.4% in winter [14]. Indeed, this finding closely parallels ours (lowest in winter, highest in summer). A similar study noted that Vit D deficiency is quite common in children, with a particularly strong seasonal pattern among girls (aged 13-18). Levels increased significantly after summer, reflecting differences in sun exposure and time spent outdoors across countries, while levels decreased in winter and spring [15]. Therefore, our findings suggest that the low levels between winter and spring may be due to a lack of sunlight and differences in supplementation/outdoor time. In this context, public health policies should take seasonal changes into account, and supplementation and awareness programs should be developed for at-risk groups, particularly during the winter and spring periods. Overall, our findings not only confirm established patterns but also contribute population-specific data that highlight critical periods (Winter-Spring), vulnerable subgroups (adolescents, girls), and gaps in current public health practices. These insights may support the development of more effective, regionally adapted supplementation and screening policies.

Our findings indicate highly significant differences in Vit D levels across months. The mean rank values follow a distinct cycle throughout the year, with lowest levels occurring in January and February and highest in July and September. This pattern suggests that Vit D synthesis is closely linked to seasonal and monthly variations in sunlight exposure. One study found that Vit D levels were lowest in March and highest in August and September in a group of children not receiving supplements [16]. Another study reported that Vit D concentrations were lowest in March-April and highest in August, and this seasonal difference was more pronounced, especially in individuals not using supplements [17]. These findings are consistent with the observed rise-and-fall data between the January-February lows and the July-September highs in our study. In summary, our findings are generally consistent with national and international literature and clearly demonstrate the existence of a monthly cycle. This points to the need for monthly public health monitoring and/or precautions for months with a high percentage risk (e.g., an intensive information and reinforcement strategy during periods such as January-February). Furthermore, future analyses that incorporate additional variables such as sunlight intensity, UVB radiation levels, cloudiness, and time spent outdoors into this period would be beneficial.

Strengths and Limitations

The strengths of this study include its large sample size and detailed month-by-month analysis, which allowed us to visualize the cyclical nature of Vit D levels across the year. However, several limitations must be acknowledged. First, the retrospective, hospital-based design may introduce selection bias. Children presenting to healthcare facilities may differ from the general population in health status. As a result, the prevalence of deficiency observed here may not fully reflect community-level data. Second, potential confounders such as dietary intake, sunlight exposure duration, clothing habits, and supplementation history were not recorded and may have affected Vit D levels. Future prospective studies incorporating lifestyle and environmental variables would provide a more comprehensive understanding of the determinants of Vit D status.

CONCLUSION

This study, using a large sample, thoroughly evaluated the distribution of Vit D levels in children, considering age, gender, and seasonal variables. Our findings revealed that Vit D levels were below the ideal range in the majority of children, and that rates of severe deficiency were higher than those reported in many studies in the literature. A significant decreasing trend in serum Vit D levels was observed with age. Furthermore, factors such as seasonal and monthly cycles, sunlight exposure, and lifestyle are among the determinants of Vit D status in children. These data strongly support the notion that Vit D deficiency is a significant health problem at the population level, demonstrating that the risk is particularly pronounced in adolescents and girls during winter and spring. Therefore, national and international health policies should take seasonal variations into account and develop preventive strategies during risk periods, along with regular Vit D supplementation and widespread awareness programs in children.

Ethics Approval and Consent to Participate

This study was approved by the he Mardin Artuklu University Non-Interventional Clinical Research Ethics Committee (Decision No: 2025/1-4; date: 07.01.2025). All procedures were conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments. Written informed consent was obtained from all individual participants included in the study.

Data Availability

All data generated or analyzed during this study are included in this published article. The data that support the findings of this study are available on request from the corresponding author upon reasonable request.

Authors' Contribution

Study Conception: AD, SCY; Study Design: AD, SCY, HI; Supervision: AD, SCY, HI; Funding: N/A; Materials: AD, SCY, HI; Data Collection and/or Processing: AD; Statistical Analysis and/or Data Interpretation: HI, AD, SCY; Literature Review: AD, SCY, HI; Manuscript Preparation: AD, SCY, HI; and Critical Review: AD, SCY, HI.

Conflict of Interest

The author(s) disclosed no conflict of interest during the preparation or publication of this manuscript.

Financing

The author(s) disclosed that they did not receive any grant during the conduction or writing of this study.

Acknowledgments

A part of this study was presented at the 15th International Gevher Nesibe Health Sciences Conference, held on September 28–30, 2025, in Ankara, Türkiye.

Generative Artificial Intelligence Statement

The author used artificial intelligence tools (ChatGPT, OpenAI) only for language editing and reference formatting. The all content of the study was produced by the author(s) in accordance with scientific research methods and academic ethical principles.

Editor's Note

All statements made in this article are solely those of the authors and do not represent the views of their affiliates or the publisher, editors, or reviewers. Any claims made by any product or manufacturer that may be evaluated in this article are not guaranteed or endorsed by the publisher.

REFERENCES

1. Corsello A, Spolidoro GCI, Milani GP, Agostoni C. Vitamin D in pediatric age: Current evidence, recommendations, and misunderstandings. Front Med (Lausanne). 2023;10:1107855. doi: 10.3389/fmed.2023.1107855.
2. Weydert JA. Vitamin D in Children's Health. Children (Basel). 2014;1(2):208-226. doi: 10.3390/children1020208.
3. Holick MF. Vitamin D deficiency. N Engl J Med. 2007;357(3):266-281. doi: 10.1056/NEJMra070553.
4. Bagci Z. Evaluation of the Effects of Age Group, Gender and Seasonal Factors On Vitamin D Levels in 9496 Children. Selcuk Med J 2021;37(4): 365-370. doi: 10.30733/std.2021.01528.
5. Cashman KD, van den Heuvel EG, Schoemaker RJ, Prévéraud DP, Macdonald HM, Arcot J. 25-Hydroxyvitamin D as a Biomarker of Vitamin D Status and Its Modeling to Inform Strategies for Prevention of Vitamin D Deficiency within the Population. Adv Nutr. 2017;8(6):947-957. doi: 10.3945/an.117.015578.
6. Ghiga G, Țarcă E, Țarcă V, et al. Vitamin D Deficiency: Insights and Perspectives from a Five-Year Retrospective Analysis of Children from Northeastern Romania. Nutrients. 2024;16(22):3808. doi: 10.3390/nu16223808.
7. Zhou DY, Wei SM, Zhu CL, et al. Age-, season- and gender-specific reference intervals of serum 25-hydroxyvitamin D3 for healthy children (0～18 years old) in Nanning area of China. J Physiol Sci. 2024;74(1):2. doi: 10.1186/s12576-023-00895-z.
8. Sarı E, Çoban G, Çelebi ÖFZ, Açoğlu AE. The Status of Vitamin D Among Children Aged 0 to 18 Years. J Pediatr Res. 2021;10,8(4):438-443. doi: 10.4274/jpr.galenos.2021.09851.
9. Yeşiltepe-Mutlu G, Aksu ED, Bereket A, Hatun Ş. Vitamin D Status Across Age Groups in Turkey: Results of 108,742 Samples from a Single Laboratory. J Clin Res Pediatr Endocrinol. 2020;12(3):248-255. doi: 10.4274/jcrpe.galenos.2019.2019.0097.
10. Isiksacan N, Bıyık I, Kasapoglu P, Koser M, Caglar FN, Kocamaz N. Increased risk of cardiovascular disease may be starting in childhood: 25OH vitamin D levels in Turkish children. J Updates Cardiovasc Med. 2018;156(1):1-6. doi: 10.15511/ejcm.18.00101.
11. Andıran N, Çelik N, Akça H, Doğan G. Vitamin D deficiency in children and adolescents. J Clin Res Pediatr Endocrinol. 2012;4(1):25-29. doi: 10.4274/jcrpe.574.
12. Zhang Y, Zhou L, Ren Y, Zhang H, Qiu W, Wang H. Assessment of serum vitamin D levels in children aged 0-17 years old in a Chinese population: a comprehensive study. Sci Rep. 2024;14(1):12562. doi: 10.1038/s41598-024-62305-7.
13. Chen Z, Lv X, Hu W, Qian X, Wu T, Zhu Y. Vitamin D Status and Its Influence on the Health of Preschool Children in Hangzhou. Front Public Health. 2021;9:675403. doi: 10.3389/fpubh.2021.675403.
14. Smyczyńska J, Smyczyńska U, Stawerska R, et al. Seasonality of vitamin D concentrations and the incidence of vitamin D deficiency in children and adolescents from central Poland. Pediatr Endocrinol Diabetes Metab. 2019;25(2):54-59. doi: 10.5114/pedm.2019.85814.
15. Davies PS, Bates CJ, Cole TJ, Prentice A, Clarke PC. Vitamin D: seasonal and regional differences in preschool children in Great Britain. Eur J Clin Nutr. 1999;53(3):195-198. doi: 10.1038/sj.ejcn.1600697.
16. Won JW, Jung SK, Jung IA, Lee Y. Seasonal Changes in Vitamin D Levels of Healthy Children in Mid-Latitude, Asian Urban Area. Pediatr Gastroenterol Hepatol Nutr. 2021;24(2):207-217. doi: 10.5223/pghn.2021.24.2.207.
17. Hansen L, Tjønneland A, Køster B, et al. Vitamin D Status and Seasonal Variation among Danish Children and Adults: A Descriptive Study. Nutrients. 2018;10(11):1801. doi: 10.3390/nu10111801.