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Arti Muley.
Department of Foods & Nutrition, Faculty of Family & Community Sciences.
The Maharaja Sayajirao University of Baroda, Vadodara. Gujarat-390002
Email: asmuley@gmail.com

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Vitamin D status of adult population aged 30-60 years in Vadodara city- A cross sectional study

Arti Muley*,Uma Iyer
Department of Foods & Nutrition, Faculty of Family & Community Sciences
The Maharaja Sayajirao University of Baroda, Vadodara. Gujarat-390002

Abstract

Background: Vitamin D deficiency (VDD) is a public health problem worldwide, but relatively few countries have data available on the vitamin D status of their population.

Objective: The objective of the study was to map the prevalence of VDD among the adult population of Vadodara city in Gujarat, West India and identify its risk factors.

Method: 141 adult subjects (males=50, females=91) in the age group 30-60 years, who gave written consent for participation, were enrolled for the cross-sectional study through snowball effect. Data on anthropometric indices and background information was collected from them.

Results: The mean serum 25(OH)D level of the subjects was found to be 13.53 ± 7.0, with significantly lower levels among females. About 88.6% subjects had VDD with 25(OH)D levels <20 ng/ml of which 94.5% were females. Only 3.5% of the subjects were in the sufficiency range (>30ng/ml). When vitamin-D status was cross tabulated with age, maximum deficiency was seen among 30-40y (31.9%) followed by 51-60y (29.8%). In relation to the anthropometric indices (BMI, WC, WHR, WSR, body fat and blood pressure), the prevalence of all the risk-factors was high among the group with low levels of vitamin-D (<20ng/ml) as compared to the high level group (≥20ng/ml). Nearly 27% subjects had a history of fractures of which 23% had VDD. With respect to sun exposure, the vitamin-D levels were significantly low among the subjects with no or low exposure (<140 min/week).

Conclusion: Thus, a high prevalence of VDD was observed in the population indicating an urgent need to discover and implement preventive strategies and address this epidemic.

Keywords: Vitamin-D deficiency, adults, anthropometric indices, sun exposure

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INTRODUCTION

Vitamin D is a group of fat-soluble prohormone with two major biologically inert precursors D3 (cholecaciferol) and D2 (ergocalciferol) (1, 2). Serum 25-hydroxyvitamin D (25[OH] D) is the major circulating metabolite of vitamin D and reflects the vitamin D received from cutaneous synthesis and dietary sources. The serum concentration of this metabolite is most commonly used and the most sensitive index of vitamin D status (3). Vitamin D is utilized by the body through various vitamin D receptors (VDR) present on many tissues and organs in the body. VDR have opened up new roles for vitamin D far beyond the traditional function of maintaining calcium-phosphate homeostatisis. Vitamin D deficiency has assumed pandemic proportions globally. Using serum (25[OH]D) values, it has been estimated that 1 billion people worldwide are vitamin D deficient or insufficient (4) and the prevalence across the globe ranges from 31-98 % (5). India, located between 8.4 and 37.6 ˚N latitude with majority of its regions receiving ample amount of sunlight throughout the year (6), was earlier thought to be spared of Vitamin D deficiency (VDD) (7). But Goswami et al in 2000, using sensitive and specific assay to measure serum 25(OH)D in apparently healthy subjects in Delhi showed that significant hypovitaminosis D was present in upto 90 % of them (8). There are other studies conducted in India on various socio-economic groups, different ages, on both genders and different race, as well as different disease states, such as primary hyperparathyroidism reporting widespread vitamin D deficiency/ insufficiency in India (9, 10). The major reasons of VDD in India despite its sunny climate maybe attributed to skin complexion, poor sun exposure, vegetarian food habits and lack of vitamin D food fortification programme in the country (8). Though vitamin D deficiency is highly prevalent in India, data about the vitamin D status of population residing in western India is scanty. Therefore, a study was carried out in Vadodara city which is the 18th largest city of the country located in western part of India at 22.30°N 73.19°E and receives ample sunlight almost throughout the year to assess the vitamin D deficiency among the population, and identifying the risk factor to study their association with the vitamin D status.

PARTICIPANTS & METHODS OF DATA COLLECTION

Vadodara city was divided into five zones. One society was selected purposively for the enrolment of the subjects in the age group 30-60 years. Then through snow ball effect the subjects who gave written consent for participation were included till the required sample size was attained. Based on the available literature taking the prevalence of vitamin D deficiency as 80% in the adult Indian population, the sample size required for a cross sectional study came out to be 138. A total of 141 subjects (males= 50 and females =91) were enrolled between the months of February to August. Background information was collected using a pre-tested semi-structured questionnaire. The time of exposure to sunlight between 10 am to 3 pm was recorded based on the occupation and other activities of the subjects. Weight was taken using Salter electronic bathroom scale and blood pressure by Omron digital BP meter. Height, waist & hip circumference were measured using non-stretchable fibre glass tape to the nearest 0.1cm. Body mass index (BMI), waist-hip ratio (WHR) and waist-stature ratio (WSR) were calculated by standard formulas. Percent body fat was measured using Omron digital fat analyzer. After an over-night fast, blood samples were collected by a trained technician. Serum was separated and 25-hydroxyvitamin D for vitamin D status was estimated by Chemiluminescence Immunoassay (CLIA) technique in an accredited laboratory. VDD was defined as serum 25(OH) D concentration of $<$20ng/ml and categorized as insufficiency (20-≤30 ng/ml) and sufficiency ($>$30 ng/ml) (11).

The limitation of the study was that population residing in the urban slums of the city were not enrolled for the data collection. The study has been approved by the *Institutional Ethics Committee for Human Research* No. IECHR/2012/21

Statistical analysis

Data was entered in Microsoft Excel 2007 and verified by the researcher. Statistical Package for Social Sciences (SPSS) version 16 and EpiInfo version 7 were used for statistical analysis of the data. A two-tailed p value was used for calculating statistical significance; a value of $p<0.05$ was taken to be significant. For quantifiable variables, descriptive statistics (means and standard deviation) were calculated. In case of categorical variables, frequency distribution was computed. Comparison of means was done using't' test and difference in proportions were compared by 'chi-square' test.

RESULTS

Table 1 gives the characteristics of the one hundred forty one subjects (50 males & 91 females) of age between 30-60 years enrolled in the study. The mean age of the subjects was 45.37 ± 9.3. The waist-stature ratio (WSR) was significantly high among female subjects as compared to males (0.55 ± 0.06 vs 0.61 ± 0.07, $p<0.001$). The mean serum 25(OH)D value for all the subjects was 13.53± 7.0, with females having significantly lower levels than males ($p<0.001$).

Parameters	Males (n=50)	Females (n=91)	Total (n=141)	t-test p value
Age (Y)	44.02 ± 8.4	46.1 ± 9.7	45.37 ± 9.3	
Waist Hip Ratio	0.9 ± 0.05	0.9 ± 0.1	0.93 ± 0.07	0.327
Waist Stature Ratio	0.55 ± 0.06	0.61 ± 0.07	0.59 ± 0.07	0.000***
Body Mass Index	26.3 ± 4.6	25.76 ± 4.63	25.96 ± 4.6	0.491
25(OH)D levels (ng/ml)	17.24± 3.5	11.49 ± 6.9	13.53± 7.0	0.000***

p < 0.001***

Table 1: Clinical profile of the subjects (Mean ± SD)

Overall, 88.6 % (125 out of 141) of the subjects studied had vitamin D deficiency with levels below 20ng/ml. The female subjects showed significantly higher prevalence than their male counterparts (94.5 vs 78%, p=0.011). It was very disheartening to note that only 5 of the 141 subjects (3.5%, 3 males & 2 females) had serum 25(OH)D levels >30 ng/ml comprising the sufficiency group (table 2).

Categories	Males (50)	Females (91)	Total (141)	
Deficiency (<20 ng/ml)	78 (39)	94.5 (86)	88.6 (125)	X^2 p value 0.011*
Insufficiency (20-≤30 ng/ml	16 (8)	3.3 (3)	7.8 (11)	
Sufficiency (>30 ng/ml)	6 (3)	2.2 (2)	3.5 (5)	

Values in parenthesis are in numbers.

p < 0.05* ,

Table 2: Vitamin D status of the subjects in relation to gender

Similarly when the vitamin D status was observed across the various age groups, the maximum prevalence of 31.9% was reported among the subjects of age 30-40 years followed by 29.8% among 51-60 years of age (figure 1).

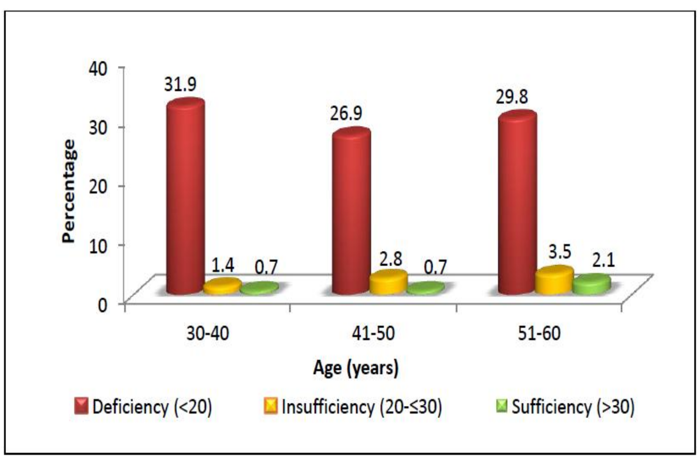

Figure 1: Vitamin D status (ng/ml) of the subjects in relation to age (n, %)

Parameter	Sun Exposure <140 minutes/week (n=110)	Sun Exposure ≥140 minutes/week (n=31)	T test p-value
Mean vitamin D levels	12.83±7.4	16.02±4.7	0.026*

p < 0.05*

Table 3: Vitamin D levels of the subjects in relation to exposure to sunlight (Mean ± SD)

Table 3 depicts the serum vitamin D levels across the duration of sun exposure. It was observed that those subjects who had exposure of more than 140 minutes per week (which is approximately >20 minutes per day) had significantly higher levels of vitamin D in them as compared to those who exposed less to sunlight (12.83±7.4 vs 16.02±4.7, p=0.026).

Further analysis was done by dividing the subjects into two groups based on their vitamin D levels. Subjects with serum 25(OH)D levels <20ng/ml formed the deficiency or low level group while those with ≥20 ng/ml were in the high levels group. The vitamin D status was studied in relation to history of fractures among the subjects. It revealed that 27% (38) of the subjects had history of fractures of which 23% (33) had VDD (table 4).

	Vitamin D <20 ng/ml (n=125)			Vitamin D ≥20 ng/ml (n=16)		
Had Fractures	Males	Females	Total	Males	Females	Total
	8.8 (11)	17.6 (22)	26.4 (33)	25 (4)	6.3 (1)	31.3 (5)
χ2 p value	0.681					

Table 4: Vitamin D status of the subjects in relation to history of fractures (n, %)

The difference was not significant among the high and low vitamin D groups. The anthropometric indices when cross-tabulated against these groups showed that the values for almost all the parameters except diastolic blood pressure were higher among the low vitamin D level group. WSR (0.59±0.07 vs 0.55±0.09, p=0.028) and percent body fat (34.61±6.1 vs 30.18±8.2, p=0.01) had significant higher values for subjects with low levels of vitamin D as compared to the other group (table 5).

Parameters	Vitamin D <20 ng/ml (n=125)	Vitamin D ≥20 ng/ml (n=16)	T-Test (p value)
Body Mass Index	26.14±4.5	24.5±5.3	0.189
Waist circumference (cm)	93.1±10.5	88.89±13.3	0.147
Waist stature ratio	0.59±0.07	0.55±0.09	0.028*
Waist hip ratio	0.93±0.06	0.91±0.08	0.434
% Body Fat	34.61±6.1	30.18±8.2	0.01**
Systolic BP	129.6±17.5	130.1±18.2	0.916
Diastolic BP	80.26±10.3	83.3±10.8	0.267

p < 0.05* , 0.01**

Table 5: Anthropometric indices across vitamin D status of the subjects (Mean ± SD)

The odds ratio was calculated to identify the risk factors for vitamin D status (table 6). It was observed that being a female posed a significant higher risk to be vitamin D deficient as compared to male gender (OR=4.85, 95% CI=1.57-14.9). Subjects with high anthropometric indices like BMI (OR=2.9, 95% CI=1.01-8.4), WC (OR=3.15, 95% CI=1.02-9.6), WHR (OR=3.6, 95% CI=1.09-11.9) and WSR (OR=4.29, 95% CI=1.14-16.1) all had significant greater odds of having low vitamin D levels.

Risk Factor	Vitamin D <20 ng/ml (n=125)	Vitamin D ≥20 ng/ml (n=16)	OR	95% CI
Age ≥ 40 y	68 (85)	81.3 (13)	0.49	0.13-1.8
Gender (Female)	68.8 (86)	31.3 (5)	4.85 **	1.57-14.9
BMI ≥ 23	74.4 (93)	50 (8)	2.9 *	1.01-8.4
WC (M≥90, F≥ 80)	84 (105)	62.5 (10)	3.15 *	1.02-9.6
WHR (M≥0.9, F≥ 0.85)	88.8 (111)	68.7 (11)	3.6 *	1.09-11.9
WSR (≥ 0.5)	92.8 (116)	75 (12)	4.29 *	1.14-16.1
Sun exposure (<140 mins/ week)	79.2 (99)	68.7 (11)	1.73	0.55-5.4

Values in parenthesis are in numbers.

p < 0.05* , 0.01**

Table 6: Risk factors for low vitamin D levels among the subjects [N=141]

DISCUSSION

Our study, from Western India found a very high prevalence (88.6%) of vitamin D deficiency (defined as serum 25(OH)D levels <20ng/ml) among apparently healthy adults residing in an urban setting. Despite its sunny environment, a high prevalence of VDD has been reported from India. Marwaha et al (12), in a study of 1346 apparently healthy individuals above 50 years from north India reported VDD with serum 25(OH)D levels below 20 ng/ml in 91.2% of the population and vitamin D insufficiency (serum 25(OH)D 20-<30 ng/ml) in 6.8% of the population. Similarly another study reported VDD in women of reproductive age group (76 %) and in post menopausal women (70%) with serum 25(OH)D levels <20ng/ml in south India (13). In a recent review the prevalence of various countries ranged from 31% in Australia to 98% in Mongolia. The reported prevalence for Indian population was 75% (5). A study carried out in Kashmir valley of India reported a prevalence of 83% among adults, with higher rates among females as compared to males (94.4 vs 76.6%) (14). In our study also levels of serum vitamin D were significantly lower among females and so the prevalence was high as compared to males. This finding relates with the lifestyle of non-working Indian women who spend a large part of their day being engaged in indoor household work and so have poor sun exposure. The clothing of Indian women which is usually a sari or salwar-kameez reduces the area of body exposed to the sun. As majority of the population in this part of India are vegetarian, the vitamin D intake from dietary sources would also be scarce due to fewer options of vitamin D sources.

Increasing age has also been associated with lower vitamin D values (15). However in our study the highest prevalence of VDD (31.9%) was observed for age group 30-40 years. The probable reasons maybe that it is a working group with majority of its time spent in offices that too indoor and have comparatively sedentary lifestyle. This is an area of concern as age >65 years is considered a risk factor for VDD and in our population high prevalence was seen among young adults, thus suggesting that vitamin D estimation should be regularly monitored from early age . These findings also relate with the significantly lower levels of vitamin D among the subjects who had less exposure to sun light. Sunlight is the most abundantly available natural source of vitamin D and exposure of atleast 20 minutes on arms and legs a day between 10am-3pm of day produces enough vitamin D in the body to attain adequacy (3). When whole body is exposed to sunlight with one minimal erythema dose (MED), *i.e.*, the minimal dose leading to pink coloration of the skin 24 h after exposure, leads to vitamin D levels comparable to oral intake of 10,000 to up to 25,000 IU vitamin D2 (16-18). But due to urbanization, long indoor working hours and lack of physical activity use of this natural source is to the minimum. Goswami et al (19) compared the serum vitamin D of urban and rural population in North India and reported that the mean 25(OH)D values for subjects in rural area were much higher than the urban area population (36.4±22.5 vs 13.5±3.0 nmol/l). This could be explained by longer duration of sunshine exposure in the former.

VDD is also associated with increased risk for fractures (4), however there are conflicting reports in the literature (11). Serum 25(OH) D levels were not significantly different among those with or without history of fracture in our study, however a higher number of subjects with low level of vitamin D had fractures. These findings are in line with the study conducted among healthy Indian adults of age 50 years and above, where in also 27.8% subjects had history of fractures with no significant difference between those with history of fractures (9.95±8.73 ng/ml) and those without (9.74±7.14 ng/ml, p=0.88) (12). Another study from UK also reported that patients with hip fracture had lower serum 25(OH) D levels compared with controls. This difference was not observed in case of fractures for other sites (20). VDD has also been linked to obesity and central adiposity (21). Waist circumference (WC), waist-to-hip ratio (WHR) & waist-to-stature ratio (WSR) are the anthropometric indices widely used for the evaluation of central body fat distribution (22-25). This relationship was also observed in our study when various anthropometric indices were cross tabulated with the vitamin D status of the subjects with WC and % body fat emerging as the modifiable factors for lower vitamin D levels. These both are related to physical activity pattern and hence propagate a daily activity routine in an individual. Modest but significant inverse relationships of vitamin D3 with weight (p = 0.0009), BMI (p = 0.005) and waist (p = 0.03) were reported in a study among 250 ambulant adults in Auckland, New Zealand, however no relationship was seen with fat % (26). The high anthropometric indices (BMI, WC, WHR & WSR) in our study, along with being a woman showed to have higher odds for poor vitamin D status, emphasising the need of regular exercise and maintaining ideal anthropometric profile, more so if you belong to the fairer sex.

CONSLUSION & RECOMMENDATION

A high prevalence of VDD was observed in the population with anthropometric parameters and low sun exposure emerging as significant risk factors. Therefore, it is recommended to conduct studies propagating the importance of increased physical activity, with at least 20 minutes of sun exposure per day, which in turn would help in improving the vitamin D status of the individuals. The findings of the study form an important data from the public point of view in India and other tropical countries with similar geographical location and also support the idea of universal supplementation program for vitamin D in the country.

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