Evaluation of Serum Vitamin D Levels according to Gender and Age at Karapınar City: A Follow-Up Study from Turkey

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Keywords

Biochemistry · Gender · Laboratory · Medicine

Abstract

Aim: Vitamin D is one of the major hormones involved in phosphorus metabolism in the secosteroid structure. Studies have shown that low serum vitamin D levels are associated with chronic diseases such as autoimmune diseases, diabetes mellitus, chronic renal failure, depression, cardiovascular diseases, hypertension, and cancer. The aim of this study was to investigate serum vitamin D levels in the adult population according to age and gender in Karapınar, Turkey. **Materials and Methods:** Serum vitamin D levels of 6,774 patients admitted to Karapınar Public Hospital between January and December 2018 were evaluated according to age and gender, investigated, and retrospectively screened. Serum vitamin D level <10 ng/mL is accepted as deficiency, 10–30 ng/mL as insufficiency, 30–100 ng/mL as sufficiency, and >100 ng/mL as toxicity. **Results:** The study consisted of 5,111 women (75.5%) and 1,663 men (24%). The mean vitamin D levels were 14.6 ± 0.2 ng/mL in women and 17.8 ± 0.3 ng/mL in men. Vitamin D levels were found to be lower in both men and women as age progressed. Deficiency (<10 ng/mL) of vitamin D was found in 83.8% of women and

18.2% of men, while insufficiency (10–30 ng/mL) of vitamin D was found in 69.6% of women and 30.4% of men. **Conclusion:** In this study, in patients who were admitted to our hospital in Karapınar City, serious vitamin D deficiency was detected. We recommend that people should take vitamin D and calcium supplements and they also should have more exposure to the sunlight.

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Introduction

Vitamin D is an important hormone for growth, development, and healthy skeletal structure that regulates calcium and phosphorus metabolism in the body. Vitamin D consists mainly of two forms: ergocalciferol (vitamin D₂) and cholecalciferol (vitamin D₃) caused by exposure to ultraviolet rays in the skin [1, 2]. 90–95% of the vitamin D in the human body is synthesized in the skin by the effect of sun rays, 25-hydroxyvitamin D (25(OH)D), and 1,25-dihydroxyvitamin D (1,25(OH)₂D) with active forms undergoing hydroxylation in liver and kidney [3]. Rickets is developing because of inadequacy of mineralization of bone tissue. Absorption disorder, insufficient access to the sun, increased need for rapid growth,

Table 1. Distribution of patients by age and gender

		Gender		χ^2		
		male	female			
<i>Levels of vitamin D</i>						
0–10, deficiency	<i>n</i>	464 ^a	2,393 ^b	2,857	200.392	0.001
	%	16.2%	83.8%	100.0%		
11–30, insufficiency	<i>n</i>	1,006 ^a	2,298 ^b	3,304	100.0%	
	%	30.4%	69.6%	100.0%		
31–100, optimal level	<i>n</i>	137 ^a	232 ^b	369	100.0%	
	%	37.1%	62.9%	100.0%		
101+, toxicity	<i>n</i>	56 ^a	188 ^a	244	100.0%	
	%	23.0%	77.0%	100.0%		
Total	<i>n</i>	1,663	5,111	6,774	100.0%	
	%	24.5%	75.5%	100.0%		

25(OH)D total: deficiency, <10; insufficiency, 10–30; sufficiency, 30–100; toxicity, >100. ^a 0 cells (0.0%) have expected count less than 5. The minimum expected count is 59.90. ^b Based on 10,000 sampled tables with starting seed 957002199.

and lack of intake of vitamin D contributes to the formation of rickets. Vitamin D deficiency has been reported to play a role in the formation of many diseases, except for the effects of bone tissue.

Serum 25(OH)D levels are considered to reflect vitamin D status [4, 5]. Recently, the term 25 vitamin D deficiency 25 was used to describe low serum 25(OH)D status [6]. Levels above 30 ng/mL (75 nmol/L), between 10 and 30 ng/mL (50–75 nmol/L), and below 10 ng/mL (50 nmol/L) are considered to be sufficient, inadequate, and deficient, respectively [7]. Since the half-life is long, it reflects the vitamin D which is both synthesized in the skin and the dietary vitamin D and shows the depot status in the body [8–10]. The data about the vitamin D status in the literature do not include our country's vitamin D test results. Due to the physical differences of the human race and the environmental factors, some country-based or even regional metabolic values may vary among individuals. Karapınar is a city of Konya. Konya is located in Turkey's Anatolian interior. It can be thought that vitamin D deficiency will not be seen because it is in an area with plenty of sun. But we have seen that a lot of patients who suffered vitamin D deficiency. The purpose of our study was to investigate serum 25(OH)D levels in the adult population (10–91) according to age and gender in Karapınar City, Turkey.

Materials and Methods

The medical records of the patients who were admitted to Karapınar State Hospital between January 2018 and December 2018 were retrospectively screened and the patient medications were evaluated. Patients with celiac disease, chronic liver disease, stage 3, 4, 5 chronic kidney disease, vitamin D replacement therapy, and autoimmune diseases were excluded from this study. Serum vitamin D levels of 6,774 patients were retrospectively screened according to age and gender. Serum 25(OH)D level <10 ng/mL is accepted as deficiency, 10–30 ng/mL as insufficiency, 30–40 ng/mL as sufficiency, and >100 ng/mL as toxicity. Serum levels of vitamin D were determined by the chemiluminescence method on Siemens Advia Centaur Classic (Siemens Healthcare Diagnostics, Tarrytown, NY, USA) using the kit (Lot 54482110) (4.2–150 ng/mL) of the same company.

Statistical Analysis

The statistical analysis was performed using IBM SPSS Statistics version 21.0 software (IBM Corp., Armonk, NY, USA). Comparisons of demographic and clinical parameters of the two groups were performed using the Chi-square test, Student *t* test (independent samples *t* test), or Mann-Whitney U test, as appropriate; the Kruskal-Wallis test was used for the comparison of more than two groups. All *p* values of less than 0.05 based on a two-tailed test were considered statistically significant.

Fig. 1. Vitamin D levels according to age.

Results

A total of 6,774 patients were evaluated for vitamin D levels in Karapınar City in 2018. Of these patients, 5,111 (75.5%) were women and 1,663 (24%) were men. In all patients, the 25(OH)D averaged over the year was 14.6 ± 0.2 ng/mL in women and 17.8 ± 0.3 in men. The distribution of patients by age and gender is shown in Table 1. When the patient results were evaluated as percentage, 83.8% of women and 18.2% of men were below the values defined for severe vitamin D deficiency (<10 ng/mL). Insufficiency in vitamin D (10–30 ng/mL) was found in 69.6% of women and 30.4% of men. The optimal level of vitamin D level of 30–100 ng/mL was found in 62.9% of women and 37.1% of men. The toxic level of vitamin D level (>100 ng/mL) was found in 77% of women and 23% of men. The distribution of patients according to vitamin D levels is given in Table 2. The differences between genders were significant in vitamin D levels ($p < 0.05$). Vitamin D levels show a significant decrease as age increases (Fig. 1; Table 3).

Discussion

Vitamin D is important for normal development and protection of bone. Vitamin D deficiency has negative effects on calcium metabolism, osteoblastic activity, matrix ossification, bone remodeling, and bone density [11]. Vitamin D deficiency is a common condition associated

Table 2. Distribution of patients by age and gender

Gender	N	$\bar{x}$	Std. deviation	Median	Min.	Max.
Male	1,663	17.81	12.70	15.01	4.20	150.00
Female	5,111	14.66	13.10	10.67	4.20	150.00
Total	6,774	15.43	13.07	11.71	4.20	150.00

Table 3. Correlation of vitamin D according to age

Vitamin D		
Age	ρ	–0.114**
	p	0.001
	n	6,790

** ρ : Spearman's rank correlation coefficient. n , total number of patients.

with many diseases including osteoporosis in the elderly, rickets in children, some cancers, cardiovascular diseases, and diabetes mellitus [12, 13]. There is no consensus on the optimal serum 25(OH)D levels for bone health. The American Institute of Medicine (IOM) and American Geriatric Society recommend that serum 25(OH)D levels should be above 20 ng/mL and 30 ng/mL, respectively, to minimize the risk of falls and fractures [14–18].

Although there is no wide-ranging study to determine vitamin D levels in our country, due to the reduced risk of falls and the benefits associated with metabolic diseases. The Osteoporosis and Metabolic Bone Diseases Working Group of the Turkey Endocrinology and Metabolism Society defined serum 25(OH)D levels above 30 ng/mL of vitamin D as optimal, levels between 20–30 ng/mL as insufficiency, <20 ng/mL vitamin D as deficiency, and <10 ng/mL as severe deficiency. It is estimated that approximately one billion people in the world suffer from vitamin D deficiency [19]. In the literature, vitamin D status differs in several countries, even in various regions of the same country. In America and Europe, vitamin D deficiency was reported to be found in 40–100% of elderly men and women living in a community [19]. Prevalence of vitamin D deficiency is also much higher in Asia. A total of 30–50% of people in India, Lebanon, and Turkey [20] and also 45.2% of women in China [20] were vitamin D deficient. Studies have shown that especially in 25(OH)D, levels were <75 nmol/L (<30 ng/mL) in the black race and elderly people in Canada. Approximate 25(OH)D levels in winter and spring seasons have been shown to be <50 nmol/L (<20 ng/mL), with seasonal variation between 60 and 120% [21].

Several studies in different parts of Turkey and among different age groups have shown a high prevalence of vitamin D deficiency [23–26]. Uçar et al. [27] found that the mean 25(OH)D levels of 513 patients were lower than 30 ng/mL, and when they were taken as 20 ng/mL cut-off, 51.8% vitamin D deficiency and 20.7% vitamin D deficiency were detected in the patients. In a study by Ögüş and his friends [28], serum vitamin D levels of the patients were found to be 22.8 ± 13.3 ng/mL. According to their study's results, they found vitamin D levels of <20 ng/mL in 47% of patients (50% of women and 38% of men). We also found that vitamin D levels were significantly lower in women than in men. In our study, our results were expressed as percentage: 83.8% of women and 18.2% of men were below the values defined for severe vitamin D deficiency (<10 ng/mL). As for vitamin D insufficiency (10–30 ng/mL), these values were found in 69.6% of women and 30.4% of men. The main cause of vitamin D deficiency can be attributed to lack of sun exposure [29]. Although our country is located in a geographic region which is sun-drenched throughout the year, it can be seen with low vitamin D levels in which the sun cannot be used sufficiently. There may be different reasons. The majority of our people are unable to benefit from the sun because of their religious beliefs.

Besides these reasons, different cut-off values in the studies and discrepancy between the measurement meth-

ods (tandem-mass spectrometry, radioimmunoassay, and automated immunoassay systems) should be taken into consideration and further standardization studies should be performed for vitamin D. Gender and age influence serum 25(OH)D levels. Differences according to gender and age group may be because of biological differences but might also be due to behavioral differences. There might be gender-specific clothing differences (necessarily not based on a religious culture). There also might be that women spend less time outside, resulting in less exposure to the sun [30]. In a study by Andersen et al. [31], serum vitamin D levels decreased during military training in the summer due to the type of clothing worn during training, coupled with inadequate vitamin D intake among the woman soldiers in the United States.

Our study found that vitamin D deficiency was also associated with age, and most studies found higher prevalence of vitamin D deficiency among the elderly [32–34], probably due to lower capacity of the skin to produce vitamin D after sun exposure [33] or less vitamin D intake in the elderly [33], although a few studies reported higher prevalence of vitamin D deficiency in young people [34].

Conclusion

Our study determined serum vitamin D levels according to age and gender in a local population. Most of the patients were found to be vitamin D deficient. There were significantly lower serum vitamin D levels in women compared to men and our study found a higher prevalence of vitamin D deficiency among elderly people. Evaluation of serum vitamin D levels with other risk factors and bone metabolism is of great importance.

Study Limitations

Since the study is retrospective, patients who get vitamin D are unknown and the degree of exposure to sun is also unknown. Most of the patients included in this study were women. The absolute majority of the participants were from Karapınar City, but more detailed information about skin type or color was not obtained. In addition, we did not have the opportunity to include patients who have applied to our primary health care services and follow patients afterwards. As a result, the study may not be representative of the general population who are from Karapınar City.

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Statement of Ethics

The work described in this article has been carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans and uniform requirements for manuscripts submitted to biomedical journals.

Disclosure Statement

The authors have no potential conflicts of interest to disclose.

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Author Contributions

Conception, design: S.K. Writing, revision: all authors. Final approval: all authors.

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