Research Article

Prevalence of Vitamin D3 insufficiency among rural ethnic population of Tripura and its association with type-2 diabetes mellitus

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ABSTRACT

Background: Different studies suggest that Vitamin D3 has a role in regulation of insulin and its deficiency leads to the development of type 2 diabetes mellitus (DM). In a study by ICMR-INDIAB (NE), it was shown that the prevalence of type 2 DM is about 9% in Tripura. However, little is known regarding the blood level of Vitamin D3 among the rural ethnic population. **Objectives:** The objectives of this study were to assess the blood level of Vitamin D3 and its association with type 2 DM in rural ethnic population. **Materials and Methods:** This cross-sectional study was undertaken from February 2018 to January 2019 at Multidisciplinary Research Unit of Agartala Government Medical College to assess the blood Vitamin D3 level in the rural ethnic population and its association with Type 2 DM. Two hundred and eight subjects were recruited from 10 different health camps. Blood samples were collected for detecting different blood glycemic parameters. The data were statistically analyzed using the Statistical Package for the Social Sciences. Pearson's correlation coefficient was used to evaluate the association of blood Vitamin D3 with glycemic parameters. **Results:** Of 208 ethnic subjects, 136 had insufficient while 72 had sufficient blood Vitamin D3 level. Overall, 65% prevalence of Vitamin D3 insufficiency has been observed in the study population. About 98.3% and 52.3% of insufficiency (<30 ng/ml) have been observed in diabetic and non-diabetic subjects, respectively. **Conclusion:** About 65% prevalence of Vitamin D3 insufficiency irrespective of diabetic status was found in this study. However, Vitamin D3 level and its inverse association with glycemic parameters in type 2 DM could not be established.

KEY WORDS: Vitamin D3; HbA1c; Type 2 Diabetes Mellitus; Ethnic Population

INTRODUCTION

Diabetes mellitus (DM) is a disease which is caused by absolute or relative insulin deficiency. Over the past 30 years, international diabetes federation estimates that the prevalence of diabetes has increased to 12–18% in urban India and 3–6% in rural India with significant regional variations. Various factors play a role in the etiopathogenesis and in the glycemic control among the type 2 diabetic patients.[1] In Tripura, about 9% of the population is suffering from DM type 2 ICMR-INDIAB (NE) study.[2] Serum Vitamin D3 level was reported to alter the glycemic control and there is evidence to suggest that altered Vitamin D3 may play a role in the development of T-2 DM.[3] Many studies have also revealed that Vitamin D3 has a role in the synthesis and the secretion of insulin[4] by receptor-mediated molecular mechanisms.[5] Vitamin D3, also called "sunshine vitamin," has been linked to everything from cancer and heart disease to diabetes.[6] The challenge for health-care providers and nutrition researchers is to determine whether Vitamin D3 deficiency or insufficiency actually causes the incidence of certain diseases or whether low levels of Vitamin D3 are

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simply coincidental as majority of the general population, regardless of disease, is likely to have insufficient levels of Vitamin D3. Researchers also need to find out whether supplementation with Vitamin D3 can prevent diseases and can it be used to treat diseases such as diabetes?[7] There are two main forms of Vitamin D: Ergocalciferol (Vitamin D2) and cholecalciferol (Vitamin D3). Vitamin D2 is synthesized by plants, whereas Vitamin D3 is synthesized in skin when it is exposed to ultraviolet B rays from sunlight. Vitamin D3 is also found in a few foods such as fatty fish.[8]

Various definitions for Vitamin D insufficiency have appeared in literature; the best-established one pertains to serum levels which are below 30 ng/ml.[6] Tribal population living in rural areas of Tripura differs from rest of the nation regarding food habit, lifestyle, sociocultural, and genetic makeup. Little is known regarding the blood level of Vitamin D3 in them. Hence, the present study was designed to assess the blood level of Vitamin D3 and its association with type 2 DM in this population.

Objectives

The objectives of this study were as follows:

1. To estimate the proportion of Vitamin D3 insufficiency among the rural tribal population of Tripura
2. To determine the association of Vitamin D3 level with blood glucose level in this population.

MATERIALS AND METHODS

This study was conducted at Multidisciplinary Research Unit of Agartala Government. Medical College, Agartala, after getting Institutional Ethics Committee clearance. It was an observational, cross-sectional study done during a period of 1 year. Minimum sample size requirement for this study was determined using the formula (sample size $n = [(Z^2_{1-\alpha/2} \times P [1-P]) \div l^2] \times 2$) for calculating sample size in prevalence studies using proportion considering[9] the prevalence of Vitamin D3 deficiency among Indian ethnic population as 84.3%[10] at 95% confidence with 10% relative error and a design effect of 2. A total of 208 ethnic subjects were recruited in this study. Multistage sampling technique was used. In the first stage, of 58 blocks of Tripura, 10 blocks having predominantly tribal population were selected by simple random sampling. In the next stage, one primary health center from each of these 10 block areas was selected by simple random sampling (SRS). Then, one health camp was organized in each of these selected primary health center areas after wide publicity through the Accredited Social Health Activists (ASHA), Anganwadi workers, health sub-centers, and open publicity. In total, 208 ethnic subjects were recruited from the attendees of these health camps following the inclusion and exclusion criteria after obtaining written informed consent for participation in this study. Those with pregnancy, below 18 years, diagnosed cases of hypercalcemia, on antipsychotic medication, on anti-TB, anticancer, and steroid medication and on Vitamin D3 medication were excluded from this study. Selected subjects were interviewed confidentially in the presence of an ASHA and information obtained was recorded in the pre-tested interview schedule and after that, 5 ml of venous blood sample was obtained using vacutainer following standard guidelines, and later on, it was transported to the MRU laboratory at Agartala Government Medical College maintaining cold chain for following investigations: 25(OH) Vitamin D – by direct ELISA method (ELISA Reader-Alere AM2100), blood glucose level (fasting and postprandial) – by fully automated analyzer (Transasia XL-640), and HbA1c – by fully automated analyzer (XL-640). Anthropometry measurements like height were determined by a stadiometer (Ishnee) and other parameters such as weight, body mass index, and body fat percentage were determined by OMRON body composition monitor (HBF-701).

Ethical Clearance

Ethical clearance (No. F.4 (6–9)/AGMC/Academic/IEC Committee/2015, dated, 06.12.2017) was obtained from the Institutional Ethics Committee of Agartala Government Medical College before conducting this study.

Statistical Analysis

All the data were statistically analyzed. Statistical parameters used were mean, standard deviation, and correlation coefficient. Dichotomized data were analyzed with Chi-square test and measurable data were analyzed by *t*-test for testing of significance. The association of blood Vitamin D3 with fasting blood sugar, postprandial blood sugar test, and HbA1c was evaluated using the Pearson's correlation coefficient. Statistical analysis was performed using the Statistical Package for the Social Sciences software, version 25. $P < 0.05$ was considered statistically significant. Statistical analysis was confirmed by consulting an expert Biostatistician from Community Medicine Department of Agartala Government Medical College.

RESULTS

Two hundred and eight ethnic subjects of Tripura were included in this study. Among these, 136 subjects had blood Vitamin D3 insufficiency, whereas only 72 subjects had sufficient amount of Vitamin D3 level in their blood [Figure 1]. Hence, 65% prevalence of Vitamin D3 insufficiency has been observed among this ethnic population of Tripura. Age of the subjects ranges from 18 years to 90 years. For this, a total of 208 ethnic subjects have been divided into seven age groups, namely, 18–28 years, 29–39years, 40–50 years, 51–61 years, 62–72 years, 73–83 years, and 84–94 years. It was observed that the prevalence of Vitamin D3 insufficiency was much higher in the age range of 51–61 years among this

ethnic population of Tripura [Table 1]. There is no significant association between sex and serum Vitamin D3 levels of ethnic subjects of Tripura attending the health camps [Table 2]. In the present study, we also observed Vitamin D insufficiency in 32 female diabetics and 26 male diabetics of 59 diabetic members. Of 59 diabetic, 33 were female and 26 were male. The mean age of diabetic subjects and non-diabetic subjects was 49.17 ± 11.57 and 48.30 ± 17.29, respectively. Vitamin D3 insufficiency was observed in both diabetic and non-diabetic subjects. The mean Vitamin D3 values in diabetic subjects were 18.46 ± 4.49 ng/ml and mean Vitamin D3 values in non-diabetic subjects were 38.45 ± 9.39 ng/ml. Although the mean values of Vitamin D3 in diabetic cases were lower than that of non-diabetic subjects, Student's *t*-test shows that there is no statistical difference in Vitamin D3 levels between diabetics and non-diabetics [Table 3]. Negative correlation was observed between Vitamin D3 levels and HBA1C (r = -0.143) and also between body fat percentage & Vitamin D3 (r = -0.108) which is not statistically significant [Table 3].

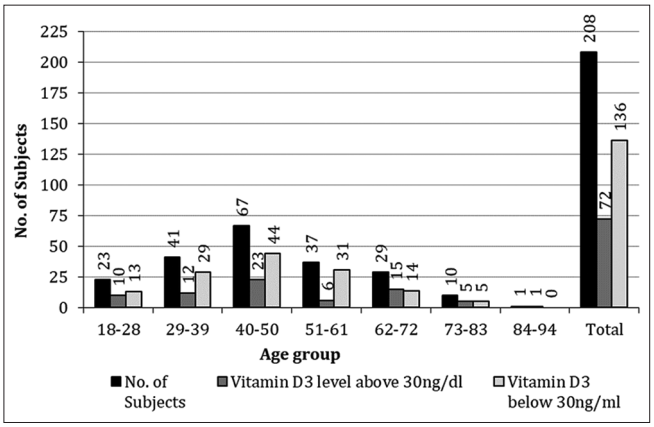

Figure 1: Status of serum Vitamin D3 level among ethnic population of Tripura

Table 1: Prevalence of lower Vitamin D3 among different age groups

Age group	Prevalence of lower Vitamin D3 level (%)
18–28	56.52
29–39	70.7
40–50	65.7
51–61	84
62–72	48.3
73–83	50
8–94	0

Table 2: Association between serum Vitamin D3 level and sex of participants

Vitamin D3 level	Male	Female	Total	Chi square value	*P*-value
<30 ng/ml	53	83	136	1.0023	0.32
>30 ng/ml	23	49	72		

DISCUSSION

Despite adequate exposure to sunlight throughout the year, Vitamin D3 insufficiency is common in Indian population of all age groups and both genders in urban and rural areas [11]. In many Indian studies, Vitamin D3 deficiency has been identified as an independent adjunctive risk factor for Type 2 DM.[11-14]. In the present study, low Vitamin D3 levels were observed in 65% of the study subjects among the ethnic population of Tripura. Vitamin D insufficiency was observed in 98.3% of diabetic subjects and 52.3% of non-diabetic subjects. In this study, the prevalence of Vitamin D3 insufficiency is higher in the age range of 51–61 years among ethnic population of Tripura which is in confirmatory with the study done by Gunjaliya *et al*. where the age group was 41–60 years.[15]

In a study done by Kanchana *et al*.,[16] Vitamin D3 level was found decreased among diabetics which is not consistent with the findings of the present study.

Kumar *et al*. observed similar type of findings in their study on evaluation of Vitamin D3 status among the diabetic population of Pondicherry, India.[17] In their study, Vitamin D3 deficiency was observed in 32% of cases and 25% of controls. Balasubramanian *et al*. also got similar type of result.[1] In that study, there was a trend toward an inverse Vitamin D3 – HbA1c association, which did not show statistical significance. Alhumaidi *et al*. also observed low Vitamin D levels in both Type-2 diabetic subjects and non-diabetic subjects[18] which were comparable to the findings of the present study. Sheth *et al*. observed lower serum Vitamin D3 level in 91.4% of cases of Type 2 DM and 93% in the control group. Sheth *et al.* could not establish any association between Vitamin D3 deficiency and glycated hemoglobin which is in agreement with the findings of the present study.[19] In a study done by Athanassiou *et al*., serum Vitamin D3 values were found to be 19.26 ± 0.95 ng/ml

Table 3: Correlation between Vitamin D3 and different parameters

	Parameters	Mean±SD	*R*-value (*P*-value)
Diabetic group	Body mass index	23.25±4.17	0.097 (0.464)
	Vitamin D3	18.46±4.49	
	Body fat %	26.63±8.62	**−0.108 (0.414)**
	Vitamin D3	18.46±4.49	
	Visceral fat	7.57±4.57	0.070 (0.598)
	Vitamin D3	18.46±4.49	
	Fasting blood sugar	153.87±74.65	0.098 (0.459)
	Vitamin D3	18.46±4.49	
	Postprandial blood sugar test	224.15±111.63	0.134 (0.312)
	Vitamin D3	18.46±4.49	
	HbA1c	7.7±1.55	**−0.143 (0.280)**
	Vitamin D3	18.46±4.49	

in type 2 DM cases which were in the insufficiency range. The findings of Athanassiou *et al*. are in agreement with the findings of the present study since the Vitamin D3 levels of the present study are also in the insufficiency range. In their study, they observed an inverse relationship between Vitamin D3 levels and glycated hemoglobin which could not be established in the present study.[20] Chiamolera *et al*. observed a 25-hydroxyvitamin D of 23.4 ± 8.3 ng/ml in patients with type 2 DM which was higher than the results of the present study.[21] Doddamani *et al*. observed Vitamin D deficiency in 70% of cases of newly diagnosed type 2 DM cases. They also observed an inverse relationship between HbA1c and Vitamin D3 levels[22] which could not be established in this study. Shanti *et al*. observed Vitamin D3 levels in the insufficiency range (18.492 ± 3.49 ng/ml) in cases of Type 2 DM which was in very close agreement with the findings of our study. They also observed a negative correlation between Vitamin D3 levels and HbA1c which was not statistically significant[23] which was consistent with the present study. Mangukiya *et al*. observed Vitamin D3 levels to be in the insufficiency range (18.5 ± 3.50 ng/ml) which was also in very close agreement with the findings of the present study. They also observed a negative association between 25-hydroxyvitamin D and HbA1c which was not statistically significant[24] and are consistent with the present study result. Kadi observed low 25-hydroxyvitamin D levels in 83% of Type 2 DM cases and 76% of control group, and in the present study, 98.3% Vitamin D3 insufficiency was found in diabetic individuals and 52.3% insufficiency was seen in non-diabetic individuals.[25] Mohapatra *et al*. observed a 25-hydroxyvitamin D level of 19.94 ± 2.41 ng/ml in cases of type 2 DM which is in agreement with 25-hydroxyvitamin D levels of the present study since it is in the insufficiency range.[26] Saha *et al*. observed significantly lower Vitamin D 3 levels in patients with type 2 DM in comparison to healthy controls.[27] Sadiya *et al*. conducted a randomized control trial (RCT) on Vitamin D deficient obese type 2 DM group but observed no improvement in metabolic control in these patients on Vitamin D3 supplementation.[28] Yiu *et al*. also observed no significant change in HbA1c after Vitamin D supplementation in type 2 DM patients.[29] Daga *et al*. carried out similar work in the North of India, in which he had mentioned that 91.1% of diabetic patients had Vitamin D3 insufficiency[30] which was consistent with the present study where we got 98.3% of Vitamin D3 insufficiency among the diabetic subjects. Garg *et al*. observed 98.75% prevalence of Vitamin D3 insufficiency among 1052 Indian women,[31] and in the present study, we observed 65% prevalence of Vitamin D3 insufficiency among the ethnic study subjects of Tripura.

Strength of Study

In this community-based study, simple random sampling technique was used for selecting the sample to avoid any type of selection bias.

Limitation of the Study

In this present study, the confounding factors for Vitamin D3 levels like complexion of the skin could not be evaluated among the study subjects. Other than this, being an observational cross-sectional study, no conclusion can be made as far as any cause and effect relationship between Vitamin D3 insufficiency and DM type 2.

Recommendations

In future, multicentric studies may be undertaken to clearly establish a causal association between Vitamin D3 levels and HbA1c level among the ethnic DM patients of northeast population. Studies like RCT will have a major role in finding whether Vitamin D3 supplementation is a useful intervention in preventing or delaying the onset of type 2 diabetes.

CONCLUSION

The findings of the present study had shown that the prevalence of 65% of Vitamin D3 insufficiency is present among the ethnic population of Tripura. Vitamin D3 level and its inverse association with glycemic parameters in type 2 DM have been established in many studies. However, such finding could not be demonstrated strongly in the present study.

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