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**Research Article**

# Correlation of Vitamin D level with glycemic control in type 2 diabetes mellitus

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**Abstract:** The aim of this study was to correlate the Vitamin D level with HBA1c and role of Vitamin D in glycemic control in type 2 diabetes mellitus. The methods in Present study was conducted in Medicine outdoor, Geriatric outdoor and Diabetic Care and Research Center, S P Medical College and associated group of PBM Hospitals, Bikaner to find out correlation of Vitamin D (Vit D) with glycemic control in patients of type 2 diabetes mellitus. All routine investigation including anthropometric measurement was done. Categorization of diabetes mellitus in type 1 and type 2 diabetes were done on clinical criteria. Vit D levels were divided into 3 quartiles: deficiency (Vit D <15 ng/dl), Insufficiency (Vit D 15.1-29.9) and sufficiency (Vit D ≥30ng/dl). SPSS was used to apply t-test ANOVA and Chi-square test for analysis of data. There was a high prevalence of Vitamin D deficiency in type 2 diabetes mellitus. Vitamin D level inversely related to HBA1c that means inversely related to glycemic control. Vitamin D level also affected by dietary pattern, age of onset of diabetes but not related to duration of diabetes. In conclusion the Vitamin D deficiency is prevalent in diabetes mellitus type 2 so by supplementation of Vitamin D we can improve glycemic control in patients of diabetes mellitus. By improving glycemic control we can reduce the complication of diabetes.
**Keywords:** diabetes mellitus, glycemic control, deficiency, HBA1c, Vitamin D.

## INTRODUCTION

Diabetes is a metabolic disease that can affect nearly every organ system in the body. Diabetes continuous to be a public health concern. It has been estimated that 380 million individuals would be affected with diabetes worldwide by the year 2025. In India alone 41 million individuals are affected by this deadly disease, and this is likely to go up to 70 million by the year 2015 [1]. Recently, Vitamin D has sparked widespread interest in the pathogenesis and presentations of diabetes. As the major regulator for calcium homeostasis, Vitamin D directly and or indirectly improves insulin exocytosis via activating calcium dependent endo peptidases .Vitamin D also improves glucose tolerance [2]. Vitamin D could also prevent type 2 diabetes through its role as an efficient antioxidant. Additionally, the steroid hormone form of Vitamin D promotes suppressor cell activity and inhibits the generation of cytotoxic(Tc), macrophages, delayed hypersensitivity type and natural killer (NK) cells.[3] Vitamin D also mediate several non calcemic functions. It is a regulator of cellular proliferation, differentiation and replication, and mediator of autoimmune reactions, in a variety of organs and biological system.

Vitamin D level insufficiency has long been suspected to be a risk factor for type 1 diabetes mellitus. In the past few years, accumulating evidence has suggested that altered Vitamin D homeostasis might also have a role in the development of type 2 diabetes mellitus. In patients with type 2 diabetes mellitus, impaired pancreatic b cell function, insulin resistance and systemic inflammation are often present in varying degrees and the evidence suggest that Vitamin D modulates all these characteristics [3]. Six longitudinal observational studies have reported an association between base line Vitamin D status (measured as Vitamin D intake or 25-hydroxyVitamin D concentration) and incident type 2 diabetes mellitus [4]. Three of the six analysis (from four different cohorts) showed a lower incidence of type 2 diabetes mellitus in participants with the highest Vitamin D status compared with those with the lowest Vitamin D status.

Treatment of Vitamin D3 and calcium carbonate supplementation in osteoporosis improve glycemic among adults with impaired glucose tolerance at baseline [5]. The researchers found that the association between 25 hydroxy-vitamin D and HBA1c was affected by age(p=0.026). Serum 25 hydroxy-vitamin D concentration was inversely associated with HBA1c level individuals 35-74 years old, but not among the younger's or older adults. These finding are also consistent with observations from other cross sectional studies that have also reported reverse

associations between 25 hydroxy vitamin D concentration and HBA1c [6,7,8,9] Kositsawat *et al.;* [10] report that the association between 25nhydroxiVitamin D and HBA1c was not present in the younger and older age group. This interesting finding might be explained by lack of statistical power, especially in the younger age group, of whom only 1.5% had hyperglycemia, in the older group, the lack of association might be explained by vitamin insufficiency being a lesser contributor to hyperglycemia than other age related risk factor for diabetes mellitus.

## MATERIALS AND METHODS

The study was planned to enrolled type 2 diabetic patients attending medical outdoor, geriatric outdoor, diabetic care and research center and admitted in hospital. All routine and relevant investigation were done like complete blood count, fasting and post prandial blood sugar, HBA1c, urine complete, renal function test, lipid profile, 25 hydroxy vitamin D level. Anthropometric measurement was taken as standing height in meter, weight in kilogram hip and waist circumference in cms and body mass index were calculated by using formula weight in kilogram/height in meter square.

Categorization of diabetes mellitus in to type 1 and type 2diabetes were done mainly on clinical criteria viz age of onset, body habit, response to treatment.

Vitamin D levels were divided in to 3 quartiles:

. Sufficiency (≥30ng/dl)
. Insufficiency (15.1-29.9 ng/dl)
. Deficiency (<15ng/dl)

SPSS software was use to apply t-test, ANOVA and Chi-square test for analysis of data. Type 1 diabetes, patients with liver and kidney disease, patients on vitamin D supplements, anticonvulsant, barbiturate and steroids were excluded from the study

## RESULT

This study was conducted in the patients of type 2 diabetes attending Medicine OPD, Geriatric OPD, attached to PBM Hospital Bikaner Rajasthan. A total 50 type 2 diabetic patients, Out of 50 patients M: F 19:31 were included in our study. The present study conducted to study the prevalence of Vitamin D deficiency in patients of type 2 diabetes mellitus and association of Vitamin D level with HBA1c.

Data on BMI, HBA1c, Serum 25(OH) Vitamin D, fasting blood sugar measure directly whereas Sex, Age, Occupation, Dietary habit, treatment history, duration and age of onset of diabetes were self reported. We divided age in to 3 groups i.e. <45 years, 45-55 years and >55years. Maximum patients (n=23) were from >55years of age groups. And out of them 14 patients had their Vitamin D level in(Vitamin D <15) deficient stage. Status of Vitamin D level in patients of type 2 diabetes mellitus in relation to age not significant. On statistical comparison the difference was statistically insignificant (p>0.05). Maximum number of patients were housewives i.e. 19 out of them 10 had their Vitamin D level <15, 6, 3 patients had their Vitamin D level 15-29.9 and >30 respectively. Next common occupation was farmer. According to Serum Vitamin D level in relation to socioeconomic condition there were maximum number of patients had their socioeconomic status was average. Serum Vitamin D status according to sex and occupation was also found statistically insignificant (p>0.05). Poor socioeconomic status patients had low Vitamin D level. Patients on vegetarians' diet also had low Vitamin D level in comparison to non vegetarian (TABLE 1, GRAPH 1).

Data also compared to age of onset of diabetes, younger onset type 2 diabetes mellitus associated with low Vitamin D status compared to patients who have normal Vitamin D status (p<0.001).We divided age of onset in to 3 groups i.e. <45 years, 45-55years and >55years. In age of onset group <45years there were total 29 cases and out of them 4, 18, 17 cases were from serum Vitamin D level <15, 15-29.9 and ≥30 respectively. In age of 45-55 years and >55years there were 14 and 7 patients respectively. Vitamin D deficient patient in age of 45-55 years were 8 and in > 55years there was 6 patients had deficient Vitamin D. On comparison of these data the difference was statistically significant (p<0.001).(TABLE 2,GRAPH 2) Data also compared according to duration of diabetes, we found there were 39 patients in the group of > 5 years in which 13 patients had Vitamin D deficiency. On comparison of these data ANOVA test was applied and difference was found statistically insignificant (p>0.05).(TABLE 3, GRAPH 3) Data also compared according to BMI(TABLE 4, GRAPH 4) systolic and diastolic blood pressure of patients of type 2 diabetes mellitus. The difference was statistically insignificant (p>0.05).

**Table-1: Distribution of cases according to serum vitamin D level in relation to dietary habits**

| Dietary Habits | Serum vitamin D level | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | <15 | | 15-29.9 | | >30 | | | |
| | NO. | % | NO. | % | NO. | % | NO. | % |
| Non Vegetarian | 0 | - | 4 | 20 | 3 | 25 | 7 | 14 |
| Vegetarian | 18 | 100 | 16 | 80 | 9 | 75 | 43 | 86 |
| Total | 18 | 100 | 20 | 100 | 12 | 100 | 50 | 100 |
| $X^2$ | 4.734 | | | | | | | |
| P | 0.094 | | | | | | | |

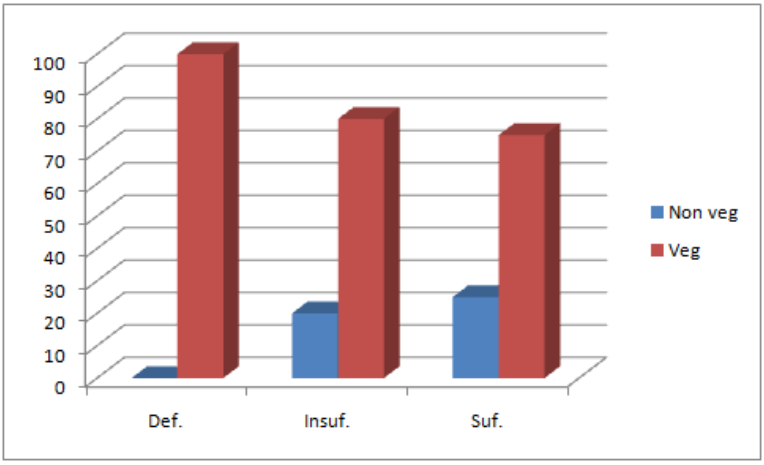


**Fig-1: Distribution of cases according to serum vitamin D level in relation to dietary habits**

**Table 2: Distribution of cases according to serum vitamin D level in relation to age of onset**

| Age of onset (years) | Serum vitamin D level | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | <15 | | 15-29.9 | | >30 | | | |
| | NO. | % | NO. | % | NO. | % | NO. | % |
| <45 | 4 | 22.2 | 18 | 90 | 7 | 58.3 | 29 | 58 |
| 45-55 | 8 | 44.4 | 1 | 5 | 5 | 41.7 | 14 | 86 |
| >55 | 6 | 33.3 | 1 | 5 | 0 | - | 7 | 14 |
| Total | 18 | 100 | 20 | 100 | 12 | 100 | 50 | 100 |
| Mean | 52.72 | | 41.25 | | 42.50 | | | |
| SD | 11.19 | | 5.07 | | 7.19 | | | |
| P | <0.001 | | | | | | | |

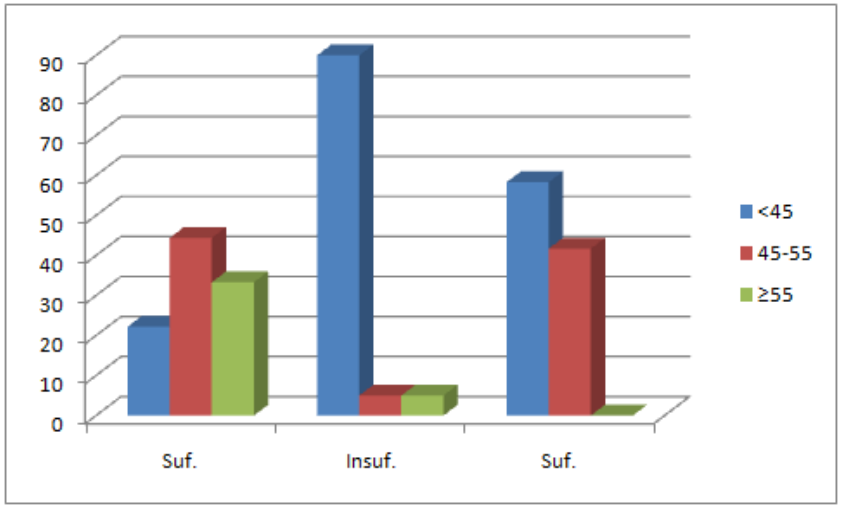


**Fig-2: Distribution of cases according to serum vitamin D level in relation to age of onset**

**Table-3: Distribution of cases according to serum vitamin D level in relation to duration of diabetes**

| Duration of diabetes | Serum vitamin D level | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | <15 | | 15-29.9 | | >30 | | | |
| | NO. | % | NO. | % | NO. | % | NO. | % |
| <5 | 5 | 27.8 | 5 | 25 | 1 | 8.3 | 11 | 22 |
| >5 | 13 | 72.2 | 15 | 75 | 11 | 91.7 | 39 | 78 |
| Total | 18 | 100 | 20 | 100 | 12 | 100 | 50 | 100 |
| Mean | 6.89 | | 11.35 | | 8.92 | | | |
| SD | 3.97 | | 8.71 | | 4.34 | | | |
| P | 0.109 | | | | | | | |

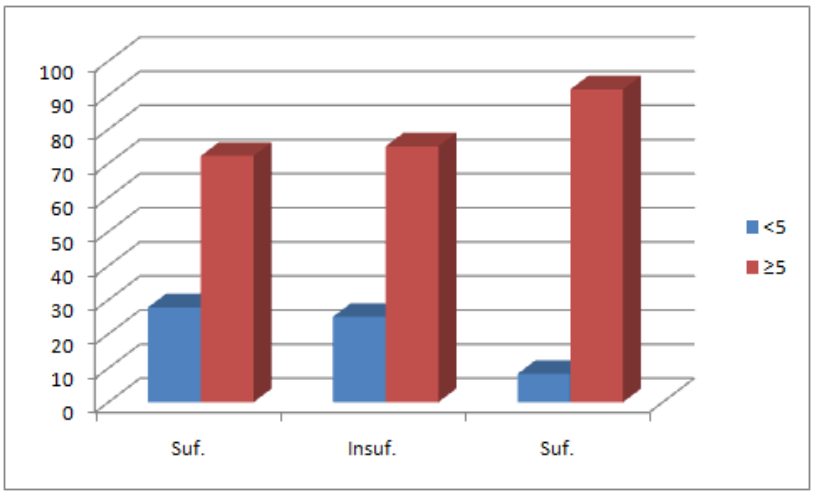


**Fig 3: Distribution of cases according to serum vitamin D level in relation to duration of diabetes**

**Table 4: Distribution of cases according to serum vitamin D level in relation to BMI**

| BMI(kg/m2) | Serum vitamin D level | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | <15 | | 15-29.9 | | >30 | | | |
| | NO. | % | NO. | % | NO. | % | NO. | % |
| <18.5 | 0 | - | 0 | - | 0 | - | 0 | - |
| 18.5-24.99 | 9 | 50 | 14 | 70 | 3 | 25 | 26 | 52 |
| >25 | 9 | 50 | 6 | 30 | 9 | 75 | 24 | 48 |
| Total | 18 | 100 | 20 | 100 | 12 | 100 | 50 | 100 |
| Mean | 26.40 | | 25.38 | | 25.63 | | | |
| SD | 3.80 | | 3.95 | | 2.12 | | | |
| P | 0.666 | | | | | | | |

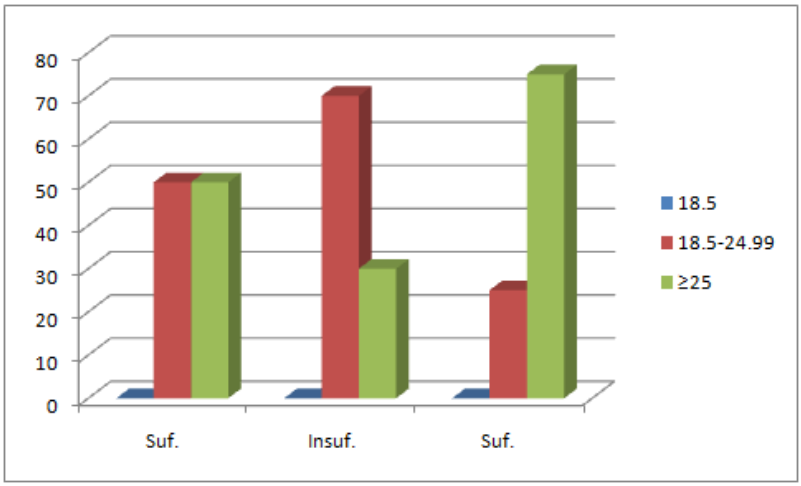


**Fig 4: Distribution of cases according to serum vitamin D level in relation to BMI**

Table shows distribution of cases according to serum Vitamin D level in relation to FBS. We divided FBS in to three groups i.e. <100,100-126 and >126mg/dl. No patient was found in FBS group 100mg/dl while in FBS group 100-126mg/dl total 9 cases were found and out of them 2,2,5, cases were from serum Vitamin D level <15,15-29.9 and ≥30 respectively. In FBS group >126mg/dl, there were total 41patients found and out of them 16, 18, and 7 had their Vitamin D level<15, 15-29.9 and ≥30 respectively. On comparison of these data the difference was statistically highly significant (p<0.001)(TABLE 5, GRAPH 5)

**Table 5: Distribution of cases according to serum vitamin D level in relation to fasting blood sugar (gm %)**

| Fasting blood sugar | Serum vitamin D level | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | <15 | | 15-29.9 | | >30 | | | |
| | NO. | % | NO. | % | NO. | % | NO. | % |
| <100 | 0 | - | 0 | - | 0 | - | 0 | - |
| 100-126 | 2 | 11.1 | 2 | 10 | 5 | 41.7 | 9 | 18 |
| >126 | 16 | 88.9 | 18 | 90 | 7 | 58.3 | 41 | 82 |
| Total | 18 | 100 | 20 | 100 | 12 | 100 | 50 | 100 |
| Mean | 183.44 | | 194.25 | | 138.33 | | | |
| SD | 33.85 | | 48.25 | | 34.98 | | | |
| P | 0.001 | | | | | | | |

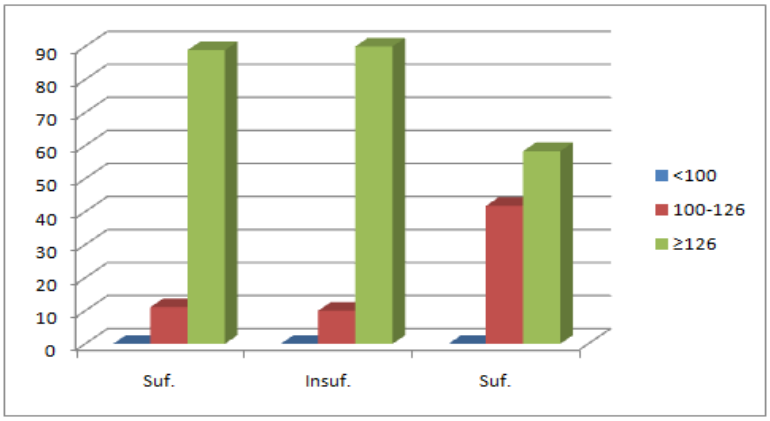


**Fig-5: Distribution of cases according to serum vitamin D level in relation to fasting blood sugar (gm %)**

Table no shows distribution of cases according to serum Vitamin D level in relation to HBA1c. We divided HBA1c in to 2 groups i.e.≤7mg/dl and >7mg/dl. In HBA1c group ≤7mg/dl there were total 14 cases and out of them 6,2 and 6 cases were from serum Vitamin D level <15,15-29.9 and ≥30 respectively. In HBA1c >7mg/dl, there were total 36 patients found and out of them 12,18,6 had their Vitamin D level <15, 15-29.9 and ≥30 respectively. On comparison of these data, ANOVA test was applied and the difference was found statistically significant (p<0.01) (TABLE 6, GRAPH 6).

**Table-6: Distribution of cases according to serum vitamin D level in relation to serum HBA1c**

| HbA1C | Serum vitamin D level | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|
| | <15 | | 15-29.9 | | >30 | | | |
| | NO. | % | NO. | % | NO. | % | NO. | % |
| <7 | 6 | 33.3 | 2 | 10 | 6 | 50 | 14 | 28 |
| >7 | 12 | 66.7 | 18 | 90 | 6 | 50 | 36 | 72 |
| Total | 18 | 100 | 20 | 100 | 12 | 100 | 50 | 100 |
| Mean | 8.22 | | 8.85 | | 7.44 | | | |
| SD | 1.21 | | 1.17 | | 0.95 | | | |
| P | 0.006 | | | | | | | |

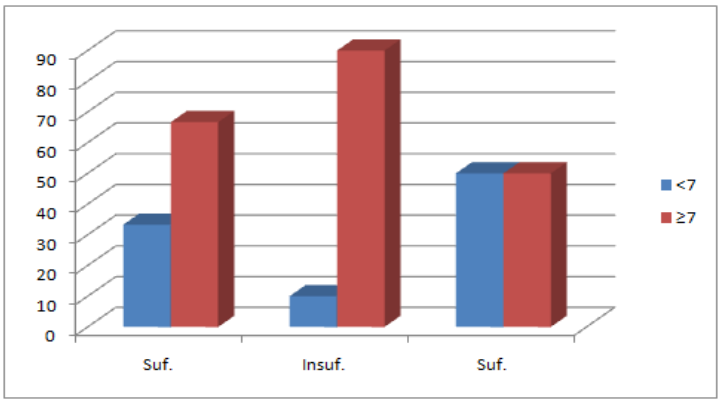


**Fig-6: Distribution of cases according to serum vitamin D level in relation to serum HBA1c**

**DISCUSSION**

In present study, in age group <45 years there was 9 patients in which 6 have low Vitamin D (2 deficiency and 4 insufficiency) in age group 45-55 years there were 18 patients 14 had low Vitamin D level (2 deficiency 12 insufficiency), in age group >55 years, there was 23 type 2diabetes mellitus patients in which 18 patients had low Vitamin D level (14 deficiency 4 insufficiency). On statistical comparison the difference was statistically insignificant (p>0.05).

Serum Vitamin D status according to sex in type 2 diabetes mellitus patients 19 males patients in which 16 have low Vitamin D level (10 deficiency and 6 insufficiency), 31 females in which 22 have low Vitamin D level (8 deficiency and 14 insufficiency). When we compared the data, the difference was found statistically insignificant (p>0.05). Poor socioeconomic status patients, had low Vitamin D level patients on vegetarian diet also had low Vitamin D level in comparison to non vegetarian.

Data are compared according to age of onset of diabetes, younger onset type 2 diabetes mellitus associated with low Vitamin D status compared to patients who have normal Vitamin D status (p<0.001) data also compared to duration of diabetes and found statistically insignificant (p>0.05) data also compared according to BMI, systolic and diastolic blood pressure of patients of type 2 diabetes mellitus. The difference was statistically insignificant.

Forty one patients out of 50 had fasting blood sugar >126,out of 41, 34 patients had low Vitamin D level(16 deficiency and 18 insufficiency) according to these observation Vitamin D level inversely related to fasting blood sugar in patients in type 2 diabetes mellitus. On comparison of these data the difference was highly significant (p<0.001).

In total 50 type 2 diabetes mellitus patients 76% were found to be Vitamin D deficiency (36% deficiency, 40% insufficiency) and serum Vitamin D level was inversely related to HBA1c.

Mean HBA1c was higher in patients with low Vitamin D level when compared with patients normal Vitamin D level (p<0.006). our result showed high prevalence of Vitamin D deficiency in type 2 diabetes mellitus and inversely related to HBA1c.Our study result are consists with observation from study of Kant *et al.;* [11] found high prevalence of Vitamin D deficiency in patients of Vitamin D deficiency in patients of type 2 diabetes mellitus (91%) and Vitamin D deficiency was inversely related to glycemic control (HBA1c).

The author estimated the prevalence of 25(OH) Vitamin Deficiency in type 2 diabetes mellitus and the association of Vitamin D level with HBA1c.They performed a retrospective continuous cohort review of 124 patients with type 2 diabetes mellitus seen at the endocrine outpatient clinic 2003 to 2008.The data included age race, HBA1c, family history of type 2 diabetes and calcium intake.

A total of 113 type 2 diabetes mellitus patients (91.1%) were found to be Vitamin D deficient. Serum Vitamin D level was inversely related to HBA1c(p=0.029), mean HBA1c was higher in patients with Vitamin D deficiency when compared with patients of normal Vitamin D(7.1% vs. 8.18%).In our study mean HBA1c in Vitamin D deficient patient(p=0.065) also high(p=0.06) similar to this study. Prevalence of Vitamin D deficiency in our study was 76% in patients of type 2 diabetes compare to this study in which it was 91.1% difference in prevalence may be due to ethnicity, sun exposure and other un-measurable variables.

The inverse relationships between Vitamin D3 level and glycemic control in this sample support an active role of Vitamin D in pathogenesis of type 2 diabetes mellitus. These finding are also consistent with observation from other cases sectional studies that had also reported inverse association between 25 (OH) Vitamin D concentration and HBA1c level both in NHANES precipitating and in cohort from outside the USA.

Our study also supported by study of Kositsawat [10] and colleagues who showed that serum Vitamin D concentration is inversely associated with HBA1c level. Our study also supported by recent study of De Boer *et al.;* [12] indicated inverse association between serum Vitamin D and risk of type 2 diabetes mellitus; there results were those from the nurses' health study by Pittas *et al.;* [3] where an inverse association was observed for the intake Vitamin D supplement.

Our study also supported by study of Sheena *et al.;* [13] examined the cross sectional association between Vitamin D and beta cell dysfunction and show high prevalence of hypo vitaminosis D was noted among women with type diabetes mellitus.

In 2010, Liu *et al.;* [14] predicted 25 hydroxy Vitamin D score and incident type 2 diabetes in the Framingham offspring study that higher Vitamin D status is associated with a decreased risk of type 2 diabetes mellitus. Major weakness in the study design that it does not establish whether improved Vitamin D status is cause or consequence of type 2 diabetes mellitus.

Thus our study show the high prevalence of Vitamin D deficiency in patients of type 2 diabetes mellitus patients residing in North Western part of India, Bikaner at PBM hospital Bikaner. Vitamin D level inversely related to glycemic control in patients of

type 2 diabetes mellitus. So we can improve the quality of life of patients by Vitamin D supplementation in patients of type 2 diabetes mellitus by improve in glycemic control and decreasing the complication of uncontrolled type 2 diabetes mellitus.

## CONCLUSION

We concluded that Vitamin D may play a role in type 2 diabetes mellitus. However, to better define the role of Vitamin D in the development and progression of type 2 diabetes mellitus, high quality observational studies and RCTs that measure blood 25(OH) Vitamin D concentration and clinically relevant glycemic outcomes are needed.

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