Assessment of Vitamin D Status in General Population of Kashmir Valley of Indian Subcontinent

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Abstract:

Introduction: The prevalence of vitamin D deficiency is reported to be high throughout the world. Overt Vitamin D deficiency manifests as rickets, birth defects and fractures in children. In adults, its manifestations include osteoporosis, osteomalacia, osteoarthritis, chronic muscular pain, increased risk of fractures, several endocrine, cardiovascular, immunological and neurologic disorders, some types of cancers, and depression. **Objectives:** To assess the Vitamin D status in general population of Kashmir valley by measuring serum 25-hydroxyvitamin D [25 (OH) D] levels. **Method:** Total 270 healthy volunteers from differing professions (69 men and 201 non-pregnant/non-lactating women, aged 18–65 years), residing in Kashmir valley were selected for this study. The samples were collected in both summer and winter months. Vitamin D deficiency/insufficiency was defined as a Serum 25 (OH) D concentration of < 30 ng/ml. **Results:** 222 (82.2%) of the subjects studied had Vitamin D deficiency. 45 of the 69 males and 177 of the 201 females were found to be Vitamin D deficient. The prevalence of vitamin D deficiency ranged from 58 % in the farmers group to 93% in the employee group. Vitamin D deficient subjects had a significantly lower mean weekly exposure to sunlight. **Conclusion:** The prevalence of Vitamin D deficiency in Kashmir valley is high especially among women. Serum 25(OH) D concentrations are significantly related to sun exposure.

Keywords: Osteoporosis, Sunlight, Vitamin D

Introduction:

Serum 25- hydroxyvitamin D [25(OH) D] is the major circulating metabolite of vitamin D. It is the most commonly used and the most sensitive index of vitamin D status in the body acquired both from the cutaneous synthesis and dietary intake.[1] Vitamin D which also known as 'the Sun Vitamin' is a fat-soluble vitamin with hormone-like activity, which regulates the functions of over 200 genes and is essential for growth and development of the body.[2] Vitamin D deficiency is widespread throughout the world. It has been estimated that almost one billion people in the world suffer from vitamin D deficiency or insufficiency.[3] Thus, it has rightly been called as an epidemic across the globe and has been reported in young adults, healthy children, middle aged and elderly population. The two main sources of vitamin D are food and sunlight.[4] There is low vitamin D content in natural food sources and therefore fortification is required. Non fortification of food stuffs, leads to generally low dietary intake of vitamin D and calcium.[5] Sunlight is an important source of

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vitamin D in the body. Inadequate sun exposure, skin pigmentation, traditional clothing practices, latitude and seasonal climate are some of the factors that have significant influence on cutaneous photochemical synthesis of vitamin D in healthy individuals.[6] Vitamin D deficiency is quite prevalent throughout the world, but it appears to be the worst in countries of South Asia, especially among children, women, and elderly. Overt vitamin D deficiency manifests as rickets, birth defects and fractures in children. In adults it manifests as osteoporosis, osteoarthritis, osteomalacia, chronic muscular pain and leads to an increased risk of fractures.[7] Additionally, Vitamin D deficiency has also been suggested as a contributing factor in the development of several other diseases and conditions such as endocrine, cardiovascular diseases, diabetes, some types of cancer, immunologic diseases, neurological disorders, and depression.[8] In this study, we aim to assess the status of vitamin D in healthy volunteers of Kashmir Valley.

Objectives:

The specific objectives of the study were:

- To assess Vitamin D status in general population of Kashmir valley.
- To assess Vitamin D levels in comparison with BMI, socioeconomic status, history of taking supplements and daily sun exposure in general population of Kashmir valley.

Method:

A community based cross sectional study was conducted from the year January 2019 to December 2020 in Kashmir valley at SKIMS Medical College Hospital, Bemina, Srinagar, J&K, India.

Inclusion criteria:

- Age between 18 years to 65 years
- Healthy volunteers from the attendants who accompanied patients at general OPD/IPD
- Healthy volunteers from medical profession
- Both sexes

Exclusion criteria:

- Extremes of age (Age < 18 years and > 65 years)
- Patients with uncontrolled medical co morbidities (Uncontrolled diabetes, uncontrolled hypertension)
- Patients with chronic kidney diseases, autoimmune disorders, connective tissue disorders.
- Pregnant, lactating women.
- Persons taking Vitamin D supplementation.

Sample size and selection of subjects : In this study, a total of 352 healthy volunteers aged 18 – 65 years were approached and screened for eligibility. The subjects were required to be apparently healthy, residing in Kashmir valley and without any suggestion of liver, kidney or Gastro-intestinal disease. Furthermore, pregnant, lactating and persons taking Vitamin D supplementation were excluded from the study. Out of the 352 volunteers approached, only 270 fulfilled the criteria and were selected for the study. The subjects who participated in the study were farmers [36 in number], employees [42 in number], housewives [72 in number], medical professionals [66 in number] and students [54 in number]. The medical professionals included doctors and nurses from our institute. After taking an informed written consent, a detailed history regarding age, occupation, monthly income, medical comorbidities, average daily sun exposure and supplementation was taken from the subjects. Weight in kg's and height in metres of every subject was measured and BMI (kg/m^2) calculated.

Blood collection & sample analysis : A blood sample (3 ml) was collected from all volunteers in our hospital using the standard procedure for blood collection. The blood sample was taken before giving any Vitamin D supplements. These blood samples were analysed for Vitamin D3 using Chemi-luminescent Immune Assay (CLIA) method on LIAISON. [9]

Anthropometric profile : Weight and height of all the volunteers were assessed by following the recommended procedure of WHO (1983).[10] For measuring weight and height of the individuals, a beam scale was calibrated with standard weights and measuring tapes. Before measuring weight, the volunteers were asked to remove heavy clothing, shoes, purse, and other unnecessary things and then the weight was noted up to the nearest 0.01 kg. Similarly, before taking height measurements, the subjects were asked to remove the head cap, shoes, and heavy garments and to stand in the centre of the platform of the scale, looking straight with his head, back, buttocks, calves and heels touching the rod. The head piece was the levelled and height was recorded up to the nearest 0.1cm. Body mass index (BMI) was calculated with the help of the formula [Kg/M^2]. [11]

Assessment of socio-economic status : A pretested semi-structured questionnaire was used to elicit information on socio-demographic profile. Assessment of Socio-economic status was done using Kuppuswamy's Socio-economic scale.[12]

Physical activity level : The standard methodology was used for calculating the value of the physical activity level [PAL].[13] Each subject was given an oral questionnaire in which 24 hours of a day were divided into 48 slots of 30 min each. The subject was enquired about the type of physical activity undertaken by him/her in each 30-minute time slot during last 24 hours. The type of physical activities was divided into light, moderate or heavy based on metabolic equivalent of task values.[13] The basal metabolic rate (BMR) of each subject for 24 hours was calculated using the FAO-WHO equation given for each age group.[13] The BMR per minute of each subject was calculated by dividing BMR of a subject by a figure of 1440 (24 h×60 = 1440 min). The time spent on each of the physical activity by the subject was multiplied with the metabolic equivalent value for that physical activity and calorie expenditure on different physical activities undertaken by the subject was calculated. The total energy expenditure (TEE) done by the subject on physical activities in 24 hours was multiplied by BMR per minute and the TEE of the subject was calculated for the 24 h. The TEE value obtained was divided by BMR of the subject and PAL value was calculated. Sedentary lifestyle was classified as PAL less than 1.4. A PAL of 1.4 to 1.54 was classified as low physically active lifestyle and a PAL of > 1.55 was taken as moderately active/active lifestyle.[13]

Assessment of exposure to sunshine: A questionnaire was utilized to elicit the information regarding the time spent in the sunshine in the last 24 hours during routine daily activities from the subjects. Area of body exposed to sunlight was calculated with the help of Wallace's Rule of Nine.[14] The type of clothing worn by the subjects and the total duration in minutes and body area (percentage) under direct sunshine was recorded.

Dietary profile : The pattern of dietary consumption of foods was collected by administering the food frequency questionnaire. The questionnaire was divided into two parts: The first part comprised 40 food groups and quantified the frequency of consumption. The second part was composed of 10 questions. Six were qualitative questions about eating habits (e.g., meal frequency, socialization during meals, source of food supplies), and four questions were used to obtain nutritional data, of which two provided more detailed information about some food groups from the first part of the questionnaire (i.e., fish and soft drinks).[15]

Statistical analysis : The collected data were entered into IBM SPSS (statistical package for social sciences) version 20.0. Continuous variables were expressed as mean $\pm$ Standard deviation with its respective range. Nominal and ordinal variables were expressed as proportions. The Chi-Square and Fishers exact tests were used for comparison of different groups and a p- value of < 0.05 was taken as statistically significant.

Results:

Table 1: Relationship between serum Vitamin D levels with different parameters in young adults of Kashmir valley in Indian subcontinent (n=270)

Sr. No.	Socio-Demographic factor	Distribution of sample according to level of Vitamin D [n= 270]		p value*
		Deficient /Insufficient (<30ng/ml) n (%)	Sufficient (≥30ng/ml) n (%)	
1	Male	45 (65.2)	24 (35)	0.000018
	Female	177 (88)	24 (12)	
2	Upper socio-economic class	57 (86)	9 (14)	0.00026
	Middle socio-economic class	87 (91)	9 (9)	
	Lower socio-economic class	75 (69)	33 (31)	
3	Sunlight exposure Time 0-60 min	120 (91)	12 (9)	0.000025
	Sunlight exposure Time 61-150(min)	88 (85)	16 (15)	
	Sunlight exposure Time more than 151 (min)	20 (59)	14 (41)	
4	Sunscreen use –Yes	32 (80)	8 (20)	0.4455
	Sunscreen use- No	195 (85)	35 (15)	
5	Sedentary lifestyle (PAL <1.4)	144 (89)	18 (11)	0.000038
	PAL 1.4-1.54	54 (75)	18 (25)	
	PAL ≥1.55	21 (58)	15 (42)	
6	Serum calcium (8.5 to 10.4mg/dl)	173 (91.5)	16 (8.5)	0.964
	Serum calcium (>10.4 mg/dl)	74 (91)	7 (9)	
7	Serum Phosphorus (<2.5 mg/dl)	7 (87.5)	1(12.5)	0.00092
	Serum Phosphorus (2.5 to 4.8 mg/dl)	216 (94)	14 (6)	
	Serum Phosphorus (>4.8 mg/dl)	31 (97)	1(3)	
8	Serum ALP (<180 IU/l)	90 (95)	5 (5)	0.87
	Serum ALP (180-1200 IU/l)	165 (94)	10 (6)	
9	BMI (<25)	138 (87)	20 (13)	0.64
	BMI (≥25)	84 (75)	28 (25)	

* P Value <0.05 show that level of vitamin D have a significant association with socio-demographic data and value >0.05 did not have any significant association between level of vitamin D and socio-demographic data.

Exposure to sunlight was related significantly to serum 25 (OH) D values. As a group, subjects with vitamin D deficiency had a significantly lower sunlight exposure time compared to those who were vitamin D sufficient. (Table 1) The serum concentrations of calcium and alkaline phosphatase were comparable in subjects with and without vitamin D deficiency. (Table 1) A total of 270 subjects (69 males and 201 non-pregnant females) belonging to five different groups (farmer, employed, household, medical personnel, and students) were evaluated for vitamin D deficiency. The subjects studied had a mean age of 35.15 years+ 4.5 years (range 18–65 years). Overall, 222 (82.2%) of the subjects studied had vitamin D deficiency/ insufficiency, defined as serum 25 (OH) D < 30

Table 2: Occupation of subjects in relation to vitamin D status

Occupation	Vitamin D deficient (n=222) n (Male:female) (%)	Vitamin D sufficient (n=48) n (Male:female)(%)	Vitamin D levels (ng/ml)
Farmer	21(21:0)(58.3)	15(15:0)(41.7)	25.6 ± 12.8
Housewife	54(0:54)(75)	18(0:18)(25)	21.9 ± 19.9
Employee	39(3:36)(92.8)	3(0:3)(7.2)	12.7 ± 15.8
Medical professional	57(18:39)(86.4)	9(9:0)(13.6)	20.8 ± 10.9
Student	48(3:45)(88.9)	6(0:6)(11.1)	19.7 ± 10.1

Table 3: Gender in relation to vitamin D status

Gender	No. of persons (%)	Vit D (ng/ml)
Male	69(25.5)	24.6 ± 12.8
Female	201(74.5)	18.7 ± 13.0

ng/ml.[16] About 65% (45 of 69) of the males and nearly all 88% (177 of 201) of the females studied were vitamin D deficient. Between 70–100% subjects in different groups were documented to have vitamin D deficiency (Table 2) except farmers.

The average vitamin D status was low in females as compared to males. Probable factors for this deficient state were household occupation, decreased sun exposure and decreased body area exposure due to veiling. (Table 3)

Discussion:

In our study around 88% of the females were found to be Vit D deficient/ insufficient. In similar studies performed by Webb AR et al. [17] and Taha SA et al.[18], Vit D levels were found to be significantly low in females as compared to males. This was attributable to significantly less sun exposure and decreased body surface area exposure as compared to male counterparts. The lower Vit D levels in females can also be explained due to the cultural practice of wearing clothes that cover most of the body and remaining indoors for household work.[18]

Socioeconomic profile of the patients plays a role on mean Vit D levels. In our study, the bulk of the persons categorised as belonging to lower socio-economic status, were farmers by profession. The mean Vit D levels were the highest in this subset of our study groups. Professionals belonging to higher socio- economic status had the lowest mean Vit D levels. This can be explained by the fact that farmers have a higher exposure to sunlight as compared to professionals working indoors. In our study 91 % of the patients having a daily exposure of 0-60 minutes to sunlight had Vit D insufficiency. This was in contrast to 59% for patients having a daily exposure to sunlight of more than 151 minutes. Hence, we found a significant correlation between mean exposure to sunlight and Vit D levels (p value = 0.000025).

No significant correlation was found between the use of sunscreen and the mean Vit D levels in our study (p value = 0.4455). A study by Young AR, Narbutt J et al,[19] concluded that sunscreens when used optimally to prevent sunburns, allowed for excellent Vit D synthesis. Hence, the benefits of sunscreen can be obtained without compromising cutaneous Vit D synthesis.

The role of physical activity and the mean levels of Vit D needs to be emphasized. In our study we found a statistically significant correlation between physical activity and mean Vit D levels. Physical activity refers to any movement caused by a muscle contraction resulting in increased energy expenditure than at rest. Physical exercise refers to any well-structured, repetitive physical activity aimed at improving the general health of the individual. Outdoor physical activity, due to exposure to sun has a beneficial effect on the levels of Vit D. In addition, indoor physical activity has also shown to be associated with higher levels of Vit D suggesting that Vit D concentration is not only associated with sun exposure.[20]

We found the serum concentrations of calcium and alkaline phosphatase to be comparable with or without Vit D deficiency. Calcium hemostasis in the human body is maintained by a variety of factors including Parathyroid hormone (PTH) and calcitonin. The levels of PTH and calcitonin were not available in our study. While some authors argue that the cut off levels of 25 (OH) D to define Vit D deficiency should be linked to changes in the PTH concentration, at present there are no clear-cut guidelines for the same.However, we found a statistically significant correlation between phosphate levels and Vit D levels (p value = 0.00092). 1,25 (OH) 2D can regulate serum phosphate level either directly or indirectly through modulating expression of fibroblast growth factor -23 (FGF23) as well as working as a calciotropic hormone. Therefore, phosphate and vitamin D metabolism are highly interconnected.[21]

Alkaline phosphatase (ALP) is a group of identical enzymes that are native to four homologous alkaline phosphatase genes.[22] Three out of these four genes encode for tissue specific enzymes, while the remaining one is present in many body tissues like bone, kidneys, and liver. Although, alkaline phosphatase is considered to be a factor required for the synthesis and mineralization of new bone, its exact function is still unknown. Being a product of osteoblasts, raised serum levels of alkaline phosphatase indicate a state of increased bone turnover. However, the correlation between ALP levels and Vit D levels has not been found to be significant. In our study we obtained a statistically insignificant relationship between the two (p value = 0.87). Hence the levels of ALP should not be used to screen/ diagnose patients with Vit D deficiency.

We found a statistically insignificant relationship between Vit D levels and BMI (p value= 0.64). Adiposity has been found to be strongly related, inversely to serum 25 (OH) D and directly to parathyroid hormone (PTH) concentrations independent of age, sex, season, or smoking. The association has been found to be weaker if anthropometric measures are used, implying a specific role for adipose tissue.[23,24] The lack of any consistent relationship between BMI and serum 25 (OH) D in our study needs to be seen in that perspective. In addition, none of the subjects in our study was actually obese (BMI >30 Kg/M^2).

The limitations of this study include a relatively small size, failure to study all subjects in both summer and winter, and lack of data on percentage of body fat of the subjects studied. Further, PTH levels were not available in our subjects. We have demonstrated a very high prevalence of vitamin D inadequacy in apparently healthy, young adults. It is likely to be even higher and more severe in children, the elderly, and in pregnant women. Given the importance of vitamin D in the regulation of calcium and phosphorous homeostasis and musculoskeletal health, its emerging role in extra-skeletal health, and the magnitude of deficiency of this vitamin, fortification of certain commonly used food items may be required.

Conclusion:

Results of the study show that there is a deficiency or insufficiency of the vitamin D in general population of Kashmir valley of Indian subcontinent irrespective of age, gender, socio-economic status, sun exposure and medical history. This reaffirms the belief that Vitamin D deficiency is a pandemic.

Recommendations:

The study highlights the urgent need to make physicians aware of the high prevalence of Vitamin D deficiency. The need for improving the status of Vitamin D in the population by educating the people/ creating mass awareness and Vitamin D supplementations programmes is paramount.

Declaration:

Conflict of interests: Nil

Funding Information: Nil

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