pISSN 2349-3925 | eISSN 2349-3933

Original Research Article

DOI: http://dx.doi.org/10.18203/2349-3933.ijam20173233

Status of vitamin D3 level and its co-relation with the glycaemic status in Indian population

Richa Giri, Rajendra Kumar Verma*, Arisht Jain, Vaibhava Srivastava

Department of Medicine, GSVM Medical College, Kanpur, Uttar Pradesh, India

Received: 25 May 2017 Accepted: 23 June 2017

*Correspondence:

Dr. Rajendra Kumar Verma, E-mail: rkv45anand@gmail.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: The growing incidence of diabetes, consequent devastating morbidity, increasing mortality highlight the need for innovative approaches for prevention and management of disease. Pleiotropic hormonal effect of vitamin D3 has speculated its role in pathogenesis of diabetes. This study aims to assess vitamin D3 levels in study and control group and co-relate its level with HbA1c.

Methods: This is a cross-sectional observational study done on randomly selected patients from January 2015 to September 2016. Patients were divided into 2 groups: control group and study group including pre-diabetics and diabetics. Venous sample for serum 25-OH vitamin D and HbA1c were collected.

Results: 109 subjects were included in the study: 37 controls, 41 pre-diabetics, 31 diabetics. Out of the 37 healthy subjects, 14 (37.9%) had sufficient levels, 11 (29.7%) had insufficient levels whereas 12 (32.4%) were deficient in Serum vitamin D3 levels. Vitamin D3 deficiency was prevalent in 46.3% pre-diabetics, 41.7% diabetics with good glycaemic control and 84.2% diabetics with poor glycaemic control.

Conclusions: Using Pearson Chi square, inverse co-relation was found between glycated haemoglobin and vitamin D3 levels (p<0.003).

Keywords: Diabetes, Glycaemic status, HbA1c, Pre-diabetes, Vitamin D3

INTRODUCTION

Diabetes and vitamin D deficiency are global epidemics. Presently, around 285 million people have diabetes and this number is expected to reach 438 million by the year 2030. Given the burden of diabetes and its complications, researchers have long been exploring the role of potentially modifiable factors to identify at-risk individuals prior to diagnosis. Our focus has now shifted to prediabetes, which is an intermediate form of dysglycemia on a spectrum ranging from normal to overt diabetes. As per American Diabetes Association, a fasting glucose of 100 - <126 mg/dL, a 2-hour plasma glucose of 140 - <200 mg/dL after a 75-g OGT test, or

HbA1c 5.7% (39mmol/mol) to <6.5% (48mmol/mol) defines prediabetes. Diabetes mellitus is diagnosed when fasting glucose >126mg/dL, 2-hour plasma glucose \geq 200 mg/dL or HbA1c \geq 6.5% (48mmol/mol).² Fasting hyperglycemia indicates an increasing risk to development of cardiovascular disease, metabolic syndrome and mortality.²

Despite the advances in the diagnosis and management of diabetes, achieving normoglycemia or optimal glycemic control is still considered challenging.⁴ This is because care of prediabetes and type 2 diabetes warrants intense life-style adaptations, polypharmacy and insulin centered regimens.

Conventional oral anti-diabetic medications are associated with hypoglycemia. Insulin treatment has been linked to poor compliance, weight gain and possibly adverse cardiovascular outcomes. In addition, progressive beta-cell dysfunction and insulin resistance can make anti-diabetic agents less effective.⁵ Moreover, newer anti-diabetic drugs such as incretin analogs and ultra-short acting insulin analogs are expensive and hence many patients in the developing world cannot afford these medications.

Vitamin D, a fat-soluble vitamin cum hormone, is synthesized in response to sunlight. It is a 9, 10-seco steroid and the most common forms in humans are vitamin D3 (cholecalciferol) and Vitamin D2 (ergocalciferol). Vitamin D undergoes two metabolic conversions, 25-hydroxylation in the liver and 1- α -hydroxylation in the kidney. The active form, 1- α -25-(OH)2D, binds to the vitamin D receptor (VDR) to modulate gene transcription and regulate mineral-ion homeostasis.

Vitamin D plays several roles in the body influencing bone health as well as serum calcium and phosphate levels. Furthermore, vitamin D may modify cell proliferation, differentiation, apoptosis and immune function. Studies have shown that it may be useful as adjunctive treatment for tuberculosis, psoriasis, and multiple sclerosis or for the prevention of certain cancers. Vitamin D insufficiency may increase the risk of Type 1 diabetes mellitus, cardiovascular disease (insulin resistance, hypertension, or low-grade inflammation), or brain dysfunction (e.g., depression).

Many large studies have revealed a higher likelihood of progression of prediabetes to diabetes among Vitamin D deficient subjects. ^{7,8} Recent observational data reports a

beneficial effect of vitamin D on preventing the onset of diabetes.⁹ But the potential benefits of vitamin D supplementation on glycemic control are still debated.

METHODS

The present study was a cross-sectional observational study done on randomly selected adult patients from medicine department, GSVM MC, Kanpur from January 2015 to September 2016. Participants were categorized into control, pre-diabetic group and diabetic group. Patients with acute illnesses, pancreatic disease, hepatic disease, renal disease, bone diseases, malignancy, pregnant females, familial hyperlipidemia, and those who were taking medication that altered vitamin D metabolism were excluded from the study.

Detailed history and physical examination including fundoscopy were done. Venous sample for fasting and post prandial blood sugar, serum HbA1c, Serum vitamin D (measured by chemiluminence method by Architect i1000SR Machine {Abbott Laboratories, Abbott park, IL 60064 USA}) and fasting lipid profile were collected. Serum vitamin D3 values were categorized as: <20 ng/mL: deficient, 20-30 ng/mL: insufficient, 30-100 ng/mL: sufficient, >100 ng/mL: toxic.⁶ Serum uric acid, serum calcium, CRP, complete blood count, serum creatinine, liver function test was measured by automated analyzers. USG abdomen was done wherever feasible and indicated.

RESULTS

A total of 109 subjects were included: 37 (33.9%) controls (15 males, 22 females), 41 (37.6%) pre-diabetics (22 males, 19 females) and 31 (28.5%) diabetics (19 males, 12 females).

Age group (years)	Deficiency	Insufficiency	Sufficiency	Total
21-30	2	-	-	2
31-40	2	2	2	6
41-50	1	3	4	8
51-60	3	4	6	13
61-70	3	1	1	5
71-80	-	1	1	2
81 and above	1	-	-	1
Total	12 (32 4%)	11 (29 7%)	14 (37 9%)	37 (100%)

Table 1: Distribution of controls according to age and vitamin D3 status.

In the diabetic group, 12 had good glycemic control while 19 patients had poor glycemic control. Out of the 37 controls, maximum population (37.9%) had sufficient vitamin D levels. 32.4% had vitamin D deficiency followed by 29.7% with vitamin D insufficiency (Table

1). The value of vitamin D in deficient, insufficient and sufficient group is 12.01, 25.944 and 40.796 ng/mL respectively. The mean value for 37 controls was 26.53±11.99 ng/ml. This is a worrisome scenario as it implies that Indians in general do not have sufficient levels of vitamin D (Table 2).

Table 2: Mean vitamin D3 levels in controls.

Age group (years)	Deficiency (ng/ml)	Insufficiency (ng/ml)	Sufficiency (ng/ml)	Mean value (ng/ml)
21-30	14.8±3.25	-	-	14.8±3.25
31-40	11.84±0.19	28.6±0.71	34.3±0.85	24.91±10.4
41-50	13.4±6.67	26.96±0.58	42.48±5.08	27.61±11.5
51-60	10.07	25.48±2.63	35.6±3.95	23.72±11.1
61-70	15.31±4.12	24.78	47.3	29.13±14.1
71-80	-	23.9	44.3	34.1±14.4
81 and above	6.6±0.8	-	-	6.6±0.8
Mean value (ng/ml)	12.01±4.4	25.944±2.1	40.796±5.6	26.53±11.99

Table 3: Distribution of pre-diabetics according to age and vitamin D3 status.

Age group (years)	Deficiency (ng/ml)	Insufficiency (ng/ml)	Sufficiency (ng/ml)	Total
21-30	-	-	-	-
31-40	-	2	1	3
41-50	10	4	3	17
51-60	5	3	2	10
61-70	3	4	-	7
71-80	1	2	1	4
81 and above	-	-	-	-
Total	19 (46.3%)	15 (36.6%)	7 (17.1%)	41(100%)

Table 4: Mean vitamin D3 levels in pre-diabetics.

Age group	Deficiency (ng/ml)	Insufficiency (ng/ml)	Sufficiency (ng/ml)	Mean value (ng/ml)
21-30	-	-	-	-
31-40	-	26.6±1.13	35.4	29.47±5.03
41-50	12.63±5.41	24.78±1.77	39.02±5.17	20.14±11.3
51-60	10.12±5.12	24.6±2.85	37.25±3.32	19.89±11.9
61-70	13±5.87	25.48±1.96	-	20.50±7.12
71-80	17.13	25.8±3.82	31.2	24.98±6.22
81 and above	-	-	-	-
Mean value (ng/mL)	12.26±5.17	25.31±2.07	36.85±4.35	21.23±10.17

Table 5: Distribution of diabetic group according to age group, vitamin D3 levels and glycaemic status.

A co cuorn	Good glycaemic control (n=12)		Poor glycaemic control (n=19)			Total	
Age group	Deficiency	Insufficiency	Sufficiency	Deficiency	Insufficiency	Sufficiency	Total
21-30	-	-	-	-	-	-	
31-40	-	-	-	-	-	-	
41-50	-	1	1	3	1	-	6
51-60	3	1	1	5	2	-	12
61-70	2	3	-	5	-	-	10
71-80	-	-	-	2	-	-	2
81 and above	-	-	-	1	-	-	1
Total	5 (41.7%)	5 (41.7%)	2 (16.6%)	16 (84.2%)	3 (15.8%)	-	31

Out of 41 pre-diabetics, 19 (46.3%) were deficient and 15 (36.6%) were insufficient. Only 7 (17.1%) were sufficient in vitamin D. 10 out of 19 deficient pre-diabetics were in the age group 41-50 years (Table 3).

The mean value of vitamin D in pre-diabetics was calculated in deficient, insufficient and sufficient group to

be 12.26, 25.31 and 36.85 ng/ml respectively. The mean for 41 pre-diabetics was 21.23±10.17 ng/ml. The pre-diabetics barely managed to avoid vitamin D3 deficiency, perhaps preventing them from stepping into overt diabetes (Table 4).

41.7% patients of diabetes with good glycemic status fell into the deficiency and insufficiency group each, while

only 16.6% patients had sufficient amounts of vitamin D. No patient with poor glycemic status had sufficient

values of vitamin D. 84.2 % had deficient vitamin D3 (Table 5).

Table 6: Mean vitamin D3 levels in diabetics with good glycaemic control.

Age group	Deficiency (ng/ml)	Insufficiency (ng/ml)	Sufficiency (ng/ml)	Mean value (ng/ml)
21-30	-	=	-	-
31-40	-	-	=	=
41-50	-	23.4	37.9	30.65±10.25
51-60	13.11±3.19	27.3	34.7	20.27±10.39
61-70	13.05±0.92	24.8±1.85	-	20.10±6.58
71-80	-	-	-	-
81 and above	-	-	-	-
Mean value (ng/mL)	13.09±2.31	25.02±1.92	36.23±2.23	21.93±9.00

Table 7: Mean vitamin D3 levels in diabetics with poor glycaemic control.

Age group	Deficiency (ng/ml)	Insufficiency (ng/ml)	Sufficiency (ng/ml)	Mean value (ng/ml)
21-30	-	-	-	-
31-40	-	-	-	-
41-50	12.67±5.11	21.6	-	14.90±6.11
51-60	10.9±6.13	27±2.97	-	15.50±9.39
61-70	10.132±2.93	-	-	10.132±2.93
71-80	8.95±0.85	-	-	8.725±0.85
81 and above	9.4	-	-	9.4
Mean value (ng/ml)	10.62±4.12	25.2±3.76	-	13.09±7.34

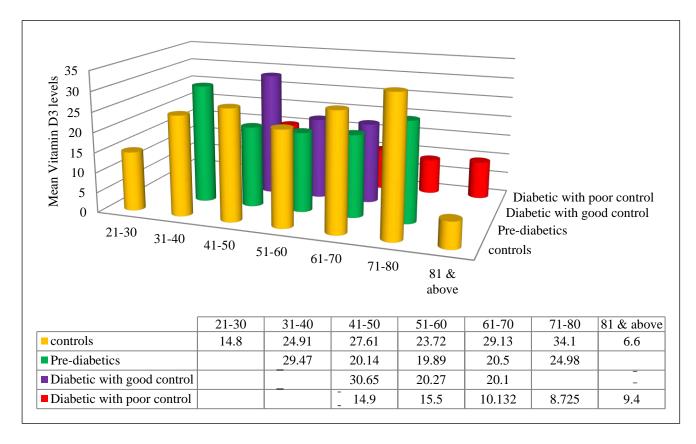


Figure 1: The mean vitamin D3 level according to age and glycaemic status of the study subject.

Table 8.	Correlation	hetween v	vitamin	D3 a	nd HhA1c

Correlations		Range DM	Range vit D
	Pearson correlation	1	0.370*
	Sig. (2-tailed)		0.000
Range DM	Sum of squares and cross-products	125.890	34.073
	Covariance	1.166	0.315
	N	109	109
	Pearson correlation	0.370*	1
	Sig. (2-tailed)	0.000	
Range DM	Sum of squares and cross-products	34.073	67.284
	Covariance	0.315	0.623
	N	109	109

The mean value of vitamin D in diabetic group with good glycemic status in deficient, insufficient and sufficient group as 13.09, 25.02 and 36.23 ng/ml respectively. The mean value of vitamin D3 for diabetics with good glycemic control was 21.93±9.00 (Table 6).

The mean value of vitamin D3 in diabetic group with poor glycemic status in deficient and insufficient group is 10.62 and 25.2 ng/ml respectively. No patient had sufficient value of vitamin D3. The mean value of vitamin D3 for 19 diabetics with poor glycemic control was 13.09±7.34 (Table 7).

The statistical co-relation between vitamin D levels and glycosylated hemoglobin has been done using Pearson chi-square test. They share significant inverse co-relation as affirmed by the 'p' value <0.003 (Figure 1 and Table 8).

DISCUSSION

The present study was a cross-sectional observational study with an aim to find out serum vitamin levels in normal subjects, prediabetics and in diabetes patients with good and poor glycemic status. Among controls we found majority of them had normal levels of serum vitamin D3 (37.9%) followed by 32.4% of controls with deficient levels and 29.7% of controls with insufficient vitamin D3 levels. No subject was found to have toxic levels of vitamin D3 levels. In a study by Gupta et al, vitamin D deficiency is no less than an epidemic in India, with an overwhelming prevalence of 70-100%. They identified that in India, widely consumed food items such as dairy products are fortified with vitamin D. Indian socio-religious and cultural practices limit sun exposure, thereby negating potential benefits of plentiful sunshine. ¹⁰

In the present study, mean value of vitamin D3 among controls was found to be 26.53 ± 11.99 ng/ml. This is a worrisome scenario as it implies that Indians in general do not have sufficient levels of vitamin D. According to a study, Harinarayan et al found that vitamin D levels in urban and rural men of Tirupati was 18.54 ± 0.8 and

23.7±0.8 respectively, while in urban and rural females it was 15.5±0.3 and 19±0.9 respectively. The results of this study are in accordance with the findings of the present study.

Among prediabetics 46.3% were deficient, 36.6% had insufficient levels while only 17.1% had sufficient levels of vitamin D3. The mean for 41 pre-diabetics was 21.23±10.17 ng/ml. The pre-diabetics barely managed to avoid vitamin D3 deficiency, perhaps preventing them from stepping into overt diabetes. These findings are in accordance to a study done in kolkatta by Dutta D et al. They inferred that Vitamin D deficiency/ insufficiency was found in 115 (73.25%) individuals with pre-diabetes. Individuals with the lowest vitamin-D levels (<10 ng/ml) had the highest insulin resistance (HOMA2-IR: 2.04 ± 0.67). They concluded that Vitamin-D deficiency/insufficiency may participate in the development or worsening of insulin resistance in individuals with prediabetes in our country who have a high cardiovascular risk.¹²

In diabetic group, 41.7% patients with good glycemic status fell into the deficient and insufficiency group each, and only 16.6% patients had sufficient amounts of vitamin D. Whereas no patient with poor glycemic status had sufficient values of vitamin D. 84.2 % had deficient vitamin D3. Kumar RA et al, have done a study in south Indians to compute the prevalence of vitamin D deficiency in 370 type 2 diabetics, deficiency was present in 83%, insufficiency in 13.8% and only 3.2% had normal vitamin D levels. The above-mentioned study did not take into consideration the glycemic status of the diabetics.

The mean value of vitamin D3 for diabetics with good glycemic control was 21.93 ± 9.00 whereas with poor glycemic control was 13.09 ± 7.34 . This could be a subtle indicator that higher vitamin D3 levels have a role in maintaining good glycemic status. Similar findings are seen in a study by Bayani MA et al. Out of 120 diabetics and 120 control group, mean concentration of vit D in the case group was 18.7 ± 10.2 and in the control group was 24.6 ± 13.5 ng/dl (p=0.002). In diabetic patients vit D was

deficient in 77 (64.2%), insufficient in 30 (25%) and sufficient in 13 (10.3%) patients.¹⁴

Second objective of the present study was to find out the correlation between Vit D3 Levels and glycated haemoglobin. Statistical evaluation using Pearson chisquare test clearly shows an inverse co-relation between vitamin D levels and glycosylated haemoglobin as affirmed by the 'p' value <0.003. Kostoglou-Athanassiou I et al also found the similar co relation in their study. Glycosylated hemoglobin and 25(OH)D3 levels were measured in 120 diabetes mellitus type 2 patients and 120 controls. 25(OH)D3 levels were lower in the diabetics than in the control group, being 19.26±0.95 ng/ml and 25.49±1.02 ng/ml respectively (p < 0.001, Student's t-test). 25(OH)D3 levels were found to have inverse co-relation with HbA1c when the patient and control groups were analysed together (p < 0.001, r (2) = 0.086). 15

CONCLUSION

People with Indian ethnicity have high prevalence of vitamin D3 deficiency/ insufficiency. Only 37.9% healthy controls had vitamin D3 levels above 30 ng/ml, with 26.53±11.99 ng/ml as the mean vitamin D level. Vitamin D3 deficiency was prevalent in 46.3% pre-diabetics, 41.7% diabetics with good glycemic control and 84.2% diabetics with poor glycemic control. HbA1c and serum vitamin D3 share a significant inverse correlation (p<0.003).

The sparse vitamin D3 levels in pre-diabetics and diabetics hint towards its role in the patho-physiology of worsening glycemic status. The present study provides the rationale for conducting interventional trials to evaluate the effect of vit D3 supplementation on glycemic control in Indian population.

ACKNOWLEDGEMENTS

Authors would like to acknowledge Department of Medicine and Department of PSM, GSVM Medical College, Kanpur, India.

Funding: No funding sources Conflict of interest: None declared

Ethical approval: The study was approved by the

 $institutional\ ethics\ committee$

REFERENCES

- 1. Hu FB. Globalization of diabetes: the role of diet, lifestyle, and genes. Diab Care. 2011;34(6):1249-57.
- Abraham TM, Fox CS. Implications of rising prediabetes prevalence. Diab Care. 2013;36(8):2139-41.

- 3. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diab Care. 2013;36(suppl. 1):S67-S74.
- 4. Wallace TM, Matthews DR. Poor glycaemic control in type 2 diabetes: a conspiracy of disease, suboptimal therapy and attitude. QJM. 2000;93(6):369-74.
- Montane J, Cadavez L, Novials A. Stress and the inflammatory process: a major cause of pancreatic cell death in type 2 diabetes. Diabetes Metab Syndr Obes. 2014;7:25-34.
- 6. Harrison's Principles of Internal Medicine. 19th edition. Vitamin and trace mineral deficiency and excess; 2015:96e-7.
- Deleskog A, Hilding A, Brismar K, Hamsten A, Efendic S, Östenson CG. Low serum 25hydroxyvitamin D level predicts progression to type 2 diabetes in individuals with prediabetes but not with normal glucose tolerance. Diabetologia. 2012;55:1668-78.
- 8. Forouhi NG, Luan J, Cooper A, Boucher BJ, Wareham NJ. Baseline serum 25-hydroxy Vitamin D is predictive of future glycaemic status and insulin resistance. Diabetes. 2008;57(10):2619–25.
- Song Y, Wang L, Pittas AG, Del Gobbo LC, Zhang C, Manson JE, et al. Blood 25-hydroxy vitamin D levels and incident type 2 diabetes: a meta-analysis of prospective studies. Diabetes Care. 2013;36:1422-8.
- Gupta A. Vitamin D deficiency in India: prevalence, causalities and interventions. Nutrients. 2014;6(2):729-75.
- Harinarayan CV, Ramalakshmi T, Venkataprasad U. High prevalence of low dietary calcium and low vitamin D status in healthy south Indians. Asia Pac J Clin Nutr. 2004;13:359-64.
- 12. Dutta D, Mondal SA, Choudhuri S, Maisnam I, Hasanoor Reza AH, Bhattacharya B, et al. Vitamin-D supplementation in prediabetes reduced progression to type 2 diabetes and was associated with decreased insulin resistance and systemic inflammation: An open label randomized prospective study from Eastern India. Diabetes Res Clin Pract. 2014;103:e18–23.
- 13. Kumar RA, Narasimhasetty KR, Bhende PV, Lalitha R, Shetty SB. Prevalence of vitamin D deficiency in south Indian type 2 diabetes individuals. Int J Clin Cases and Invest. 2013;5(4)(15):19.
- 14. Bayani MA, Akbari R, Banasaz B, Saeedi F. Status of Vitamin-D in diabetic patients. Caspian J Intern Med. 2014;5(1):40-2.
- Kostoglou-Athanassiou I, Athanassiou P, Gkountouvas A, Kaldrymides P. Vitamin D and glycemic control in diabetes mellitus type 2. Ther Adv Endocrinol Metab. 2013;4(4):122-8.

Cite this article as: Giri R, Verma RV, Jain A, Srivastava V. Status of vitamin D3 level and its corelation with the glycaemic status in Indian population. Int J Adv Med 2017;4:1067-72.