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Original Research Article

Prevalence and predictors of vitamin D deficiency among hospital staff in tertiary care center: a cross sectional study

Mohammad Ashraf Ganie[1], Shivani Sidana[2]*, Reyaz Ahmad Misgar[1], Tajali Sehar[1], Tripti Sharma[1]

[1]Department of Endocrinology, SKIMS, Srinagar, Jammu and Kashmir, India
[2]Department of Endocrinology, AIIMS, Bathinda, Punjab, India

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***Correspondence:**
Dr. Shivani Sidana,
E-mail: shivani66sidana@gmail.com

ABSTRACT

Background: Vitamin D deficiency (VDD) is prevalent across all age groups in general population not sparing the health care workers. This study aimed to assess the prevalence and risk factors of VDD among the hospital workers of tertiary care center in Kashmir valley.
Methods: In this cross-sectional study, a total of 216 apparently healthy subjects were screened for VDD from three groups, group A- minimal sunlight exposure (office employees), group B- moderate sunlight exposure (nursing students) and group C- abundant sunlight exposure (gardeners). Serum calcium, phosphorus, alkaline phosphatase, 25-hydroxy vitamin D [25(OH)D], PTH levels and urine calcium/creatinine was assessed in all subjects. Dietary assessment of vitamin D (VD) and calcium intake was done using three days dietary recall. The percent body surface area (BSA) exposed to sunshine was estimated by applying the Wallace rule of nine.
Results: Serum 25(OH)D level was found to be lower in group A (17.29±10.87) as compare to group B (21.78±16.37) and group C (26.40±15.59). Prevalence of VDD was 71.6%, 70.6% and 50% in group A, group B and group C respectively. VDD was more prevalent in females and risk increased with age and BMI, decreased with duration of daily sunlight exposure, percentage BSA and dietary VD intake.
Conclusions: Burden of VDD is high among hospital workers despite their direct contact with healthcare. Strategies should be made to screen them regularly and supplementation of VD should be provided to effectively counteract VDD.

Keywords: Hospital workers, India, Kashmir, 25(OH)D, Sun exposure, Vitamin D deficiency

INTRODUCTION

Vitamin D (VD) has an essential role in maintaining the bone and mineral homeostasis.[1] Apart from the skeletal benefits, there is increasing evidence for the non-skeletal beneficial effects of VD, such as reducing the risk of many acute and chronic diseases including upper respiratory tract infections, tuberculosis, type 2 diabetes mellitus, rheumatologic disorders, cardiovascular disease, mood disorders and reduction of all-cause mortality, especially cancer mortality etc.[2-4] The unique feature of VD is that significant amount is synthesized endogenously in epidermal keratinocytes and dermal fibroblasts from 7-dehydrocholesterol on cutaneous exposure to ultraviolet B (UV-B; 290-375 nm) rays.[5] Under the ordinary living conditions, UV-mediated cutaneous VD production has been reported to contribute to as much as 90% of the total VD requirement, with dietary intake making only the residual 10% contribution.[6] Then, it is quite natural to presume that VD deficiency (VDD) is less common in the countries with abundant sunshine. Contrary to this, VDD is highly prevalent worldwide, affecting around one billion people globally.[7,8] In India, despite being a tropical country with

adequate day light and sunshine, VDD affects 70-100% individuals irrespective of their age, gender; race in both rural and urban areas.[9,10] Kashmir valley is located at latitude: 32°44'N, longitude: 74°54'E and an altitude of 1,574-5,425 feet above the sea level at average UV index is 3.4 in winters (December-March) and 12.27 (June-August) in summer. Despite this, VDD is highly prevalent in Kashmir, with reported prevalence of 83% in healthy adults 91.1% in diabetics, 88.6% in adolescent girls and 74% in pregnant women in different studies.[11-13]

This discrepancy of high prevalence of VDD despite endogenous synthesis and abundant sunshine may be due to various factors that affect amount of effective UVB radiation reaching the skin surface (affected by the latitude, ozone layer, atmospheric pollution, season, water vapor and clouds) and several local factors affecting cutaneous VD synthesis such as melanin pigmentation, skin types, clothing and use of sun screens.[14,15]

Hospital workers are frontline for providing health to the community. Hence their health is paramount importance for the healthy community. Despite being directly involved in health-related issues, studies have shown gross unawareness and high prevalence of VDD among health care workers. Lack of awareness and inadequate sunlight exposure makes them more vulnerable to VDD. Selection of hospital workers provided a double opportunity of sensitizing them toward their health, thus targeting a section of the general population and spreading the awareness by their means to the community regarding the need to tackle the prevailing of VDD. Hence, we aimed this study to evaluate the prevalence of VDD and its risk factors among the hospital workers of tertiary care center of the Kashmir valley.

METHODS

This was a cross sectional study carried out at department of endocrinology, Sher-i-Kashmir Institute of Medical Sciences (SKIMS) Kashmir from December 2017 to March 2019. The study protocol was approved by Institutional Ethical Committee of SKIMS vide No. SIMS 1 131/ IEC-SKIMS/2018-274.

Subject selection

The hospital staff were recruited mainly from three different clusters, office employees, gardeners and nursing students according to their level of sunlight exposure. group A- minimal sunlight exposure (office employees), group B- moderate sunlight exposure (students), group C- abundant sunlight exposure (gardeners). All the subjects were explained about the purpose and protocol of study. Healthy adults aged 18-60 years of any sex who were willing to give written consent of participation were included in the study after applying exclusion criteria. Subjects were tested in winter during December to March with average UV index 4.87. Subjects with history of tuberculosis, sarcoidosis or other granulomatous diseases, any chronic illness- kidney, liver, lung, bone, muscle, heart disease, malabsorption, diabetes mellitus, hypertension, stroke, malignancy, rheumatologic disease, thyroid parathyroid, adrenal or pituitary disease, history of any drug intake that affect calcium and VD metabolism, history of intake of calcium, VD supplements in last 3 months, accident or surgery requiring immobilization in last 6 weeks, family history of defect in calcium metabolism, pregnancy, miscarriage and lactation in last 6 months, hypercalcemia or hypocalcemia were excluded from study.

Clinical assessment

All participants fulfilling the inclusion criteria were subjected to receive an interview including age, gender, education level, sun exposure, dietary consumption, and history of any systemic disorders. Medication and supplement use data were obtained through questionnaire and pill bottle reviews. Thereafter patients were examined thoroughly including vital parameters like blood pressure, pulse rate, respiratory rate, temperature and systemic examination. Anthropometric data including height, weight, waist circumference, hip circumference, waist/hip ratio were noted and BMI was calculated. The percent body surface area exposed (BSA) to sunshine was estimated by applying the Wallace rule of nine.[16]

Laboratory evaluation

After an overnight fast, a 10 ml venous blood sample was withdrawn for measurement of serum lipids, liver and kidney function, glucose, calcium, phosphorus, 25(OH)D, and PTH. The blood samples were centrifuged at the study site and the aliquots were transported within 2 hours in cold boxes to the storage sites. The samples were aliquoted for immediate biochemical estimations, while as for hormonal analysis samples were stored at -80oC until the assay. The blood samples were collected in a plain, EDTA and fluoride vacutainer depending upon the assay. Serum calcium, phosphate and alkaline phosphate were measured by commercially available kit using automated biochemistry analyser Response- 910 (Diasys Diagnostics). The serum 25(OH)D, and PTH (reference range: 10-65 pg/ml, analytical sensitivity 0·7 pg/ml) using electrochemiluminiscence assay (Roche Diagnostics). Intra- and inter-assay CV was 3·5 and 5% for serum 25(OH)D and 2·4 and 3·6% for serum PTH. VDD. Urinary samples were collected for the random urinary calcium:creatinine ratio (UCaCrR- both calcium and creatinine measured in mg) and was performed using AU–680 (Beckman Coulter).

Data analysis

Descriptive statistics are presented as mean±SD if not stated otherwise. Differences in baseline groups descriptive characteristics were compared by one-way ANOVA for normally distributed parameters and Kruskal-Wallis tests if parameter was not normally

distributed. Associations between baseline serum 25(OH)D and various parameters were examined by means of the Pearson correlation coefficient or- when one or both outcome variables had a skewed distribution- the Spearman rank order correlation coefficient. Data was log- transformed before analyses (normal distribution was confirmed after transformation) wherever necessary. All tests were conducted two-sided, and a p value <0.05 was considered statistically significant. All statistical analyses were performed using SPSS software, version 22 (SPSS Inc, Chicago, IL, USA).

RESULTS

Baseline characteristics

The mean age of male subjects (n=92) was 38.86±11.20 years and with a mean BMI of 23.33±3.11 kg/m^2 and the mean age of female subjects (n=124) was 28.69±11.19 years with a mean BMI of 22.84±3.57 22.84±3.57 kg/m^2 (Table 1). Mean age of office employees (40.59±10.89), and gardeners (46.38±9.77) was significantly more than, students (22.52±2.91). Baseline mean serum calcium, phosphorus, were comparable among three groups. Mean serum alkaline phosphatase was significantly higher and urine calcium/creatinine levels significantly lower in group A as compare to group B and group C. Mean daily sunlight exposure (minutes) was significantly lower in group A (16.61±13.71) and group B (28.07±22.29) as compared to group C (182.31±90.02). Percentage BSA exposed to sunlight in group A, B and C was 9.06±3.18, 7.72±4.10 and 11.06±1.14 respectively. Mean dietary intake of calcium and VD was similar among the three groups. Males (71.68±86.15) had significantly longer duration of daily sunlight exposure as compare to females (20.56±18.71). Similarly, males (10.45±1.92) have larger %BSA exposed to sunlight than females (7.27±4.07).

Table 1: Baseline clinical and biochemical characteristics of the three groups.

Parameter	Group A minimal sunlight exposure (n=81)	Group B intermediate sunlight exposure (n=109)	Group C abundant sunlight exposure (n=26)	P value
Age (years)	40.59±10.89	22.52±2.91^{x}	46.38±9.77^{y,z}	0.001
Height (cm)	162.49±8.88	160.75±8.32	161.69±5.68	0.356
Weight (Kg)	64.47±9.52	56.07±9.36^{x}	64.27±8.41^{z}	0.001
BMI (Kg/m^2)	24.43±3.25	21.67±2.95^{x}	24.61±3.15^{z}	0.001
Waist circumference (cm)	88.54±9.84	79.52±11.86^{x}	91.54±7.27^{y,z}	0.001
Hip circumference (cm)	95.59±9.63	89.62±10.97^{x}	98.85±6.61^{y,z}	0.001
SBP (mmHg)	120.72±11.28	120.20±10.38	129.00±8.75	0.071
DBP (mmHg)	77.94±10.88	75.57±9.65	79.46±8.11	0.106
Pulse rate (bpm)	82.83±8.17	82.88±6.91	83.85±6.74	0.814
Blood urea (mg/dl)	24.76±5.09	23.09±5.03	24.63±6.54	0.076
Serum creatinine (mg/dl)	0.80±0.15	0.70±0.18	0.88±0.69	0.095
Serum bilirubin(mg/dl)	0.72±0.26	0.71±0.31	0.82±0.40	0.243
Serum AST (IU/l)	26.47±8.19	23.58±6.63^{x}	23.30±8.22^{y}	0.020
Serum ALT(IU/l)	23.17±11.89	22.52±10.20	21.90±9.50	0.260
Serum total protein (gm/dl)	7.75±0.49	7.84±0.45	7.83±0.44	0.390
Serum albumin (gm/dl)	4.55±0.44	4.50±0.48	4.47±0.26	0.450
Fasting plasma glucose (mg/dl)	87.70±7.02	86.71±6.73	84.43±7.37	0.112
Serum total cholesterol (mg/dl)	182.44±37.86	160.48±34.30^{x}	208.08±40.01^{y,z}	0.001
Serum LDL (mg/dl)	100.58±25.50	88.34±24.83^{x}	121.85±25.83^{y,z}	0.001
Serum triglyceride (mg/dl)	153.72±70.83	120.84±50.86^{x}	162.15±58.82^{y,z}	0.001
Serum VLDL (mg/dl)	30.73±14.17	24.29±10.43^{x}	32.42±11.79^{y,z}	0.001
Serum HDL (mg/dl)	46.05±9.75	41.49±9.93^{x}	49.88±10.25^{y,z}	0.001

Distribution of serum 25(OH)D and PTH levels

The mean (±SD) serum 25(OH)D status of the cohort was 20.65±14.69 ng/ml. Mean serum 25(OH)D concentration was significantly lower in females (18.82±13.84) as compared to male (23.12±15.51) subjects (p-0.018). Mean serum 25(OH)D levels were significantly lower in group A (office employees) 17.29±10.87, group B (students) 21.78±16.37 as compared to group C (gardener) 26.40±15.59 (Table 2).

Table 2: Comparison of biochemical and hormonal parameters among the three groups.

Parameter	Group A Minimal sunlight exposure (n=81)	Group B intermediate sunlight exposure (n=109)	Group C abundant sunlight exposure (n=26)	P value
Serum calcium-total (mg/dl)	9.59±0.52	9.63±0.57	9.62±0.40	0.903
Serum phosphorus (mg/dl)	3.22±0.39	3.31±0.45	3.43±0.37	0.065
Serum alkaline phosphatase (IU/l)	103.40±28.72	91.41±24.65^{x}	89.87±35.73^{y,z}	0.007
Urine calcium/creatinine (mg/mg)	0.116±0.049	0.134±0.045^{x}	0.145±0.038^{y,z}	0.005
Serum 25(OH)D (ng/ml)	17.29±10.87	21.78±16.37^{x}	26.40±15.59^{y,z}	0.011
Serum PTH (pg/ml)	48.58±21.33	47.10±23.06^{x}	33.64±16.54^{y,z}	0.008
HOMA-IR (mIU/l)	1.62±0.56	1.63±0.65	1.69±0.29	0.838
Daily sunlight exposure (minutes)	16.61±13.71	28.07±22.29^{x}	182.31±90.02^{y,z}	0.001
Percentage BSA exposed	9.06±3.18	7.72±4.10x	11.06±1.14^{y,z}	0.001
Dietary calcium intake (mg/day)	367.46±101.71	377.06±154.42	329.63±109.74	0.259
Dietary vitamin D intake (IU/day)	603.38±251.29	627.14±298.05	699.39±297.50	0.320

p<0.05, Comparison between groups : x- Group A versus B, y- Group A versus C, z- Group B versus C.

Prevalence of VDD

According to ES guidelines [deficiency (<20 ng/ml), insufficiency (20-30 ng/ml), sufficiency (>30 ng/ml)], VDD was found in 70.6% students, 71.6% office employees and 50% gardeners.[17] Among students' employees and gardeners, 10.1%, 16 % and 7.7% had insufficient and 19.3%, 12.3% and 42.3% had sufficient VD levels respectively. However, when analyzed according to IOM/ global consensus guidelines, [deficiency (<12 ng/ml), insufficiency (12-20 ng/ml), sufficiency (>20 ng/ml)], among students, office employees and gardeners, 23.9 %, 40.7% and 19.2% had VDD, 46.8%, 30.9% and 30.8% had insufficient and 29.4%, 28.4% and 50% had sufficient VD levels respectively (Figure 1).[18,19]

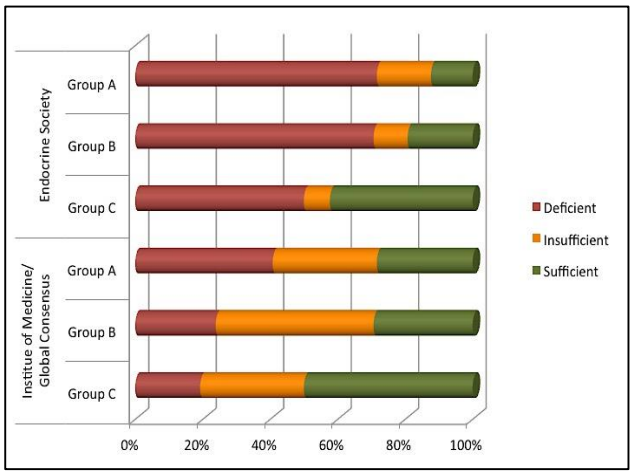

Figure 1: Serum 25(OH)D status according to Endocrine Society* and IOM/Global consensus Guidelines among three groups.**

*Deficient (<20 ng/ml), insufficient (21-29 ng/ml) and sufficient (≥30 ng/ml). **Deficient (<12 ng/ml), insufficient (12-20 ng/ml) and sufficient (≥20 ng/ml).

Correlation of serum 25(OH)D levels and various parameters

Mean serum 25(OH)D levels were negatively correlated with age (p-0.006) and BMI (p-0.047). Dietary VD intake, duration of daily sunlight exposure and %BSA exposed was positively correlated with serum 25(OH)D levels. There was a significant negative correlation between PTH and serum 25(OH)D levels (p-0.001). Among biochemical parameters, serum alkaline phosphatase was negatively correlated (p-0.001), while no significant correlation was found between serum calcium, phosphorus, urine calcium/creatinine, fasting plasma glucose, HOMA-IR and serum 25(OH)D levels (Table 3).

Table 3: Correlation of serum 25(OH)D levels with various clinical and biochemical parameters.

Parameter	Correlation coefficient	P value
Age	-0.187	0.006*
Male gender	0.135	0.047*
BMI	-0.282	0.001*
Serum calcium total	0.064	0.346
Serum phosphorus	0.031	0.651
Serum alkaline phosphatase	-0.311	0.001*
Urine calcium/creatinine	0.098	0.169
Serum PTH	-0.490	0.001
HOMA-IR	0.030	0.662
Sunlight exposure (minutes/day)	0.313	0.001*
% BSA exposed	0.250	0.001*
Dietary VD intake	0.183	0.007*

*correlation (2-tailed) is significant at p <0.05 level

Risk factors affecting VDD

VDD was prevalent across all age groups, however risk of VDD increased in older age groups. Risk of VDD

increased with increasing BMI from overweight to obese group. Females were found at higher risk as compared to males. Higher dietary VD intake, longer duration of sunlight exposure and larger percentage BSA exposed to sunlight decreased the risk VDD among all the groups.

Table 4: Risk factors predicting vitamin D deficiency in the three groups.

	Group A minimal sunlight exposure (n=81)			Group B intermediate sunlight exposure (n=109)			Group C abundant sunlight exposure (n=26)		
	N (%)	25(OH)D levels (ng/ml) Mean±SD	OR (95%CI)	N (%)	25(OH)D levels (ng/ml) Mean±SD	OR (95%CI)	N (%)	25(OH)D levels (ng/ml) Mean±SD	OR (95%CI)
Age group (years)									
<30	19 (23.5)	21.04 ±12.97	1(Ref)	105 (96.3)	22.07±18.87	1(Ref)	3 (11.5)	33.10±16.03	1 (Ref)
31-40	25 (30.9)	18.16 ±10.38	2.31 (0.66,8.11)	4 (3.7)	13.87±5.29	1.26 (0.13,12.55)	5 (19.2)	30.15±19.86	1.33 (0.07,26.61)
41-50	18 (22.2)	15.86±12.39	3.15 (0.75,13.16)				7 (26.9)	28.39±17.32	1.50 (0.09, 25.39)
>50	19 (23.5)	13.61±6.01	4.80 (1.04,22.1)				11 (42.3)	21.62±13.04	3.50 (0.24,51.90)
Sex									
Female	42 (51.9)	16.34±10.45	1(Ref)	82 (75.2)	20.09±15.19	1(Ref)			
Male	39 (48.1)	18.32±11.36	1.02 (0.39,2.67)	27 (24.8)	26.88±18.95	0.32(0.13,0.80)	26 (100)	26.40±15.59	
BMI (kg/m^2)									
Normal	27 (33.3)	22..73±13.49	1(Ref)	79 (72.5)	24.04±18.21	1(Ref)	8 (30.8)	33.43±13.50	1 (Ref)
Overweight	22 (27.2)	16.83±10.08	2.72 (0.78, 9.52)	15 (13.8)	18.39±8.65	1.35(0.39,4.64)	7 (26.9)	25.64±13.50	4 (0.44,35.78)
Obese	32 (39.5)	13.01±6.21	3.47(1.08,11.14)	15 (13.8)	13.23±4.95	3.19(0.67,15.18)	11 (42.3)	21.79±17.18	5.25 (0.70,39.47)
Sunlight exposure									
No exposure	5 (6.2)	10.06±7.56	1(Ref)	16 (14.7)	14.67±8.71	1(Ref)			
<10 min/day	43 (53.1)	16.18±9.31	0.72 (0.07,7.22)	16 (14.7)	17.11±12.29	0.20(0.02,2.03)			
10-20 min/day	16 (19.8)	19.26±13.90	0.55 (0.05, 6.26)	18 (16.5)	21.61±8.06	0.13(0.01,1.26)			
>20 min/day	17 (21)	20.35±11.62	0.45 (0.41, 5.08)	59 (54.1)	25.02±19.76	0.12(0.01,0.98)	26 (100)	26.40±15.59	
% BSA exposed									
No exposure	5 (6.2)	10.06±7.56	1(Ref)	16 (14.7)	14.67±8.71	1(Ref)			
<10% exposed	23 (28.4)	14.43±9.95	0.71(0.07,7.66)	35 (32.1)	19.89±13.02	0.19(0.02,1.67)	2 (7.7)	13.71±5.84	1 (Ref)
10-20% exposed	53 (65.4)	19.21±11.10	0.58 (0.06, 5.59)	58 (53.2)	24.87±18.98	0.08 (0.01,0.60)	24 (92.3)	27.46±15.73	0.31 (0.01, 8.3)
Dietary vitamin D intake (IU/day)									
<600	39 (48.1)	16.13±10.36	1(Ref)	51 (46.8)	16.71±10.94	1(Ref)	10 (38.5)	22.37±16.68	1(Ref)
>600	42 (51.9)	18.37±11.35	0.46 (0.17,1.26)	58 (53.2)	23.23±18.96	0.21(0.08,0.54)	16 961.5	28.94±14.85	0.26 (0.05, 1.39)
Dietary calcium intake (mg/day)									
<500	76 (93.8)	17.22±10.72	1 (Ref)	97 (89)	22.26±16.72	1(Ref)	23 (88.5)	26.42±16.24	1 (Ref)
>500	5 (6.2)	18.32±14.43	0.57 (0.09,3.67)	12 (11)	17.89±13.17	2.23 (0.46,10.84)	3 (11.5)	26.32±12.73	0.46 (0.04, 5.79)

DISCUSSION

Our results have shown that VDD is a health hazard in hospital workers. Using the definition of serum 25(OH)D levels ≤20 ng/ml, we found that 82.3% of students and 63.2% of hospital employees and 44.4% gardeners suffering from VDD. Three subgroups of participants in our study represent the three major sections of community, office employees represent the housewives, nursing homes inhabitants, indoor companies and office workers, who spent minimum time in sunshine, nursing students represent the student section community with moderate time spent outside as a part of their extra-curricular activities and travel to the school and tuitions, and gardeners represent the farmers, village inhabitants, fruit and veggie wanders and manual laborers who spent sufficient amount of time working in the fields and outdoor. The prevalence of VD deficiency and insufficiency in our study confirm previous studies conducted in the valley and other parts of world.[11,20-22] Many risk factors predispose to development of VDD in different subgroups. Although VDD was found to be prevalent in all the age groups, the older age imparts a higher risk of having VDD, likely due to less VD synthesis because of lesser subcutaneous fat in older age group.[22,23] However, VDD appears to start early in life with only 19.3% of students and 12.3% of office employees had sufficient VD levels indicating that if necessary action is not taken on time, there is a potential exacerbation of VDD in the growing generations and in future we have to handle more skeletal problems in growing age. VDD was found to be more prevalent in females as compared to males (74.2% versus 60.9%) due to lesser duration (20.56±18.71 versus 71.68±86.15) and

lower %BSA (7.27±4.07 versus 10.45±1.92) exposed to sunlight in females because of cultural and personal habbits.[23] We found an inverse correlation between BMI and serum 25(OH)D levels. Risk of VDD was more in overweight and obese category among the three groups. However, in literature, the temporal relationship between VDD and obesity is still not clear, whether VDD is a cause or consequence of obesity is still not clear. In addition to the sedentary behavior and tendency to spend more time indoors and receive less sunshine, VD is sequestered in large body pool of fats in obese people causing inverse relationship between obesity and serum 25(OH)D levels.[22,24] Similarly, the absence of VD interferes with the normal functioning of leptin, a stop signal to the brain while feeding, leading to overeating and obesity.[25]

Sunlight exposure increases subcutaneous synthesis of serum 25(OH)D, many studies have found a positive correlation with sunlight exposure and serum 25(OH)D levels.[26,27] We also found sun exposure as one of the key determinants of VD status. Risk of VDD decreased with longer duration of sunlight exposure and higher percentage BSA exposed to sunlight. Office employees and students were at a 1.5 times higher risk for VDD compared to gardeners who had six times higher sunlight exposure, suggesting the sunlight exposure as a prime but not the only determinant of VDD.

Besides sun exposure, dietary VD intake is another contributing factor for maintaining serum 25(OH)D levels. We found a significantly positive correlation between dietary intake of VD and serum 25(OH)D levels. Sufficient VD intake (>600 IU/day) was associated with lower risk of VDD. However only 56.9% office employees, 64.2% students and 37.5% of gardeners were having sufficient dietary VD intake.

VD is known to affect mineral metabolism. To date, variable relationships of serum 25(OH)D levels with serum calcium, serum phosphate, and serum alkaline phosphatase reported, some studies have found a significant positive correlation between VD and serum calcium, serum phosphorus and negative correlation between serum 25(OH)D and serum alkaline phosphatase levels.[28-30] However, these findings were not replicated in other studies, likewise, we did not find a significant correlation between serum 25(OH)D levels with serum calcium, and phosphorus.[22,27] Serum alkaline phosphatase and PTH levels were found to be negatively correlated with serum 25(OH)D levels. In literature also VDD is found to cause secondary hyperparathyroidism resulting in bone turnover and thus leading to raised alkaline phosphatase levels.[1] Our finding of raised alkaline phosphatase levels is consistent with previous reports suggesting measurement of plasma alkaline phosphatase activity as a single routine biochemical test to detect rickets or Osteomalacia.[31-33] VD has been found to affect insulin resistance (IR) by mainly regulating calcium metabolism, insulin gene expression, glucose transporter-4 (GLUT-4) expression.[34,35] VD, receptors have been found on skeletal muscles; which by activation of the peroxisome proliferator activator δ receptor (PPARδ) stimulate the expression of insulin receptors in the target tissues and improves insulin sensitivity.[36] Some studies have found negative correlation of IR with serum 25(OH)D levels, while this finding was not replicated in other studies.[38-40] Similarly we didn't find any correlation between serum 25(OH)D levels with fasting plasma glucose and HOMA-IR.

The limitations of the study are: a) small sample size, b) inability to evaluate bone formation and resorption markers which are important to gauge the effect of vitamin D in bone mineral homeostasis.

CONCLUSION

This was a hospital-based study to assess the VD status students and employees. In our study by analyzing three subgroups of office employees, students and gardeners, we tried to visualize VD status of three larger sections of community they represent differing among themselves with regard to amount of sunlight exposed. We found sunlight exposure as major determinant factor for high prevalence of VDD. Besides this dietary VD intake has positive and increasing age, and BMI was found to have negative effect on serum 25(OH)D levels. Given the deleterious consequences of VDD on both skeletal and extra-skeletal health, there is an urgent need to intervene and relevant programs need to be designed to enable accessible and timely diagnosis and management of VDD.

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