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The Prevalence of Vitamin D Deficiency in Children, Adolescents and Adults in a Sample of Turkish Population

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ABSTRACT Researchers have determined the prevalence of deficiency and insufficiency of vitamin D levels in a sample of Turkish children, adolescents and adults. This study retrospectively reviewed the record of a total of 803 children, adolescents and adults aged between 0 and 89 years. This study was conducted with 596 females (74.2%) and 207 males (25.8%). Subjects' ages ranged from 0 to 89. Vitamin D values ranged from 3 ng/mL to 222.9 ng/mL with a mean value of 21.0 ±20.7. Vitamin D values were below 10 ng/mL in 28.5 per cent (n=229), between 10 to 24 ng/mL in 43 percent (n=345), between 24.1 to 80 ng/mL in 26.7 percent (n=214) and more than 80 ng/mL in 1.9 percent (n=15) of subjects. Hypovitaminosis D prevalence as to age, gender and seasons showed a similar parallel rate with the literature.

INTRODUCTION

Vitamin D plays an essential role in calcium homeostasis and mineralization. Vitamin D deficiency causes rickets in children, exacerbates osteopenia and osteoporosis in adults. It may help to prevent type 1 diabetes mellitus, hypertension and many cancers and also has an immunomodulatory role implicated in both viral, bacterial diseases and in mycobacterium tuberculosis infection (Dyson et al. 2014; Hollick et al. 2008; Hollick 2006).Vitamin D deficiency appears to be common worldwide (Gebreegziabner et al. 2013; Alhamad et al. 2014; Reusch et al. 2009; Diennane et al. 2014). Rickets has reemerged due to vitamin D deficiency over the last years in spite awareness, sun exposure, reinforcement policies and prescription of supplements. The way of clothing and living, and doctors' advice not to expose oneself to the Sun due to the risk of developing skin cancer is likely to prompt people to stay away from useful sunrays. Adding vitamin D to food to increase its nutritive value has been proven to be insufficient to compensate for the deficiency unless there is enough exposure to sunshine. Formally individuals without adequate sun exposure, with unsufficient daily dietary intake or impaired oral absorbtion are prescribed supplementation. (Hollick et al. 2008; Misra et al. 2008).

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Deficiency of vitamin D prevalence was 36 percent in healthy adults in the USA. This rate was higher in Europe. Among general medicine patients inadequacy of vitamin D was 57 percent (Hollick 2006). In Turkey, its exact prevalence is unknown. We can only extrapolate from scarce and small sample studies. In one study its prevalence was reported as 25 percent for deficiency and 15 percent for insufficiency in a group of 440 children and adolescents (Andiran et al. 2012). In another study done in Turkey its prevalence (deficiency) was reported as 51.8 percent in 18-70 age group (Uçar et al. 2012).

The study seeks to find out how prevalent the deficiency and insufficiency of vitamin

D in Turkish children, adolescents and grownups to examine the factors associated with low vitamin D. It aims to investigate the association of Vitamin D deficiency with age, sex, seasonal variations.

METHODOLOGY

This retrospective study included 803 subjects of all ages who applied for various reasons to Kagithane State Hospital Between January 7, 2013 and December 24, 2013 to assess vitamin D levels. Measurement of a serum 25 (OH) D concentration is the best way to determine vitamin D levels. While the half life of active 1.25 Dihidroxy vitamin D is 4-5 hours, the half life of 25(OH) D is 2 to 3 days In order to appraise the results the study population were assigned into groups depending on their vitamin D level. The vitamin D level groups were as follows: severe deficiency (<10 ng/mL),mild to moderate deficiency(10-24 ng/mL)optimal level (25-80 ng/mL) and possible toxicity level(>80 ng/mL) (Table 1) (Kennal et al. 2010) The age groups were as follows: pre-school (<5 years)middle childhood (5-10) adolescent (10-20),adults (20-40) older adults (>40 years) The patients with chronic diseases were ruled out from the study. All patients underwent measurement of venous blood 25(OH) D levels from antecubital areas, between 8 and 8.[30] a.m using liquid chromotography (Spektra 2000Sr).

Table 1: Mayo medical laboratories reference ranges for total serum 25 hydroxyvitamin D [25(OH) D]'

Severe deficiency level	<10 ng/mL
Mild to moderate deficiency level	10-24 ng/mL
Optimal level	25-80 ng/mL
Possible toxicity level	>80 ng/mL

Statistical Analysis

CSS (Number Cruncher Statistical System) 2007 and PASS (Power Analysis and Sample Size) 2008 Statistical Software (Utah, USA) were used for statistical analysis. To analyze the study data researchers used Pearson Chi-square test(χ^2), Fisher-Freeman-Halton exact test besides statistically defining parameters such as; mean standard deviation frequency, ratio, minimum, maximum.

Table 2: Distribution of defining characteristics of study

		Min-Max	*Mean±SD*
Age		0-89	29.1±21.0
Vit D		3.0-222.9	21.0±20.7
		n	*%*
Age	0-5	124	15.4
	6-10	68	8.5
	11-20	129	16.1
	21-40	244	30.4
	>41	238	29.6
Gender	Female	596	74.2
	Male	207	25.8
Season	Winter	213	26.5
	Spring	226	28.1
	Summer	254	31.6
	Fall	110	13.7
Vit D	<10	229	28.5
	10-24	345	43.0
	24.1-80	214	26.7
	>80	15	1.9

RESULTS

The researchers re-examined retrospectively the recordings of 803 children, adolescents and adults (0 to 89 years old). This study was conducted with 596 female (74.2%) and 207 male (25.8%) subjects. Subjects' ages ranged from 0 to 89 with a mean value of 29.1 ±21.0 years. Vitamin D values ranged from 3 ng/mL to 222.9 with a mean value of 21.05 ±20.7 vitamin D values were below 10 in 28.5 percent (n=229), between 10 to 24 in 43 percent (n=345), between 24.1 to 80 in 26.7 percent (n=214 and more than 80 ng/mL in 1.9 percent n=15) of subjects (Table 2).

Percentage distribution of age was 15.4 percent (n=124) for 0 to 5 years, 8.5 percent (n=68) for 6 to 10 years, 16.1 percent (n=129) for 11 to 20 years, 30.4 percent (n=244) for 21 to 40 years

Table 3: Evaluation of vitamin D values according to age

		Age					
		0-5	*6-10*	*11-20*	*21-40*	*>41*	
Vit D	Min-Max	4.0-193.0	4.7-80.5	4.0-130.4	4.0-222.9	3.0-180.4	
	Mean±SD	30.2±22.1	20.1±10.2	17.6±16.9	17.1±19.3	22.1±23.7	
		n (%)	*n (%)*	*n (%)*	*n (%)*	*n (%)*	*P*
Vit D	<10	4 (3.2%)	7 (10.2%)	44 (34.0%)	99 (40.6%)	75 (31.5%)	0.001**
	10-24	46 (37.1%)	42 (61.8%)	65 (50.4%)	103 (42.2%)	89 (%37.4)	
	24.1-80	72 (58.1%)	18 (26.5%)	18 (14.0%)	39 (16.0%)	67 (28.2%)	
	>80	2 (1.6%)	1 (1.5%)	2 (1.6%)	3 (1.2%)	7 (2.9%)	

Fisher-Freeman-Halton exact test $^{**}p<0.01$

and 29.6 per cent (n=238) for 41 years plus older age group.

Seasonal distribution of patients admitted to hospital were 213 in winter, 226 in spring, 110 in fall and 254 in summer (Table 2). Severe vitamin D deficiency (<10 ng/mL) in 21-40 age group was significantly higher than all other age groups. Vitamin D deficiency (10-24 ng/mL) was significantly higher in 6-10 and 11-20 age groups in comparison to all other groups. Vitamin D levels (25-80 ng/mL) were better in 0-5 age group in comparison to other groups (Table 3).

An important difference was present in the values of vitamin D between genders favouring males. A higher percentage of females showed severe vitamin D deficiency (Table 4).

Table 4: Distribution of vitamin D levels according to gender

			Gender		
			Female	*Male*	
Vit D	Min-Max		3.0-222.9	4.0-130.4	
	Mean±SD		20.4±22.3	22.5±15.1	
		n (%)	*n (%)*		*p*
Vit D	<10	199 (33.4%)	30 (14.5%)		*0.001***
	10-24	241 (40.4%)	104 (50.2%)		
	24.1-80	143 (24.0%)	71 (34.3%)		
	>80	13 (2.2%)	2 (1.0%)		

Pearson Chi-square test $^{**}p<0.01$

Distribution of vitamin D values showed a statistically significant change with seasons. Values showed a significant rise in the fall .Values in the fall was significantly higher than all other seasons (Table 5).

Table 6 shows seasonal variation of vitamin D values in different age groups. With respect to vitamin D values there was no a statistically significant difference among all age groups in fall.

Researchers encountered a high vitamin D deficiency in older than 6 year age group probably reflecting vitamin D supplementation policy by health authorities under 6 year age group.

DISCUSSION

Vitamin D is deficiency is now accepted both as a pandemic illness (Hollick 2006) and a public health problem worldwide. It is a problem both in developed and undeveloped countries from east to west and south to north. A study that was performed in five Chinese cities on 2173 subjects showed a sufficiency rate of 5.4 percent for vitamin D (Yu et al. 2015). A Pakistani study on 858 healthy subjects in a low income district showed a 58.4 percent deficiency rate (Mehboobali et al. 2015).

A wide variety of factors affect the amount of UVB reaching the skin and its effectivity (Kennel et al. 2010). Some studies show that female gender, season and concealing clothing were predictors of vitamin D deficiency (Hollick et al. 2008; Misra et al.2008; Sayed et al. 2014).

The study showed that the general prevalence of severe vitamin D deficiency was 28.5 percent (25 (0H) D3 <10 ng/ml) and deficiency was 43.0 percent (25 (0H) D3 10-24 ng/ml).

A German study demonstrated that vitamin D deficiency seemed to be present during the months with less sunlight and severe vitamin D deficiency was seen in 30 percent of the people overall, regardless of gender. Vitamin D deficiency existed in 25 percent of adolescent and young adult age groups. An undersupply of vitamin D was evident in all age groups in this study (Kramer et al. 2014).

Table 5: Evaluation of vitamin D values according to seasons

		Winter	*Spring*	*Fall*	*Summer*	
Vit D	*Min-Max*	3.9-222.9	4.0-180.4	4.0-193.0	3.0-122.7	
	Mean±SD	21.9±26.1	19.5±19.1	26.8±25.1	19.0±13.1	
		n (%)	*n (%)*	*n (%)*	*n (%)*	*p*
Vit D	<10	72 (33.8%)	72 (31.8%)	13 (11.8%)	72 (28.3%)	*0.001***
	10-24	83 (39.0%)	97 (42.9%)	46 (41.8%)	119 (46.9%)	
	24.1-80	51 (23.9%)	53 (23.5%)	48 (43.7%)	62 (24.4%)	
	>80	7 (3.3%)	4 (1.8%)	3 (2.7%)	1 (0.4%)	

Fisher-Freeman-Halton exact test $^{**}p<0.01$

Table 6: Seasonal variation of vitamin D levels in age groups

	Vit D	*Age*					
		0-5 n (%)	*6-10 n (%)*	*11-20 n (%)*	*21-40 n (%)*	*>41 n (%)*	*P*
Winter	<10	2 (9.5%)	2 (12.5%)	13 (40.6%)	30 (44.1%)	25 (32.9%)	*0.001***
	10-24	6 (28.6%)	11 (68.8%)	17 (53.1%)	23 (33.8%)	26 (34.2%)	
	24.1-80	13 (61.9%)	3 (18.8%)	1 (3.1%)	13 (19.1%)	21 (27.6%)	
	>80	0 (0%)	0 (0%)	1 (3.1%)	2 (2.9%)	4 (5.3%)	
Spring	<10	2 (3.9%)	4 (13.8%)	12 (32.4%)	27 (52.9%)	27 (46.6%)	*0.001***
	10-24	20 (39.2%)	19 (65.5%)	24 (64.9%)	17 (33.3%)	17 (29.3%)	
	24.1-80	29 (56.9%)	5 (17.2%)	0 (0%)	6 (11.8%)	13 (22.4%)	
	>80	0 (0%)	1 (3.4%)	1 (2.7%)	1 (2.0%)	1 (1.7%)	
Fall	<10	0 (0%)	0 (0%)	2 (16.7%)	6 (23.1%)	5 (11.4%)	*0.081*
	10-24	5 (25.0%)	3 (37.5%)	4 (33.3%)	10 (38.5%)	24 (54.5%)	
	24.1-80	13 (65.0%)	5 (62.5%)	6 (50.0%)	10 (38.5%)	14 (31.8%)	
	>80	2 (10.0%)	0 (0%)	0 (0%)	0 (0%)	1 (2.3%)	
Summer	<10	0 (0%)	1 (6.7%)	17 (35.4%)	36 (36.4%)	18 (30.0%)	*0.001***
	10-24	15 (46.9%)	9 (60.0%)	20 (41.7%)	53 (53.5%)	22 (36.7%)	
	24.1-80	17 (53.1%)	5 (33.3%)	11 (22.9%)	10 (10.1%)	19 (31.7%)	
	>80	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (1.7%)	

Fisher-Freeman-Halton exact test $^{**}p<0.01$

This study has 3 important findings: firstly, the highest prevalence for severe vitamin D deficiency was found in 21-40 age groups. Age group 0-5 has the highest vitamin D levels probably related to preventive measures conducted by public health authorities. Similar results were found with higher vitamin D levels in 0-5 year age group in another study (Andiran et al. 2012). In Brittany prevalence of vitamin D deficiency in children aged 5-10 years was 51.6 percent but it was a mere 8.8 percent in the group aged 0-18 months (Beuzit et al. 2015).

Secondly, researchers found severe vitamin D deficiency in a higher percentage in females than males of all ages. A Syrian study carried out in adults also showed that vitamin D deficiency was higher in females than in males (Sayed et al. 2014). In another study perfomed in Lebanon, no difference was noted in vitamin D levels according to gender (Gannage et al. 2014). Contradictory results as to gender difference between Lebanon study and Syrian study probably originates from clothing habits.

Thirdly, the researchers found that vitamin D levels increased in summer and peaked in fall. In Syrian study season influenced vitamin D status in men but not in women (Sayed et al. 2014).

In northern latitude locations 40.6 percent of the population had levels of less than 20 ng/mL and 12.2 percent of the population had levels of less than 10 ng/mL during winter (Kennal et al. 2010). Hence, it must be kept in mind that geographic location and seasons have an effect on vitamin D levels and that alteration in sun exposure may result in changes in vitamin D level of a person regardless of diet. A study performed on prison inmates showed relationship between 25 (OH) D levels and the seasons with higher vitamin D levels seen in summer and even higher in the fall (Nwosu et al. 2014). But a study in Ethiopia showed that insufficient vitamin D posed an acute problem in individuals in the study and that the places where people live did not matter (Gebreegziabner et al. 2013).

This is the first combined study including both children and adults in Turkey with respect to vitamin D levels and related parameters such as gender, season and age. Prevalence of vitamin D deficiency was high in Turkey as in the World. Active form of vitamin D is acquired cutaneously through exposure to UVB radiation in the form of sunlight but the most important factor is inadequate intake (Kennal et al. 2010). As is noted in the literature, factors, including latitude, traditional way of clothing, seasons, use of sunscreens to avoid sun, can interfere with vitamin D production. Hypovitaminosis D caused by not being exposed to sun, is not readily compensated by vitamin intake per se in the absence of supplements.

There is an interplay between sun exposure and dietary intake in terms of vitamin D levels. Both factors seem important for adequate levels .Vitamin D sources are scarce so foods must be fortified with vitamin D to ensure adequate levels. Transference of vitamin D hypovitaminosis to older ages probably stemming from public health measures promoting supplemental vitamin D administration in 0-5 age group emphasizes the importance of vitamin D intake. Despite fortification of foods and social welfare the high prevalence of vitamin D deficiency in developed countries and also its high prevalence in tropics makes us think of other causes of vitamin D deficiency.

CONCLUSION

Vitamin D Supplementation protocols, fortification of foods are being utilized almost in all countries. But many researchers report an increased prevalence of vitamin D worldwide. We are protecting ourselves from useful rays of sun and in northern latitudes sun rays are limited. But other factors may be operative. The culprit doesn't seem to be solely inadequate intake of vitamin D but probably there may be a problem in the absorption of this vital element. Researchers encountered vitamin D deficiency in all four seasons probably reflecting veiled clothing habits in Turkey. But the low prevalence of vitamin D deficiency in 0-5 age group shows the success of supplementation efforts of public health authorities. This also proves the efficacy of vitamin D supplementation and vitamin D fortification of foods in preventing its deficiency in all age groups. This deficiency is not confined to childhood but is prevalent in all ages.To reduce vitamin D deficiency this efforts should be carried into older age groups. At present two factors seem important from the viewpoint of this deficiency; dietary intake and sun exposure. This two factors must coexist to sustain adequate levels.

RECOMMENDATIONS

Vitamin D deficiency is a serious problem at any age with considerable implications for human health. If we take into consideration the high prevalence of vitamin D in any age group of the population, its level should be checked in all age groups and precautions must be taken against this malady. Increasing the dietary intake of vitamin D musn't be the sole solution but the affect of sun rays in the activation of this vitamin should be seriously taken into consideration. A new factor related to the absorbtion of Vitamin D perhaps an altered intestinal flora may become pertinent to the vitamin deficiency discussion in near future.

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