



Prevalence of Vitamin D Deficiency among University Students in Uşak, Turkey

**Saygın Kamacı¹, Senem Şanlı^{2*}, Ayşe Özdemir³, Seyfi Sardoğan⁴,
Sanem Erdoğan⁵ and Nurullah Şanlı⁵**

¹Department of Orthopaedics and Traumatology, Faculty of Medicine, Hacettepe University, 06100, Ankara, Turkey.

²Department of Chemistry, Faculty of Science and Arts, Uşak University, 64100, Uşak, Turkey.

³Department of Biochemistry, Faculty of Medicine, Uşak University, 64100, Uşak, Turkey.

⁴Department of Food Engineering, Faculty of Engineering, Uşak University, 64100, Uşak, Turkey.

⁵Research and Development (R&D) Center, MURATBEY Dairy Products Company, 64100, Uşak, Turkey.

Authors' contributions

This work was carried out in collaboration among all authors. Authors SK and SŞ designed the study, wrote the protocol and performed the statistical analysis. Authors AÖ and NŞ wrote the first draft of the manuscript and managed the analyses of the study. Authors SS and SE managed the literature searches and performed necessary corrections. All authors read and approved the final manuscript.

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ABSTRACT

Vitamin D deficiency is now recognized as a pandemic with implications for multi-organ systems including bone health and immunological processes. Low levels have been associated with several chronic and infectious diseases. The aim of the study was to evaluate the prevalence of vitamin D deficiency among university students in Uşak, Turkey. This cross-sectional study included 100 (44 male and 56 female) university students between January 2020 to February 2020. Demographics, medical history, sunlight exposure, dietary vitamin D intake, body mass index of each individual were recorded in face-to-face interviews. Subjects with known metabolic conditions affecting

*Corresponding author: E-mail: senemkamacisanli@gmail.com;

vitamin D metabolism were excluded. Vitamin D nutritional status was assessed as deficient if 25(OH)D levels were <20ng/mL, insufficient if between 20 and 30 ng/mL, sufficient if ≥ 30 ng/mL, while <10ng/mL was considered as severe. The mean age for all students was 20.18 ± 1.77 (18-30) years. The mean serum 25(OH)D level was 11.60 ± 9.81 among all students (12.22 ± 5.40 ng/mL in males, 11.11 ± 12.24 ng/ml in females). 91 students (91%) were assessed as vitamin D deficient (92.86% among female, 88.64% among male, $P > .05$). Prevalence of vitamin D insufficiency and deficiency among male students were 11.36 and 88.64%, respectively. Vitamin D deficiency was highly prevalent among medical students included in this study and its deficiency especially among female students is alarmingly prevalent. Absence of vitamin D fortified foods in Turkish market is shortcoming. Therefore, preventive strategies parallel to regular vitamin D fortified food consumption is seriously recommended.

Keywords: University students; vitamin D deficiency; Turkey.

1. INTRODUCTION

Vitamin D deficiency has emerged as an important worldwide public health problem. Vitamin D is a lipid-soluble hormone found in some foods and it can be synthesized from precursors in the skin when exposed to ultraviolet light [1-3]. Vitamin D plays a critical role in bone metabolism and many cellular and immunological processes; and its low levels have been associated with several chronic and infectious diseases [4-8]. A further challenge to those with several factors during the current COVID-19 pandemic may involve vitamin D deficiency / insufficiency. Vitamin D deficiency is usually caused by insufficient exposure to sunlight or excessive use of sunscreen and/or malnutrition [9]. Several other factors such as malabsorption disorders, age, weight, dark skin pigmentation and disorders that affect vitamin D metabolism can also change vitamin D concentrations [1-3]. Plasma (or serum) 25(OH)D level is currently the best indicator for assessing vitamin D status [1]. This parameter shows vitamin D level from all sources as cutaneous synthesis, diet and supplements, and that reflects the measure of the circulating concentration of serum 25(OH)D [1,3]. Although there is no consensus on optimal serum levels of 25(OH)D, vitamin D deficiency is defined by most experts as a level less than 20 ng/mL [1].

Vitamin D is absorbed in lipid micelles and incorporated into chylomicrons. Some dietary fat is therefore needed to absorb dietary vitamin D. To become physiologically active, vitamin D must undergo two hydroxylation reactions. Colecalciferol is hydroxylated in the liver to form 25-hydroxyvitamin D — 25(OH)D — which is released into the circulation. The second stage of vitamin D metabolism occurs in the kidney where 25(OH)D undergoes either 1-hydroxylation to yield 1,25-dihydroxyvitamin D (calcitriol) or 24-hydroxylation to yield 24,25-dihydroxyvitamin D. Renal synthesis of calcitriol is homeostatically controlled by parathyroid hormone (PTH). Synthesis of PTH is regulated by serum concentrations of calcium and phosphate. Oral colecalciferol intake results in a 70 per cent higher plasma 25-(OH)D concentration compared with the same amount of ergocalciferol [10] (Fig. 1).

Several studies have been reported on the relationship between vitamin D and different health outcomes, but fewer studies addressed young adults [11-13]. Many young adults drink carbonated drinks instead of milk, reducing their intake of both calcium and vitamin D and herewith the risk of fracture can potentially increase [14]. College students have more freedom and control over their lifestyles before going to school, making college years a

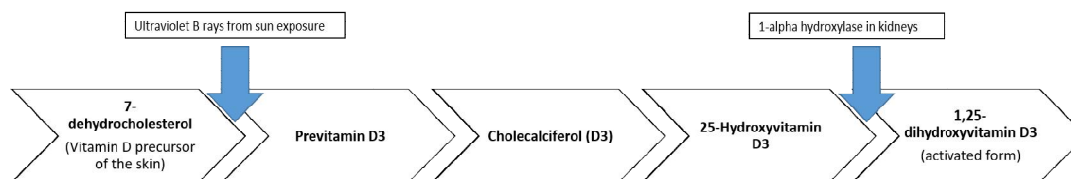


Fig. 1. Vitamin D synthesis

convenient time to develop healthy lifestyle patterns and behaviors [15]. Nowadays, most university students are interested in learning about healthy nutrition [16] to boost their dietary habits [17] and they are at an ideal age to start a long-term positive change regarding vitamin D. Therefore, this age group should be a primary target for vitamin D deficiency prevention and intervention programs that promote their long-term health and protect them from disease development later in their life [18].

The world is in the grip of the COVID-19 outbreak. Through several mechanisms, vitamin D can reduce risk of infections. Many observational and clinical trials reported that vitamin D supplements reduce the risk of influenza, while others did not [19]. Although, Turkey is in sunny region in the world, vitamin D deficiency in Turkish citizens is very prevalent [20]. To date, few papers have been reported about the vitamin D status of adults in Turkey [21-24]. However, no report has been given about the vitamin D status of University students in Turkey. The purpose of the study was to evaluate the prevalence of vitamin D deficiency in university students, aged 18–30 years, and prior to the end of peak bone formation years. Information about the status of this vitamin may help to inform politicians and health service managers regarding possible preventative health measures for this population.

2. METHODOLOGY

2.1 Participants and Procedures

This cross-sectional study was conducted in the city of Uşak (38° 40' 24.64" N latitude), a non-coastal city in the Aegean region of Turkey. The purpose of the study was explained and no identifying information was requested from the participants. Students were recruited to participate in the study by sending an e-mail invitation or by classes. Students who randomly responded to the e-mail between January and February 2020 and the students who fulfilled the inclusion criteria were enrolled in the study. Serum vitamin D (25(OH)-D) status and vitamin D intake were examined for 100 university students' aged 18 to 30 years. Inclusion criteria was university students aged 18–30 years old, non-pregnant, have no chronic diseases and allergic history, did not have any obvious symptom of endocrine kidney liver or skeleton diseases, willingness to complete the questionnaire and provide serum 25(OH)D test

results. The students were informed that participation is voluntary, all responses will be anonymous and would remain confidential, and that participation in the survey implied consent.

2.2 Data Collection and Study Variables

The main method of data collection was a questionnaire that consisted of two parts (total of 15 questions) as follows: first part was demographic information, e.g. age, gender, weight, height. Second part was questions regarding autoimmune diseases of the participants and/or their families, possibility of pregnancy, allergic history and obvious symptom of endocrine, kidney, liver or skeleton diseases. Weight was measured by using a digital scale to the nearest of 0.1 kg (Beurer BG 40 diagnostic scale, Germany) while the participants were wearing light clothing and no shoes. Height was determined with a stadiometer to the nearest of 0.1 cm (Seca model 213). Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Following the World Health Organization classification [25], BMI ≤ 18.5 is considered underweight, a BMI ≥ 25 was considered overweight, while above 30 was considered obese. Regular wearing of clothing limiting exposure to sunlight was also asked, as a yes/no question. 'Yes' was recorded if usually the person wore clothing which allowed for only the face and hands to be exposed to the sun. If otherwise, 'no' was recorded.

Also, 5 mL of blood was collected from a peripheral vein, quickly placed on ice, and transported to the laboratory where it was centrifuged at 4000 rpm for 4 minutes, then serum and plasma were stored at -80°C until analysis. Immunochemical assays analyzed on AbbottArchitect i-2000 (Abbott Park, IL, USA). Vitamin D nutritional status was assessed as deficient if 25(OH)D levels were < 20 ng/mL, insufficient if between 20 and 30 ng/mL, sufficient if ≥ 30 ng/mL [1], while < 10 ng/mL was considered as severe deficiency [26].

2.3 Statistical Analyses

The data were summarized either as percentages or means \pm standard deviations (SD). All statistical analyses were performed using SPSS for Windows® 22.0 (SPSS, Inc. Chicago, USA). Chi-square test and Student's t test were used for bivariate analysis. Sex (male/female), clothing limiting exposure to

sunlight (Yes/No) and Body mass index (BMI) were included as potential confounders in the multivariate analysis. Significance was set at $P < .05$ using 95% confidence interval (CI) for all comparisons. P values less than 0.05 were regarded as statistically significant.

3. RESULTS AND DISCUSSION

One hundred university students participated in this study (mean age 20.18 ± 1.77 years): 54% male (mean age 20.52 ± 2.26 years), 56% female (mean age 19.91 ± 1.21 years; Table 1). No patient was taking vitamin D as a supplement. None had a parathyroid problem, chronic kidney disease, liver disease or other medical conditions which might affect vitamin D metabolism.

As can be deduced from Table 1, mean \pm standard deviation (SD) of serum 25(OH)D were 12.22 ± 5.40 (ng/mL) among male students and 11.11 ± 12.24 (ng/mL) among female students which is significantly less than males ($P < .005$). The overall mean 25(OH)D level was 11.60 ± 9.81 ng/mL. Also the values of sun exposure are shown in Table 1. Overall, 39.0% of the respondents usually wore clothing that prevented exposure to sunlight (70.6% in female, 29.4% in male, $P = 0.084$, Table 1). Female had less exposure to sunlight than men (Table 1). Body mass index (BMI) was significantly different when analyzed according to gender ($P < .005$).

25(OH)D status was significantly different when analyzed according to gender and sun exposure (Table 2). In contrast, 25(OH)D status did not change significantly according to BMI values ($P > .05$) (Table 2). Dramatically, overall vitamin D status observed in 98% of the subjects had low levels; 58.0% had severe deficiency, 33.0% had

vitamin D deficiency, 7.0% had vitamin D insufficiency, and just only 2.0% had sufficient levels of vitamin D. Severe vitamin D deficiency was significantly more common among women (67.9%) than men (45.5%), ($P < .05$).

Those students who avoided sun exposure for any reason had lower level of vitamin D. 25(OH)D levels according to style of dress and sunlight exposure are given in Table 2. Those wearing clothing which restricted exposure to sunlight were more likely to have vitamin D total deficiency (97.4%) than those who wore clothing which allowed more sunlight exposure (86.9%). In the same way, those wearing clothing which restricted exposure to sunlight were lower vitamin D insufficiency (2.6%) than those who wore clothing which allowed more sunlight exposure (9.8%, $P < .05$, Table 2). Just only 3.3% had sufficient levels of vitamin D who replies "no" to the questionnaire. Our study could not show correlation of BMI and level of Vitamin D ($P > .05$, Table 2).

It is shown in Fig. 2 that 38.0% of female students had severe vitamin D deficiency and 14% of them were vitamin D deficient. Among male students prevalence of vitamin D deficiency including severe deficiency were almost the same (39.0%) and just only 9.0% of total students had insufficiency and sufficient status, respectively.

Vitamin D deficiency is being increasingly recognized worldwide [1,3]. Studies among those living in Turkey have been few, and most have been performed among women, those in nursing homes, and the elderly [21-24]. Up to date, no study has been performed vitamin D status in a population based on University students in Turkey. This is the first study, and surprisingly

Table 1. Demographic characteristics, sunlight exposure, BMI and mean 25(OH) D levels of the participants

	Male	Female	Total	P
Total (n = 100)	44 %	56 %	100 %	
Wearing clothes which restrict exposure to sunlight				$P^* = 0.084$
Yes	29.41 %	70.59 %	39 %	
No	50.82 %	49.18 %	61 %	
Age (year)	20.52 ± 2.26	19.91 ± 1.21	20.18 ± 1.77	$P^* = 0.109$
Mean \pm SD; (Min-Max)	(18-28)	(18 – 24)	(18 – 28)	
BMI (kg/m²)	22.71 ± 3.27	20.75 ± 2.40	21.61 ± 2.97	
Mean \pm SD; (Min-Max)	(18.35 – 33.06)	(16.23 – 28.52)	(16.23 – 33.06)	$P^* = 0.001$
Mean \pm SD 25(OH)D level (ng/mL)	12.22 ± 5.40	11.11 ± 12.24	11.60 ± 9.81	$P^{**} = 0.001$

*Chi-square test **Student's t test

Table 2. Vitamin D status and gender, body mass index (BMI), age and sunlight exposure

	25(OH)D Status				P*
	Severe deficiency (< 10 ng/mL)	Deficient (10-19.99 ng/mL)	Insufficient (20-20.99 ng/mL)	Sufficient (≥ 30 ng/mL)	
Total (n = 100)	58.0 %	33.0 %	7.0 %	2.0 %	
Gender					
Male (n = 44)	45.46 %	43.18 %	11.36 %	-	P = 0.040
Female (n = 56)	67.86 %	25.00 %	3.57 %	3.57 %	
BMI (kg/m²)					
≤ 18.5	9.0 %	-	-	-	P = 0.121
18.5 < BMI ≤ 25	44.0 %	31.0 %	6.0 %	2.0 %	
25 < BMI ≤ 30	4.0 %	2.0 %	-	-	
> 30	1.0 %	-	1.0 %	-	
Wearing clothes which restrict exposure to sunlight					
Yes (n = 39)	74.35 %	23.08 %	2.56 %	-	P = 0.047
No (n = 61)	47.54 %	39.34 %	9.83 %	3.28 %	

*Chi-square test

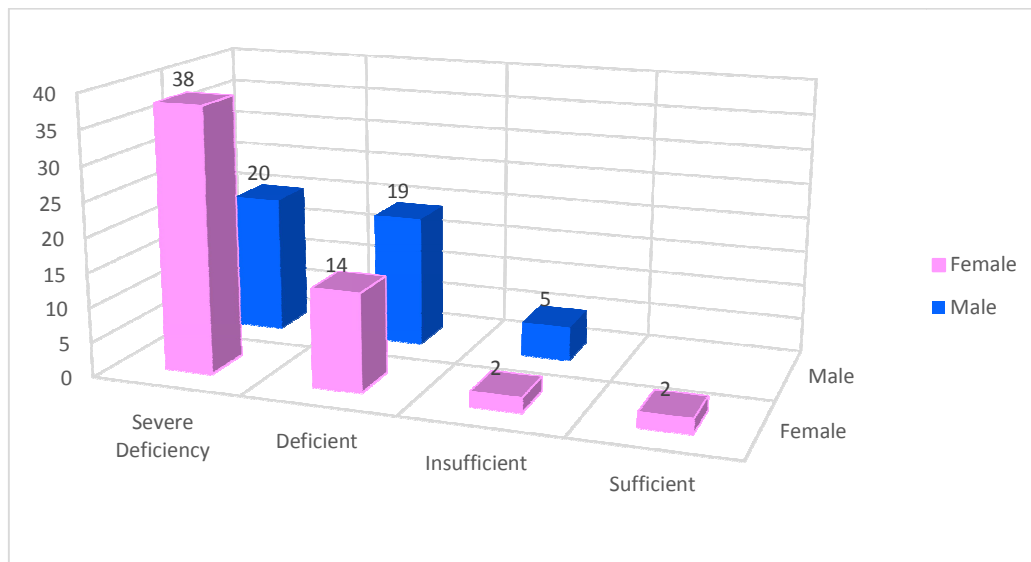


Fig. 2. Vitamin status of participants by gender

found quite a high total prevalence of vitamin D deficiency (91%) and insufficiency (7%) in Uşak city which gets lots of sunlight.

Especially in countries where food stuffs are not enriched with vitamin D, young population are at risk to vitamin D deficiency [27]. Despite the fact that vitamin D drug forms are widely available and is inexpensive, various social and cultural factors including modern life, religious reasons and the possible harmful effects of sun on skin, avoid students to take advantage of it. Considering the fact that Uşak is located in Aegean region of Turkey in the 38° 40' 24.64" N

latitude, it is sunny most of the days, however living in apartments is so common among university students and people can't walk to school to expose to the sunlight. If in this situation vitamin D deficiency is high, it is most probable that it is prevalent in other cities too. Knowing all these facts reveals the significance of this survey in university students in Turkey.

A study in Turkey indicated the season effect so as in winter 60% and in summer 25% of girls belonging to higher socioeconomic class suffered from vitamin D deficiency. However, this was less prominent in urban areas [28]. Another one,

Hatun et al., reported that subclinical vitamin D deficiency is increased in adolescent girls who wear concealing clothing and showed the high prevalence of poor vitamin D status. They reported that this finding is partly due to type of dressing and time being outdoors which is related to the cultural factors and lifestyle of the participants [29]. Outdoor recreational activities and tourism were the least preferred recreation activities among university students. This finding might also reflect the opportunities available [30].

In our study, the mean 25(OH)D level was low (11.60 ± 9.81 ng/mL) and mean 25(OH)D levels in women were significantly lower than in men as in other studies [20,23]. As known, regular sunlight exposure acts as prophylactic effect to prevent vitamin D deficiency. But even in Middle Eastern juvenile populations, who live in sunny climates, vitamin D deficiency is a clinical problem and recently shown that 82.5% of entire study cohort had inadequate serum 25(OH)D levels [31]. Similarly, Al-Daghri reported vitamin D deficiency is highly prevalent in Saudi Arabia across all demographics and is associated with several extra-skeletal, chronic metabolic diseases in the local population, particularly insulin resistance and its related comorbidities [32].

Additionally, according to the World Health Organization (WHO), by September 3, 2020, coronavirus disease 2019 (COVID-19) had been identified in 25,884,895 people globally, with mortality of approximately 3.32% worldwide [33]. In a recent review regarding the role of vitamin D in reducing the risk of the influenza and/or COVID-19; to reduce the risk of infection, it is recommended that people at risk of influenza and/or COVID-19 consider taking 10,000 IU/d of vitamin D₃ for a few weeks to rapidly raise 25(OH)D concentrations, followed by 5000 IU/d. The goal should be to raise 25(OH)D concentrations above 40–60 ng/mL (100–150 nmol/L). For treatment of people who become infected with COVID-19, higher vitamin D₃ doses might be useful [34]. Panarese and Shahini claimed it seems plausible that Vitamin D prophylaxis (without over-dosing) may contribute to reducing the severity of illness caused by SARS-CoV-2, particularly in settings where hypovitaminosis D is frequent [35].

4. CONCLUSION

This population-based survey among medical university students in the Aegean region of

Turkey indicates that vitamin D deficiency is very prevalent. Vitamin D deficiency especially among female students is alarmingly prevalent. Also absence of vitamin D fortified foods in Turkish market is another shortcoming. Regarding the importance of vitamin D status in calcium absorption, prevention of osteoporosis and its correlation to obesity and chronic diseases, recently contribution to reducing the severity of illness of COVID-19, vitamin D deficiency is a public health concern. An urgent action has to be taken in order to prevent adverse consequences of low vitamin D in the young populations. Therefore, preventive strategies parallel to regular vitamin D fortified food consumption is seriously recommended.

CONSENT AND ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

The study protocol was approved by the Institute of Health and Human Development Ethical Issues on Clinical Trials Review Board of Uşak University (approval number 2019/08). Informed consent was taken from each individual.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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