International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(4): 1138-1141

Received: 23-05-2020
Accepted: 05-06-2020

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Impact of lifestyle and dietary factors on 1, 25-dihydroxyvtamin d concentration of women of reproductive age group

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DOI: https://doi.org/10.22271/chemi.2020.v8.i4i.9758

Abstract
Lifestyle and dietary factors play a major role in maintaining and regulating the concentration of 1, 25-dihydroxyvitamin D in the body. The study was conducted on 350 women (aged 18-45 years), considering the significance of vitamin D in the health of women of reproductive age. 1, 25-dihydroxyvitamin D concentration was assessed using enzyme immunoassay method and chemiluminescence. Dietary history was assessed through 24-hour recall method and a pre-tested food frequency questionnaire for vitamin D and calcium intake. Data on lifestyle practices, including sun exposure pattern was recorded using a pre-tested questionnaire. Results revealed that the 1, 25-dihydroxyvitamin D concentration of tobacco and alcohol consumers were 19.87±3.78 ng/ml and 19.67±5.43 ng/ml, respectively, which were much below the normal range for 1,25-dihydroxyvitamin D concentration (30 ng/ml). Data on dietary intake showed that 1, 25-dihydroxyvitamin D concentration of both non-vegetarian and non-vegetarian were much below the normal range (18.67±7.66 ng/ml and 19.93±5.31 ng/ml, respectively). Correlation analysis between vitamin D concentration and dietary intake of vitamin D and calcium revealed a significant positive association between the two ($p<0.05$), indicating decrease in dietary intake of vitamin D and calcium led to the decrease in serum vitamin D concentration. Simple linear regression analysis revealed that 34.45 per cent of the total variability on the 1,25-dihydroxyvitamin D concentration was determined by dietary intake of vitamin D and 35.12 per cent of the total variability of 1,25-dihydroxyvitamin D was determined by dietary calcium intake, respectively Thus, the present study shows that the low concentration of 1,25-dihydroxyviatmin D was attributed to lifestyle practices like tobacco and alcohol abuse and inadequate dietary intake of vitamin D and calcium. The need of the hour is to sensitize the women about the significance of lifestyle and dietary attributes in improving the concentration of 1, 25-dihydroxyvitamin D and hence, preventing vitamin D related disorder especially pertaining to this age group.

Keywords: 1, 25-dihydroxyviatmin D, women, reproductive age, dietary intake, alcohol, tobacco abuse

Introduction
Vitamin D deficiency has been recognised as a major epidemic with a global prevalence of 1 billion, affecting 70-90 per cent of the population. The scenario of vitamin D deficiency is more precarious in developing countries of South Asia, with an estimate of 60-70 per cent of the population suffering from vitamin D deficiency (Palacios *et al*., 2013) [9]. Amongst the developing countries of South Asia, India occupies a larger share of vitamin D deficient population (more than 60%) where poverty and malnutrition continue to prevail and exacerbate the magnitude of vitamin D deficiency. Vitamin D deficiency is associated with certain lifestyle and dietary factors that lead to reduced cutaneous synthesis of vitamin D. (Chirumbolo, 2015) [2]. Inadequacy in dietary intake of vitamin D and calcium is another major contributor of high vitamin D deficiency in many populations (Garg *et al*., 2014) [3]. In India, social taboos affect the lifestyle of the individuals, resulting in reduced affordability in purchasing vitamin D rich food sources and supplements. Faulty lifestyle habits such as excessive tobacco and alcohol abuse disrupts vitamin D absorption and utilisation, causing a serious depletion in vitamin D concentration in the body (Ritu *et al*., 2014) [11].
Vitamin D deficiency gravely affects the women in reproductive age, affecting their health in numerous ways.

Vitamin D deficiency at this age often manifests as bone disorders such as osteoporosis and osteomalacia in the later lives of the women. Vitamin D is associated with the reproductive health of the women and has been found to have an important role in the management of Polycystic Ovarian disease (PCOD) by controlling metabolic disturbances like menstrual irregularities, infertility, hyperandrogenism, increased testosterone, obesity and insulin resistance. (Vaidya *et al.*, 2010) [12]. Vitamin D has been linked with increased risk of metabolic syndromes such as hypertension and diabetes mellitus, autoimmune diseases, cancer and cardiovascular diseases. (Wacker *et al*., 2013) [13]. Women in reproductive age undergo nutritional exhaust owing to the various metabolic processes during this stage accompanied by dietary inadequacy, poor health care, and episodes of morbidity. The present study is an attempt to assess the vitamin D status of the reproductive aged women residing in Upper Assam and to determine the association with dietary and lifestyle factors.

Materials and methods

Non-probability purposive sampling method was used for the selection of respondents. A total of 370 women in the reproductive age (18-45 years), residing in Upper Assam were selected for the study. Data on lifestyle pattern, including sun exposure pattern of the women was collected using a standardized questionnaire. Dietary history was recorded using 24-hour recall method. Dietary intake of calcium and vitamin D was obtained from a pre-tested food frequency questionnaire. Serum 1, 25-dihydroxyvitamin D_3 was assessed by using enzyme immunoassay method and chemiluminescence. The data obtained was statistically analysed for determining association between the variables.

Inclusion criteria

Inclusion criteria: age 18-45 years, all women residing in Upper Assam.

Exclusion criteria

Exclusion criteria: age>18 years; pregnant and lactating women; women with chronic liver disease; women with renal disease.

Results

Sun exposure patterns indicated that 100 % of the women who were exposed to sun for more than 4 days per week had a mean 1,25-dihydroxyvitamin D concentration of 19.05±6.34 ng/ml, which was below the normal range (30 ng/ml). 46.80% of the women who were exposed to sun for 30 minutes to 1 hour had a mean 1, 25-dihydroxyvitamin D concentration of 18.95±7.11ng/ml, while 53.20% of the women who were exposed to sun for more than 3 hours had a mean 1, 25-dihydroxyvitamin D concentration of 19.87±5.98 ng/ml, indicating low vitamin D concentration in both the sun exposure duration.

The mean 1,25-dihydroxyvitamin D concentration of the women who followed a clothing pattern of saree with full sleeved shirt and gloves and respondents who followed a clothing pattern of saree with full sleeved shirt and no gloves were 19.62±6.40 ng/ml and 19.93±3.56 ng/ml, respectively, which were below the normal range (30 ng/ml). The respondents who followed a clothing pattern of saree with short sleeved blouse had a normal 1,25-dihydroxyvitamin D concentration of 32.00±8.02 ng/ml, indicating a significant difference (p<0.05) in the vitamin D concentration of the women in different clothing patterns (Table 1).

Table 1: Mean 1, 25-dihydroxyvitamin D concentration of the respondents in different sunning practices

Variables	Categories	Mean 1,25-dihydroxyvitamin D concentration ± SD (ng/ml)	t (p value)	Normal 1,25-dihydroxyvitamin D concentration
Sun exposure per week	1 day	-	-	>30 ng/ml
	2 days	-	-	
	3 days	-	-	
	4 or more days	19.05±6.34	-	
Sun exposure time per day	30 minutes-1 hour	18.95±7.11	0.73	
	1- 2 hours	-		
	2-3 hours	-		
	More than 3 hours	19.87±5.98		
Time of day spent outdoors	7am-10am	19.67±1.25	0.94	
	10am-1pm	19.94±7.30		
	1pm-4pm	19.45±5.16		
Clothing pattern	Saree with full sleeve shirt and gloves	19.62±6.40	0.07*	
	Saree with full sleeve shirt	19.95±3.56		
	Saree with short sleeve blouse	32.00±8.02		

*significant at p<0.05

Mean 1,25-dihydroxyvitamin D concentration of tobacco users and non-tobacco users were 19.87±3.78 ng/ml and 32.65±8.93 ng/ml, and for alcohol consumers and non-alcohol consumers were 19.67±5.43 ng/ml and 32.49±9.02 ng/ml, respectively. For vegetarian and non-vegetarian the mean 1, 25-dihydroxyvitamin D concentrations were 18.67±7.66 ng/ml and 19.93±5.31 ng/ml, respectively. (Table 2)

Table 2: Mean 1,25-dihydroxyvitamin D status of the respondents in different lifestyle practices

Variables	Categories	Mean 1,25-dihydroxy vitamin D ±SD (ng/ml)	t(p value)
Tobacco consumption	Tobacco consumers	19.87±3.78	0.02*
	Non Tobacco consumer	32.65±8.93	
Alcohol consumption	Alcohol consumer	19.67±5.43	0.04*
	Non Alcohol consumer	32.49±9.02	
Dietary habit	Non-vegetarian	18.67±7.66	0.67
	Vegetarian	19.93±5.31	

Significant at p<0.05

Mean food intake (Table 3) revealed that the consumption of food among the respondents from the different food groups was deficit as compared to Balanced Diet Recommended by National Institute of Nutrition, 2017 [10]. Cereals, pulses, green leafy vegetables, other vegetables, roots and tubers, fruits, meat/fish/poultry, oils and fats, sugars and jaggery were deficit by 37.40 per cent, 35.04 per cent, 8.49 per cent, 62.38 per cent, 60.19 percent, 45.55 percent, 68.29 percent, and 48.08, respectively.

Table 3: Mean food intake of the respondents

S. No.	Food groups (g/ml)	RDA	Mean food intake± SD	Excess or deficit	% Excess or deficit
1.	Cereals (g)	330	206.6±53.9	(-) 123.40	37.40
2.	Pulses (g)	75	48.72±9.39	(-) 26.28	35.04
3.	Green leafy vegetables (g)	100	91.51±14.8	(-) 8.49	8.49
4.	Other vegetables (g)	200	75.24±5.91	(-) 124.76	62.38
5.	Roots and tubers (g)	200	79.62±28.19	(-) 120.38	60.19
6.	Fruits (g)	100	50.45±10.91	(-) 45.55	45.55
7.	Meat/Fish/Poultry (g)	30	12.96±16.41	(-) 17.04	56.80
8.	Milk and milk products (ml)	300	95.13±33.6	(-) 204.87	68.29
9.	Oils/Fat (ml/g)	25	12.98±3.64	(-) 12.02	48.08
10.	Sugar/Jaggery	20	11.64±6.24	(-) 8.36	41.80

Mean nutrient intake (Table 4) of the respondents were deficit in terms of energy, protein, fat, calcium and iron when compared with Recommended Dietary Allowance by National Institute of Nutrition, 2017 [10]. Energy was deficit by 40.27 per cent, protein by 30.29 per cent, fat by 51.15 per cent, calcium by 60 per cent and iron by 29.71 per cent. Vitamin D intake was deficit by 74 per cent, as per recommendations by Institute of Medicine (2011) [6].

Table 4: Mean nutrient intake of the respondents

S. No.	Nutrients	RDA	Mean nutrient intake ± SD	Excess or deficit	% Excess or deficit
1.	Energy (kcal)	2370	1415.42± 67.37	(-) 954.58	40.27
2.	Protein (g)	55	38.34±8.76	(-) 16.66	30.29
3.	Fat(g)	20	9.77±3.32	(-)10.23	51.15
4.	Vitamin D (µg)	10	2.60±4.67	(-)7.40	74
5.	Calcium (mg)	600	239.65±54.9	(-)360.35	60
6.	Iron (mg)	21	14.76±9.65	(-)6.24	29.71

Correlation analysis (Table 4) revealed significant positive correlation between 1,25-dihydroxyvitamin D concentration and dietary intake of vitamin D and calcium. Correlation coefficient between 1, 25-dihydroxyvitamin D and dietary intake of vitamin D and calcium was 0.414 and 0.209, respectively.

Table 4: Correlation of 1, 25-dihydroxyvitamin D status of the respondents with dietary intake of vitamin D and calcium

S. No.	Dietary intake	Correlation coefficient
1.	Dietary vitamin D	+ 0.414 **
2.	Dietary calcium	+ 0.209*

**significant at $p<0.01$, *significant at $p<0.05$

Simple linear regression analysis of dietary intake of vitamin D and calcium on serum vitamin D status of the respondents (Table 5) revealed that 34.45 per cent of the total variability on the serum vitamin D status was determined by dietary intake of vitamin D and 35.12 per cent of the total variability of serum vitamin D was determined by dietary calcium intake, respectively.

Table 5: Simple linear regression analysis of dietary intake of vitamin D and calcium on the 1, 25-dihydroxyvitamin D concentration

Independent variables	Intercept	Regression coefficient	't' value	R^2 % (coefficient of determination
Dietary vitamin D	6.814	0.1507	2.359**	34.45
Dietary calcium		0.0016	2.282*	35.12

**significant at $p<0.01$, *significant at $p<0.05$

Discussion

Despite of long durations of sun exposure, the women had very low concentrations of vitamin D. Harinarayan *et al*., (2009) [4] reported high prevalence of vitamin D deficiency among agricultural labourers exposed to sunlight for more than 4 h with at least 35% of their body surface area exposed to sunlight. Clothing pattern of the women significantly influenced the 1, 25-dihydroxyvitamin D concentrations of the women. Vitamin D synthesis in the skin is dependent on the availability of UVB radiation to the skin, which is reduced by covering body surfaces such as hands and arms. Lack of sun exposure as a result of covered clothing style were the most important risk factors for low serum 25-hydroxyvitamin D in many countries in the Middle East. (Ahasan *et al*., 2013) [1]. We came to know from the present study that vitamin D deficiency is associated with lifestyle behaviours such as smoking and alcohol consumption as these practices are deleterious to health and increases the chances of liver damage and kidney failure and thereby hinders the metabolism of vitamin D in the body. As, liver and kidney are the major sites of conversion of the active form of vitamin D, any disruption in their functioning reduces vitamin D

activation and utilisation and results in lower concentration of 1,25-dihydroxyvitamin D. (Jiang *et al*., 2016) [7].

A significant positive correlation between 1, 25-dihydroxyvitamin D concentration and dietary intake of vitamin D and calcium of the women indicated that with decrease in the dietary intake of vitamin D and calcium, there was decrease in the 1,25-dihydroxyvitamin D concentration of the women. Adequate dietary intake if vitamin D increases vitamin D stores in the body, making it available for the various metabolic process in the body. Calcium intake improves vitamin D absorption in the intestine and maintains the levels of serum vitamin D. Vaidya *et al*., (2010) [12] reported that lower intake of calcium affects vitamin D absorption in the intestines, leading to vitamin D deficiency. Harinarayan *et al*., (2009) [4] reported high prevalence of vitamin D deficiency in Indian population resulting due to low dietary intake of vitamin D. Reduced intake of vitamin D led to low vitamin D stores in the body for a prolonged time, which led to vitamin D deficiency.

Conclusion

From the present study it can be concluded that there is a close association of lifestyle and dietary factors on the 1, 25-dihydroxyvitamin D concentrations in the women in reproductive age. Developing countries like India are more predisposed to the damaging effects of vitamin D deficiency for a number of reasons including poverty, illiteracy and socio-economic and cultural behaviour. India stands at the 130th rung of development ladder in the world which necessitates more rigorous local and global efforts to overcome this issue of tremendous health significance. The paradigm entailing mere dependence upon cutaneous photosynthesis for adequate vitamin D levels, prevailing among common and working population in developing countries does not stand true as vitamin D deficiency has been recognized in a large number of countries with adequate sunshine. Perusal of several research findings in the recent past shows lifestyle practices, availability of vitamin D rich foods, mandatory vitamin D fortification of the foods, vitamin D supplementation programs, sufficient sun exposure, reduced environmental pollution and facilities for inexpensive and accessible diagnosis of vitamin D deficiency would help mitigate the gravity of the prevalence of vitamin D deficiency in the study population. Further efforts are needed to create awareness among population groups on deleterious health implications associated with vitamin D deficiency and the ways to overpower this issue of public health significance at individual and collective levels.

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