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RESEARCH ARTICLE

Serum 25(OH) Vitamin D Levels of Adolescent and Young Medical Students

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Abstract

Objectives: The purpose of this study was to determine vitamin D levels in adolescents and young medical students and to name factors that affect vitamin D levels.

Materials and methods: This prospective clinical study was conducted with healthy medical students aged up to 24 years. Height, weight and waist circumference were measured; body mass index (BMI) was calculated and each participant was questioned on demographic characteristics. Blood samples for Ca, P, ALP, PTH and 25(OH)D vitamin levels were drawn after an 8-hour fast. For vitamin D levels, ≥ 30 ng/mL was considered sufficient, 21-29 mg/dL insufficient and ≤ 20 ng/mL as vitamin D deficiency.

Results: Of patients in the study, 47.6% (n = 276) were female and 52.4% (n = 304) were male; the mean age was 19.2 ± 1.00 years. Only 8.8% of students (n = 51) had sufficient vitamin D levels. Some 91.2% of students had low vitamin D levels; 54.1% deficiency, 37.1% insufficiency and 14% severe vitamin D deficiency. Sex, BMI, traditional clothing, spending less time in sunny areas and physical activity status had a statistically significant relation with 25(OH)D levels.

Conclusion: Vitamin D deficiency is common in adolescents and young people. Female adolescents are especially at risk for vitamin D deficiency. Being female, traditional clothing style, being underweight, sun avoidance, lack of physical activity, smoking and alcohol use are risk factors for vitamin D deficiency. Vitamin D levels should be screened in high-risk groups and low vitamin D levels must be treated.

Keywords

Adolescent, Vitamin D deficiency, 25(OH)D

Introduction

Vitamin D has an important role in many parts of the body, it maintains serum calcium (Ca) and phosphorus (P) homeostasis and is necessary for the health of bones and muscles. It also has positive effects on the immune system. It has a protective effect against hypertension, cardiac disease, various cancers, type 1 diabetes, autoimmune and allergic diseases [1-3].

The consumption of foods that contain vitamin D and adequate sun exposure are important to prevent vitamin D deficiency. Some factors are important for the optimum vitamin D synthesis in the skin through sun exposure, such as the angle of the sunlight, duration of sun exposure, size of the exposed skin surface, sunscreen use, clothing style and air pollution [2-6]. Decreased vitamin D synthesis, insufficient consumption of vitamin D, poor absorption from the intestine (malabsorption syndromes), liver or kidney disease, certain medications (such as corticosteroids, phenytoin, phenobarbital), advanced age, obesity and extreme weakness can be considered as the main causes of vitamin D deficiency [2,3,7,8]. In addition, sedentary lifestyle and inadequate physical activity are also risk factors for vitamin D deficiency [9].

To understand the normal level of vitamin D in people, 25(OH)D levels should be checked. 25(OH)D level lower than 20 ng/mL is defined as a vitamin D deficiency, 21-29 ng/mL insufficiency and 30 to 100 ng/mL as normal vitamin D levels [2,3,10].

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The World Health Organization defines the 10-19 years age group as adolescent, 15-24 age group as youth and 10-24 age group as young people [11]. Being adolescent and young are risk factors for vitamin D deficiency and is known to be more common in females than males [12,13]. Although being adolescent and young is a risk factor for vitamin D deficiency, there are few studies on this issue in our country and abroad. More research is needed in this regard and we planned this study accordingly. Adolescents and young medical students were examined in terms of demographic characteristics and vitamin D deficiency.

Materials and Methods

This cross-sectional study was organized as clinical research and it was conducted in Istanbul Faculty of Medicine between September 1st, 2013 and October 31st, 2013. 580 medical students aged up to 24 years participated in the research. Students aged more than 24 years, who were from foreign countries and had a chronic disease or a history of drug use that could affect vitamin D levels were excluded from the study. After receiving Ethics Committee approval, we began our research and conducted the study in a single center.

After obtaining the consent of our participants, the students were given a questionnaire based on their declaration. Height, weight and waist circumference were measured and BMI was calculated. BMI levels classified as underweight (< 18, 5), normal (18, 5-24, 99), overweight (≥ 25) and obese (> 30). We asked about any chronic diseases, habits, medication use and any vitamins that could affect vitamin D levels. The students were also asked about various topics such as clothing styles, fish consumption, as well as milk and dairy products consumption. Daily Ca amounts were calculated using the United States Department of Agriculture (USDA) Nutrients Database [14]. Skin color was measured as either dark or light skin. Other markers included sunscreen use, time spent in open spaces during the day and time spent in school. The students were also asked about daily physical activity.

Ca, P, ALP measurements were made by photometry, PTH was measuered by electrochemiluminescence and 25(OH)D was measured by high-pressure liquid chromatography (HPLC).

The Number Cruncher Statistical System 2007 & Power Analysis and Sample Size 2008 Statistical Software (Utah, USA) were used for the statistical analysis. Significance was considered as $p < 0.01$ and $p < 0.05$. The statistical methods as student's t-test, Mann-Whitney *U* test, ANOVA, Welch tests, Tukey HSD, Tamhane test, Kruskal-Wallis test, Pearson's Chi-square test and Pearson's and Spearman's correlation analysis were used.

Results

Five hundred eighty students participated in the study; 47.6% (n = 276) were female and 52.4% (n = 304) were male and the mean age was 19.2 ± 1.00 years. The distribution of the defining characteristics of the patients are listed in Table 1. Low BMI (11.6%) and normal (79.0%) BMI levels were higher in the women than in the men; however the incidence of being overweight (21.7%) and obesity (3.9%) were significantly higher among the male students (p = 0.001).

Smoking and alcohol use, dark skin color, spending more than 60 minutes in sunny areas daily, physical activity and physical activity duration (> 60 min) were significantly higher in male students. The average daily Ca consumption among female students were 585 mg and were 541 mg in male students (p = 0.039). The average value of calcium consumption, sunscreen use and spending more than 5 hours at school were significantly higher among female students. The distribution of demographic characteristics are summarized in Table 2.

Based on the clothing style results, 68% of female students had an open clothing style, only 32% of female students wore traditional clothing. There was no statistically significant difference between the clothing style and other demographic characteristics (p > 0.05) (Table 3).

The mean vitamin D level was 19.27 ± 8.06 ng/mL (2.0-54.8 ng/mL). Vitamin D levels of 14% of the students (n = 81) were lower than 10 ng/mL, 54.1% (n = 313) were lower than 20 ng/mL, 37.1% (n = 215) between 21-29 ng/mL and only 8.8% (n = 51) had vitamin D levels over 30 ng/mL. The mean vitamin D level of the male students (21.70 ± 6.89 ng/mL) were significantly higher than females (16.59 ± 8.41 ng/mL) (p = 0.001). The mean Ca level was 10.03 mg/dL, P was 3.89 mg/dL, ALP was 69.6 U/L and PTH was 33.59 pg/mL. There was a negative correlation between vitamin D and PTH (r = -0.307; p = 0.001).

There was a positive relationship between vitamin D and height, weight and waist circumference (r = 0.248,

Table 1: Distribution of descriptive characteristics.

TOTAL			**Female (n = 276)**	**Male (n = 304)**	***p***
	Min-Max	Mean ± SD	Mean ± SD	Mean ± SD	
Age (year)	16.7-23.6	19.2 ± 1	19.16 ± 1.06	19.17 ± 0.91	0.867
Height (cm)	150-196	172.1 ± 8.9	165 ± 5.6	178.5 ± 6.1	0.001**
Weight (kg)	41-130	66.4 ± 13.1	57.7 ± 7.9	74.3 ± 11.8	0.001**
Waist circumference (cm)	56-130	75.8 ± 10.3	69.5 ± 6.9	81.4 ± 9.7	0.001**
BMI (kg/m^2)	14.9-37.2	22.3 ± 3.2	2.2 ± 2.7	2.3 ± 3.2	0.001**

BMI: Body mass index; SD: Standard deviation; *p < 0.05; **p < 0.01.

Table 2: Distribution of demographic characteristics.

		Total (n = 580) n (%)	Female (n = 276) n (%)	Male (n = 304) n (%)	*p*
Ca consumption	< 500 mg	288 (49.6)	122 (44.2)	166 (54.6)	0.021*
	500-1000 mg	237 (40.9)	129 (46.7)	108 (35.5)	
	> 1000 mg	55 (9.5)	25 (9.1)	30 (9.9)	
Fish consumption	None	118 (20.3)	56 (20.3)	62 (20.4)	0.579
	1-2 times a week	190 (32.8)	96 (34.8)	94 (30.9)	
	1-2 times a month	272 (46.9)	124 (44.9)	148 (48.7)	
Habit	Smoking	22 (3.8)	5 (1.8)	17 (5.6)	0.039*
	Alcohol	16 (2.8)	6 (2.2)	10 (3.3)	
	No	542 (93.4)	265 (96.0)	277 (91.1)	
Skin color	Dark	228 (39.3)	88 (31.9)	140 (46.1)	0.001**
	Light	352 (60.7)	188 (68.1)	164 (53.9)	
Use of sunscreen	Using	108 (18.6)	81 (29.3)	27 (8.9)	0.001**
	Not using	472 (81.4)	195 (70.7)	277 (91.1)	
Time spent in sunny areas during the day	< 15 min	39 (6.7)	31 (11.2)	8 (2.6)	0.001**
	15-60 min	282 (48.6)	152 (55.1)	130 (42.8)	
	60 > min	259 (44.7)	93 (33.7)	166 (54.6)	
Time spent in sunny areas during the day	< 60 min	321 (55.3)	183 (66.3)	138 (45.4)	0.001**
	> 60 min	259 (44.7)	93 (33.7)	166 (54.6)	
Doing sports	Yes	466 (80.3)	195 (70.7)	271 (89.1)	0.001**
	No	114 (19.7)	81 (29.3)	33 (10.9)	
Physical activity duration	< 15 min	41 (8.8)	24 (12.3)	14 (6.3)	0.001**
	15-60 min	312 (67)	144 (73.8)	168 (62.0)	
	> 60 min	113 (24.2)	27 (13.8)	86 (31.7)	
Physical activity duration	< 60 min	353 (75.8)	168 (86.2)	185 (68.3)	0.001**
	> 60 min	113 (24.2)	27 (13.8)	86 (31.7)	
Grade	Grade 1	300 (51.7)	137 (49.6)	163 (53.6)	0.247
	Grade 2	192 (33.1)	90 (32.6)	102 (33.6)	
	Grade 3	88 (15.2)	49 (17.8)	39 (12.8)	
Time spent in school	< 5 hours	285 (49.1)	117 (42.4)	168 (55.3)	0.002**
	> 5 hours	295 (50.9)	159 (57.6)	136 (44.7)	

Ca: Calcium; *p < 0.05; **p < 0.01.

Table 3: Evaluations of female students according to clothing style.

		Clothing Style		*P*
		Unconcealing n = 188 n (%)	Concealing n = 88 n (%)	
Age (year)	Mean ± SD	19.35 ± 1.05	18.74 ± 0.96	0.001**
Height (cm)	Mean ± SD	165.3 ± 5.6	164.4 ± 5.5	0.247
Weight (kg)	Mean ± SD	57.6 ± 7.9	57.8 ± 7.9	0.786
Waist circumference (cm)	Mean ± SD	69.1 ± 6.9	70.3 ± 6.9	0.196
BMI (kg/m²)	Mean ± SD	21.13 ± 2.69	21.38 ± 2.68	0.476
Ca consumption levels	< 500 mg	84 (44.7)	38 (43.2)	0.848
	500-1000 mg	86 (45.7)	43 (48.9)	
	> 1000 mg	18 (9.6)	7 (8.0)	
Ca consumption	Mean ± SD (mg)	588.69 ± 301.39	578.01 ± 271.34	0.761
	Median (mg)	557	557	
Fish consumption	None	37 (19.7)	19 (21.6)	0.934
	1-2 times a week	66 (35.1)	30 (34.1)	
	1-2 times a month	85 (45.2)	39 (44.3)	
Skin color	Dark	62 (33.0)	26 (29.5)	0.568
	Light	126 (67.0)	62 (70.5)	
Use of sunscreen	Using	59 (31.6)	22 (25.0)	0.266
	Not using	129 (68.6)	66 (75.0)	
Time spent in sunny areas during the day	< 15 min	21 (11.2)	10 (11.4)	0.099
	15-60 min	96 (51.1)	56 (63.6)	
	> 60 min	71 (37.8)	22 (25.0)	
Physical activity	Yes	134 (71.3)	61 (69.3)	0.739
	No	54 (28.7)	27 (30.7)	

Grade	Grade 1	81 (43.1)	56 (63.7)	0.001**
	Grade 2	64 (34.0)	26 (29.5)	
	Grade 3	43 (22.9)	6 (6.8)	

BMI: Body mass index; Ca: calcium; *p < 0.05; **p < 0.01.

Table 4: Evaluation of vitamin D levels according to demographic characteristics.

		Total Vitamin D			P
		n	Mean (ng/mL)	SD	
Ca intake	< 500 mg	288	19.05	7.98	0.482
	500-1000 mg	237	19.26	8.03	
	> 1000 mg	55	20.48	8.6	
Fish consumption	None	118	18.73	8.94	0.154
	1-2 times a week	190	20.19	8.11	
	1-2 times a month	272	18.86	7.58	
Habits	[1]Smoking	22	23.94	6.95	0.003*
	[2]Alcohol	16	23.12	5.21	1 > 3
	[3]No	542	18.13	9.73	
Habits in females; (Median)	[1]Smoking	5	25.06 (24.7)	9.82	0.016*
	[2]Alcohol	6	22.50 (21.1)	5.12	
	[3]No	265	16.29 (15.9)	8.33	
Habits in males; (Median)	[1]Smoking	17	23.62 (24.9)	6.22	0.112
	[2]Alcohol	10	23.49 (23.9)	5.5	
	[3]No	277	21.52 (20.5)	6.96	
Skin color	Dark	228	20.01	7.94	0.074
	Light	352	18.79	8.11	
Use of sunscreen	Yes	108	18.62	8.7	0.351
	No	472	19.42	7.91	
Time spent in sunny areas during the day	< 15 min	39	17.19	8.9	0.059
	15-60 min	282	18.83	8.72	
	> 60 min	259	20.06	7.06	
Time spent in sunny areas during the day	< 60 min	321	18.63	8.74	0.030*
	> 60 min	259	20.06	7.06	
Sports	Yes	466	19.65	7.91	0.021*
	No	114	17.71	8.49	
Physical activity duration	1 < 15 min	41	20.41	8.19	0.034*
	215-60 min	312	18.99	8.05	2 < 3
	3 > 60 min	113	21.19	7.24	
Physical activity duration	< 60 min		19.16	8.06	0.018*
	> 60 min	353	21.18	7.24	
		113			
Time spent in school	< 5 hours	285	19.74	8.05	0.164
	> 5 hours	295	18.81	8.05	
		N	R	P	
Time spent in school		580	-0.07	0.093	

R: Spearman correlation coefficient; SD: Standard deviation; *p < 005.

p = 0.001; r = 0.255, p = 0.001; r = 0.186, p = 0.001; r = 0.181, p = 0.001). According to BMI levels, vitamin D levels of paticipants were statistically significant (p = 0.001). Students with low BMI levels had significantly lower vitamin D levels (mean 15.05 ng/mL) than those with normal BMI (mean 19.23 ng/mL) and those who were overweight (mean 21.37 ng/mL) (p = 0.001; p = 0.001). Although the difference was not statistically significant, the obese group had lower vitamin D levels (mean 20.28 ng/mL) (p > 0.05).

Smokers had significantly higher vitamin D levels than non-smokers (p = 0.012). This difference was especially noted in the female students. The vitamin D levels of female students who did not smoke or drink alcohol were significantly lower than those who did (p = 0.038; p = 0.040). There were only 5 female students who smoked and only 6 female students who drank alcohol and all of these females had non-traditional clothing and all spent more than 60 minutes in sunny areas daily.

The vitamin D levels of students who did sports and spent more than 60 minutes to physical activity had higher vitamin D levels than other groups (p = 0.034, p = 0.018) (Table 4).

When comparing clothing, vitamin D levels of female students who preferred traditional dress (mean, 8.6 ± 9.49 ng/mL) were significantly lower when compared with students who preferred a non-traditional style of dress (mean 19.3 ± 9.49 ng/mL) (p = 0.001). The vita-

Table 5: Evaluation of the parameters affecting the levels of vitamin D with linear regression analysis.

I.	B	SE	T	P	CI 95% for β	
					LL	UL
Constant	-8.868	8.319	-1.066	0.287	-25.208	7.473
Gender (male)	3.932	0.793	4.957	0.001**	2.374	5.49
Age	0.563	0.447	1.259	0.209	-0.316	1.442
Waist circumference	-0.136	0.058	-2.332	0.020*	-0.25	-0.021
BMI	0.543	0.164	3.311	0.001**	0.221	0.865
Habit (smoking)	3.853	1.566	2.46	0.014*	0.777	6.93
Habit (alcohol)	3.016	1.817	1.66	0.097	-0.552	6.585
Skin color	0.364	0.619	0.588	0.557	-0.851	1.579
Time in sunny areas	0.634	0.621	1.022	0.307	-0.584	1.853
Physical activity	0.23	0.773	0.297	0.767	-1.289	1.749
Ca	2.548	0.763	3.341	0.001**	1.05	4.047
ALP	-0.003	0.015	-0.197	0.844	-0.032	0.026
PTH	-0.124	0.019	-6.526	0.001**	-0.162	-0.087
II.						
Constant	19.973	11.841	1.687	0.093	-3.339	43.285
Age	0.771	0.594	1.298	0.195	-0.399	1.941
Waist circumference	-0.036	0.091	-0.392	0.695	-0.215	0.144
BMI	0.248	0.15	1.65	0.1	-0.048	0.544
Habit	-2.334	0.975	-2.394	0.017**	-4.253	-0.415
Skin color	-1.084	0.871	-1.244	0.215	-2.799	0.631
Time in sunny areas	0.375	1.3	0.288	0.773	-2.186	2.935
Physical activity	0.329	0.444	0.74	0.46	-0.546	1.203
Clothing	-8.883	0.925	-9.599	0.001**	-10.705	-7.061
Ca	2.423	1.032	2.349	0.020**	0.392	4.454
ALP	-0.006	0.023	-0.275	0.783	-0.051	0.039
PTH	-0.087	0.022	-3.895	0.001**	-0.131	-0.043
III.						
Constant	27.24	3.373	8.077	0.001**	20.603	33.877
Age	-0.409	0.578	-0.708	0.479	-1.546	0.728
Waist circumference	-0.157	0.065	-2.401	0.017**	-0.286	-0.028
BMI	0.616	0.195	3.158	0.002**	0.232	0.999
Habit	-0.68	0.533	-1.275	0.203	-1.73	0.37
Skin color	0.274	0.757	0.362	0.718	-1.215	1.763
Time in sunny areas	2.27	2.398	0.947	0.345	-2.45	6.99
Physical activity	-0.631	0.613	-1.03	0.304	-1.836	0.575
Ca	0.817	0.946	0.863	0.389	-1.045	2.678
ALP	-0.006	0.018	-0.362	0.718	-0.041	0.028
PTH	-0.129	0.03	-4.276	0.001**	-0.189	-0.07

I: Linear regression analysis with all subjects; II: Analysis with female students alone; III: Analysis with male students alone; Ca: Calcium; ALP: Alkaline phosphatase; PTH: Parathyroid hormone; BMI: Body mass index; Se: Standard Error; CI: Confidence Interval; LL: Lower Limit; UL: Upper Limit; *p < 0.05; **p < 0.01.

min D levels of male students (mean 21.70 ± 6.89) were even significantly higher than the female students who choose non-traditional clothing (mean 19.3 ± 9.49 ng/mL) (p = 0.002).

Linear regression model was used to examine the effects of statistically significant variables or variables close to significance (p < 0.100) on vitamin D levels (Table 5). In the analysis of all patients, male sex was observed to cause a 3.932-fold increase in vitamin D status. It was also found that one unit increment of waist circumference caused a 0.136-fold increase in vitamin D levels and a unit increment of BMI level caused a 0.543-fold increase in vitamin D levels.

When using the linear regression analysis on female students, clothing style and habits were found to affect vitamin D levels. In particular, it was observed that traditional clothing caused an 8.883-fold decrease in vitamin D levels. With this analysis, it should be noted that smoking and alcohol habits were found to reduce levels of vitamin D 2.334 times.

Discussion

There are various views about normal levels of vitamin D, according to the Institute of Medicine, levels above 20 ng/mL are defined as vitamin D sufficiency [15]. But some authors use ≥ 30 ng/mL as the limit of sufficiency, because PTH levels did not change in these values [16,17]. In a study from the United Kingdom (UK), vitamin D insufficiency (< 20 ng/mL) was found in 35% of subjects and vitamin D levels were observed to be lower in young people aged 14-18 years than in children aged 4-8 years [18]. In Brasil, 60% of adolescents showed vitamin D insufficiency (< 30 ng/mL) [9]. In a study from the United Arab Emirates (UAE) conducted with 208 students, only three male students had normal vitamin D levels (≥ 30 ng/mL) [19]. In Iran, mean vitamin D level was found as 16.8 ± 4.7 ng/mL in 100 students aged 20-30 years; 99% of these students had 25(OH)D levels under 30 ng/mL [20]. In a study from Italy, 49.9% of adolescents had vitamin D deficiency (≤ 20 ng/mL) and 32.3% of them had vitamin D insufficiency (< 30 ng/mL) [21]. In a study conducted in the United States of America; vitamin D deficiency (≤ 15 ng/mL) was found in 24.1% of adolescents, severe vitamin D deficiency (≤ 8 ng/mL) in 4.6% and vitamin D insufficiency (≤ 20 ng/mL) in 42% of the adolescents [22]. In the present study, only 8.8% of the students had sufficient levels of vitamin D; 91.2% of the students had vitamin D insufficiency or deficiency (vitamin D deficiency in 54.1% and vitamin D insufficiency in 37.1% of the students). Additionally, severe vitamin D deficiency (< 10 ng/mL) was found in 14% of the students. Whereas the prevalence of vitamin D deficiency among healthy medical students included in our study was much higher than that found in studies from the UK, Brazil, the USA and Italy; the prevalence was lower compared with that found in studies from Iran and the UAE. The higher prevalence in Iran and UAE were found to be closely associated with concealing clothing style in these countries.

It is known that being adolescent and young are risk factors for vitamin D insuffiency and that is more common among females than males [12,13]. Likewise, vitamin D levels were lower in female students in UAE and Iran studies [19,20]. Similarly, we also found that vitamin D levels were significantly lower in female students. Altough the rate of being underweight, use of sunscreen and time spent in school were higher among female students; the time spent in sunny areas, rate of physical activity and being dark skinned were lower among female students when compared with males. 32% of the female students preferred a full concealing clothing style. Although the levels of vitamin D were significantly lower in women who preferred concealing clothing style when compared with the others, also vitamin D levels were found lower in female students who preferred non-concealing clothing style when compared with male students. In a regression analysis that was performed while keeping other variables constant, we found that female sex was a risk factor for vitamin D deficiency, which is further increased by chosing a concealing clothing style.

It is known that adolescents have lower vitamin D levels when compared with children [12]. In our study we found a negative correlation between age and vitamin D level, although this did not reach statistical significance.

Obese individuals have lower vitamin D levels, because vitamin D is scattered and stored in the adipose tissue. Furthermore, vitamin D levels are increased in these children when they loss weight [7,23]. In USA elevated BMI was found to be a risk factor for vitamin D deficiency [22]. At the same time, it has been underlined that vitamin D levels are low also in anorexia nervosa as in obesity, being underweight also poses a risk for vitamin D deficiency [24]. Correlation analysis in the present study yielded that vitamin D levels increased along with waist circumference. But linear regression analysis revealed that the increase in waist circumference was found to be a risk factor for low vitamin D levels. It was observed in the correlation analysis that vitamin D levels increased with the increase in weight and BMI and the regression analysis supported this positive correlation. When BMI levels were classified, vitamin D levels were found to be significantly lower in underweight participants than in normal and overweight paticipants and the highest vitamin D levels were found in the overweight group. Although not statistically significant, vitamin D values were higher in the obese group than in the normal and underweight groups. However, this finding might be attributable to the fact that our study included only 14 obese students. In our study, being underweight rather than obese was found to be a risk factor for vitamin D deficiency. Low levels of vitamin D in these underweight young people might be the result of their poor nutritional habits. Adequate nutrition is necessary for development of the bony structure and resistance to mechanical stress. Therefore, malnutrition should be corrected and vitamin D supplementation should be administered to underweight young people.

Vitamin D is plentiful in several fish and small amounts in milk and dairy products. However, no food products contain enough vitamin D to meet the daily requirement [2,3]. In USA, most milk and dairy products are fortified with vitamin D, in our country vitamin D fortification is found in a limited number of these products. It was determined in the Brazil study that adolescents were not consuming food such as milk and fish in adequate amounts and only 14% were taking 200 IU/day vitamin D on their diet [9]. In our study, fish consumption was very low with only 32% of the students consuming fish 1-2 times a week. When the amounts of daily Ca intake with milk and dairy products was calculated, only 55 of the 580 students consumed the recommended daily Ca intake (> 1000 mg), the daily Ca consumption was under 500 mg in 288 students. Adolescence is a crucial period for structuring and re-structuring processes of bones. 40-60% of peak bone mass that comprises the bony tissue throughout life is gained in this period. The risk for osteoporosis and fracture increases if optimal peak bone mass can't be reached. Low Ca consumption and high BMI in healthy adolescents increases the risk for fractures. Sufficiency of nutritional content and lifestyle are important for bone health. Bone mass increases with the peak in growth in this period, thus increasing the need for vitamin D and Ca. Optimal bone gain in this period has long-term effects in prevention of osteoporosis. Ca is stored for life during puberty. Therefore, the amount of Ca taken in this period is an important determinant of peak bone mass [25,26]. As a result, encouraging consumption of natural food sources and fortification of foods with vitamin D or supplementation with vitamin D preparations becomes important. In the present study, nutritional habits and levels of vitamin D in adolescents were found insufficient for healthy bone mass. Therefore, it is important for young persons to form balanced nutritional habits and to be informed about this topic for their future bone health. Alcohol consumption and smoking also influence bone health. When chronically consumed in high amounts, alcohol is toxic for osteoblasts and may impair bone formation. Smoking causes bone resorption by disrupting Ca and vitamin D metabolism [25]. In our study when all participants were analyzed smoking and alcohol habits were seemed to be an advantage for optimum vitamin D levels. When it was analazyed in only male students there wasn't a statistical significance, but in female students it showed significance. It was found that the difference resulted from the female students because all of the female students who smoked and used alcohol were those who preferred non-concealing clothing and spent more than 60 minutes in sunny areas during the day; the regression analysis among the females showed that smoking and alcohol habits actually negatively affected vitamin D levels. In our study, only 22 students smoked and 16 students used alcohol; 542 students had neither of these habits.

The main source of vitamin D is sunlight. Everthing effecting to take benefit from sunlight also influence the level of vitamin D. Melanin competes with provitamin D3 for sunlight; therefore, dark-skinned people must be exposed to sunlight for longer periods of time. In a study conducted in Boston, the levels of vitamin D were lower in the African Americans than the light-skinned people [6]. When in the present study skin color was classified as dark and light, no statistical significance was observed between skin color and vitamin D levels. However, dark-skinned participants in our study were infact wheat-skinned and there were no black students included in the study. In a study from Austria, the rate of outdoor activity was significantly lower in participants with vitamin D deficiency [27]. Also in Italy the prevalence of vitamin D deficiency was higher in people who were doing outdoor activity for less than 3 hours a week [21]. It was found in our study that spending less time in sunny areas was a risk factor for vitamin D deficiency, whereas spending at least 1 hour in sunny areas during the day was important in terms of vitamin D levels. The level of vitamin D was lower in students who used sunscreen compared with those not using, although the difference was not statistically significant.

Adolescence is a critical period for bone mineral gain when 90% of bone mass is achieved. The most important factors for peak bone mass include vitamin D, genetics, physical activity and diet [25,26]. In the Brazilian study, vitamin D levels were higher among adolescents who had moderate to heavy physical activity compared with those who preferred a sedentary life [9]. In our study the levels of vitamin D were higher in students who took part in physical activity compared with those who did not.

Although the production of vitamin D varies according to seasons, latitude and skin pigmentation; legs and arms should be exposed to sunlight for 5 to 30 minutes between 10:00 AM and 03:00 PM twice a week for sufficient production of vitamin D. The European Society of Pediatric Endocrinology states this duration as 2 hours a week when fully dressed but hatless [28]. Whole body exposure to 1 minimal erythemal dose causes an increase in the serum level of cholecalciferol, which is equivalent to a 10000-20000 IU dose of vitamin D [2,29]. In a study conducted in Turkey 89 female students aged 13-17 years were examined for vitamin D deficiency. The authors concluded that vitamin D deficiency was found in 70% and insufficiency in 30% of the female students who preferred a concealing clothing style [30]. In a study conducted in Lebanon, healthy children and adolescents were screened for vitamin D deficiency. The level of vitamin D was found to be significantly lower in female students than in male students and attributed to female students preferring a concealing clothing style [31]. In the evaluation made according to clothing style, 93.1% of female students with concealing clothing had vitamin D deficiency and their level of vitamin D was considerably lower compared with female students who chose non-concealing clothing style. It was also found in the regression analysis that concealing clothing style cause 8.883-fold decrease in vitamin D levels and the analysis showed that parameter the most affected the level of vitamin D was concealing clothing style. It was concluded in our study that concealing clothing style prevents benefit from sunlight and this is an important factor for vitamin D deficiency. Screening young people who prefer this clothing style for vitamin D levels and providing them supplementation is of paramount importance for their future bone health.

Conclusion and Recommendations

Vitamin D deficiency is common in adolescence and youth. Female adolescents in particular are at higher risk for vitamin D deficiency. Additionally, being underweight is also risk factor for vitamin D deficiency. Therefore, malnutrition should be corrected and vitamin D supplementation should be administered in underweight young people. Fish and milk intake of students during youth is insufficient and daily amount of Ca they consume does not meet the recommended daily amount. As a result, encouraging consumption of natural foods and fortification of foods with vitamin D or supplementation with vitamin D preparations become important. Vitamin D level increases with the amount of sunbathing. Spending more than 60 minutes in sunny areas during the day is necessary for sufficient levels of vitamin D. Sport and sparing more than 60 minutes per day for physical activities are also important for sufficient levels of vitamin D. Concealing clothing style is an important risk factor for severe vitamin D deficiency. Screening young people who wear concealing clothing for vitamin D levels and providing them supplementation is of paramount importance and necessary for their future bone health.

Disclosure Statement

The authors have nothing to disclose.

References

1. Cannell JJ, Hollis BW, Zasloff M, Heaney RP (2008) Diagnosis and treatment of vitamin D deficiency. Expert Opin Pharmacother 9: 107-118.
2. Holick MF (2007) Vitamin D deficiency. N Engl J Med 357: 266-281.
3. Holick MF (2006) High prevalence of vitamin D inadequacy and implications for health. Mayo Clin Proc 81: 353-373.
4. Webb AR, Kline L, Holick MF (1988) Influence of season and latitude on the cutaneous synthesis of vitamin D3; exposure to winter sunlight in Boston and Edmonton will not promote vitamin D3 synthesis in human skin. J Clin Endocrinol Metab 67: 373-378.
5. Agarwal KS, Mughal MZ, Upadhyay P, Berry JL, Mawer EB, et al. (2002) The impact of atmospheric population on vitamin D status of infants and toddlers in Delhi, India. Arch Dis Child 87: 111-113.
6. Harris SS, Dawson-Hughes B (1998) Seasonal changes in plasma 25-hydroxyvitamin D concentrations of young American black and white women. Am J Clin Nutr 67: 1232-1236.
7. Wortsman J, Matsuoka LY, Chen TC, Lu Z, Holick MF (2000) Decreased bioavailability of vitamin D in obesity. Am J Clin Nutr 72: 690-693.
8. Gatti D, El Ghoch M, Viapiana O, Ruocco A, Chignola E, et al. (2015) Strong relationship between vitamin D status and bone mineral density in anorexia nervosa. Bone 78: 212-215.
9. Peters BS, dosSantos LC, Fisberg M, Wood RJ, Martini LA (2009) Prevalence of vitamin D insufficiency in Brazilian adolescents. Ann Nutr Metab 54: 15-21.
10. Holick MF, Binkley NC, Bischoff-Ferrari HA, Gordon CM, Hanley DA, et al. (2011) Evaluation, treatment and prevention of vitamin D deficiency: an Endocrine society clinical practice guideline. J Clin Endocrinol Metab 96: 1911-1930.
11. http://www.euro.who.int/document/e81703.pdf
12. Moore C, Murphy MM, Keast DR, Holick MF (2004) Vitamin D intake in the United States. J Am Diet Assoc 104: 980-983.
13. Rockell JE, Green TJ, Skeaff CM, Whiting SJ, Taylor RW, et al. (2005) Season and ethnicity are determinants of serum 25-hydroxyvitamin D concentrations in New Zealand children aged 5-14 y. J Nutr 135: 2602-2608.
14. (2014) U.S. Department of Agriculture, Nutrient Data Laboratory.
15. (2014) Institute of Medicine, Food and Nutrition Board. Dietary reference intakes for calcium and vitamin D. National Academy Press, Washington, DC.
16. Chapuy MC, Preziosi P, Maamer M, Arnaud S, Galan P, et al. (1997) Prevalence of vitamin D insufficiency in an adult normal population. Osteoporos Int 7: 439-443.
17. Thacher TD, Clarke BL (2011) Vitamin D insufficiency. Mayo Clin Proc 86: 50-60.
18. Absoud M, Cummins C, Lim MJ, Wassmer E, Shaw N (2011) Prevalence and predictors of vitamin D insufficiency in children: a Great Britain population based study. PLoS One 6: e22179.
19. Al Anouti F, Thomas J, AbdelWareth L, Rajah J, Grant WB, et al. (2011) Vitamin D deficiency and sun avoidance among university students at Abu Dhabi, United Arab Emirates. Dermatoendocrinol 3: 235-239.
20. Zabihiyeganeh M, Jahed SA, Sarami S, Nojomi M (2014) Hypovitaminosis D: are medical students at risk? Int J Prev Med 5: 1161-1168.
21. Vierucci F, Del Pistoia M, Fanos M, Erba P, Saggese G (2014) Prevalence of hypovitaminosis D and predictors of vitamin D status in Italian healthy adolescents. Ital J Pediatr 40: 54.
22. Gordon CM, DePeter KC, Feldman HA, Grace E, Emans SJ (2014) Prevalence of vitamin D deficiency among healthy adolescents. Arch Pediatr Adolesc Med 158: 531-537.
23. Daniel D, Hardigan P, Bray N, Penzell D, Savu C (2015) The incidence of vitamin D deficiency in the obese: a retrospective chart review. J Community Hosp Intern Med Perspect 5: 26069.
24. Watanabe D, Hotta M, Ichihara A (2015) Osteomalacia, severe thoracic deformities and respiratory failure in a young woman with anorexia nervosa. Intern Med 54: 929-934.
25. Henwood MJ, Binkovitz L (2009) Update on pediatric bone health. J Am Osteopath Assoc 109: 5-12.
26. Bachrach LK (2000) Making an impact on pediatric bone health. J Pediatr 136: 137-139.
27. Kaehler ST, Baumgartner H, Jeske M, Anliker M, Schennach H, et al. (2012) Prevalence of hypovitaminosis D and folate deficiency in healthy young female Austrian students in a health care profession. Eur J Nutr 51: 1021-1031.
28. Hochberg Z, Bereket A, Davenport M, Delemarre-Van de Waal HA, De Schepper J, et al. (2002) European Society for Paediatric Endocrinology (ESPE) Bone Club. Consensus development for the supplementation of vitamin D in childhood and adolescence. Horm Res 58: 39-51.
29. http://www.cdc.gov/nccdphp/dnpa/nutrition/
30. Hatun S, Islam O, Cizmecioglu F, Kara B, Babaoglu K, et al. (2005) Subclinical vitamin D deficiency is increased in adolescent females who wear concealing clothing. J Nutr 135: 218-222.
31. El-Hajj Fuleihan G, Nabulsi M, Choucair M, Salamoun M, Hajj Shahine C, et al. (2001) Hypovitaminosis D in healthy schoolchildren. Pediatrics 107: E53.