

Vitamin D Deficiency Among Afghan Adolescents in Kabul

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ABSTRACT

Objective: To determine vitamin D deficiency (25-OH-D level <20 ng/ml) frequency among apparently healthy Afghan adolescents.

Study Design: Cross-sectional analytical study.

Place and Duration of Study: Pathology Department, French Medical Institute for Mothers and Children (FMIC) Kabul, from June to Sep 2016.

Methodology: Adolescents who reported for analysis of vitamin D level in their sera were included. Age, gender, duration of sun exposure, area of exposed skin, types of living and eating lifestyles were documented. Vitamin D levels were measured by chemiluminescence method, using immunoassay autoanalysers. The participants were divided into five categories according to their serum vitamin D levels as sufficiency: ≥ 30 -100 ng/ml; insufficiency: ≥ 20 -29 ng/ml; deficiency: <20 ng/ml; severe deficiency: <10 ng/ml; and intoxication: >150 ng/ml. Participants who had vitamin D intoxication were excluded from the study.

Results: Out of 308 cases for final analysis, 202 (65.6%) were females and 106 (34.4%) were males. Of all, 238 (77.3%) had a low level of vitamin D in their sera, whereas 70 (22.7%) had vitamin D sufficiency. Among those having hypovitaminosis D, 107 (45%) had severe deficiency, 81 (34%) had deficiency and 50 (21%) had vitamin D insufficiency. More pronounced lower levels were observed in females. Exposure to sun, use of a sun protector, vitamin D supplements, and vitamin D rich food intake, type of living, skin colour, and BMI of participants were seen as important factors linked to vitamin D levels.

Conclusion: Hypovitaminosis D is prevailing among Afghan adolescents, more pronounced in girls. Wearing of traditional clothes, duration of sunlight, type of living and inadequate consumption of vitamin D rich foods are significant determinants of hypovitaminosis D.

Key Words: Vitamin D, Prevalence, Deficiency, Associated factors, Afghan adolescents.

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INTRODUCTION

The sunlight is by far the major source of vitamin D (25-OH-D) in human body. It is synthesised on interaction of ultraviolet B (UVB) rays of sun with 7-dehydrocholesterol present in the skin. It is also present naturally in some foods, but in small quantities. Furthermore, vitamin D supplements are available in medical stores. The important risk factors linked with vitamin D deficiency are little exposure to sun, atmospheric pollution, high rise buildings, skin pigmentation, indoor restriction during the day, and low physical activity.¹⁻⁶ In nations like Afghanistan, social, ethnic and economic factors are considered to be the main barriers in obtaining sufficient quantity of this micronutrient from dietary sources. However, hypovitaminosis D is now documented as a pandemic, both in developed as well as developing countries. Various studies have reported that vitamin D deficiency is prevalent among adolescents in the United

States, where it is predominant during the winter and spring as compared to fall and summer. A study done on Turkish girls found that those wearing religious dress had vitamin D deficiency.⁷ Studies conducted in Iran established a high frequency of vitamin D deficiency; the prevalence in Tehran healthy adolescents' girls was higher than boys.^{8,9} Studies conducted in different parts of Pakistan have also shown a high occurrence of hypovitaminosis D.¹⁰⁻¹² In India, studies from many parts of the country have also reported a high prevalence of hypovitaminosis D in their youths.^{13,14}

Vitamin D deficiency is fairly prevalent all over the globe. However, data about vitamin D status among Afghan adolescents is lacking due to scarcity of research on the subject.

Therefore, the objective of the present study was to determine the status of vitamin D deficiency among apparently healthy adolescents reporting to a tertiary care facility in Kabul and to identify factors that represent forecasters for hypovitaminosis D in the study population.

METHODOLOGY

It was a cross-sectional analytical study conducted at Pathology Department, French Medical Institute for

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Mothers and Children (FMIC) Kabul, from June to Sep 2016. Approval for the study was obtained by Ethical Committee of the Institute and Ministry of Public Health (MoPH), Afghanistan.

All adolescents (both boys and girls) between 10 and 18 years of age, who reported or were referred to Hospital Laboratory of French Medical Institute for Mothers and Children for determination of vitamin D (25-OH-D) level in their sera were included in the study. A total of 310 adolescents participated during study period. Two of the participants, who had vitamin D intoxication (25-OH-D level of >150 ng/ml), were excluded from the study and; hence, 308 was the size of the sample for the final analysis. Individuals with celiac disease, Crohn's disease, cystic fibrosis, who had history of past surgery that removed or bypassed portions of the stomach or intestines, who had history of pituitary gland problem, asthma, kidney diseases and other chronic diseases and all those who were not willing to participate in the study, were excluded. To find the factors linked with vitamin D deficiency, various clinical and demographic characteristics of adolescence, including age, gender, educational level, skin colour, body mass index (BMI), type of living, outdoor activity, sun exposure, type and usage of sun protectors, use of vitamin D rich foods or supplements and surgical procedure were noted. Data was collected for participants from the day of appointment, including contact number, age, sex, and self-declared lifestyle. Participants were asked to complete questionnaires concerning their nutritional intake, physical activity during the the day, and assessment of supplement intake. Determination of 25-OH-D level was carried out by collecting 5 ml of blood in SST (Serum Separator Tube) provided by BD Vacutainer® from each participant at the time of visit. The sample tube was centrifuged and serum 25-OH-D measurement was carried out by chemiluminescence immunoassay using ADVIA Centaur analyser supplied by Siemens. The participants were divided into five categories according to 25-OH-D levels in their sera: 1) Sufficiency: ≥ 30 -100 ng/ml; 2) Insufficiency: ≥ 20 -29 ng/ml; 3) Deficiency: < 20 ng/ml; 4) Severe deficiency: < 10 ng/ml; and 5) Intoxication: > 150 ng/ml.

Descriptive and inferential statistics were used for data analysis. The analysis was done using Statistical Package for the Social Science (SPSS) version 21. Level of 25-OH-D was considered as variable and proportion was described. A p-value of < 0.05 was considered as statistically significant. To determine the association of independent variables with 25-OH-D level, Chi-square test of independence was carried out.

RESULTS

The results of vitamin D measurements revealed a mean value of 21.82 ng/ml, with median value of 14.94 ng/ml; maximum and minimum values being 115.28 ng/ml and

4.20 ng/ml, respectively. Of all, 238 (77.3%) of adolescents had a low level of vitamin D in their sera. A high number of 107 (34.7%) participants had severe deficiency, 81 (26.3%) had deficiency, 50 (16.2%) had insufficiency, whereas only 70 (22.7%) had sufficiency.

Table I shows the inferential statistics for the association between vitamin D status and clinical demographic variables of the study participants. Majority of those, *i.e.*, 202 (65.6%) were females and 106 (34.4%) were males, with a female to male ratio of 1.9:1. The mean age of the sample was 14.39 ± 2.82 years with median age of 14 years. A large number of participants, *i.e.* 162 (52.6%), were educated and had sufficient information about vitamin D. Many of the participants, *i.e.* 136 (44.2%), had fair skin color and the rest categories of skin color were almost equally distributed among the remaining. Most of the study subjects, *i.e.* 195 (63.3%), had normal body Mass Index (BMI), whereas 85 (27.6%) were either overweight or obese and 28 (9.1%) were found to be underweight. A majority of the participants, *i.e.* 198 (64.3%), were living in yards while 110 (35.7%) were living in apartments. A high proportion of adolescents, *i.e.* 234 (76%), had outdoor activity (with the mean of 3.12 hours), while the remaining had no or less than measurable amount of outdoor activity. Exposure to sunlight was not observed in 118 (38.3%) of the study subjects. Conversely, the rest 190 (61.7%) had exposure to the sunlight. Among the participants who had sun exposure, only 54 (17.5%) of them had sunlight exposure to the whole body and 136 (44.2%) of them had exposure only to face and hands. The amount of sun exposure was measured as minute/day and 118 (38.3%) had sun exposure of < 5 minutes/day, which was considered as no sun exposure; whereas among participants who had sun exposure, 112 (36.4%) had > 30 minutes/day and the rest 78 (25.3%) had 6-15 minute/day. Half of the participants, *i.e.* 154 (50%), were regular users of sun protectors and the rest 50% were not regular users of sun protectors. Out of those who were regular users of sun protectors, 70 (22.7%) were using sunscreen, 48 (15.6%) were wearing heavy clothes, and 36 (11.7%) were using both. The intake of supplemental calcium with vitamin D was seen only in 108 (35.1%), while 200 (64.9%) were not receiving any supplemental calcium+vitamin D. A high percentage of the participants, *i.e.* 217 (70.5%), were identified as individuals who took regular milk intake. The frequency of the Omega-3 intake and history of surgical procedure were observed in a minority of the individuals, *i.e.* 19 (6.2%) and 11 (3.6%), respectively.

Table I also describes the association between independent variables and outcomes of vitamin D status among Afghan adolescents. Significant associations were found with gender, exposure to sunlight, use of sun protector, heavy clothes, skin color, BMI, type of living, and diet.

Table I: Inferential statistics for the association between vitamin D status and clinical demographic variables of adolescents visiting FMIC (n=308).

Characteristics	Vitamin D level cut off				p-value
	Sufficiency (≥ 30 ng/ml)	Insufficiency (≥ 20 -29 ng/ml)	Deficiency (< 20 ng/ml)	Severe deficiency (< 10 ng/ml)	
Gender					
Male (n=106)	32	20	42	12	<0.001
Female (n=202)	38	30	39	95	
Age in year					
Mean (SD)	14.36 (2.919)	14.24 (2.994)	13.84 (2.857)	14.90 (2.577)	0.081
Education level					
Yes (educated)	42	18	42	60	0.055
No (uneducated)	28	32	39	47	
Sun exposure					
Yes	50	34	42	64	0.044
No	20	16	39	47	
Exposed area of the body to the sunlight					
All the body	24	4	14	12	<0.001
Face and hand	26	30	28	52	
No exposure	20	16	39	43	
Amount of sun exposure					
>30 minute/day	38	12	18	38	<0.001
6-15 minute/day	12	22	24	26	
<5 minute/day	20	16	39	43	
Usage of sun protector					
Yes	18	28	39	69	0.003
No	52	22	42	38	
Kind of sun protector					
No sun protector	52	22	42	38	<0.001
Sun screen	8	22	16	24	
Heavy clothes	10	4	8	26	
Both	0	2	15	19	
Skin colour					
White	18	6	2	20	0.004
Fair	34	28	36	38	
Light brown	8	10	23	25	
Dark brown / black	10	6	20	24	
Calcium+vitamin D supplement intake					
Yes	44	22	26	16	<0.001
No	26	28	55	91	
Daily milk intake:					
Yes	60	30	65	62	<0.001
No	10	20	16	45	
Vit D rich food intake					
Yes	66	36	59	57	<0.001
No	4	14	22	50	
Omega 3 intake					
Yes	8	0	2	9	0.024
No	62	50	79	98	
Body Mass Index					
Normal weight (≥ 5 -85%)	70	31	36	59	<0.001
Underweight (< 5 %)	0	0	12	16	
Overweight (> 85 -95%)	0	19	29	25	
Obese (> 95 %)	0	0	5	7	
Type of living					
Yards	52	40	49	57	0.002
Apartments	18	10	32	50	
Surgical procedure					
Yes	0	0	4	7	0.054
No	70	50	77	100	
Outdoor activity					
Yes	56	40	64	74	0.241
No	14	10	17	33	

There were no meaningful differences between age of the participants and serum vitamin D levels ($p=0.081$). There was also no statistical association between vitamin D status and education of the participants. Surgical procedure, too, was not found significant ($p=0.054$). Likewise, there were no significant associations were found between the outdoor activities and serum 25-OH-D levels ($p=0.241$).

DISCUSSION

Hypovitaminosis D is now documented as a pandemic both in developed as well as developing countries. Sunlight is by far the main source of vitamin D. Very few foods naturally contain vitamin D, and foods that are fortified with vitamin D are insufficient to meet the requirements of vitamin D. In a review done by International Osteoporosis Foundation (IOF), hypovitaminosis D (25-OH-D level <30 ng/ml) was prevalent in many regions of the world, whereas severe vitamin D deficiency (25-OH-D level <10 ng/ml) was most common in South Asia and the Middle East.¹⁵ A study conducted in a high-risk population at a peak season for vitamin D deficiency concluded that the population of children between 6 months to 5 years of age living in Kabul was at great risk of developing vitamin D deficiency.¹⁶ To the best of our understanding, this is the first study to evaluate the status of vitamin D in Afghan adolescents.

The findings of our study revealed that nearly three-quarters of Afghan adolescents residing in Kabul province had varying degrees of hypovitaminosis D. We found a significant association between gender and serum 25-OH-D concentration. Females were more predisposed to severe vitamin D deficiency than males. Similar findings were found in many studies conducted in neighbouring countries.⁷⁻⁹ The possible causes of severe vitamin D deficiency among female adolescents might be due to decreased syntheses of vitamin D in their skin as a result of reduced sun exposure, wearing religious clothes (which cover all the body), usage of sun screens and more time spent indoors. However, more studies are required to explain the possible causes of hypovitaminosis D among Afghan female adolescents.

The influence of sunlight on vitamin D status in humans is well recognised and confirms the significance of sunlight exposure in the synthesis of vitamin D. Our study showed that sunlight exposure was one of the dominant factors of vitamin D status in Afghan adolescents living in Kabul province. The duration of sunlight exposure and exposed skin area correlates with vitamin D levels. Such correlation has also been shown in many other studies.¹⁷⁻¹⁹

A darker skin requires more sun exposure than lighter skin to produce equal amount of vitamin. The avoidance of sun light due to anxiety of blackening of skin and covering of whole body conscientiously, especially in

females when going outside, were the key factors. Male subjects also avoid sun exposure due to misconception regarding harmful effects of sunlight and unawareness regarding the source of Vitamin D. Consistent with the previous findings in the literature, the current study also suggests that usage of any kind of sun protector (sun screen, heavy clothes or both) is positively linked with mild to severe hypovitaminosis D.²⁰

Dietary intake was another contributing factor regarding high prevalence of vitamin D deficiency, since most of these participants were consuming low amount of milk, and foods containing natural quantity of vitamin D. Factual assessment of vitamin D intake was not possible due to ignorance about amount of diet intake by participants and unobtainability of food composition catalog for vitamin D used in Afghanistan. It has been suggested that Omega-3 intake is positively associated with vitamin D status.²¹ This study also ratified the same. Although a large number of participants did not have information about Omega-3 and therefore, this variable was not focused. However, among the adolescents who used Omega-3, most of them did not have hypovitaminosis-D.

The use of supplements is mostly a health and lifestyle choice. Reduced intake of vitamin D supplements, especially in the context of Afghanistan, is possibly due to socio-economically disadvantaged population. In this study, a significant association was observed in supplement intake and vitamin D status. Among those who regularly had supplement intake, most of them had vitamin D sufficiency. However, among adolescents who did not take any supplement, a high percentage had severe vitamin D deficiency. Thus our study reveals that supplementation of calcium and vitamin D has an important role in culmination of vitamin D deficiency.

The required dose of UVB is lower in individual with white skin, compared to those with dark skin. The possible cause of vitamin D deficiency among darker skin persons might be that larger amounts of melanin pigment interfere in the absorption of UVB in the skin. It has been studied that ultraviolet rays are reduced maximum by black fabric and minimum by white clothes.²² In this region, a noteworthy section of women wear dusky clothes customarily for veiling while outside. Our study is congruent with the literature that persons with darker skin colour have more marked vitamin D deficiency than persons with lighter skin colour.²³

Serum 25-OH-D level is inversely linked with BMI. The explanation of this could be that the amount of vitamin D synthesised is diluted in the body of obese individuals than individuals with normal weight. Capacity of skin for production of vitamin D is not affected by obesity but obesity might have effects on release of vitamin D from the skin into the blood circulation. The findings of our study were consistent with previous studies.²⁴

The physical activity decreases calcium excretion and increases absorption ability thus increasing serum calcium, which results in sparing serum vitamin D.²⁵ The current study findings, however, suggested no relationship between outdoor activities and serum vitamin D concentration. Likewise, our results showed that there is no meaningful difference between age of the participant and serum vitamin D level. Surgical procedure was not found significant too. Furthermore, no statistical association between vitamin D status and education of the participant was found.

One limitation of the present study was that a single determination of serum 25-OH-D level was done, which might not accurately reflect vitamin D status for the whole year; at least two samples should have been taken in different months of the year to determine seasonal variation. Other limitations were that parathyroid hormone (PTH) and bone turnover markers were not studied as indicators of vitamin D status.

CONCLUSION

Hypovitaminosis D is present in Afghan adolescents residing in Kabul province, more marked in girls. Wearing of traditional clothes, duration of sunlight exposure, and inadequate intake of vitamin D rich foods and supplements are significant determinants of vitamin D status. Future studies are needed to find out the seasonal variation; and to provide a fuller picture of the burden of vitamin D deficiency among population of all ages. Besides, behaviour recommendations to maximise skin production of vitamin D, public health efforts should be focussed to educate people on the use of vitamin D adjuncts foods and supplements to improve vitamin D levels in Afghan population who are at risk of developing vitamin D deficiency.

ETHICAL APPROVAL:

Ethical approval was obtained from Ethical Review Committee (ERC) of French Medical Institute for Mothers and Children, Kabul, Afghanistan prior to initiation of the research work.

PATIENTS' CONSENT:

Informed consents were obtained from the study participants to publish their data.

CONFLICT OF INTEREST:

Authors declared no conflict of interest.

AUTHORS' CONTRIBUTION:

SA: Carried out the study, analysed the data, and aided in writing the manuscript.

TMT: Conceived the study, was supervisor of overall planning/direction and wrote the manuscript.

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