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Original Article

EVALUATION OF VITAMIN-D LEVELS IN CHILDREN WITH TYPE-1 DIABETES MELLITUS

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ABSTRACT

Objective: Vitamin D supplementation during pregnancy and early childhood decreases the risk of autoimmune diabetes, and perhaps even after the onset of diabetes, it may improve glycemic control. Hence, the present study focuses on evaluating vitamin D levels in type-1 DM.

Methods: It is a case-control study conducted on children aged from 6 y to 15 y who presented with type 1 DM and were admitted to the Department of Pediatrics, Dr. Patnam Mahender Reddy Institute of Medical Sciences, Chevella. Diabetic Mellitus was studied using a predesigned and pre-tested proforma. 100 children in the age group of 6-15 y were included, further divided into two groups. Children with Type 1 DM were enrolled as cases, while the normal children were enrolled as controls. Information was collected from the patient or attender or relative about the sociodemographic profile, dietary intake, and treatment history. A detailed clinical examination of the child was conducted with exact anthropometric measurements. Metabolic profile was done by investigating fasting blood sugar, postprandial blood sugar, and glycosylated hemoglobin. Blood samples were collected from all participants for measurement of hematological parameters. A Minividas analyzer estimated vitamin D, the Chemiluminescence method.

Results: Most children with Type 1 DM were 10-14 y old, and the mean age of the cases was 11.36. This study's female-to-male ratio was 1.3:1 (29 and 21), respectively. In this study, we found that 38(76%) children were in the deficiency range, the majority in the age group of 10-14 y, while 7(14%) children were in the insufficiency range, only 5(10%) were in the sufficiency range. The significant finding in this study was the mean Vitamin D level for cases was 16.81, while in comparison, controls had a mean Vitamin D level of 25.74; it was significant.

Conclusion: The present study revealed that the prevalence of vitamin D deficiency and insufficiency among T1 diabetes children was very high.

Keywords: Type-1 DM, Vitamin D, Children, Glycosylated haemoglobin, Blood sugar

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INTRODUCTION

Elevated fasting and postprandial blood sugar levels and the development of long-term micro and macrovascular problems are the hallmarks of the clinical syndrome known as diabetes mellitus (DM) [1]. Type 1 diabetes mellitus, which results in inadequate insulin secretion due to damage to the pancreatic beta cells, is separated from type-2 diabetes mellitus, which results in insulin resistance at the level of skeletal muscle, the liver, and adipose tissue with varying degrees of beta cell impairment [1]. There are few epidemiological statistics from India. However, a recent study in Madras estimates that the prevalence of diabetes in Indian children is 10.5 per 1,000 patients per year. In India's urban population, the majority of pediatric diabetes is 0.26 per 1000. Nearly 90% to 100% of all children with diabetes have type 1 diabetes [2]. By modulating immunological mechanisms, vitamin D deficiency may have a role in the pathophysiology and development of type 1 diabetes. Numerous epidemiological research point to a connection between the two diseases [3]. At least 1 billion people are thought to be vitamin D deficient globally, primarily due to poor sun exposure and vitamin D food consumption [3]. It has repeatedly been demonstrated that people with vitamin D deficiency are more likely to develop type 1 diabetes mellitus. The death of insulin-secreting pancreatic beta cells is autoimmune and progressive [4]. Retrospective analysis and observational studies on children with type 1 diabetes mellitus revealed a significant frequency of vitamin D deficiency. They suggested a role for vitamin D deficiency in developing type 1 diabetes [5-8]. Vitamin D supplementation during pregnancy and early childhood decreases the risk of autoimmune diabetes, and perhaps even after the onset of diabetes, it may improve glycemic control [9-12]. This study focuses on evaluating vitamin D levels in type-1 DM.

MATERIALS AND METHODS

Source of data

It is a case-control study conducted on children aged from 6 y to 15 y who presented with type 1 DM and were admitted to the Department of Pediatrics, Dr. Patnam Mahender Reddy Institute of Medical Sciences, Chevella, Telangana.

Study duration: The study was conducted from January 2021 to May 2022.

Inclusion criteria

1. Children already diagnosed with type 1 diabetes mellitus are 6 to 15 y old.

2. Cases of non-diabetic children are also enrolled as controls.

Exclusion criteria

1. Children with the age group of less than 6 y and more than 15 y.

2. Children who have already taken vitamin D supplementation.

3. Children with clinical evidence of nutritional rickets.

Institutional ethics approval

The institutional ethical committee granted ethical approval for the study. Informed consent was obtained from parents or legal guardians.

Data collection and methodology

All children attending Department of Pediatrics, Dr. Patnam Mahender Reddy Institute of Medical Sciences, Chevella, who are already diagnosed with Type 1 DM, were included in the study. Diabetic Mellitus was studied using a predesigned and pre-tested proforma. 100 children in the age group of 6-15 y were included, further divided into two groups. Children with Type 1 DM were enrolled as cases, while the normal children were enrolled as controls. Information was collected from the patient or attender or relative about the sociodemographic profile, dietary intake, and treatment history. A detailed clinical examination of the child was conducted with exact anthropometric measurements. Weight for age was calculated according to the Indian Academy of Pediatric centile charts (IAP grades) [13]. Height was measured using a stadiometer, and the Indian Academy of Pediatric centile graphs were used for height for age criteria [2]. Metabolic profile was done by investigating fasting blood sugar, postprandial blood sugar, and glycosylated hemoglobin. Blood samples were collected from all participants for measurement of hematological parameters. A Minividas analyzer estimated vitamin D, the Chemiluminescence method [14]. The glycemic control was labeled normal, good, fair, unsatisfactory, and poor according to their glycosylated hemoglobin levels. Urine examination for albumin, sugar, and microscopy: Urine sugar was estimated by Benedict's test.

Statistical analysis

Data was collected in a predetermined proforma, entered in an MS Excel sheet, and results were analyzed using the Software Statistical Package Student Science (S. P. S. S) version 19.0. Results were expressed in terms of % statistical tests used: unpaired test, Chi-square test ($\chi 2$), and odds ratio. A p-value<0.05 is considered significant, and A p-value<0.001 is regarded as highly significant.

RESULTS

Table 1 shows that out of 50 cases studied, most of the cases were reported from 10-14 y age 28(56%), whereas in controls out of 50 studied, 33(66%) were in the age group of 5-9 y. From table 2, it was shown that most of the cases reported were females, 29 (58%). In cases, there was female predominance (58%) of type-1 DM cases. From table 3, it was shown that out of 50 cases studied, the majority were 16(32%), having a duration of 1-2 y of type-1 DM, and another 16(32%) having a duration of 2-4 y. Fig. 1 shows the family history of diabetes mellitus among the study participants. Of 50 cases, 22 (44%) had a family history of diabetes mellitus. Table 4 shows consanguinity in diabetes mellitus. Out of 50 cases, only 17(34%) had a consanguineous family history, and the rest (66%) were non-consanguineous. Fig. 2 depicts the education of parents in cases and controls. In these study cases, most parents were illiterate 25(50%). Table 5 represents the nutritional status of the study participants as per the IAP grades (height). In the present study (30%) cases were noted in less than<1SD. Table 5 shows the nutritional status of the study participants as per the IAP grades (weight). In the present study (28%) were noted in less than<1SD, (34%) cases were reported in less than<2SD. Table 6 depicts the various ranges of fasting blood sugar. The present study compared fasting blood sugar levels with the controls. In the majority of the cases, the fasting blood sugar was in the range of 100-200 mg/dl, i.e., 25(50%). In comparison with the controls, 45(90%) of the controls were 100 or less than 100; statistically, this study was highly significant. Table 7 shows various ranges of postprandial blood sugar. The cases were equally distributed in the present study, ranging from 100-400 mg/dl. In some cases, the mean postprandial blood sugar was 310 mg/dl, whereas in controls, it was 121.2 mg/dl. In a comparison of cases and controls, it was statistically significant. Table 8 shows various levels of glycosylated hemoglobin levels in cases and controls. In the present study, 50% of diabetic children showed poor control only. Benedict's test did urine sugar analysis, and brick Red precipitates were identified in 48% of samples. Urine albumin was absent in all the patients. Table 10 and table 11 showed the overall incidence of Vitamin D in both cases and controls, where in cases, 78% were in the deficiency group, 16% were in the insufficiency group, and only 6% were in the sufficiency group. In comparison with cases and controls, this study was statistically significant. The mean Vitamin D levels in cases was 16.81, whereas in controls, it was 25.74. In the cases in the deficiency group, the majority of children, 19 cases were in the age group of 10-14 y, whereas in the insufficiency group, it was 6 cases in the age group of 10-14 y, and in the sufficiency group also 4 cases were in the age group of 10-14 y (table 12, table 13, table 14). In the case of controls in the deficiency group, the majority of the controls (6) were in the age group of 5-9 y; in the insufficiency group, 15 controls were in the age group of 5-9 y; in the sufficiency group, majority of the cases (11) were in the age group of 5-9 y (table 15). The above bar graph shows Vitamin D levels in children and their relation to sex, where in the case of cases (28), female children were in both deficiency and insufficiency groups. In contrast, males were only (17) in both the deficiency and insufficiency group. This study shows female preponderance (fig. 3). Religion and Vitamin D levels in relation to cases were found to be in 90% of cases were Hindu, and 9% were Muslim (fig. 4). Religion and Vitamin D levels about controls were 68% in Hindus, 21% in Muslims, and 10% in Christians (fig. 5).

Table 1: Age distribution of patients

Age group	Cases	%	Controls	%
5-9	13	26	33	66
10-14	28	56	17	34
15-19	9	18	0	0
Total	50	100	50	100

Table 2: Gender distribution of patients

Sex	Cases	%	controls	%
Male	21	42	38	76
Female	29	58	12	24
Total	50	100	50	100

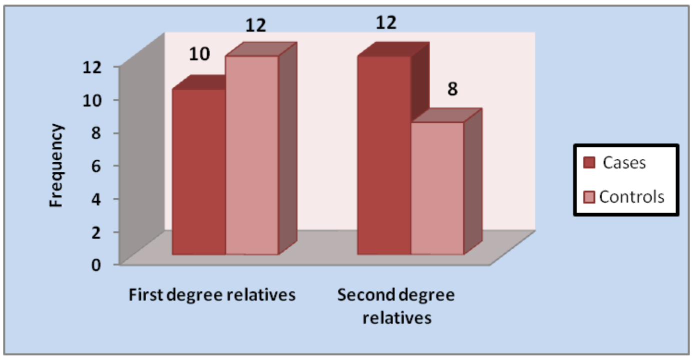

Fig. 1: Family history of DM in both cases and controls

Table 3: Duration of diabetes mellitus

Duration	No. of cases	Percentage
Newly diagnosed	7	14
1-2 y	16	32
2-4 y	16	32
4-6 y	7	14
6-11 y	4	8
Total	50	100.00

Table 4: Consanguinity both in cases and controls

Consanguinity	No. of cases	%	Controls	%
Second degree consanguineous	17	34	15	30
Non consanguineous	33	66	35	70
total	50	100	50	100

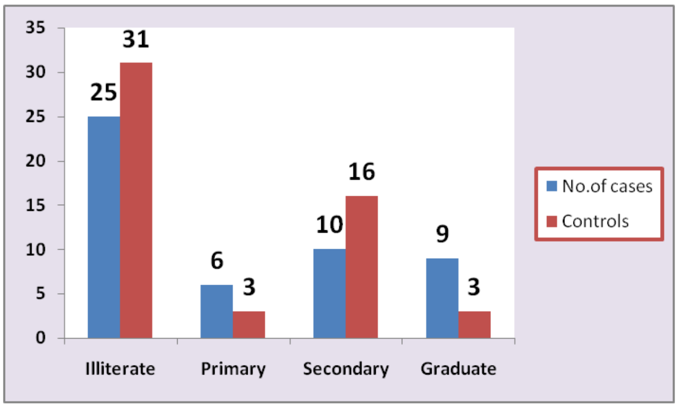

Fig. 2: Education of parents in cases and controls

Table 5: Nutritional status (IAP standards) of cases

Nutritional status	No. of cases			
	Ht	%	Wt	%
<1SD	15	30	14	28
<2SD	13	26	17	34
<3SD	12	24	7	14
>1SD	4	8	0	0
>3SD	1	2	0	0
1SD	1	2	2	4
M	4	8	10	20
Total	50	100	50	100

Table 6: Fasting blood sugar level in cases and controls

Fasting blood sugar (mg/dl)	Cases	Percentage	Controls	Percentage	χ^2-value	p-value
0-100	1	2	45	90	79.42	<0.0001**
100-200	25	50	5	10		(Significant)
200-300	15	30	0	0		
300-400	5	10	0	0		
>400	4	8	0	0		
Total	50	100	50	100		
	Mean	SD	t-value	p-value	Result	
Cases	211.8	104.03	8.54	<0.0001	HS	
Controls	85.46	10.8				

Table 7: Postprandial blood sugar levels in cases and controls

Post prandial blood sugar (mg/dl)	Cases	Percentage	Controls	Percentage	χ^2-value	p-value
100-200	10	20	50	100	66.67	<0.0001**
200-300	13	26	0	0		
300-400	15	30	0	0		
>400	12	24	0	0		
Total	50	100	50	100		

Table 8: Glycosylated hemoglobin levels in cases and controls

Glycosylated hemoglobin levels	Cases	Percentage	Controls	Percentage	χ^2-value	p-value
4-7	2	4	46	92	78.7	<0.0001**
8-10	23	46	4	8		
10-13	17	34	0	0		
13-15	8	16	0	0		
Total	50	100	50	100		

Table 9: Urine sugar levels in cases

Urine sugar levels	No. of cases	Percentage
Orange (1.0-1.5 g/dl)	11	22
Brick Red (1.5-2.0 g/dl)	24	48
Green (0.1-0.5 g/dl)	3	9
Yellow (0.5-1.0 g/dl)	12	24
Absent	0	0
Total	50	100

Table 10: Vitamin-D levels in both cases and controls

Vitamin D ng/ml	Cases	%	Controls	%
0-20	39	78	11	22
20-29	8	16	24	48
29-100	3	6	15	30
Total	50	100	50	100

Table 11: Vitamin D in cases and controls

Vitamin D ng/ml	Mean	SD	t-value	p-value	Result
Cases	16.81	6.29	6.59	<0.0001	HS
Controls	25.74	7.22			

Table 12: Vitamin-D levels in children (cases and controls)

Vitamin D US Endocrine Society	Cases	%	Controls	%
0-20	38	76	11	22
20-29	7	14	23	46
29-100	5	10	16	32
Total	50	100	50	100

Table 13: Vitamin-D levels in cases (U. S endocrine society)

Vitamin D US Endocrine Society	Cases
0-20	38
20-29	7
29-100	5
Total	50

Table 14: Vitamin-D levels in controls (U. S endocrine society)

Vitamin D US Endocrine Society in controls	Controls
0-20	11
20-29	23
29-100	16
Total	50

Table 15: Age distribution of patients (cases and controls) studied with vitamin D levels

Age (y)	Vitamin D					
	Cases	Controls	Cases	Controls	Cases	Controls
	Deficiency (%)		Insufficiency (%)		Sufficiency (%)	
5-9	10(26.32)	7(69.64)	1(14.28)	15(65.21)	1(20)	11(68.75)
10-14	19(50)	4(36.36)	6(85.72)	8(34.78)	4(82)	5(31.25)
15-19	9(23.68)	0(0)	0(0)	0(0)	0(0)	0(0)
Total	38(100)	11(100)	7(100)	23(100)	5(100)	16(100)

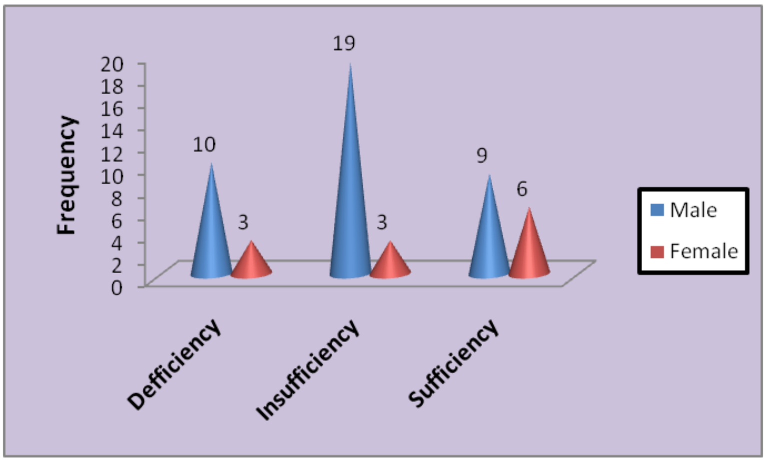

Fig. 3: Vitamin D (controls) levels of cases gender wise

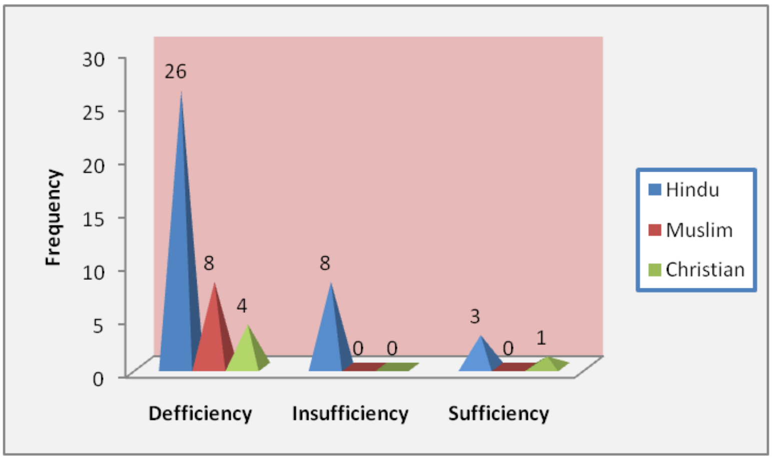

Fig. 4: Showing religion distribution in cases studied with vitamin-D levels

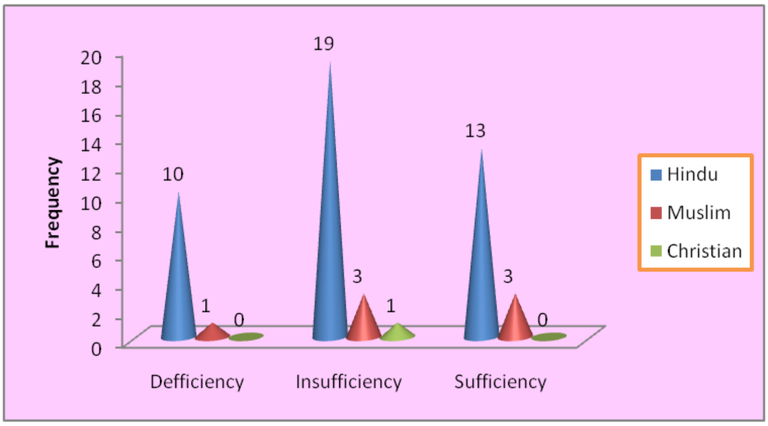

Fig. 5: Showing religion distribution in controls studied with vitamin-D levels

DISCUSSION

Diabetes Mellitus is one of the chronic diseases of children and youth worldwide, and we know very little about the magnitude or determinants of childhood and youth onset of diabetes in India. Although initially described as a "vitamin," vitamin D is now recognized as a hormone synthesized in the human body and exerts its action on other organs via a nuclear receptor (vitamin D receptor, VDR). A significant source of Vitamin D for our body is cutaneous synthesis through the effect of UVR on 7-dehydrocholesterol because dietary source through fatty fishes, organ meat, egg yolk, cod liver oil, and milk products does not contribute significantly as these are not consumed in sufficient quantities by children. Thus, fortifying foods with vitamin D remains the only alternative if cutaneous synthesis is inadequate. It is surprising and disturbing to note that hypovitaminosis D is highly prevalent even in areas with adequate sunshine. In the present study, the peak incidence was in the age group of 10–14 y (56%). In similar studies, the peak age at diagnosis was 11 y in girls and between 11 to 18 y in boys, and female predominance was present [15]. In the present study, 44% had a family history of diabetes mellitus, 20% had first-degree diabetic relatives, 24% had second-degree relatives, and 34% of children had a second-degree consanguineous family history. No incidence of diabetes was found in the siblings. A similar study in Chennai showed a 6.14% incidence of diabetes in siblings and 20.52% in second-degree consanguineous family history [16]. A similar study of 110 diabetic children in Saudi Arabia showed their parents were often related, 31% being first-degree cousins and 12% second-degree cousins. First-degree family history was positive for type I diabetes in 28%. Among these, siblings accounted for 26.00% [17]. In another study, 23.00% had a consanguineous family history [18]. HBA1C level in the present study showed 50% to be of poor glycemic control, 46% unsatisfactory control, and 4% had fair control. Two studies showed 50% and 28% poor glycemic control, respectively. The present study showed the mean glycosylated hemoglobin in cases was 10.17%, whereas, in controls, the mean glycosylated hemoglobin was 5.66%; statistically, in comparison, the T value was 12.96%, and the p-value was<0.001, statistically, which is highly significant. Studies revealed a lack of association between glycemic control changes and therapeutic regimen changes. However, a significant correlation was found with the duration of diabetes. The low socioeconomic level is related to poor glycemic control. Factors such as the attitude of treatment teams, self-care behaviors, education, or patient satisfaction may be more directly related to outcomes than the insulin regimens [19]. In this study, we found levels of Vitamin D were more in the levels of deficiency for 39 (78%) children insufficiency range for 8(16%) children, and sufficiency range for 3(6%) children, whereas in controls, only 11(22%) were in the level of deficiency and 24(48%) were in the level of insufficiency, 15(30%) were in the level of sufficiency The mean Vitamin D levels for cases was 16.81 and. In contrast, for controls, it was 25.74%, and statistically, the t-value was 6.59, and the p-value was<0.0001, which is highly significant. In the study by Ataie-Jafari *et al.* [20], Vitamin D deficiency is a common problem even in healthy children and adolescents. Higher BMI in children and adolescents is accompanied by rapid growth of bones as they are taller than average and their bone age is slightly advanced. These children need more vitamin D because of the high expenditure that would result in low blood levels of this vitamin. In our study, we also found that there was a severe deficiency of vitamin D in the same age group [21]. In this study, the female-to-male ratio was 1.3:1 (29 and 21), respectively. In the present study, 56% of females combined were in both the deficiency and insufficiency range, whereas in males, it was 34% in the deficiency and insufficiency range. In the study by Ataie-Jafari *et al.*[20], similar results related to the present study were found., Serum vitamin D levels were significantly higher in boys compared to the girls (18.3±7.8 and 10.8±4.3 ng/ml, respectively; (P = 0.004). We can't compare religion and its relation to Vitamin D levels as in this study, 90 percent were Hindus as this area has a Hindu majority, and only 9.9% were Muslims. However, among Hindus, 80% had levels in the deficiency and insufficiency groups. In Muslims, 70% were in deficiency and insufficiency range. In the Christian, 8% were in deficiency range.

CONCLUSION

In this study, we tried to evaluate the Vitamin D levels in type 1 DM cases and compare the values with controls, and the relationship was found that Vitamin D levels were severely low in type 1 DM cases as compared to the controls. In the case of gender, males had better vitamin D levels compared to females. The majority of the children were in the age group of 10-14 y, and the mean age of the cases was 11.36. In the present study, 44% had a family history of diabetes mellitus. No incidence of diabetes was found in the siblings. 50% of the cases had HBA1C levels of>10%, which indicates poor glycemic control, while 46% had unsatisfactory glycemic control, and only 4% of cases had fair glycemic control. In the present study, 56% of females combined were in both the deficiency and insufficiency range, whereas in males, it was 34% in the deficiency and insufficiency range.

FUNDING

Nil

AUTHORS CONTRIBUTIONS

All the authors have contributed equally.

CONFLICT OF INTERESTS

Declared none

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