Available online at www.medicinescience.org

ORIGINAL ARTICLE

Medicine Science International Medical Journal

Medicine Science 2020;9(3):614-8

Evaluation of vitamin D levels according to season and age

Ayhan Vurmaz, Tulay Koken

Afyonkarahisar Health Sciences University Medical Faculty Medical Biochemistry, Afyon, Turkey

Received 14 May 2020; Accepted 06 June 2020
Available online 23.06.2020 with doi: 10.5455/medscience.2020.05.081

Abstract

Low vitamin D levels have also been associated with many chronic diseases, including diabetes mellitus, hypertension, cancer, and autoimmune diseases. This study aimed to examine the 25-hydroxy vitamin D (25OH-D) level studied Medical Biochemistry Laboratory of Afyon Health Sciences University between January and December 2015 according to age, sex, and season. A total of 7291 individuals (5326 women and 1965 men) who applied to the Afyon Health Sciences University Medical Biochemistry Laboratory for the first time between January 1 and December 31, 2015, were included in the study. The 25OH-D level of the individuals included was retrospectively evaluated according to age, sex, and season. Results: It was observed that 61.7% of the measurements were done in summer and 39.3% in winter. The 25OH-D level was on an average 19.913.27 ng/mL in men and 14.9313.75 ng/mL in women, and an average of 16.4313.54 ng/mL in summer and 16.0214.21 ng/mL in winter. Although a significant correlation was found between the 25OH-D level and sex, no statistically significant correlation was found with the season. When the 25OH-D level was evaluated according to age decades, the lowest value was observed in the tenth decade, with an average of 13.1612.87 ng/mL, and the highest value was observed in the first decade, with an average of 31.6216.89 ng/mL. A statistically significant difference was found between decades. Located in the Aegean region, Afyonkarahisar is suitable for benefiting from the sun due to its latitude and atmospheric structure. Moreover, sun exposure during the day is low due to the lifestyle and clothing style. For this reason, the level of vitamin D synthesized in individuals is affected because ultraviolet-B radiation does not reach the skin. These findings suggest that both nutritional and vitamin D supplements are important for the improvement in vitamin D deficiency in Afyonkarahisar province.

Keywords: Age, season, sex, vitamin D

Introduction

The term vitamin D refers to a group of steroid-like molecules containing cholecalciferol, ergocalciferol, calcidiol, and calcitriol. Vitamin D compounds, which control bone and calcium (Ca) metabolism, have many important physiological functions, including nonskeletal muscle function, immunity, pregnancy, and cardiovascular function [1–3]. Adequate vitamin D is needed for healthy skeletal development and mineralization in humans [1]. While 10%–20% of vitamin D required for the human organism is supplied in the form of nutrients (most life conditions are lower than this in the US and Europe), the remaining 80%–90% is synthesized on the skin by sunlight ultraviolet-B (UV-B) (at wavelengths of 290–315 nm) [1]. Two forms of vitamin D, plant-derived ergocalciferol (vitamin D2) and animal-derived cholecalciferol (vitamin D3), are important [3,4]. Vitamin D, which is absorbed from the intestine or synthesized on the skin, is then carried to the liver with a vitamin D–binding protein. It is converted into 25-hydroxyvitamin D (25OH-D) by the 25-hydroxylase enzyme in the liver. The serum concentration of 25OH-D is generally considered to be the best indicator of the vitamin D status [3]. This is because 25OH-D3 has a long half-life (15–35 days) and has high concentrations in the blood [5]. 25OH-D is transported to the kidneys and then converted into its active form, 1,25-dihydroxyvitamin D (1.25OH-2D), by the 1α-hydroxylase enzyme. After activation in kidneys, it is carried to vitamin D receptor (VDR)-positive tissues (such as skin, bone, gut, and parathyroid gland) for genomic and nongenomic effects through vitamin D–binding protein [4].

The VDR acts through its specific receptors. The vitamin D complex binds to the nuclear receptor, which then binds to specific response elements on DNA. Although the response elements can be found in the promoter regions of some vitamin D–regulated genes, they are located a few kilobase sizes away from the most transcriptional starting regions [4]. Vitamin D regulates up to 200 genes directly or indirectly. The effects of vitamin D, such as angiogenesis, metastasis and invasion inhibition, inflammation reduction, stimulation of differentiation, apoptosis, and antiproliferation, are regulated by transcriptional regulation [6]. Additionally, it regulates the production of renin from kidneys, insulin from

***Coresponding Author:** Ayhan Vurmaz, Afyonkarahisar Health Sciences University Medical Faculty Medical Biochemistry, Afyon, Turkey, E-mail:ayhan.vurmaz@gmail.com

pancreas, cathelicidin from macrophages, cytokine release from lymphocytes, and proliferation and growth of vascular smooth muscle cells with cardiomyocytes [7]. The general function of 25OH-2D is to maintain the plasma Ca level. Vitamin D enhances the absorption of Ca from the duodenum and phosphorus (P) from the ileum. In addition, vitamin D acts to increase the plasma Ca level by decreasing Ca loss from kidneys and increasing bone resorption [1-3].

Clinical studies have shown that the serum 25OH-D level should be higher than 30 ng/mL (75 nmol/L) in healthy individuals. The serum 25OH-D level lower than 20 ng/mL is considered as vitamin D deficiency, between 21 and 29 ng/mL as 25OH-D insufficiency, and higher than 30 ng/mL as normal. A 25OH-D level higher than 150 ng/mL is considered as 25OH-D intoxication [5,8,9].

This retrospective study aimed to investigate the correlation of the 25OH-D level with age, sex, and seasonal differences in individuals admitted to Afyon Health Sciences University Hospital in 2015.

Materials and Methods

The 25OH-D level of 7291 individuals (5326 women and 1965 men) who applied to the Medical Biochemistry Laboratory of Afyon Health Sciences University located in the city center of Afyonkarahisar between January 1 and December 31, 2015, were evaluated. The individuals included in the study were classified according to gender and season. In addition, all age groups are included in the study. The first 25OH-D levels of the individuals in Afyon Health Sciences University Hospital were selected. However, whether individuals took vitamin D supplements was not inquired. The data of the individuals included were evaluated retrospectively.

Levels of 25OH-D were studied on the same day from venous blood samples from anti-coagulan-free vacuum biochemical tubes. The 25OH-D levels were studied using the Roche cobas 601 immunoassay (Roche Diagnostics International Ltd CH-6346, Rotkreuz, Switzerland). The measurement range of the study was 3–70 ng/mL.

Statistical analysis

Descriptive statistics (mean, standard deviation, and percentage distributions) were performed to examine raw data. The suitability of the data to normal distribution was evaluated using Shapiro–Wilk and Kolmogorov–Smirnov tests. The Kruskal–Wallis test was used to compare the average values of more than two groups. While comparing the mean between the two groups, the Mann–Whitney U test was used when the independent group t-test was not provided and the parametric conditions were met. The chi-square test was used to evaluate the percentage distributions between the groups.

The analyses were carried out using the SPSS v18 program. A P value less than 0.005 was considered significant.

Results

It was observed that 27.0% of 7291 individuals included in this study were men and 73.0% were women. Moreover, 61.7% of the measurements were done in summer (between April and October) and 39.3% in winter (between November and March). Further, the 25OH-D level of all individuals on an average was 19.9 ± 13.27 ng/mL in men and 14.93 ± 13.75 ng/mL in women (Figure 1). The 25OH-D level was statistically lower in women than in men (P < 0.001). The average 25OH-D level of all individuals was 16.43 ± 13.54 ng/mL in summer and 16.02 ± 14.21 in winter (Figure 2). A statistically significant difference in the 25OH-D levels was found between seasons (P = 0.227).

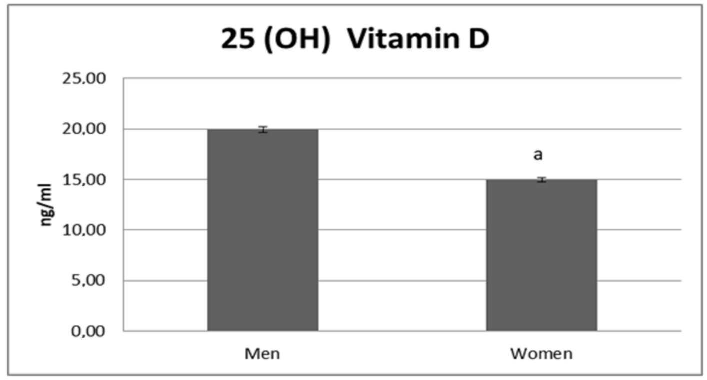

Figure 1. 25OH-D level of men and women. a, Compared with the men (P < 0.001)

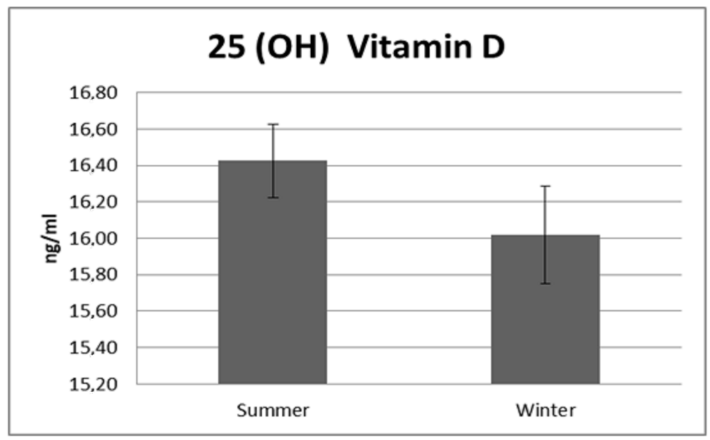

Figure 2. Average 25OH-D level of all individuals between seasons

The distribution of the 25OH-D mean level according to decades is shown in Figure 3. The lowest mean level was observed in the tenth decade with a value of 13.16 ± 12.87 ng/mL and the highest was observed in the first decade with a value of 31.62 ± 16.89 ng/mL. A statistically significant difference was found between decades (Figure 3).

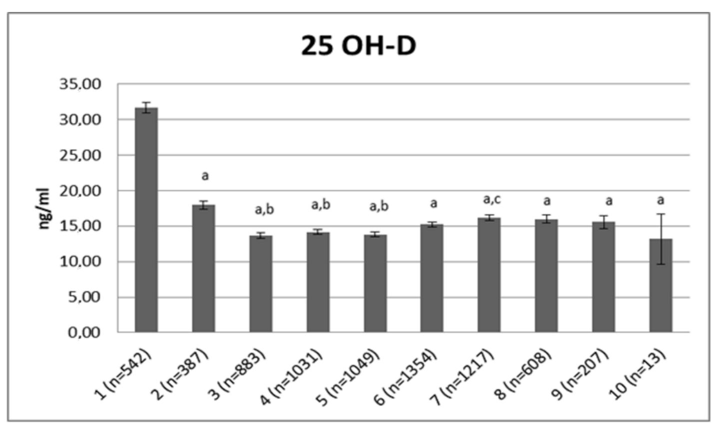

Figure 3. Distribution of 25OH-D mean levels by decades. a, Compared with the first decade (P = 0.001); b, compared with the second decade (P < 0.001); c, compared with the third decade (P < 0.001)

In men, the 25OH-D level was 20.65 ± 12.88 ng/mL in summer and 18.61 ± 13.83 ng/ml in winter on average. In women, it was found to be 14.82 ± 13.44 ng/mL in summer and 15.11 ± 14.23 ng/mL in winter on average. Although the 25OH-D level in men was statistically significantly higher in summer than in winter (Figure 4; P < 0.001), no significant difference was found between seasonal measurements in women (Figure 4; P = 0.447).

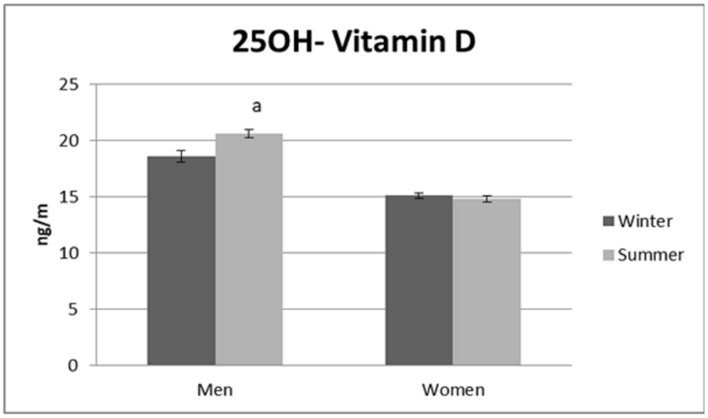

Figure 4. Seasonal average 25OH-D levels of men and women. a, Compared with summer in men (P < 0.001)

The seasonal comparison of the 25OH-D level measured in decades is shown in Figure 5. Although the 25OH-D level measured in the first three decades was found to be higher than that measured in winter, no significant correlation was observed between the season and the 25OH-D level in other decades (Figure 5; a, P < 0.001; b, P < 0.001; c, P = 0.24).

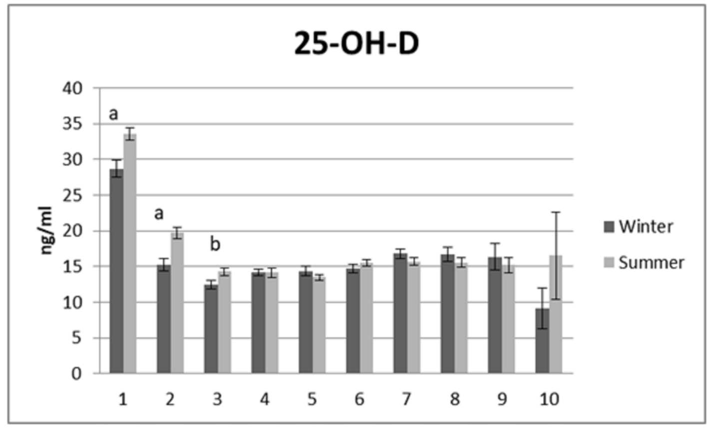

Figure 5. Comparison of the 25OH-D level determined according to decades in summer and winter. a, Compared with summer (P < 0.001); b, compared with the second decade of summer (P < 0.001); c, compared with the third decade of summer (P = 0.024)

The reference range for the 25OH-D level used in Afyon Health Sciences University Hospital was 10–60 ng/mL in winter and 20–120 ng/mL in summer. The 25OH-D level was clinically lower in 45.5% of men and 66.8% of women included in this study, among 70.5% of patients who applied in summer and 45.8% of the individuals who applied in winter. A statistically significant correlation was found between sex (P < 0.001) and application periods (P < 0.001) and clinical evaluation of the 25OH-D level (Table 1).

When the 25OH-D level was clinically evaluated in different decades, 17.34% of individuals were observed to have low levels of 25OH-D in their first decade. This low 25OH-D level was found to be statistically low compared with the level in the third and ninth decades (*, P = 0.001; Table 1).

Table 1. Comparison of women and men by low 25OH-D levels, seasons, and decades a, Compared with men; b, compared with summer; *, compared with the first decade (P = 0.001)

	Vitamin D				p
	Low		Normal		
Sex	N	%	N	%	
Male	894	45.50	1071	54.50	<0.001
Female	3556	66.77	1770	33.23	
Seasons					
Summer	3171	70.48	1328	29.52	<0.001
Winter	1279	45.81	1513	54.19	
Decades					
1	94	17.34	448	82.66	<0.001
2	188	48.58	199	51.42	
3	608	68.86	275	31.14	
4	697	67.60	334	32.40	
5	734	69.97	315	30.03	
6	878	64.84	476	35.16	
7	736	60.48	481	39.52	
8	370	60.86	238	39.14	
9	136	65.70	71	34.30	
10	9	69.23	4	30.77	

Discussion

Factors affecting the UV-B radiation reaching the skin, such as season, latitude, atmospheric structure, clothing style, and sunscreen use, influence the 25OH-D level synthesized in individuals [10]. Hilger et al., in a study conducted in 2014, evaluated the 25OH-D levels in individuals belonging to the Middle East and Africa regionally and found that, although no statistically significant difference was found between men and women, the 25OH-D level tended to be lower in women than in men [11]. In the present study, the 25OH-D level was found to be statistically significantly higher in men than in women. Similar to this study, another study conducted in the Aegean region found a higher 25OH-D level in men [12]. This situation might be related to the geographic location, traditional clothing habits, and women spending less time outside compared with men. Serdar et al. found no difference in the 25OH-D level between men and women in Turkey [13]. When the values measured in summer and winter were compared by sex, a seasonal difference was observed between the measurements in men, but not in women. This difference between men and women might be due to the differences in clothing habits and the time spent outside.

In the Afyonkarahisar region, the month with the highest solar radiation is July, while the month with the lowest solar radiation is December. Significant seasonal changes were found in these measurements [14]. In this study, no significant difference was found in the 25OH-D values measured in the entire patient group in summer and winter. The lack of difference might be attributed to summer and winter covering a wide range during 6-month periods. Studies showed that the 25OH-D level followed a steady increase–decrease pattern in February–March, with the highest being in September–October [13,15]. In a study conducted in Germany [16], while no statistically significant correlation was found between seasons and 25OH-D changes, Öğüş et al. and Bozkurt et al. [17,18] reported seasonal differences in the 25OH-D level.

When the 25OH-D value was classified into low and normal according to reference values, it was found that 45.5% of men and 66.8% of women had low values. Serdar et al. [13] reported 25OH-D deficiency between 58% and 80%, although it varied according to the seasons. Although the average of 25OH-D values was observed to be higher than the values determined in this study, the population in which 25OH-D deficiency was detected was similar to that in this study. The reason might be the different reference intervals used in published studies [13]. Although a relationship between a 25OH-D deficiency and many diseases has been observed in the literature, the optimal 25OH-D levels were still controversial and different reference values were used [10,19]. In another study conducted in Turkey that had a similar reference range as that used in this study, 50% of women and 38% of men were found to be 25OH-D deficient.

The 25OH-D level is expected to be lower in the elderly than in younger individuals due to the decrease in vitamin D3 synthesis on the skin with the advancement of age; however, different results were reported in the literature. Hilger et al. did not find a correlation between age and the 25OH-D level in the North American and European populations. The same study reported a lower 25OH-D level in children in Asia and a higher 25OH-D level in children in the Middle East [11,20]. In this study, the highest 25OH-D level was observed in the first decade, similar to the finding of Serdar et al. [13]. This high value observed in the first decade was thought to be related to the 25OH-D replacement during the routine follow-up of infants. In Turkey, Bozkurt et al. [18] and Hekimsoy et al. [12] did not find any correlation between age and the 25OH-D level. Failure to classify infancy or the first decade as a separate age group in these studies might be the reason why the high 25OH-D level observed in the first decade was not observed in the present study. Nevertheless, the indirect effects of age were associated with many different variables and should not be ignored when evaluating the literature.

The prevalence of 25OH-D deficiency has been reported to be high not only in risk groups but in all age groups, especially in the Middle East [21]. When 25OH-D deficiency was evaluated according to the decades of the participants in this study, a 25OH-D deficiency was observed as 17.3% in the first decade, 48.9% in the second decade, and 60%–70% in the third decade or more. In a study conducted in Pulstpryn in Japan in 2018, 25OH-D deficiency under the age of 5 years was reported to be 21.0% [22]. In another study conducted in adult individuals in the US between the ages of 18 and 39, 40 and 59, and more than 60 years, the 25OH-D level was 30.8%, 28.1%, and 27.1%, respectively (lower than 20 ng/mL) [23]. Another study conducted in the US stated that the 25OH-D level in individuals with levels lower than 20 ng/mL increased up to 40% periodically [15].

Previous studies showed that 25OH-D deficiency was associated with many diseases [24]. It should not be ignored that 25OH-D deficiency in individuals included in this study might be higher than that in normal individuals.

When different seasonal comparisons were made by decades, the 25OH-D level was found to be higher in the first three decades, while no significant difference was found in seasonal decades of four and higher. The reason might be the change in lifestyle and eating habits with advanced age.

Based on the results of the present study and other studies conducted in Turkey, vitamin D deficiency may be considered a common and social health problem. Today, the sunshine required for an individual is not sufficient due to various reasons such as socioeconomic conditions, clothing habits, and geographic locations. Therefore, necessary preventive measures are suggested to be taken, such as educating the society through health institutions, determining the risk groups in terms of vitamin D deficiency, and supplementing dietary and dietary products with vitamin D.

Competing interests
The authors declare that they have no competing interest.

Financial Disclosure
This study received no financial support.

Ethical approval
This study was carried out with etics rapor code no: 2011-KAEK-2; obtained from Afyonkarahisar Health Sciences University, Clinical research ethics committee.

References

1. Reichrath J, Saternus R, Vogt T. Endocrine actions of vitamin D in skin: Relevance for photocarcino-genesis of non-melanoma skin cancer, and beyond. Mol Cell Endocrinol. 2017;453:96–102.

2. Wimalawansa SJ. Non-musculoskeletal benefits of vitamin D. J Steroid

Biochem Mol Biol. 2018;175:60–81.

3. Aggarwal A, Feldman D, Feldman BJ. Identification of tumor-autonomous and indirect effects of vitamin D action that inhibit breast cancer growth and tumor progression. J Steroid Biochem Mol Biol. 2018;177:155–8.

4. Duffy MJ, Murray A, Synnott NC, et al. Vitamin D analogues: Potential use in cancer treatment. Crit Rev Oncol Hematol. 2017;112:90–7.

5. Matyar S, Dişel NR, Açıkalın A, et al. Çukurova Bölgesinde D vitamini düzeyleri. Cukurova Med J. 2017;42:320-8.

6. Ness RA, Miller DD, LI W. The role of vitamin D in cancer prevention. Chin J Nat Med. 2015;13:481–97.

7. Biricik E, Güneş Ya. Vitamin D ve Anestezi. Turk J Anaesth Reanim 2015;43:269-73.

8. Özcelik Dç, Koçer H, Kasım İ, et al. Vıtamın D. Turkish Med J. 2012;6:61–7.

9. Yavuz D, Mete T, Yavuz R, et al. D Vitamini, kalsiyum & mineral metabolizması, d vitaminin iskelet dışı etkileri ve kronik böbrek yetmezliğinde nütrisyonel d vitamini kullanımı. Ankara Med J. 2014;14:162–71.

10. Tsiaras W, Weinstock M. Factors Influencing Vitamin D Status. Acta Derm Venereol. 2011;91:115–24.

11. Hilger J, Friedel A, Herr R, et al. A systematic review of vitamin D status in populations worldwide. Br J Nutr. 2014;111:23–45.

12. Hekimsoy Z, Dinç G, Kafesçiler S, et al. Vitamin D status among adults in the Aegean region of Turkey. BMC Public Health 2010;10:782:1-7.

13. Serdar MA, Can BB, Kilercik M, et al. Analysis of Changes in Parathyroid Hormone and 25 (OH) Vitamin D Levels with Respect to Age, Gender and Season: A Data Mining Study. J Med Biochem 2017;36:73–83.

14. Radyasyon Mevsimler - Meteoroloji Genel Müdürlüğü [Internet]. [accessed 2019 Feb 6]. Available from: https://www.mgm.gov.tr/kurumici/radyasyon_iller.aspx?il=afyon

15. Kroll MH, Bi C, Garber CC, et al. Temporal relationship between vitamin D status and parathyroid hormone in the United States. PLoS One. 2015;10:1–13.

16. Pourhassan M, Wirth R. Seasonal variation in vitamin d status among frail older hospitalized patients. J frailty aging. 2018;7:95–9.

17. Öğüş E, Sürer H, Kılınç AŞ, et al. D vitamini düzeylerinin aylara, cinsiyete ve yaşa göre değerlendirilmesi. Ankara Med J. 2015;15:1–5.

18. Bozkurt S. Age, sex, and seasonal variations in the serum vitamin d3 levels in a local turkish population. Arch Rheumatol. 2014;29:14–9.

19. Dawson-Hughes B, Heaney RP, Holick MF, et al. Estimates of optimal vitamin D status. Osteoporos Int. 2005;16:713–6.

20. Mithal A, Wahl DA, Bonjour JP, et al. Global vitamin D status and determinants of hypovitaminosis D. Osteoporos Int. 2009;20:1807–20.

21. Van Schoor N, Lips P. Worldwide Vitamin D Status. Vitam D Fourth Ed. 2017;2:15–40.

22. Nakano S, Suzuki M, Minowa K, et al. Current vitamin d status in healthy japanese infants and young children. J Nutr Sci Vitaminol (Tokyo). 2018;64:99–105.

23. Liu X, Baylin A, Levy PD. Vitamin D deficiency and insufficiency among US adults: Prevalence, predictors and clinical implications. Br J Nutr. 2018;119:928–36.

24. Langlois PL, Szwec C, D'Aragon F, et al. Vitamin D supplementation in the critically ill: A systematic review and meta-analysis. Clin Nutr. 2018;37:1238–46.