Vitamin D and Linear Growth in a Sample of Egyptian Adolescents

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ABSTRACT

Background: Vitamin D deficiency is a common health problem worldwide. Decreased appreciation of the importance of sun exposure to provide children and adults with vitamin D requirement led to a pandemic of vitamin D deficiency. Vitamin D deficiency may exert a negative influence on bone development causing not only rickets, but also interfering with achieving genetically programmed height. **Objective:** To assess vitamin D status among healthy Egyptian adolescents and its relation to height percentile. **Patients and Methods:** Our study was conducted on 180 healthy adolescent males and females aged 10-19 years. Exclusion criteria included subjects with chronic systemic diseases and those with height that is 2 standard deviation (SD) below the mean age. All participants were subjected to detailed history including sun exposure, dietary pattern, socioeconomic status, physical and anthropometric evaluation, laboratory investigations including: hemoglobin concentration, serum creatinine, serum albumin, corrected serum total calcium, serum phosphorus and serum 25 hydroxy-vitamin D level. **Results:** The prevalence of vitamin D deficiency was 142 out of 180 (78.9 %) which was significantly higher among females. On comparing vitamin D status groups as regard stature for age percentile we found ***non-significant*** statistical difference **(*p*=0.394)**, however there was a positive significant correlation between vitamin D level and stature for age percentile (p=0.019).

Conclusion: Subclinical vitamin D insufficiency and deficiency are common problems in apparently healthy Egyptian adolescents with negative impact on height percentile.

Keywords: Vitamin D, Linear Growth, Egyptian Adolescents.

INTRODUCTION

Vitamin D deficiency is a common health problem among the world [(1)] which is present in many continents and affecting all ages, sexes and races [(2)]**.** It is estimated that more than billion people are vitamin D deficient or insufficient all over the world [(3)]**.**

High percent of vitamin D insufficiency in healthy adolescents and children was reported worldwide in the past few years. Studies in India found that 95% of apparently healthy adolescents were vitamin D deficient. Other studies reported different prevalence of vitamin D deficiency as 59.4% in Turkey, 42.5% in Beijing, 47% in Greece and 78% in France [(4)]**.**

In spite of the abundance of sunshine in the Middle East allowing vitamin D synthesis all the year, the region shows some of the lowest levels of vitamin D and the highest levels of hypovitaminosis D all over the world. Several studies in Jordan, Lebanon, Iran, Saudi Arabia, United Arab Emirates and Qatar showed that 30-75% of healthy children and adolescents have vitamin D deficiency [(5)]**.**

In a recent study conducted on 90 healthy Egyptian adults aged 20-60 years, the prevalence of vitamin D deficiency with level of 25 hydroxy (OH) vitamin D <20 ng/ml was 77%, while prevalence of vitamin D insufficiency with level of 25(OH) vitamin D between 20-29 ng/ml was 20% [(6)]**.** However the status of vitamin D among adolescents in Egypt and its relation to growth has not been addressed yet.

Vitamin D deficiency during stages of growth may exert a negative influence on bone development, resulting in not only rickets, but also affecting attainment of genetically programmed height [(7)]. So, we aim in our study to assess the status of vitamin D among healthy adolescents (age 10-19 years) in Egypt and its relation to height percentile in both genders.

MATERIALS AND METHODS

A cross-sectional study was conducted during winter and spring in the period from January 2017 to May 2017 in Cairo, Egypt. The average UV index during January is about 4 and during May is about 12. It included 180 healthy adolescent males (n=84) and females (n=96) aged 10-19 years, randomly selected from Ain Shams University Hospital outpatients with minor intercurrent illness or companions of inpatients were invited to participate in the study after explaining the objective of the study.

Ethical approval:

The study was accepted by the local Ethical Committee of Ain Shams Faculty of Medicine and a written consent was taken from all subjects or their parents. Subjects with chronic diseases like: Diabetes mellitus, chronic liver or kidney diseases, congenital or rheumatic heart disease, malabsorption syndrome, thyroid diseases and juvenile rheumatic diseases were excluded from our study. Also, participants with height that is 2 SD below the mean of their age and sex were excluded to rule out diseases causing short stature.

All Participants were subjected to detailed history emphasizing on:

1-***Sun exposure Assessment:***

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A questionnaire was utilized to elicit information as followed [8]:

- Average daily time spent in sun during the school day and on weekends (<30 minutes or >30 minutes).
- What area of body exposed to sunlight? (face/hands; face/hands and arms; face/hands and legs)
- What percent of time did you wear long sleeves, long pants, veil or niqab?
- What percent of time did you spend under shade?
- Do you use sunscreen?

The total duration in minutes and body area under direct sunshine were recorded.

Then classified according to **WHO [9]**:

- Adequate: >30 minutes/day with face and arm or legs exposed.
- Non-adequate <30 minutes/day, veiled girls.

None of our participants were using sunscreen.

2-Socioeconomic status (SES):

Classified into:

A= Privileged class: High SES, **B**= Middle social class, **C**= Under-privileged class: Low SES.

3-Dietary Intake:

The pattern of dietary consumption of vitamin D rich foods was collected by administering the food frequency questionnaire. Foods rich in vitamin D are milk, sardine, tuna, salmon, yoghurt cereals and egg, then classified into high intake (H) > 3 meals/week, moderate intake (M) 2-3 meals/week, low intake (L) < 2 meals/week [10].

4- Vitamin D or calcium supplementation.

None of our participants were taking vitamin D or calcium supplements.

Physical Examination:

Participants were subjected to thorough clinical examination, anthropometric measurements, including weight and height. Height and weight for age percentiles were calculated using CDC (The Centers for Disease Control and Prevention) growth charts calculator.

Laboratory investigations included:

Hemoglobin (Hb) concentration, Serum creatinine, Serum albumin, Corrected serum total calcium, Serum phosphorus PO4, Serum 25 (OH) vitamin D level by total ELISA kit, which is a solid phase enzyme-linked immunosorbent assay (ELISA), based on the principle of competitive binding. The color reaction is started by addition enzyme substrate and stopped after a defined time. The color intensity is inversely proportional to the concentration of 25(OH) vitamin D in the sample.

Sampling and analysis:

Subjects were instructed to fast 8 hours (overnight fasting), 5 ml was collected of venous blood by venipuncture without tourniquet. Serum was separated by centrifugation and the sample was used for measurement of serum Hb, creatinine, serum albumin, corrected serum total calcium, serum PO_4 and 25(OH)vitamin D.

Statistical analysis:

After collection of data, revision and tabulation; statistical presentation and analysis of the present study was conducted, using the range, mean, standard deviation for parametric quantitative data and student t-test was used to compare between two groups while for nonparametric quantitative data median and interquartile range (IQR) were calculated and Mann-Whitney was used for comparison between 2 groups. Analysis of variance [ANOVA] was used to compare more than 2 means. Chi-square or Fisher’s exact test was used to compare two groups as regard qualitative data, which were presented as frequency and percent. Linear correlation coefficient was used for detection of correlation between two quantitative variables in one group. SPSS V 17 program was used.

RESULTS

The demographic and descriptive data of the participants are shown in table (1).

Table (1): Demographic data of the studied subjects (n=180).

Descriptive Data	
	Mean ±SD
Age (Years)	14.499±2.768
Stature For Age Percentile (%)	31.668±25.853
Weight For Age Percentile (%)	36.887±26.093
Vitamin D (ng/ml)	22.456±9.114
Adjusted Calcium (mg/dl)	9.400±0.453
Serum Phosphorous (mg/dl)	4.863±0.555
Serum Albumin (gm/dl)	4.383±0.217
Hemoglobin (gm%)	12.806±1.558
Serum Creatinine (mg/dl)	0.521±0.288

On comparing males and females, our results showed that females had a significantly lower vitamin D level than that of males with (p<0.001). We also found that females had significantly less sun exposure (p<0.001) and significantly less dietary intake of vitamin D rich food (p=0.02) Also subjects (n=6) with severe vitamin D deficiency <10 ng/ml were all females. We also found that females have significantly lower corrected serum calcium and lower serum phosphorus (P<0.001) and (P=0.001) respectively.

On comparing vitamin D status groups as regard stature for age percentile we found a non-significant statistical difference (Table 2) and on comparing upper and lower quartile of vitamin D level as regard stature for age percentile we did not find significant statistical difference (Table 3), also a non-significant statistical difference was found on comparing vitamin D status groups as regard weight for age percentile (Table 4).

Table (2) Comparison between vitamin D status groups as regard stature for age percentile.

Vitamin D (ng/ml)	Stature For Age Percentile (%)	ANOVA	
	Mean±SD	F	P-value
Sufficient	37.218±29.132	1.001	0.394
Mild Deficiency	32.723±26.120		
Moderate Deficiency	29.084±24.128		
Severe Deficiency	25.967±26.518		

Table (3) Comparison between upper quartile and lower quartile of vitamin D level as regard stature for age percentile using Mann-Whitney Test.

Vitamin D (ng/ml)	Stature For Age Percentile (%)		Mann-Whitney Test	
	Median	IQR	Z	*P*-value
Sufficient	22.50	39.93	1.575	0.115
Severe deficiency	9.10	51.60		

Table (4) Comparison between vitamin D status groups as regard weight for age percentile.

Vitamin D (ng/ml)	Weight For Age Percentile (%)	ANOVA	
	Mean±SD	F	*P*-value
Sufficient	42.408±31.208	1.495	0.217
Mild deficiency	31.944±22.196		
Moderate deficiency	37.886±26.083		
Severe deficiency	26.800±9.646		

Table (5) shows the socioeconomic status among the studied subjects and on comparison between vitamin D status groups as regard socioeconomic status we found a non-significant statistical difference. Table (6) shows sun exposure among the subjects and on comparison between vitamin D status groups as regard adequacy of sun-exposure we found highly significant difference.

Table (5) Comparison between vitamin D status groups as regard socioeconomic status

Socio-Economic Status	Vitamin D (ng/ml)										Chi-Square	
	Sufficient		Mild deficiency		Moderate deficiency		Severe deficiency		Total			
	n	%	n	%	n	%	n	%	n	%	X^2	*P*-value
Under-privileged	28	73.68	30	62.50	58	65.91	6	100.00	122	67.78	4.212	0.239
Middle class	10	26.32	18	37.50	30	34.09	0	0.00	58	32.22		
Total	38	100.00	48	100.00	88	100.00	6	100.00	180	100.00		

According to our cross sectional study we found the following ratios of vitamin D deficiency: **Sufficient group:** 38/180 subjects (21.11%) with vitamin D level above > 30 ng/ml, **Mild deficiency group:** 48/180 subjects (26.67%) with vitamin D level between 21-29 ng/ml, Moderate deficiency group: 88/180 subjects (48.89%) with vitamin D level between 10-20 ng/ml, Severe deficiency group: 6/180 subjects (3.33%) with vitamin D level below < 10 ng/ml.

Table (6) Comparison between vitamin D status groups as regard sun-exposure.

Sun-Exposure	Vitamin D (ng/ml)										Chi-Square	
	Sufficient		Mild deficiency		Moderate deficiency		Severe deficiency		Total			
	n	%	N	%	n	%	n	%	N	%	X^2	P-value
Adequate	30	78.95	30	62.50	40	45.45	2	33.33	102	56.67	14.183	0.003
Non-adequate	8	21.05	18	37.50	48	54.55	4	66.67	78	43.33		
Total	38	100.00	48	100.00	88	100.00	6	100.00	180	100.00		

In spite of this difference in vitamin D level, which didn't reach a significant statistical difference, we found a significant positive correlation between vitamin D level and stature for age percentile (p=0.019) (Fig 1).

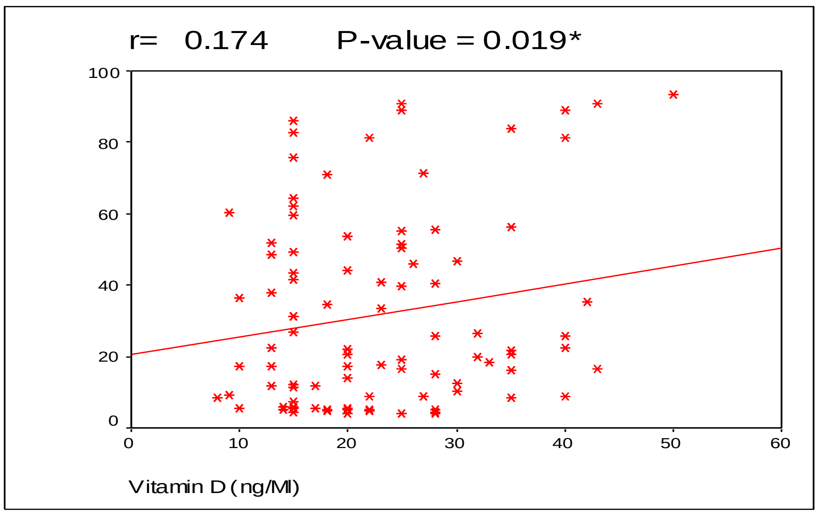

Figure (1): Correlation between vitamin D level and stature for age percentile.

DISCUSSION

During periods of adolescence and puberty, growth and bone mineral deposition appears to be dependent on dietary absorption of calcium and on decreasing its excretion and this is dependent on adequate vitamin D status. So, vitamin D deficiency can exert a negative influence on bone development, causing not only rickets, but also affecting attainment of genetically programmed height [(7)].

According to our study the only percentage with sufficient vitamin D was (21.11%). A general hypovitaminosis D problem in adolescence has already been recorded in studies performed in several countries. In a study published by **Dong *et al.*** [(11)]**,** the overall prevalence of vitamin D insufficiency and deficiency in US children and adolescents was 56.4 and 28.8%, respectively. In HELENA study (the Healthy Lifestyle in Europe by Nutrition in Adolescence) reported that 80% of adolescents from 9 European countries had 25(OH) D levels < 30 ng/ml [(12)].

In Egypt, most of the adolescent girls prefer to wear concealing clothing due to religious and cultural reasons, and their outdoor activity is limited resulting in decreased exposure to sunlight and suggesting that vitamin D insufficiency may be a problem among Egyptian adolescent girls and young women.

Our results showed that the females had a significantly lower vitamin D level than that of males. These results are in agreement with **Habibesadat *et al.*** [(13)] **and Joshi and Bhatia** [(14)]**,** they reported that despite of the tropical climate, vitamin D deficiency and insufficiency are highly prevalent among females which may be due to inadequate sun exposure possibly related to cultural/social factors, and avoiding sun exposure for cosmetic reasons in addition to insufficient dietary calcium.

We should be particularly concerned about the vitamin D status of children and teenage girls of all ages. Vitamin D deficiency will lead to growth retardation and insufficient bone mineralization during their growth spurt. And on growing to the childbearing age, their vitamin D status can improve pregnancy outcomes and improve the health of their developing infant.

Our study revealed significant positive correlation between vitamin D level and stature for age percentile. This was in consistence with **Kremer *et al.*** [(15)] who also found positive correlation between circulating 25(OH) D and height in young women living in sun-rich area in the United States. Adequate vitamin D is needed to achieve genetic growth potential among children, and to test the impact of vitamin D supplementation on serum 25(OH) D levels and linear growth, **Rao *et al.*** [(16)] conducted a recent study and found positive response of vitamin D supplementation on height standard deviation score. Similarly, **Billoo *et al.*** [(17)] showed that with the one dose of vitamin D 200,000 IU (cholecalciferol), there was obvious gain of weight and height during follow-up.

In a recent study, **Ganmaa *et al.*** [(18)] conducted randomized, double-blind, placebo-controlled trial in urban areas selected school age children having no clinical signs of rickets. The study was a 6-month intervention with supplementation of 800 IU vitamin D3 daily, compared to placebo, 113 children aged 12-15 years had significantly increased stature, but not increased body weight. So, treating vitamin D deficiency in children in areas in which vitamin D deficiency is endemic may enable them to reach their full height potential.

However, in our study, we could not demonstrate significant difference in height percentile between the lowest and the highest quartile of vitamin D sufficiency. We postulate that our study was not sufficiently powered to detect a small difference.

We should be concerned about the height of the adolescence due to its social and psychological impact, the experience of being a short person would cause teenagers to view themselves more negatively, reducing their sense of self-esteem and generating a sense of vulnerability. On the other hand, taller adolescents would be more confident and are more likely to participate in social activities that build productive human resources. Researchers have shown that the height and associated social experiences of taller male adolescent at the age of 16 would likely lead to higher income in later adulthood as compared to shorter male adolescent height. They found that on an increase in height by one inch at age of 16 years old, increase male adult earnings by 2.6 percent [(19)]**.**

Governments and policy makers should implement some steps that could correct this important nutrient deficiency. Governments should enhance population education about the importance of safe sun exposure to promote vitamin D synthesis in skin. They can increase the garden areas to motivate the families for some outdoor activities. Moreover, they can provide the children and adolescence at schools with vitamin D fortified food (e.g. milk). Such simple and low-cost changes, can lead to important reductions in the morbidity associated with low vitamin D.

We should encourage children and adolescence to spend time outdoors in the middle of the day with some skin uncovered without sun screen; 10-15 minutes daily of natural sun exposure should be enough. When it comes to sun exposure, little and often is better, and the more skin that is exposed, the greater the benefit of making sufficient vitamin D.

Therefore, we propose that vitamin D supplementation, should be the preferred recommendation during the adolescent years to maintain normal serum 25(OH) D levels to avoid the hazardous effects accompanied by its deficiency.

CONCLUSION

Subclinical vitamin D insufficiency and deficiency are common problems in apparently healthy Egyptian adolescents with negative impact on height percentile.

CONFLICT OF INTEREST

There is no conflict of interest.

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