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Research Article

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The Effect of Monthly Mean Global Horizontal Solar Radiation and Sunshine Duration on Vitamin D Levels in Young Women

Genç Kadınlarda Aylık Ortalama Küresel Yatay Güneş Radyasyonu ve Güneşlenme Süresinin Vitamin D Düzeyine Etkisi

Şükriye Taşçı[1], Sevil Turhan[2], Hülya Coşkun[1], Seher Kır[3], Yusuf Emre Bostan[2], Raziye Yıldız[4]

[1] *Karadeniz Technical University, Faculty of Medicine, Department of Internal Medicine, Trabzon, Turkey*

[2] *Karadeniz Technical University, Faculty of Medicine, Department of Public Health, Trabzon, Turkey*

[3] *Ondokuz Mayıs University, Faculty of Medicine, Department of Internal Medicine, Samsun, Turkey*

[4] *İzmir Katip Çelebi University, Faculty of Medicine, Department of Medical Biochemistry, İzmir, Turkey*

ABSTRACT

Aim: The most important reason for vitamin D deficiency is the lack of synthesis in the skin. The synthesis of vitamin D can be affected by many variables such as geographical region, race, season, monthly average daily sun exposure duration (MADSD), monthly average daily global horizontal solar radiation (MADGHSR). In this study, we aimed to investigate possible association between vitamin D levels and MADSD and MADGHSR in young women.

Methods: This is a retrospective study evaluating the levels of Vitamin D classified by age, seasons, months, MADGHSR and MADSD in women aged between 15-45 years admitted to a secondary state hospital.

Results: All of the women involved were at reproductive age and approximately 94.6% of them had vitamin D levels below 30 ng/mL. The median (minimum-maximum) vitamin D level was 16.1 (3.6-49.4) ng/mL in summer and 14.3 (3.2-49.8) ng/mL in winter (p=0.001). The rate of vitamin D deficiency (<20 ng/mL) was 68.1% in summer and 75.1% in winter (p<0.001). The median MADGHSR was 4.6 (3.4-5.7) hours in winter and 6.9 (5.2-7.2) hours in summer and the median MADSD was 3.3 (1.6-3.5) watt/m^2/day in winter and 15.2 (12.2-15.8) watt/m^2/day in summer. Vitamin D level was weakly correlated with age (r=0.082, p=0.002), MADSD (r=0.075, p=0.001) and MADGHSR (r=0.062, p=0.006).

Conclusion: We found that MADGHSR and MADSD had an effect on vitamin D synthesis in addition to factors related with personal and environmental situations. We suggest that routine optimal dose vitamin D replacement is necessary in geographies similar to the population in our study.

Key Words: Vitamin D Deficiency, Daily Sunshine Duration, Global Solar Radiation

ÖZET

Amaç: D vitamini eksikliğine neden olan en önemli neden ciltte sentez eksikliğidir. D vitamini sentezi yaşanılan coğrafi bölge, ırk, mevsim, maruz kalınan aylık ortalama günlük güneşlenme süresi (MADSD), aylık ortalama günlük küresel yatay güneş radyasyonu (MADGHSR), gibi pekçok değişkenden etkilenebilir. Bu çalışmada genç kadınlarda D vitamini düzeyi ile MADSD ve MADGHSR değerleri arasındaki ilişkinin araştırılmasını amaçladık.

Yöntem: Bu çalışma retrospektif olarak ikinci basamak bir devlet hastanesine başvuran 15-45 yaş arasındaki kadınlarda yapıldı ve D vitamini düzeyleri yaş, mevsimler, aylar, MADGHSR ve MADSD değerlerine göre sınıflandırıldı.

Bulgular: Çalışmaya dahil edilen tüm kadınlar üreme çağında olup yaklaşık %94,6'sının D vitamini düzeyi 30 ng/mL'nin altındaydı. Ortanca (minimum-maksimum) D vitamini düzeyi yazın 16,1 (3,6-49,4) ng/mL, kışın 14,3 (3,2-49,8) ng/mL idi (p=0.001). D vitamini eksikliği (<20 ng/mL) oranı yazın %68,1 ve kışın %75,1 olarak saptandı (p<0.001). Medyan MADGHSR kışın 4,6 (3,4-5,7) saat ve yazın 6,9 (5,2-7,2) saat ve medyan MADSD kışın 3,3 (1,6-3,5) watt/m^2/gün ve yazın 15,2 (12,2-15,8) watt/m^2/gün bulundu. D vitamini düzeyinin yaş (r=0.082, p=0.002), MADGHSR (r=0.062, p=0.006) ve MADSD (r=0.075, p=0.001) ile zayıf korelasyon gösterdiği saptandı.

Sonuç: Bireysel ve çevresel faktörlerin yanı sıra MADGHSR ve MADSD'nin vitamin D sentezi üzerinde etkili olduğunu bulduk. Çalışmamızdaki popülasyona benzeyen coğrafyalarda rutin optimal doz D vitamini takviyesinin gerekli olduğunu düşünüyoruz.

Anahtar Kelimeler: D Vitamini Eksikliği, Günlük Güneşlenme Süresi, Küresel Güneş Radyasyonu

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Corresponding author: Seher KIR. Ondokuz Mayıs University, Faculty of Medicine, Department of Internal Medicine, Samsun, Türkiye
Phone: +903623121919 / **mail:** seherkr@yahoo.com
ORCID: 0000-0003-2835-1745

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Introduction

Vitamin D deficiency is a leading health issue in most of the developed and developing countries due to numerous influential factors. Vitamin D is very important for bone mineralization and its deficiency has negative impacts on many bodily systems [1-4]. Moreover, the importance of vitamin D for the immune system has also been emphasized in studies after coronavirus disease 2019 (COVID-19) outbreak [5,6].

Vitamin D is a steroid hormone and dietary vitamins, D2 (ergosterol) and D3 (cholecalciferol), are transported to fat cells by chylomicrons. The vitamin D synthesis is completed in the skin, liver, and kidney, respectively and the most important synthesis site is the skin. The lack of vitamin D synthesis in the skin is the most crucial step causing vitamin D deficiency in the absence of liver and kidney failure. Vitamin D synthesis begins with the penetration of ultraviolet B (UVB) radiation into the skin, in the epidermis, at a wavelength of 290-315 nm and its absorption by 7-dehydrocholesterol (7-DHC). After taking the form of previtamin-D, it exits the cells and then enters the bloodstream. Then, 25-hydroxylation in the liver and 1 alpha-hydroxylation in the kidney occurs. Vitamin D metabolism is regulated by parathormone (PTH), serum calcium (Ca^{+2}), fibroblast growth factor 23 (FGF23), phosphorus (P), and other factors [7,8].

Increased body weight, insufficient dietary intake of vitamin D, use of sunscreen, and wearing clothes that cover the whole body reduce the effect of the sun and vitamin D synthesis. In addition, there are other factors that related with vitamin D synthesis, including race, skin colour (melanin content in the skin), geographic region, seasons, monthly mean daily global horizontal solar radiation (MADGHSR) and monthly mean daily sun exposure (MADSD) [9,10]. The MADSD and MADGHSR can be calculated using various meteorological and geographical data. MADSD can be estimated by analyzing the average daily hours of sunshine recorded at a specific location over a month. This data can be obtained from local meteorological stations or global databases. MADGHSR is calculated using models that account for various factors, such as the angle of incidence of solar radiation, atmospheric conditions, and the Earth's tilt and orbit. A widely used model for estimating solar radiation is the Angström-Prescott equation [11,12]

A vitamin D level of 30 ng/mL and above is essential not only for calcium metabolism but also for all other body functions that involve role of vitamin D leading to its transformation to previtamin D3, which is rapidly converted to vitamin D3. Season, latitude, time of day, skin pigmentation, aging, sunscreen use, and glass all influence the cutaneous production of vitamin D3. Once formed, vitamin D3 is metabolized in the liver to 25-hydroxyvitamin D3 and then in the kidney to its biologically active form, 1,25-dihydroxyvitamin D3. Vitamin D deficiency is an unrecognized epidemic among both children and adults in the United States. Vitamin D deficiency not only causes rickets among children but also precipitates and exacerbates osteoporosis among adults and causes the painful bone disease osteomalacia. Vitamin D deficiency has been associated with increased risks of deadly cancers, cardiovascular disease, multiple sclerosis, rheumatoid arthritis, and type 1 diabetes mellitus. Maintaining blood concentrations of 25-hydroxyvitamin D above 80 nmol/L (approximately 30 ng/mL(4). Although there are different threshold values determined around the world, vitamin D level is defined as insufficiency if it is below 30 ng/mL, deficiency if it is below 20 ng/mL and severe deficiency if it is below 12 ng/mL [13]. Studies have shown that 5.9-13% of the world population has severe vitamin D deficiency and 24-40% of them has vitamin D deficiency, although these rates vary across regions [14]. Additionally, in similar academic studies, it was reported that 41.4% of the general population in the United States of America (USA) had a vitamin D deficiency [15].

Vitamin D synthesis is affected by seasonal differences, latitude, and the time and angle of UVB rays reaching the earth. Additionally, environmental factors, clothing, ethnic group of the individual, and the geographical region of residence also have impacts on vitamin D synthesis [4,7,15,16].

The present study was conducted in the Eastern Black Sea Region in the north east of Turkey, which is located between 39-40°E longitude and 40-41°N latitude and at a mean altitude of 24 m above the sea level. In this region, typical Black Sea climate with moderate summers and mild winters is seen and all seasons are cloudy. Most of the women living in this region wear clothes that cover most of the body due to the weather conditions as well as their traditional lifestyles and religious preferences.

In this study, we aimed to investigate relationship between vitamin D levels and MADSD and MADGHSR values in female patients between the ages of 15-45 residing in the Akçaabat district in Trabzon province, which is located in the north-east of Turkey and receives relatively little sunlight. We also aimed to determine whether environmental factors or sunlight exposure were more effective on vitamin D synthesis.

Materials and Methods

This descriptive study retrospectively examined reproductive-aged women (15-45 years old), who presented to Akçaabat State Hospital, a secondary care hospital in

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Trabzon province, and had their vitamin D level status measured. Vitamin D levels classified according to age, seasons, months, MADGHSR and MADSD.

Measurements of serum 25-hydroxyvitamin D (25(OH)D) levels were performed using an enzyme chemiluminescence immunoassay method on an autoanalyzer (Beckman Coulter UniCel DXI 800 Immunoassay Systems, California, USA). These measurements were retrieved from the hospital data system and prescription data were obtained from the prescription drug monitoring program. Patients were excluded from the study that has inadequate medical records, kidney failure, liver failure, calcium metabolism disorders, malabsorption, intestinal diseases, and those who received vitamin D replacement within the last six months.

The MADSD and MADGHSR metrics are employed to evaluate solar energy potential and to compare different regions. MADSD is expressed in hours and represents the duration of sunlight available for solar energy production. MADGHSR is expressed in kWh/m^2/day or MJ/m^2/day and takes into account both direct and diffuse sunlight. These two parameters play a significant role in designing solar energy systems suited to a specific location [11,12].

This study was approved by Ethics Committee of Karadeniz Technical University (Number:2019-54).

Statistical Analysis

SPSS for Windows version 23.0 (Armonk, NY: IBM Corp.) was used for analyzing the data. The categorical variables were expressed by frequencies (n) and percentages (%) and the continuous variables were expressed as mean ± standard deviation (SD) and/or median (minimum-maximum). The normal distribution of data was analyzed by Kolmogorov-Smirnov test. Mann-Whitney *U* and Kruskal-Wallis tests were used for the comparison of independent continuous variables. Mann-Whitney *U* test was also used for post-hoc analysis of groups that showed a significant difference on the Kruskal-Wallis test. The categorical variables were compared by Chi-square test or Fisher's test, followed by post-hoc Bonferroni correction test. The correlation between continuous variables were evaluated using Spearman's Correlation test. A p value of <0.05 was considered as significant.

Results

A total of 1901 women were included and the mean age of the patients presented to hospital in summer was 31.1±7.9 years and in winter was 30.2±8.6 years. The median (min-max) vitamin D level was 16.1 (3.6-49.4) ng/mL in summer and 14.3 (3.2-49.8) ng/mL in winter (p=0.001). The median MADGHSR was 4.6 (3.4-5.7) hours in winter and 6.9 (5.2-7.2) hours in summer. The median MADSD was 3.3 (1.6-3.5) watt/m^2/day in winter and 15.2 (12.2-15.8) watt/m^2/day in summer. Moreover, MADSD values showed remarkable variation during the six months (Table 1).

The vitamin D level was significantly higher in summer than in winter (p<0.001). A significant difference was found during the six months with regard to vitamin D levels (p<0.001), which was due to the significantly higher vitamin D levels in July and August compared to the other months. Similarly, a significant difference was found between the three age groups in terms of vitamin D levels, as vitamin D levels in the 35-45 age group were significantly higher than in other age groups (p=0.008) (Table 2).

Table 1. Meteorological data and characteristics of study group

Season / Month	N	Vitamin D (ng/mL) Mean ±SD	Age (years) Mean ± SD	MADGHSR* (hours) Median (min-max)	MADSD**(Watt/m^2/day) Median (min-max)
Winter	896	15.9 ± 7.5	30.2±8.6	4.6 (3.4-5.7)	3.3 (1.6-3.5)
November	287	16.5 ± 7.1	30.5±8.8	3.3	5.7
December	205	15.3 ± 8.2	28.6±8.5	1.6	3.4
January	404	15.7 ± 7.3	30.8±8.3	5.2	4.6
Summer	1005	17.3 ± 7.3	31.1±7.9	6.9 (5.2-7.2)	15.2 (12,2-15.8)
June	440	16.1 ± 7.5	30.9±7.6	7.2	15.8
July	428	18.2 ± 7.1	31.2±5.4	5.2	15.2
August	137	18.5 ± 6.9	31.5±8.7	6.9	12.2
All months	**1901**	16.6 ± 7.4	**30.6±8.3**	**12,2 (3.4-15.8)**	**5.5 (1.6-7.2)**

*MADGHSR: Monthly average daily global horizontal solar radiation. **MADSD: Monthly average daily sunshine duration. These data were obtained from the Regional Directorate of Meteorology as only monthly average.

Table 2. Comparison of vitamin D levels by season, months and age groups.

Parameters	Vitamin D level (ng/mL)			*p*
	Median	Minimum	Maximum	
Season				
Summer	16.1	3.6	49.4	*<0.001*
Winter	14.3	3.2	49.8	
Month*				
June[a]	14.4	4.5	49.4	
July[b]	17.4	3.6	47.9	
August[b]	17.2	5.5	40.7	*<0.001*
November[a]	15.2	3.5	46.7	
December[a]	13.1	3.2	49.8	
January[a]	14.2	3.5	43.0	
Age (years)* (n=1473)				
15-24[a]	14.0	3.4	48.6	*0.008*
25-34[a]	14.1	3.2	49.4	
35-45[b]	15.6	3.5	49.8	
Total	15.2	3.2	49.8	

In the comparison of age groups according to different cut-off values, a significant difference was found only between women with severe and non-severe vitamin D deficiency (≤12 ng/mL and >12 ng/mL, respectively) (*p*<0.001). In addition, while severe vitamin D deficiency was found in 26.4% of women aged 35-45, it was found to be significantly more common in women aged 25-34 (34.4%) and women aged 15-24 (37.1%) (p =0.001) (Tables 3 and 4).

In terms of seasonal variation, there was a significant difference between the cutoff values of 12 and 20 ng/mL. Severe vitamin D deficiency (≤12 ng/mL) was detected in 25.4% in summer and 34.2% in winter (*p*<0.001) and vitamin D deficiency (<20 ng/mL) was 68.1% in summer and 75.1% in winter (p<0.001). At a cutoff value of 30 ng/mL, there was no significant difference between summer and winter (*p*=0.438) (Table 3 and 4). There was a weak correlation between vitamin D level and age (r=0.082, *p=0.002*), MADSD (r=0.075, *p=0.001*) and MADGHSR (r=0.062, *p=0.006*) (Table 5).

Table 3. Comparison of vitamin D levels in age and seasonal groups.

≤12		Vitamin D Level (ng/mL)				
		12 -20	20 - 30	>30	Total (n)	
Age groups (years)						
15-24	n (%)	163 (37.1)	168 (38.3)	90 (20.5)	18 (4.1)	439 (100)
25-34	n (%)	172 (34.4)	205 (41.0)	97 (19.4)	26 (5.2)	500 (100)
35-45	n (%)	141 (26.4)	238 (44.6)	120 (22.5)	35 (6.5)	534 (100)
Total	**N (%)**	**476 (32.3)**	**611 (41.5)**	**307 (20.8)**	**79 (5.4)**	**1473 (100)**
Season						
Summer	n (%)	255 (25.4)	429 (42.7)	260 (25.8)	61 (6.1)	1005 (100)
Winter	n (%)	306 (34.2)	367 (41.0)	176 (19.6)	47 (5.2)	896 (100)
Total	**N (%)**	**561 (29.5)**	**796 (41.9)**	**436 (22.9)**	**108 (5.7)**	**1901 (100)**

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Table 4. Comparison of vitamin D levels in age and seasonal groups according to different cut-off values

≤12		Vitamin D (ng/mL)			Vitamin D (ng/mL)			Vitamin D (ng/mL)			Total (n)
		>12	***p***	**≤20**	**>20**	***p***	**≤30**	**>30**	***p***		
Age groups (years)*											
15-24	n	163^{a}	276^{a}	*0.001*	331	108	0.178	421	18	0.235	439
	%	37.1	62.9		75.4	24.6		95.9	4.1		100
25-34	n	172^{a}	328^{a}		377	123		474	26		500
	%	34.4	65.6		75.4	24.6		94.8	5.2		100
35-45	n	141^{b}	393^{b}		379	155		499	35		534
	%	26.4	73.6		71.0	29.0		93.4	6.6		100
Total	**n**	**476**	**997**		**1087**	**386**		**1394**	**79**		**1473**
	%	**32.3**	**67.7**		**73.8**	**26.2**		**94.6**	**5.4**		**100**
Season											
Summer	n	255	750	*<0.001*	684	321	*0.001*	944	61	0.438	1005
	%	25.4	74.6		68.1	31.9		93.9	6.1		100
Winter	n	306	590		673	223		849	47		896
	%	34.2	65.8		75.1	24.9		94.8	5.2		100
Total	**n**	**561**	**1340**		**1357**	**544**		**1793**	**108**		**1901**
	%	**29.5**	**70.5**		**71.4**	**28.6**		**94.3**	**5.7**		**100**

Chi Square test
*a, b: There is no significant difference between variables with the same letter.

Table 5. Correlation of Vitamin D levels with age, MADGHSR and MADSD

	Age		MADGHSR*		MADSD**	
	r	***p***	**r**	***p***	**r**	***p***
Vitamin D level	0.082	0.002	0.062	0.006	0.075	0.001

Spearman's Correlations test
*MADGHSR: Monthly average daily global horizontal solar radiation, **MADSD: Monthly average daily sunshine duration

Discussion

The mean vitamin D level in this study cohort was 16.6±7.4 (range, 3.2-49.75) ng/ mL. It was also noted that in 94.4% of the participants the vitamin D level was ≤30 ng/mL whereas it was ≤20 ng/mL in 73.8% and ≤12 ng/mL in 32.3% of the participants. A study conducted in Turkey by Ogus et al. reported that 50% of the participants had a vitamin D level of ≤20 ng/mL [17]. In another study, Alagol et al. reported vitamin D deficiency in 66.6% of reproductive aged Turkish women [18]. A study from USA showed that 42% of female participants aged 15-49 years had a vitamin D level of ≤15 ng/mL at the end of winter [19]. Aydın et al. evaluated the vitamin D levels of athletes and reported that 21.6% of them had severe deficiency (<11 ng/mL), 42.7% had deficiency (11-20 ng/mL), and 19.5% had insufficiency (21-30 ng/mL) [20]. In our study, the prevalence of vitamin D deficiency and insufficiency was remarkably higher than those reported in the literature.

In our study, although the difference between the median vitamin D levels in summer and winter was low (1.8 ng/ mL), it was still statistically significant (p=0.001). Some other studies, however, have reported more differences between summer and winter for vitamin D levels. Ogus et al. examined vitamin D levels in Ankara province, Turkey, which has a continental climate, and reported a mean vitamin D level of 17.23 ng/mL for winter and a mean level of 26.26 ng/mL for summer [17]. Carnevale et al. reported that a 25(OH)D level of <12 ng/ml was detected in 17.8% and 2.2% of all participants in winter and summer, while it was detected in 27.8% and 3.4% of female participants, respectively [21]. The study also noted that the mean vitamin D level in women was 15.2±5.68 ng/mL in winter and

30.7±8.01 ng/mL in summer. In our study, seasonal variation was lower than expected when compared to those reported in other studies.

A study conducted by Oren et al. in Israel at 30-33°N latitude reported mean vitamin D levels of 21.6±8 ng/mL and 23.9±8 ng/mL for winter and summer, respectively [22]. The authors also noted that the prevalence of vitamin D insufficiency (<30 ng/mL) was 82.9% and 82.6% and vitamin D deficiency (<15ng/mL) prevalence was 21.7% for summer and 22.9% for winter. There was no significant difference between the two seasons for vitamin D levels. In contrast, the rates of severe deficiency (12 ng/mL) in our study were relatively lower (25.4% in summer and 34.2% in winter).

In our study, there was a significant difference between the two seasons for median MADGHSR and MADSD values. Additionally, vitamin D level was weakly correlated with age, MADGHSR, and MADSD. This finding does not support other studies that reported a positive correlation between vitamin D levels and sun exposure and seasonal differences [4,16,17,23,25].

It is commonly known that most of the women living in Turkey wear clothes that cover most of their body due to the weather conditions as well as their traditional lifestyles and religious preferences. Additionally, according to the latest research, 58% of Turkish women wear headscarves and this rate can reach up to 70% depending on the region [26].

Alagol *et al.* evaluated the impact of clothing on vitamin D levels and showed that clothing preferences had a significant impact on vitamin D synthesis [18]. This phenomenon could be the reason as to why we could not detect the expected effect of seasonal differences on our patients' vitamin D levels. In addition, based on this finding, it can also be assumed that although sun exposure is highly important for vitamin D synthesis, individual and other environmental factors may be more effective [4,15,22,27].

The present study was conducted on relatively young women (age of 30.6±8.3 years) and it is a common fact that vitamin D level is also important in terms of public and pregnancy health in reproductive aged women. Meaningfully, studies have found that low vitamin D levels are related with preeclampsia, gestational diabetes mellitus, pregnancy-induced hypertension, congenital heart diseases, and miscarriage [27,28,29]. Similarly, we also found a high rate of vitamin D deficiency in young women, which is a public health problem in this respect.

Because of the retrospective nature of our study, other factors such as body mass index and nutrition that could affect vitamin D synthesis could not be evaluated.

Among the limitations of this study are its retrospective design, which precluded the analysis of potential factors influencing vitamin D synthesis, such as body mass index and dietary habits. The demographic diversity of the sample is limited, given the focus on young women. While the study examined the impact of specific factors such as clothing preferences and sun exposure on vitamin D levels, other potential environmental and individual factors were not sufficiently explored. Generalizing the findings to broader and diverse populations, considering geographic, cultural, and individual variations, is challenging. Furthermore, the inability to fully ascertain the expected seasonal variations in vitamin D levels underscores the need for more comprehensive studies in this field.

Conclusion

The findings of this study indicate that geographical region, MADGHSR and MADSD values, and individual and environmental factors have a direct effect on sun exposure. It was also revealed that the regional clothing habits of our population was an important factor for low vitamin D levels. We suggest that routine optimal dose vitamin D supplementation is necessary for women that reside in similar geographical regions and have similar clothing preferences to the present study.

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ORCID and Author contribution: Ş.T. (***0000-0001-5423-7490), S.T. (0000-0002-8534-2928), H.C. (0000-0002-7837-4251), S.K. (0000-0003-2835-1745), Y.E.B.(0000-0003-2418-1793), R.Y. (0000-0002-5578-3722).*** All authors contributed to the study conception and design, material preparation, data collection. Analysis was performed and first draft of the manuscript was written by Ş.T. and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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References

1. Holick MF. Vitamin D: a D-Lightful health perspective. Nutr Rev. 2008;66(10 Suppl 2):S182-94. doi:10.1111/j.1753-4887.2008.00104.x.
2. Bouillon R, Eelen G, Verlinden L, Mathieu C, Carmeliet G, Verstuyf A. Vitamin D and cancer. J Steroid Biochem Mol Biol. 2006;102(1-5):156-62. doi:10.1016/j.jsbmb.2006.09.014.
3. Ness RA, Miller DD, Li W. The role of vitamin D in cancer prevention. Chin J Nat Med 2015;13(7):481-97. doi:10.1016/S1875-5364(15)30043-1.
4. Kriegel MA, Manson JE, Costenbader KH. Does vitamin D affect risk of developing autoimmune disease?: a systematic review. Semin Arthritis Rheum. 2011;40(6):512-31. doi: 10.1016/j.semarthrit.2010.07.009.
5. Holick MF. Sunlight and vitamin D for bone health and prevention of autoimmune diseases, cancers, and cardiovascular disease. Am J Clin Nutr. 2004;80(6 Suppl):1678–88. doi: 10.1093/ajcn/80.6.1678S.
6. Bilezikian JP, Bikle D, Hewison M, Lazaretti-Castro M, Formenti AM, Gupta A, et al. Mechanısms in endocrinology: Vitamin D and COVID-19. Eur J Endocrinol. 2020;183(5):133-47. doi: 10.1530/EJE-20-0665.
7. Ali N. Role of vitamin D in preventing of COVID-19 infection, progression and severity. J Infect Public Health. 2020;13(10):1373–80. doi:10.1016/j.jiph.2020.06.021.
8. Marwaha RK, Yenamandra VK, Sreenivas V, Sahay R, Baruah MP, Desai A, et al. Regional and seasonal variations in ultraviolet B irradiation and vitamin D synthesis in India. Osteoporos Int. 2016;27(4):1611–7. doi: 10.1007/s00198-015-3427-0.
9. Hagenau T, Vest R, Gissel TN, Poulsen CS, Erlandsen M, Mosekilde L, et al. Global vitamin D levels in relation to age, gender, skin pigmentation and latitude: An ecologic meta-regression analysis. Osteoporos Int. 2009;20(1):133-40. doi: 10.1007/s00198-008-0626-y.
10. Prentice A. Vitamin D deficiency: a global perspective. Nutr Rev. 2008;66(10 Suppl 2):S153-64. doi: 10.1111/j.1753-4887.2008.00100.x.
11. Suri M., Huld, T A, Dunlop ED, Ossenbrink HA. Potential of solar electricity generation in the European Union member states and candidate countries. Solar Energy. 2007;81(10):1295-1305. doi: 10.1016/j.solener.2006.12.007.
12. Marion W, Wilcox S. Interpreting the data tables. Solar Radiation Data Manual for Flat-Plate and Concentrating Collectors. National Renewable Energy Laboratory (NREL). 1994;3-6. Retrieved from https://www.nrel.gov/docs/legosti/old/5607.pdf Date accessed: October 20, 2022.
13. Forrest KYZ, Stuhldreher WL. Prevalence and correlates of vitamin D deficiency in US adults. Nutr Res. 2011;31(1):48–54. doi:10.1016/j.nutres.2010.12.001.
14. Liu X, Baylin A, Levy PD. Vitamin D deficiency and insufficiency among US adults: Prevalence, predictors and clinical implications. Br J Nutr. 2018;119(8):928–36. doi: 10.1017/S0007114518000491.
15. Pettifor JM, Moodley GP, Hough FS, Koch H, Chen T, Lu Z, H, et al. The effect of season and latitude on in vitro vitamin D formation by sunlight in South Africa. S Afr Med J. 1996;86(10):1270-2. PMID: 8955733.
16. Buckley AJ, Hannoun Z, Lessan N, Holick MF, Barakat MT. Environmental determinants of previtamin D synthesis in the United Arab Emirates Emirates. Dermatoendocrinology. 2017;9(1):e1267079. doi:10.1080/19381980.2016.1267079.
17. *Öğüş E, Sürer H, Kılınç AŞ, Fidancı V, Yılmaz G, Dindar N, et al. D Vitamini Düzeylerinin Aylara, Cinsiyete ve Yaşa Göre Değerlendirilmesi. Ankara Med J. 2015;15(1):1–5.* doi: 10.17098/amj.88875
18. Alagöl F, Shihadeh Y, Boztepe H, Tanakol R, Yarman S, Azizlerli H, et al. Sunlight exposure and vitamin D deficiency in Turkish women. J Endocrinol Invest. 2000;23(3):173-7. doi: 10.1007/BF03343702.
19. Nesby-O'Dell S, Scanlon KS, Cogswell ME, Gillespie C, Hollis BW, Looker AC, et al. Hypovitaminosis D prevalence and determinants among African American and white women of reproductive age: third National Health and Nutrition Examination Survey, 1988-1994. Am J Clin Nutr. 2002;76(1):187-92. doi: 10.1093/ajcn/76.1.187.
20. Aydın *CG, Dinçel YM, Arıkan Y, Taş SK, Deniz S. The effects of indoor and outdoor sports participation and seasonal changes on vitamin D levels in athletes. SAGE Open Med.* 2019;7:2050312119837480. doi: 10.1177/2050312119837480.
21. Carnevale V, Modoni S, Pileri M, Di Giorgio A, Chiodini I, Minisola S, et al. Longitudinal evaluation of vitamin D status in healthy subjects from southern Italy: Seasonal and gender differences. Osteoporos Int. 2001;12(12):1026–30. doi: 10.1007/s001980170012.
22. Oren Y, Shapira Y, Agmon-Levin N, Kivity S, Zafrir Y, Altman A, et al. Vitamin D insufficiency in a sunny environment: A demographic and seasonal analysis. Isr Med Assoc J. 2010;12(12):751–6. PMID: 21348404.
23. Engelsen O. The Relationship between Ultraviolet Radiation Exposure and Vitamin D Status. 2010;482–495.
24. Looker AC, Dawson-Hughes B, Calvo MS, Gunter EW, Sahyoun NR. Serum 25-hydroxyvitamin D status of adolescents and adults in two seasonal subpopulations from NHANES III. Bone. 2002;30(5): 771–7. doi: 10.1016/s8756-3282(02)00692-0.
25. Matsuoka LY, Wortsman J, Dannenberg MJ, Hollis BW, Z Lu MFH. Clothing prevents ultraviolet-B radiation-dependent photosynthesis of vitamin D3. J Clin Endocrinol Metab. 1992:75(4)1099–1103. doi:10.1210/jcem.75.4.1328275
26. Aslan A, Karakoyun O, Güler E, Aydin S, Gök MV, Akkurt S. Kastamonu'da yaşayan Türk kadınlarında kemik mineral yoğunluğu, osteoporoz yaygınlığı ve bölgesel risk faktörlerinin değerlendirilmesi: KASTÜRKOS çalışması Eklem Hastalik Cerrahisi. 2012;23(2):62-7. Turkish. PMID: 22765482.
27. Heyden EL, Wimalawansa SJ. Vitamin D: Effects on human reproduction, pregnancy, and fetal well-being. J Steroid Biochem Mol Biol. 2018;180:41–50. doi:10.1016/j.jsbmb.2017.12.011
28. Koster MPH, van Duijn L, Krul-Poel YHM, Laven JS, Helbing WA, Simsek S, et al. A compromised maternal vitamin D status is associated with congenital heart defects in offspring. Early Hum Dev. 2018;117:50–6. doi:10.1016/j.earlhumdev.2017.12.011
29. Fogacci S, Fogacci F, Banach M, Michos ED, Hernandez AV, Lip GYH, et al. Vitamin D supplementation and incident preeclampsia: A systematic review and meta-analysis of randomized clinical trials. Clin Nutr. 2020;39(6):1742–52. doi:10.1016/j.clnu.2019.08.015.