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ORIGINAL ARTICLE

Vitamin D Deficiency to the Age and Season of Turkish Patients Admitted to Family Medicine: A Retrospective Hospital-based Study in Istanbul

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Abstract

Introduction: In our study, we aimed to determine the prevalence of Vitamin D deficiency and evaluate Vitamin D levels according to age, gender, and season.

Methods: The data of Vitamin D levels, age, and gender of persons who admitted to Istanbul Medeniyet University, Göztepe Training and Research Hospital, Department of Family Medicine between 2012 and 2017 were collected. SPSS22 was used for statistical analysis and $p<0.05$ was considered as statistically significant.

Results: The data of 4227 patients, 80.44% women and 19.56% men, were included in the study. We found Vitamin D levels as follows: 1038≤10 ng/ mL, 1348 between 10 ng/mL and 20 ng/mL, 931 between 20 ng/mL and 30 ng/mL, 886 >30 ng/ mL and 24 >150 ng/mL. Vitamin D levels were found significantly higher in autumn than winter season in the age groups 6.1–17, 18–44, 45–64, and ≥ 65 ($p<0.001$). We found Vitamin D deficiency and insufficiency 56.45% and 78.48%, respectively. Sufficient Vitamin D levels were found in only 21.53% of subjects. About 80.9% of the participants in the winter season and 73.9% in the autumn period had Vitamin D levels below normal.

Discussion and Conclusion: Our results show that Vitamin D deficiency is quite high in our population. As we expected, sufficient Vitamin D levels were lower in winter than the autumn due to low sun exposure. While, we found higher Vitamin D levels in women than men and Vitamin D values increased with increasing age. To increase Vitamin D levels in our society, increasing sun exposure time or Vitamin D supplementation might be considered.

Keywords: Age; season; vitamin D deficiency.

There are two main forms of Vitamin D, is soluble in fat and has pleitropic hormone properties, that are D2 and D3[1]. Some natural foods such as oily fish, Vitamin D-fortified foods such as margarine, and external Vitamin D supplementation are the source of Vitamin D[2-4]. Vitamin D2 can only be taken with the diet, while Vitamin D3 can be taken with the diet and produced in the body[5]. Ultraviolet rays (UVB 280-320) directly stimulate the conversion of 7-dehydrocholesterol to pre-vitamin D3 by breaking ring B in the skin[6]. Once Vitamin D enters the circulation is bound by the Vitamin D-binding protein (DBP) and lipoproteins. Vitamin D separates from the DBP protein in the liver. Then, Vitamin D (D3) is converted to 25-hydroxycholecalciferol (25[OH]D3) and 1,25-dihydroxycolecalciferol (1,25[OH]

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2D3) in the liver and kidney, respectively.[7] The active form 1,25(OH) 2D3 binds to Vitamin D receptors[8,9] and this interaction is responsible for up to 80 different metabolic processes, such as cellular proliferation, differentiation, apoptosis, and DNA repair[10]. The producing amount of Vitamin D is depending on many factors including season, geographic location, different times of day, and UVB-irradiated skin surface[11].

Vitamin D deficiency may cause bone and muscle-related symptoms and diseases such as decreased muscle strength, musculoskeletal pain, rickets in children, and osteomalacia in adults[12]. Vitamin D deficiency is also associated with diabetes, infectious diseases, and cancer[13] and Vitamin D plays an effective role in the metabolism of calcium, phosphorus, and bone, is accepted as a global epidemic. Vitamin D levels is described as; <10 ng/mL severe deficiency,[14] <20 ng/mL deficiency, <20–30 ng/mL insufficiency, >30 ng/mL sufficient, and >150 ng/mL intoxication[15].

In the present retrospective study, Vitamin D levels of patients, who were admitted to Istanbul Medeniyet University, Göztepe Training and Research Hospital, Department of Family Medicine between 2012 and 2017 and had Vitamin D measurements, were evaluated according to gender, age, and months. We aimed to determine the prevalence of Vitamin D (25[OH]D3) deficiency living in Istanbul and surrounding area.

Materials and Methods

In this retrospective hospital-based study, the hospital registries of Istanbul Medeniyet University, Göztepe Training and Research Hospital between 2012 and 2017 were evaluated. Ethical approval was obtained from the Ethics Committee of Istanbul Medeniyet University, Göztepe Training and Research Hospital (No:2017/0072, February 28, 2017). The outpatients admitted to the family medicine that made the request Vitamin D levels. Vitamin D levels used in the study were measured by the same method in the same laboratory. To evaluate the effects of sunlight on Vitamin D, 25(OH)D3 values in autumn and winter periods covering September, October, November, February, March, and April were analyzed according to age and gender. Vitamin D measurements including the months of September, October, and November were included in autumn season; while the months of February, March, and April were included in winter season. The autumn months of September, October, and November are the reason, we prefer due to the fact that the levels of Vitamin D are produced after intense exposure to sunlight in the summer is still at a sufficient level in these months and the sunlight still does not lose its effect in autumn season.

Statistical Analysis

Statistical analysis was performed with SPSS software for Windows, version 22.0 (IBM Corp., Armonk, NY, USA). Mann–Whitney U, Kruskal–Wallis, and Pearson's Chi-square tests were used for data analysis. $p<0.05$ was considered as statistically significant.

Results

The number of Vitamin D measured in the family medicine polyclinic between 2012 and 2017 was 4227, 80.44% women and 19.56% men and very few of the subjects were under 18 years of age (2.37%). The 64.68% of the Vitamin D measurements were performed in winter (n=2784) and 1493 (35.32%) measurements were performed in autumn. The Vitamin D levels of the subjects were as follows: 1038 subjects (24.56%) were at or below 10 ng/mL, 1348 subjects (31.89%) were between 10 ng/mL and 20 ng/mL, 931 subjects (22.03%) were between 20 ng/mL and 30 ng/mL, 886 subjects (20.96%) were between 30 ng/mL and 150 ng/mL, and only 24 subjects Vitamin D level were (0.57%) at or above 150 ng/mL (Table 1). We considered that subjects with Vitamin D levels of 150 ng/mL and above may have taken the measurement after Vitamin D loading.

Table 1. Demographic characteristics of the study population

	n	%
Gender		
Women	3400	80.44
Men	827	19.56
Age groups (years)		
≤1	9	0.21
1.1–6	10	0.24
6.1–17	81	1.92
18–44	1819	43.03
45–64	1547	36.60
≥65	761	18.00
Season		
Winter	2734	64.68
Autumn	1493	35.32
Vitamin D level (ng/mL)		
≤10	1038	24.56
10–20	1348	31.89
20–30	931	22.03
30–150	886	20.96
>150	24	0.57

The Vitamin D measurements were 23.22±21.81 in the women subjects with a minimum 1.29 and maximum 167.98. The Vitamin D measurements of the men subjects vary between 3 and 160 with an average of 20.86±14.53 and Vitamin D measurements were not statistically significant (p>0.05) according to gender. When Vitamin D levels were grouped according to Table 2, it was found that Vitamin D levels of women were statistically different compared to men in all groups (p<0.01). The distribution of subjects according to season and Vitamin D levels is also presented in Table 2. The Vitamin D measurements were 21.24±20.48 in the winter season, while 25.53±20.57 in autumn season (p=0.001). The Vitamin D measurements of subjects admitted in the autumn season were significantly higher than winter season in each Vitamin D groups (p<0.001) (Table 2).

According to Table 3, the subjects 1 or below years of age had significantly higher the Vitamin D levels than those of 1.1–6 years of age, 6.1–17 years of age, 18–44 years of age, 45–64 years of age, and 65 and above years of age (p<0.001). The 65 and above years of age had second highest Vitamin D level and the mean Vitamin D level (27.57±23.2) was higher than the other groups except 1 year or below years of age (p<0.001). The lowest Vitamin D levels were found in the 18–44 years of age with average of 19.37±17.5. Severe Vitamin D deficiency (<10 ng/mL) was observed in 40.7% of the subjects with 6.1 and 17 years of age and 30.6% of the subjects with 18–44 years of age (p<0.01). Vitamin D deficiency (10–20 ng/mL) was found in 40% of the subjects with 1.1 and 6 years of age, 33.3% of the subjects with 6.1 and 17 years of age, and 34.9% of the subjects with 18 and 44 years of age (p<0.01). The Vitamin D insufficiency (20–30 ng/mL) was observed in 33.3% of 1 or below years of age and 30% of 1.1 and 6 years of age (p<0.01). The sufficient Vitamin D levels (30–150 ng/mL) were found in 33.3% of 1 or below years of age and 31.7% of 65 and above years of age (p<0.01) (Table 3).

Table 2. Distribution of the subjects according to gender, season, and Vitamin D levels

	Gender		
	Women	**Men**	**p**
Vitamin D level (ng/ mL)			
Min-Max	1.29–167.98	3–160	[a]0.864
Mean±SD	23.22±21.81	20.86±14.53	
Median	17.66	17.4	
Vitamin D level (ng/mL) n (%)			
<10	892 (26.23)	146 (17.65)	[b]<0.001**
10–20	999 (29.4)	349 (42.2)	
20–30	745 (21.91)	186 (22.5)	
30–150	741 (21.79)	145 (17.53)	
>150	23 (0.67)	1 (0.12)	
	Seasons		
	Winter (n=2734)	**Autumn (n=1493)**	**p**
Vitamin D level (ng/mL)			
Min-Max	1.29-160	3-167.98	[a]0.001**
Mean±SD	21.24±20.48	25.53±20.57	
Median	14.8	21.6	
Vitamin D level (ng/mL) n (%)			
<10	836 (30.6)	202 (13.5)	[b] <0.001**
10–20	877 (32.1)	471 (31.5)	
20–30	500 (18.3)	431 (28.9)	
30–150	509 (18.6)	377 (25.3)	
>150	12 (0.4)	12 (0.8)	

[a]Mann–Whitney U Test; [b]Pearson Chi-square Test; **p<0.01.

Table 3. Distribution of the subjects according to Vitamin D levels and age groups

Vitamin D level (ng/mL)	Age groups (years)						p
	≤1 (n=9)	1.1–6 (n=10)	6.1–17 (n=81)	18–44 (n=1819)	45–64 (n=1547)	≥65 (n=761)	
Min-Max	13.6–45.3	9.62–38.4	3.5–160	1.29–160	3–160	3–167.98	[a]<0.001**
Mean	28.18	20.58	21.31	19.37	24.43	27.57	
SD	11.02	10.13	29.41	17.5	21.5	23.2	
Median	27.1	18.25	12.2	14.7	19.3	23.3	
<10; n (%)	0 (0)	1 (10)	33 (40.7)	556 (30.6)	320 (20.7)	128 (16.8)	[b]<0.001**
10–20; n (%)	3 (33.3)	4 (40)	27 (33.3)	634 (34.9)	480 (31)	200 (26.3)	
20–30; n (%)	3 (33.3)	3 (30)	12 (14.8)	349 (19.2)	378 (24.4)	186 (24.4)	
30–150; n (%)	3 (33.3)	2 (20)	7 (8.6)	274 (15.1)	359 (23.2)	241 (31.7)	
>150; n (%)	0 (0)	0 (0)	2 (2.5)	6 (0.3)	10 (0.6)	6 (0.8)	

[a]Kruskal–Wallis Test; [b]Pearson Chi-square Test; **p<0.001.

Vitamin D levels were found significantly higher in autumn than winter season in the age groups 6.1–17, 18–44, 45–64, and ≥65 (p<0.001). No statistically significant difference was found in 1 or below and 1.1–6 years of age according to the seasons (p>0.05). Furthermore, Vitamin D levels were found high in autumn in both men and women subjects (p<0.001) and were given in Table 4.

We found a positive correlation between Vitamin D levels, age, and season (Table 5) (p<0.001). It was found that Vitamin D value decreased from autumn to winter in every age group (Table 4). Considering the distribution of Vitamin D levels by age groups, it was observed that the actual accumulation is over 18 years old. Contrary to expectations, we observed that Vitamin D values increased with increasing age in terms of correlation. On the other hand, we found a negative correlation between age and gender (Table 5) (p<0.01).

Discussion

In this retrospective hospital-based study, Vitamin D levels of subjects who admitted to Family Medicine of XXXX Training and Research Hospital between 2012 and 2017 were evaluated and Vitamin D deficiency was found in 55.63% in women and 59.85% in men. As a results, 77.54% of the women and 82.35% of the men Vitamin D levels were below the normal levels.

Vitamin D is obtained by exposure to ultraviolet light or consumption of natural foods, fortified foods, and supplements[16]. An estimated 10–20% of Vitamin D is supplied through supplements or food and the rest is synthesized in

Table 4. Distribution of age and gender according to seasons

	Vitamin D level (ng/mL)		
	Winter (n=2734) Mean±SD (median)	Autumn (n=1493) Mean±SD (median)	p Mann Whitney U test
Age			
≤1 age	23.35±9.23 (21.3)	37.83±7.93 (38.7)	0.071
1.1–6 age	15.35±4.79 (15.15)	28.42±11.54 (31.2)	0.088
6.1–17 age	17.88±24.74 (10.7)	28.56±36.95 (15.25)	0.039 *
18–44 age	17.8±17.61 (12.1)	22.12±16.98 (19)	<0.001**
45–64 age	22.85±20.89 (17.2)	27.36±22.33 (22.74)	<0.001**
≥65 age	26.36±23.82 (20.8)	29.97±21.78 (26.55)	<0.001**
Gender			
Women	21.86±21.5 (15.2)	25.67±22.17 (21.2)	<0.001**
Men	18.77±15.55 (13.75)	24.93±11.25 (22.8)	<0.001 **

*p<0.05; **p<0.001.

Table 5. Correlation between Vitamin D levels, gender, age, and season

Spearman's rho	Gender	Season	Vitamin D levels	Age
Gender				
Correlation Coefficient	1.00	0.014	−0.01	−0.048
p	-	0.368	0.496	0.002*
Season				
Correlation Coefficient	0.014	1.00	0.194	−0.021
p	0.368	-	<0.001**	0.166
Vitamin D levels				
Correlation Coefficient	−0.01	0.194	1.00	0.216
p	0.496	<0.001**	-	<0.001**
Age				
Correlation Coefficient	−0.048	−0.021	0.216	1.00
p	0.002*	0.166	<0.001**	-

*p<0.01; **p<0.001.

the human body through sunlight activation[17]. Vitamin D status is measured by the storage form of Vitamin D (25-hydroxyvitamin D) and the levels of Vitamin D vary a wide range of exogenous factors such as latitude, season of testing, and skin color[18]. Furthermore, Vitamin D deficiency increases with age and the optimum serum level of Vitamin D is above 30 ng/mL and 1000 IU is recommended for daily intake[12]. The high levels of Vitamin D among adults were found associated with decrease in the cardiovascular diseases, diabetes, and metabolic syndrome in a meta-analysis study[19].

Cashman et al.[20] found that 13% of the 55,844 European individuals had serum 25(OH)D concentrations below 30 nmol/L. The 17.7% of the individuals in winter (October–March) and 8.3% of the individuals in summer (April–November) periods were below 30 nmol/L. The prevalence of Vitamin D deficiency was found 40.4% and that was higher in dark-skinned ethnic subgroups[20]. Rabenberg et al.[21] reported that 61.6% of German population (61.5% of women and 61.7% of men) had serum 25(OH)D levels below 50 nmol/l (20 ng/mL). The 55.9% of 18–44 aged, 63.3% of 45–64 aged, and 69.8% of 65–79 aged of the women were found below 50 nmol/l due to age and lower socioeconomic status. The 61.5% of 18–44 aged, 61.5% of 45–64 aged, and 62.6% of 65–79 aged of the men were found below 50 nmol/l and they suggested that is derived from low Vitamin D intake and more residential traffic. Furthermore, the half of the subjects had serum 25(OH)D levels below 50 nmol/l in summer. In our study, the prevalence of Vitamin D deficiency was found in 56.45% of the subjects, 55.63% of women, and 59.85% of men and our results are similar to the study of Rabenberg et al.[21] The Vitamin D deficiency rate of Turkish population was slightly lower to German population probably higher sun exposure. The 65% of 18–44 aged, 51.7% of 45–64 aged, and 43.1% 65 and over aged of the subjects were also found below 20 ng/ml (Table 3).

Palacios et al. [22] reported that low Vitamin D levels are a global problem even in countries with sun exposure all year round, especially in the girls and women living in Middle East. Moreover, in countries with long winter season, persons had generally less deficiencies than in sunny countries and it is thought to this is originated from the nutritional style. Thus, season was evaluated as small component of describing the Vitamin D deficiency worldwide. High skin melanin content, limited exposure to sunlight, aging, use of extensive skin coverage, a low Vitamin D intake, and high rates of obesity were identified as possible causes of high prevalence of low Vitamin D status. Allali et al. [23] showed that wearing a veil was associated with 2.29 fold increased risk of osteoporosis in postmenopausal osteoporotic patients (OR: 2.29, 95% CI, 1.38–3.82). Although the Islamic-style clothing is used in Türkiye, Vitamin D levels were higher in women than men (sufficient Vitamin D levels were found in 22.46% of women and in 17.65 % of men). This finding might be aroused from the number of women patients that is higher than men patients admitted to family medicine polyclinic and probably the higher level of Vitamin D of the women is stem from the vitamin is D supplements due to this women patients who were followed regularly.

In Marmara region of Türkiye, Sezgin et al. [24] found Vitamin D deficiency and insufficiency as 75% and 91.1%, respectively, in Istanbul. The mean levels of Vitamin D were 14.10±11.55 in women and 16.26±10.94 in men. It was reported that the Vitamin D levels were statistically significant according to summer (15.79±12.06) and winter (13.27±10.45) seasons. The Vitamin D levels of subjects 1 year or below years of age were found significantly higher than other age groups. The Vitamin D levels of 49.6% of the subjects aged 65 years and over were found below 10 ng/mL and Vitamin D levels decreased with age. Hekimsoy et al. [25] reported that 74.9% of the adults residing in Manisa which is a city in the Aegean region of Türkiye having Vitamin D deficiency (<20 ng/mL) and which was more common among females (78.7%) than males (66.4%). Solak et al. [26] studied Vitamin D levels in the 35,667 individuals admitted to a hospital in Konya, a city Central Anatolia of Türkiye. The 94.47% of the participants had Vitamin D levels <30 ng/ml and Vitamin D deficiency was found 76.25% in the individuals. Ozturk et al. [27] showed that the Vita-

min D levels of 94.92% of 1161 healthy subjects residing in Gaziantep, a South-east province of Türkiye measured between October 2016 and March 2017 were below 30 ng/ml. Vitamin D deficiency was found this study group 75.54% in spite of Gaziantep is a sunny city and men had significantly higher serum 25(OH)D levels compared to women. A negative correlation between Vitamin D levels and ageing was also found in the study of Ozturk et al. However, in our study, we found that Vitamin D deficiency (56.45%) and insufficiency (78.48%) were below than other studies which were conducted in the Türkiye and the mean levels of Vitamin D were 23.22±21.81 in women and 20.86±14.53 in men. The insufficient Vitamin D levels (<30ng/mL) were higher in winter (81%) to the autumn (73.9%) (Table 2). The subjects with 1 or below years of age had significantly higher the Vitamin D levels than other age groups. However, we did not observe decreasing Vitamin D levels with age due to 65 and above years of age had second highest Vitamin D level in the age groups. Contrary to what we expected, we found a positive correlation between Vitamin D levels and age, while Ozturk et al.[27] found negative correlations. In our study, regular follow-up of patients who admitted to family medicine and Vitamin D supplementation due to low Vitamin D measurements could explain the difference between two studies performed in the same region.

Our study was carried out in Göztepe Training and Research Hospital located in the Asian region of Istanbul and this hospital is preferred by patients living in the Marmara region. We found severe Vitamin D deficiency, Vitamin D deficiency and Vitamin D insufficiency are quite high in our population. Although there are studies showing that women have lower Vitamin D levels due to less exposure to the sun and clothing styles, we found higher Vitamin D levels in women than men. Interestingly, we observed that Vitamin D values increased with increasing age. While, as we expected sufficient Vitamin D levels were lower in winter than the autumn due to low sun exposure. We thought that the results found different from the studies may have resulted from regular follow-up of patients who applied to Family Medicine. To increase Vitamin D levels in our society, increasing sun exposure at a reasonable level or taking a Vitamin D supplements may be considered.

Limitations of the Study

Our study results may be affected by not evaluating various diseases such as kidney diseases or Vitamin D supplements to regular follow-up of patients applying to family medicine. We could not reach data about patients' disease histories and other blood parameters and we evaluated only those who applied to family medicine. The number of samples in the some of our age groups (1 or below year and 1.1–6 years) is very low, we could not make a proper evaluation and that is another factor that constitutes the limitations of our study.

Ethics Committee Approval: Ethical approval was obtained from Ethics Committee of Istanbul Medeniyet University, Göztepe Training and Research Hospital (No: 2017/0072, February 28, 2017).

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References

1. Lips P. Vitamin D physiology. Prog Biophys Mol Biol 2006;92:4–8. [CrossRef]
2. Holick MF, MacLaughlin JA, Doppelt SH. Regulation of cutaneous previtamin D3 photosynthesis in man: Skin pigment is not an essential regulator. Science 1981;211:590–3. [CrossRef]
3. Clemens TL, Adams JS, Henderson SL, Holick MF. Increased skin pigment reduces the capacity of skin to synthesise vitamin D3. Lancet 1982;1:74–6. [CrossRef]
4. Matsuoka LY, Wortsman J, Haddad JG, Hollis BW. Skin types and epidermal photosynthesis of vitamin D3. J Am Acad Dermatol 1990;23:525–6. [CrossRef]
5. Yılmaz R, Ozkayit S. Vitamin D deficiency and chronic widespread pain. EMJ Rheumatol 2017;4:104–11.
6. Bikle DD. Vitamin D metabolism, mechanism of action, and clinical applications. Chem Biol 2014;21:319–29. [CrossRef]
7. Holick MF. Resurrection of vitamin D deficiency and rickets. J Clin Invest 2006;116:2062–72. [CrossRef]
8. Bogunia-Kubik K, Middleton P, Norden J, Dickinson A, Lange A. Association of vitamin D receptor polymorphisms with the outcome of allogeneic haematopoietic stem cell transplantation. Int J Immunogenet 2008;35:207–13. [CrossRef]
9. Provvedini DM, Tsoukas CD, Deftos LJ, Manolagas SC. 1,25-dihydroxyvitamin D3 receptors in human leukocytes. Science 1983;221:1181–3. [CrossRef]
10. Hossein-nezhad A, Spira A, Holick MF. Influence of vitamin D status and vitamin D3 supplementation on genome wide expression of white blood cells: A randomized double-blind clinical trial. PLoS One 2013;8:e58725. [CrossRef]
11. Holick MF. Environmental factors that influence the cutaneous production of vitamin D. Am J Clin Nutr 1995;61(3 Suppl):638S–45S. [CrossRef]
12. Wintermeyer E, Ihle C, Ehnert S, Stöckle U, Ochs G, de Zwart P, et al. Crucial role of Vitamin D in the musculoskeletal system.

Nutrients 2016;8:319. [CrossRef]
13. Holick MF. Vitamin D deficiency. N Engl J Med 2007;357:266–81. [CrossRef]
14. Revuelta Iniesta R, Rush R, Paciarotti I, Rhatigan EB, Brougham FHM, McKenzie JM, et al. Systematic review and meta-analysis: Prevalence and possible causes of vitamin D deficiency and insufficiency in pediatric cancer patients. Clin Nutr 2016;35:95–108. [CrossRef]
15. Fidan F, Alkan BM, Tosun A. Çağın pandemisi: D vitamini eksikliği ve yetersizliği. Türk Osteoporoz Derg 2014;20:71–4.
16. McKenna MJ, Murray BF, O'Keane M, Kilbane MT. Rising trend in vitamin D status from 1993 to 2013: Dual concerns for the future. Endocr Connect 2015;4:163–71. [CrossRef]
17. Pereira-Santos M, Costa PR, Assis AM, Santos CA, Santos DB. Obesity and vitamin D deficiency: A systematic review and meta-analysis. Obes Rev 2015;16:341–9. [CrossRef]
18. Vinkhuyzen AAE, Eyles DW, Burne TH, Blanken LME, Kruithof CJ, Verhulst F, et al. Prevalence and predictors of vitamin D deficiency based on maternal mid-gestation and neonatal cord bloods: The Generation R Study. J Steroid Biochem Mol Biol 2016;164:161–7. [CrossRef]
19. Parker J, Hashmi O, Dutton D, Mavrodaris A, Stranges S, Kandala NB, et al. Levels of vitamin D and cardiometabolic disorders: Systematic review and meta-analysis. Maturitas 2010;65:225–36. [CrossRef]
20. Cashman KD, Dowling KG, Škrabáková Z, Gonzalez-Gross M, Valtueña J, De Henauw S, et al. Vitamin D deficiency in Europe: Pandemic? Am J Clin Nutr 2016;103:1033–44. [CrossRef]
21. Rabenberg M, Scheidt-Nave C, Busch MA, Rieckmann N, Hintzpeter B, Mensink GB. Vitamin D status among adults in Germany--results from the German Health interview and examination survey for adults (DEGS1). BMC Public Health 2015;15:641. [CrossRef]
22. Palacios C, Gonzalez L. Is vitamin D deficiency a major global public health problem? J Steroid Biochem Mol Biol 2014;144:138–45. [CrossRef]
23. Allali F, El Aichaoui S, Saoud B, Maaroufi H, Abouqal R, Hajjaj-Hassouni N. The impact of clothing style on bone mineral density among post menopausal women in Morocco: A case-control study. BMC Public Health 2006;6:135. [CrossRef]
24. Sezgin G, Ozturk G, Turkal R, Caykara B. Vitamin D levels of outpatients admitted to a university hospital in the Marmara region of Türkiye over 3 years. J Med Biochem 2019;38:181–7.
25. Hekimsoy Z, Dinç G, Kafesçiler S, Onur E, Güvenç Y, Pala T, et al. Vitamin D status among adults in the Aegean region of Türkiye. BMC Public Health 2010;10:782. [CrossRef]
26. Solak I, Cihan FG, Mercan S, Kethuda T, Eryılmaz MA. Evaluation of 25-Hydroxyvitamin D levels in central anatolia, Türkiye. Biomed Res Int 2018;2018:4076548. [CrossRef]
27. Öztürk ZA, Gol M, Türkbeyler İH. Prevalence of vitamin D deficiency in otherwise healthy individuals between the ages of 18 and 90 years in southeast Türkiye. Wien Klin Wochenschr 2017;129:854–5. [CrossRef]