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Correlates of Vitamin D Status among Adults in Western India

Research Article

Muley A[1]* and Iyer U[2]

[1]*Symbiosis Institute of Health Sciences, Symbiosis International (Deemed University), Pune, India*

[2]*Department of Foods & Nutrition, Faculty of Family & Community Sciences, The Maharaja Sayajirao University of Baroda, Vadodara, India.*

***Corresponding author:** Muley A, Symbiosis Institute of Health Sciences, Symbiosis International (Deemed University), Pune, India; Email: arti@sihspune.org

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Abstract

Vitamin D deficiency (VDD) prevalence has been addressed in many studies covering all continents and having enormous public health consequences. Though VDD is highly prevalent in India, there is paucity of data about it among population in Western regions which receive ample sunlight round the year. Hence this cross-sectional research attempted to investigate the vitamin D levels and the probable determinants in apparently healthy Indians from urban Vadodara in Gujarat state. About 129 subjects (30-60 years of age) from five zones of Vadodara were enrolled through snow-ball effect. Along with informed consent, demographic data and risk factors of VDD were gathered using a semi-structured questionnaire. Fasting blood samples of the participants were collected, and the serum was used to analyze vitamin D by ELISA. Serum 25(OH) D levels of more than equal to 75 nmol/L i.e. ≥30 ng/mL were considered sufficient while levels less than 75 nmol/L were reported as insufficiency or deficiency. The data was subjected to appropriate statistical analysis using SPSS v20. The results revealed that almost 88% of the subjects had VDD, with significant high prevalence among females ($p<0.01$). Percent body-fat, LDL-cholesterol and thyroid hormones- TSH & T3 showed significant negative correlation with the vitamin D levels, while hemoglobin was positively correlated. These along with age emerged as significant predictors for the vitamin D status in the multivariate regression model. Thus it was concluded that VDD was high among the population. So, there is a need to address the predictors for low vitamin D status by adopting a healthy dietary pattern and an active lifestyle with adequate exposure to sunlight.

Keywords: Vitamin D; Risk factors; Determinants; Apparently healthy adults; Gujarat; India

Introduction

Vitamins are organic compounds that are required in minute quantities to sustain life. Two compounds of vitamin D, namely-Ergocalciferol and cholecalciferol are important in living creatures. The prominent breakdown product of vitamin D in the body is 25-hydroxyvitamin D (written as 25 (OH)D), as it takes into account both the vitamin D obtained from cutaneous synthesis as well as the dietary sources. The of 25(OH)D concentration in serum is believed to be an accurate index of one's vitamin D levels (Holick, 2004) [1]. VDD has assumed pandemic proportions globally with the prevalence ranges between 31-98% based on this index (Wacker & Holick, 2013) [2]. Due to availability of good amount of sunlight, it is presumed that those residing in tropical countries may be little safer against developing VDD. However, data available so far proves it wrong. In a research among 3,262 adult subjects residing in Beijing and Shanghai, it was observed that the mean 25(OH)D level was about 40 nmol/l, and 69% and 24% of the subjects were having VDD and insufficiency respectively (Lu et al., 2009) [3]. Similarly in Korean population also VDD defined as values less than 20 ng/mL, was reported in 56.9% of the subjects (47.3% males and 64.5% females). Only about 20% of male the population had levels greater than 30 ng/mL (Choi et al., 2011) [4].

India is also a tropical country. Hence maybe it was never thought that VDD would be prevalent here. However about 90% of evidently healthy people in north India (Delhi) showed significant prevalence of hypovitaminosis D among themselves, when a sensitive and specific assay was used to measure serum 25(OH)D levels (Goswami et al., 2000) [5]. In a survey among hospital staff the mean serum levels were 30 nmol/L (Arya et al., 2004) [6], while among pregnant women it was 35 nmol/L [7] and 36 nmol/L for the post-menopausal women in India [8]. In a cross sectional study among 444 subjects belonging to higher socioeconomic population of different age groups and gender in Ahmedabad City, Gujarat majority of the subjects (46.4%) were severely deficient [8,9] also in their previous study reported sub-optimal serum 25(OH)D quantity among adult population with significantly low amounts among women as compared to males (11.49±6.9 vs 17.24±3.5, $p<0.001$). A study from north India among healthy individuals above the age of 50 years VDD was present in 91.2% of the population while 6.8% reported insufficiency [10]. The major reasons attributed to VDD in India are duskier skin complexion, less exposure to sunlight, predominantly vegetable oriented dietary pattern and scarcity of vitamin D fortified foods in the market [11]. Thus though a fair body of literature on prevalence of VDD for Indian population exists, there is a scarcity of data from western states of India; especially on risk factors and determinants of vitamin D status among apparently healthy population in spite of sunlight. Thus to challenge the hypothesis that availability of ample sunshine decreases the risk of VDD, the current research was conducted in Vadodara city. It is the eighteenth biggest city in India and the third largest of the state. Its location is 22.30°N 73.19°E in central Gujarat and is blessed with sunshine almost all long the year because of its strategic location. An attempt was made to determine the factors for poor vitamin D status among the participants.

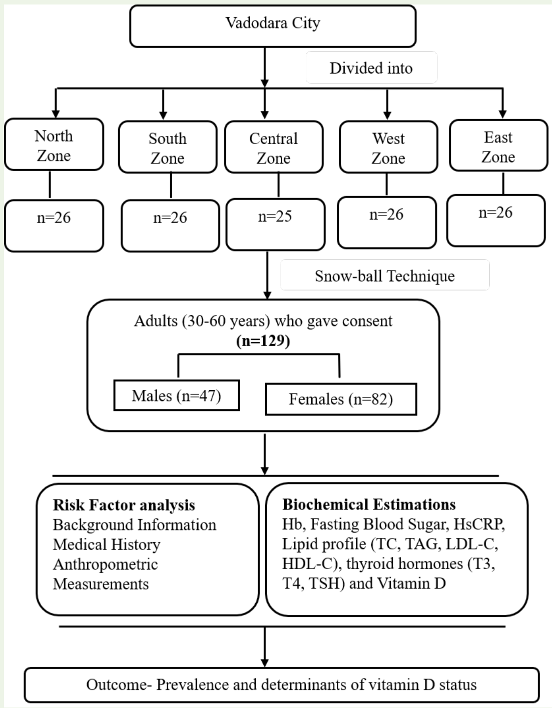

Figure 1: Flow Diagram for the study.

Materials and Methods

The present research is a cross-sectional study carried out among apparently healthy individuals residing in city of Vadodara in Gujarat state, western India.

Selection of participants

For the enrolment of participants living in different localities of the city, the city was divided into five zones- north, south, central, west & east. Through snow ball effect, 129 participants (twenty-six each from north, south, east and west zone and twenty-five from the central zone) were enrolled (Figure 1).

Inclusion-exclusion criteria

The inclusion criterion was subjects should be in the age group 30-65 years; they should be residents of the city and give a positive consent to participate in the study and for the blood estimations as well. Pregnant women and lactating mothers and those suffering from diabetes mellitus were not included in the study along with those taking vitamin D supplements present and past six months.

Ethical approval

Ethical approval was obtained from the Institute's Ethic Committee. Informed written consent was obtained from all the participants in English as well as local language (Gujarati).

Data collection

Information pertaining to social and demographic background, health information was collected using a questionnaire which was pilot tested before use in the study. Body measurements like weight, height, waist circumference and hip circumference were noted for all the subjects using standard tools and procedures. Weight was recorded by a standardized electronic bathroom scale and height by non stretchable tape. The waist and hip circumference measurements were recorded as per the standard definitions and protocols [12,13]. Percentage body fat was calculated using the Omron body fat monitor (Model HBF-306). Researcher was trained to take all the measurements. Standard formula was used to compute BMI. Blood pressure was measured by clinically validated digital BP meter (Omron HEM-7203 model). An average of the three recorded readings was considered.

The participants were asked to observe an over-night fast (12 hours post dinner). Blood samples were collected by a certified technician for the biochemical profile. CLIA technique using kit procured from Simens-ADVIA Centaur was used to estimate 25(OH) D for vitamin D status. The serum level of 25(OH)D gives a correct picture of combined values obtained from sunlight exposure and intake through food and hence considered as a 'gold standard' for the present study also [14]. The definition given by Lips (2001) was used to classify the subjects based on their vitamin D status. Lipid profile (total cholesterol, triglycerides, low density lipoprotein and high density lipoprotein), was estimated using Olympus AU2700 and Advia 1800 and the detection technology was by Photometry. Haemoglobin was estimated by cyanmethemoglobin method in autoanalyser, HsCRP by Nephelometry and fasting blood glucose using GOD/POD method by enzymatic kit from Ecoline. Detection Technology used for the estimation of TSH was ultrasensitive sandwich chemiluminescent immuno assay by Advia centaur CP and XP systems. These biochemical analyses were carried out by a private laboratory certified by ISO 9001:2008 and NABL (India).

Statistics

Data entry was done in Excel; checked and verified by the investigator. Statistical analysis was done using SPSS v20. *p* value of <0.05 was considered for significance. Chi square values were computed for checking the significance for categorical variables. Pearson '*r*' value was calculated to study the correlations for vitamin D status and risk factors. To identify the predicators of serum vitamin D status a stepwise multivariate analysis (Linear regression) was computed.

Results

This study reports the results on 129 participants. A part of the results are published elsewhere. Mean serum vitamin D for the enrolled participants was observed to be 13.7 ng/mL, which is much lower than the recommended optimum level of >30 ng/mL [15]. As seen from Table 1 almost 88% of the subjects were vitamin D deficient and only 4% were in the sufficiency range with levels >30 ng/mL. The deficiency was significantly higher among females as compared to male subjects.

The vitamin D deficient subjects were further classified into sub-category of mild, moderate and severe deficiency. As can be seen from Figure 2, about 53.5% subjects were falling under mild category with higher number of males (74.5%) as compared to females (41.5%), while nearly half (51.2%) of the deficient female population showed moderate vitamin D deficiency. It was heartening to see that only two of the females (2.4%) had severe deficiency i.e,, levels <5 ng/mL. The correlation of various parameters with serum vitamin D levels revealed that among the anthropometric measurements, percent body fat was negatively significantly correlated with the subjects' vitamin D status. While for biochemical parameters LDL cholesterol and thyroid hormones- TSH & T3 had a significant negative correlation, while hemoglobin showed to be positively significantly correlated (Table 2).

Table 1: Gender wise vitamin D status of the subjects (n= %).

Serum 25(OH)D ng/ml	Females (n=82)	Males (n=47)	Total (n=129)	X^2 value
Deficiency (<20)	78 (95.1)	36 (76.6)	114 (88.4)	
Insufficiency (20-≤ 30)	2 (2.4)	8 (17)	10 (7.7)	
Sufficiency (>30)	2 (2.4)	3 (6.4)	5 (3.8)	10.55**

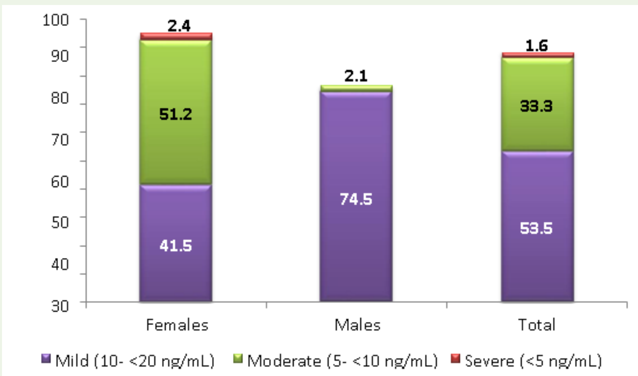

Figure 2: Gender wise sub-classification of vitamin D deficiency (%).

Table 2: Correlation of serum vitamin D levels with anthropometric measurements & biochemical parameters of the subjects.

Variable	Pearson r value	*p* value
Anthropometric measurement		
Body fat (%)	-0.246	0.005**
Biochemical Parameters		
LDL Cholesterol	-0.184	0.036*
Hb (gm/dl)	0.314	0.000***
TSH	-0.223	0.011*
T3	-0.180	0.041*

p< 0.001***, <0.01**, <0.05*

Table 3: Multivariate predictors of vitamin D status among the subjects (Stepwise Linear Regression).

Predictor Variables	Adjusted r^2	Standardized β coefficients	*p* value
% Body fat	0.279	-0.162	0.057
Age		0.273	0.001**
TSH		-0.267	0.001**
Haemoglobin		0.292	0.000***
LDL cholesterol		-0.210	0.008**
T3		-0.168	0.031*
Fasting Blood Sugar		-0.169	0.037*

p< 0.001***, <0.01**, <0.05*

Considering serum vitamin D levels as the dependent variable in the multivariate analysis (Table 3), showed that the model that explained maximum amount of variation (27.9%) consisted of seven variables: % body fat, age, TSH, hemoglobin, LDL cholesterol, T3 and FBS; with six predictors being statistically significant except percent body fat which just missed the significance.

Discussion

Deficiency of vitamin D is prevalent in countries which are 'sunshine deficient' as well as 'sunshine sufficient'. It is considered a public health concern in country like India too [16]. Thus this research attempted not only to study the vitamin D deficiency levels but also to recognize the determinants for poor 25(OH) D status. In the present study it was observed that almost 88% of the participants had vitamin D deficiency, with significantly among females. These results are similar to studies reported elsewhere. A cross sectional study in an existing Malay cohort in Kuala Lumpur reported that women possesed significantly poor vitamin D status compared to men (36.2 against 56.2 nmol/L respectively). About 41% of men and 87% women had levels <50 nmol/L (p<0.001) [17,18] reported that about 25.2% were vitamin D deficient and 36.2% were insufficient among 365 participants, enrolled clinics in the state of Kuwait. Females and participants of 60 years and above showed significant frequency of being vitamin d deficient. Similar results have been reported by Indian authors also. A study carried out in Kashmir valley among 150 healthy volunteers, aged 18-40 years observed 83% as vitamin D deficient, with females having significantly higher prevalence compared to males (94.4 and 76.6%, p<0.001) [19]. The possible reasons contributing to this gender difference may be that Indian women especially the homemakers and those who work from home; spend a big amount of day time doing indoor household work, or home employment like taking coaching classes, running a beauty parlor, tailoring activities, and restricts them to sunlight exposure. The clothing style of females, such as wearing long sleeves salwar-kameez, sari, or using hand gloves or sun-coat and covering the face with dupatta while going out reduces the total body area exposed to sunlight and thus reducing vitamin D production beneath the skin.

To see the extent of deficiency among the population the subjects were further categorized in various stages of VDD as proposed by [20]. The segregation showed that majority were in mild to moderate category and only 1.6% of the population had levels <5ng/mL comprising the severe category, also reported similar analysis, wherein the reported prevalence of severe deficiency (27.9% and 27.5% respectively) was more in comparison to the present study. In the present study age emerged as significant determinant for vitamin D status. As age advanced the levels too increased [21], also reported a significant age related increase of vitamin D levels among healthy Omanis of age 18 to 55 years. Females, as compared to males, possessed significantly less values of vitamin D (28.2 against 36.8 nmol/L, $p<0.0001$). The overall prevalence of VDD in the population was about 88%. In the KNHANES study also poor vitamin D status was most prevalent in the age of 20-29, with 65% of males and 80% females being deficient as compared to the older age groups. A study conducted among 77 healthy women, age 19 to 66 years, working in nursing homes in Japan also reported low serum levels among the young age group [22].

The correlations and multivariate analysis revealed that age and hemoglobin levels had positive associations with vitamin D levels while percent body fat, LDL-cholesterol, thyroid hormones and serum glucose emerged as negative determinants for poor vitamin D status. A study among healthy Omani population also reported, poor vitamin D status to be associated moderately with BMI and prominently with indices of abdominal obesity. Waist-to-Hip ratio emerged as the main predictor of serum 25(OH)D levels among the participants also reported that being a women (Odds Ratio= 8.68; 95% CI: 5.1-14.8) and having abdominal obesity defined by high WC (OR 2.57; 95% CI: 1.51-4.39) had significantly higher odds for insufficient Vitamin D status. [23] reported some very favorable results in his study on 171 healthy Korean adults who had no cardiac disease history. Vitamin D levels were positively correlated with age ($p<0.05$), HDL-C ($p<0.05$), and the inflammatory marker adiponectin ($p<0.05$) levels. These results clearly emphasize the requirement of regular exercise to maintain desired anthropometry measurements and biochemical parameters, more so if one is a woman.

Conclusion

Thus from this cross sectional study it can be concluded that VDD was highly present in the apparently healthy adult population with women being a vulnerable gender. All the significantly emerged variables can ultimately be managed and maintained by adopting a healthy dietary pattern and an active lifestyle with adequate exposure to sunlight which needs due attention. The results though cannot be generalized to entire nation as our participants belonged only to the urban setting of a city in western India. However, as per our review, this is the only study of its kind to map the prevalence of VDD in Vadodara and investigate the relationship of vitamin D levels with clinical conditions. This study will also add to the exciting literature that reports a high prevalence of VDD in India, thus emphasizing the need for a nationalized vitamin D supplementation and fortification programme.

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