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Evaluation of Hba1c and Serum Levels of Vitamin D in Diabetic Patients

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Abstract
Objective:
The most prevalent metabolic disorder worldwide is diabetes mellitus. The current investigation seeks to examine serum levels of vitamin D and haemoglobin A1C (HbA1C) in diabetic patients.
Methods:
102 diabetic patients who visited the tertiary care hospital in Government General Hospital, Vijayawada in 2022 were the subject of a descriptive study. The gathered information where it was subjected to the appropriate statistical tests for analysis. The terms mean and standard deviation were employed to describe the quantitative variables. Also, the terms "number" and "percentage" were used to describe the qualitative factors. Using Chi-square and ANOVA, the mean serum levels of vitamin D and HbA1C were compared for various factors.
Results:
The HbA1C and fasting blood sugar have a favourable and statistically significant association (FBS). Moreover, there is a statistically significant link between body mass index and smoking, as well as the blood vitamin D level (BMI). Moreover, there is an inverse linear association between vitamin D and HbA1C, FBS, BMI, and the length of the disease. HbA1C with FBS and disease duration had a linear, direct association. HbA1C and BMI have an inverse linear connection, however it is not statistically significant.
Conclusion:
It seems useful to monitor the serum level of vitamin D in a diabetic patient and provide its supplements if necessary given the involvement of this vitamin in secretion and the effect of insulin.
Keywords: *Patients with diabetes, haemoglobin A1Cand serum vitamin D levels*

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I. Introduction

The most prevalent metabolic disorder in the world is diabetes mellitus. It is estimated that 300 million individuals will have this condition by 2025[1], The importance of vitamin D in diet cannot be overstated. Vitamin D differs from the other vitamins in that it has particular physiological and metabolic effects.

Similar risk factors for type 2 diabetes and vitamin D deficiency include race, obesity, advanced age, place of residence, and inactivity. Many studies have shown that diabetes patients have significantly lower serum levels of 25-hydroxyvitamin D than healthy people. [2,3,4] Insulin synthesis, secretion, and sensitivity are all impacted by vitamin D. [5] Vitamin D may also have an impact on type 2 diabetes management and risk reduction[6,7,8,9]. [3,6] It is crucial to research this connection because type 2 diabetes is becoming more common and there is a vitamin D shortage. Many studies on this subject have been carried out globally as a result.

Systemic inflammation, insulin resistance, and improved pancreatic beta cell function are all associated with a higher incidence of type 2 diabetes. There is proof that vitamin D has an impact on the aforementioned issues. [10] Via beta cells and other insulin-targeted organs, vitamin D is expected to indirectly influence insulin secretion and sensitivity. Vitamin D's immunomodulatory properties in connection to the activity of T cells are useful for various immunological processes that result in type 1 diabetes. [11]

Many studies have shown a connection between vitamin D deficiency and changes in insulin and blood glucose concentrations as well as the sensitivity of the tissues that respond to insulin. [12,13] Moreover, a metabolic syndrome is prone to develop in type 2 diabetes patients who do not get enough vitamin D, and vitamin D treatment can lessen insulin resistance. [14] Studies have shown that vitamin D is important for insulin secretion and performance issues. [15] Many cross-sectional studies have shown a correlation between vitamin D level and the prevalence of either diabetes or impaired glucose tolerance (IGT). The correlation between vitamin D status and the risk of developing type 2 diabetes has been observed in two US studies by Kohert and one in Finland. [16,17] According to a study on women's health, getting 511 units of vitamin D per day as opposed to 159 units will probably lower your chance of developing type 2 diabetes. Other than age, no other intervention factors have been taken into account in this analysis. [16] High serum vitamin D levels and low diabetes incidence in Finnish males are statistically significantly correlated. [17] A different New Zealand study revealed that people with type 2 diabetes and IGT had lower vitamin D levels than the control group. [18] The serum level of 25-hydroxyvitamin D may be positively correlated with obesity, according to one theory. According to some experts, the association between vitamin D and improved lipogenesis and lipolysis control in in vitro tests is favourable. [19] Other research in this area, however, revealed a negative impact. [20,21]

Given the conflicting results of the existing studies, it appears necessary to conduct additional research with various statistical populations; if it is determined that a lack of vitamin D significantly contributes to the incidence of type 2 diabetes, treating this deficiency will be the primary focus of care for diabetic patients. As a result, the current research was carried out to examine HbA1C and vitamin D serum levels and determine the serum level of vitamin D in diabetic patients due to the significance of the issue, variety in the research findings, differences in climatic conditions, the dietary practises of people in different areas. Age, gender, smoking, location of residence, body mass index (BMI), duration of diabetes, glycated haemoglobin, fasting glucose level, and vitamin D status of the patients were also determined.

II. Materials and methods

Cross-sectional descriptive study was done on diabetes patients in Government General Hospital, Vijayawada. Using specific questionnaires, the patient's demographic and anthropometric data were gathered. Before taking any medications to lower blood sugar, a fasting condition was used for sampling between the hours of 8 and 10 in the morning, and the serum level of vitamin D was evaluated using the enzyme-linked immunosorbent assay (ELISA) method and the kit. With a sample size error rate of 0.1 and a prevalence of >70%, the lack of vitamin D in 81 diabetes patients was assessed. 102 patients were examined in order to increase the statistical power of the study.

After using the inclusion and exclusion criteria, the sample size was determined at random. The following requirements apply to inclusion: Menopause or pregnancy (for female participants); lack of intervention medications or vitamin D (corticosteroids, anticonvulsants, contraceptives); absence of history of angina, myocardial infraction, stroke, kidney or liver diseases, chronic inflammatory diseases, and thyroid diseases within the past year; absence of treatment with thiazolidinedione medications; and absence of menopause or pregnancy. The exclusion criteria include having a creatinine level of more than 2 mg/dl, malabsorption, infertility, oligomenorrhea, pregnancy, breastfeeding, diagnosed malignancy, using drugs that affect bone metabolism, drinking alcohol, being inactive for more than a week, taking calcium supplements within the past two weeks, taking vitamin D supplements within the past three months, taking vitamin D injections within the past six months, being obese (BMI >40 kg/m2), and having severecomplications of diabetes in patients suffering from diabetes (nephropathy, retinopathy, and so on), and HbA1C >11%.

The qualified participants were directed to the laboratory, where 10 ml of their blood was drawn after they had their demographic and anthropometric details recorded, their blood pressure had been checked, and they had fasted for 12 hours. The Hitachi 917 auto analyzer was used to analyse blood samples in order to measure fasting blood sugar (FBS). Using a photometric approach, the Hitachi 917 machine was utilised to measure the blood lipid profile. 30-100 ng/mL was determined to be the natural level of 25-hydroxyvitamin D after the blood level was measured using the chemiluminescence method with the LIAISON machine and then analysed with the DIaSorin30 kit. Moreover, vitamin D insufficiency was defined as 20 vit D (OH) 25 ng/mL, inadequacy of vitamin D was defined as 25 vit D 30 ng/mL, and adequacy of vitamin D was defined as vit D >30 ng/mL. [22]

The patient data was subjected to statistical tests for analysis. The terms mean and standard deviation were employed to describe the quantitative variables. Also, the terms "number" and "percentage" were used to describe the qualitative factors. The Chi-square and analysis of variance were used to compare the mean blood levels of vitamin D and HbA1C for various factors (ANOVA). The gold standard for blood glucose management and a standard for determining the severity of its consequences was glycated haemoglobin (HbA1C).

III. Results

Tables 1 and 2 display the frequency distribution of demographic data as well as the means of quantitative variables.

Table 1

Frequency distribution of demographic variables in the patients studied

Table 2

Demographic variables		Frequency	Percentage
Age	<30 30-60 >60	11 66 25	10.8 64.7 24.5
Gender	Male Female	28 74	27.5 72.5
Smoking	Yes No	24 78	23.5 76.5
BMI	<20 20-25 >25	37 48 17	36.3 47 16.7
Place of residence	City Village	88 14	86.3 13.7

The mean of quantitative variables in patients studied

Variable	n	Mean±SD	Minimum	Maximum
Age	102	15.38±48.95	19	82
Disease duration	102	1.91±3.58	1	9
Weight	102	9.55±71.43	50	95
Height	102	8.2±167.14	141	190
FBS	102	64.15±139.48	59.3	433
HbA1C	102	1.91±7.31	5.1	13.4
Vit D3	102	8.77±19.75	1.3	46.1
BMI	102	3.11±21.47	16.98	30.34

The results show a substantial positive connection between HbA1C and FBS [Table 3].

Table3

Mean and standard deviation of HbA1C in patients studied according to different variables

Variables		n	Mean±SD	P
Smoking	Yes	24	1.95±7.39	0.74
	No	78	1.91±7.28	
Age	<30	11	1.36±6.47	0.18
	30-60	66	1.86±7.29	
	>60	25	2.17±7.73	
Gender	Male	28	2.06±7.14	0.58
	Female	74	86.1±37.7	
FBS	<70	1	10.3	0.000
	70-115	46	1.9±8.45	
	>115	55	1.22±6.3	
BMI	<20	37	2.33±7.67	0.35
	20-25	48	1.64±7.1	
	>25	17	1.56±7.11	

According to the results [Table 4], there is a substantial correlation between the serum vitamin D level in smokers and BMI.

Table 4
Mean and standard deviation of the serum level of vitamin D in patients studied according to different variables

Variables		n	Mean±SD	P
Smoking	Yes	24	10.79±20.27	0.04
	No	78	8.15±21.44	
Age	<30	11	8.04±20.78	0.93
	30-60	66	9.2±21.41	
	>60	25	8.33±20.68	
Gender	Male	28	10.82±22.79	0.25
	Female	74	7.9±20.55	
FBS	<70	1	15.3	0.78
	70-115	46	8.92±21.04	
	>115	55	8.82±21.37	
BMI	<20	37	8.88±23.36	0.003
	20-25	48	6.68±20.08	
	>25	17	10.12±15.89	

According to the Pearson correlation coefficient test, there is an inverse linear link between vitamin D and HbA1C, FBS, BMI, and the length of the disease. Also, the Pearson correlation coefficient shows a linear direct association between the length of the disease and HbA1C with FBS. Inverse linear and insignificant was the link between HbA1C and BMI [Table 5].

Table 5
The correlation co-efficient between serum level of vitamin D and HbA1C with the indices studied.

		Age	Vitamin D	HbA1C	FBS	BMI	Disease duration
Age	Pearson	1	0.038	0.221	0.315	0.102	0.080
	P		0.7	0.02	0.001	0.3	0.42
Vitamin D	Pearson	0.038	1	-0.088	-0.047	-0.187	-0.164
	P	0.703		0.378	0.643	0.059	0.1
HbA1C	Pearson	0.221	-0.088	1	0.670	-0.082	**0.693
	P	0.02	0.378		0.000	0.411	0.000
FBS	Pearson	0.315	-0.047	0.670	1	-0.144	**0.401
	P	0.001	0.643	0.000		0.149	0.000
BMI	Pearson	0.102	-0.187	-0.082	-144.0	1	0.017
	P	0.309	0.059	0.411	149.0		0.869
Disease duration	Pearson	0.080	-0.164	0.693	0.401	0.017	1
	P	0.424	0.1	0.000	0.000	0.869	

IV. Discussion and conclusion

According to the results, diabetic patients had low serum vitamin D levels, and there was no connection between these patients' vitamin D levels and their HbA1C or diabetes duration.

According to the study's results, vitamin D has an inverse linear connection with HbA1C (P<0.37), FBS (P<0.64), BMI (P<0.59), and disease duration (P<0.1). Moreover, there was a direct linear link between HbA1C and FBS and disease duration (P<0.000 and P<0.000) and an inverse linear relationship between HbA1C and BMI (P<0.41). The serum level of vitamin D in diabetic patients should be monitored, and if necessary, supplements should be prescribed, given the involvement of this vitamin in secretion and the impact of insulin.

53.9% of the patients in the current study had vitamin D deficiencies, which is roughly similar to the findings of the study by Taheri et al.; vitamin D deficiencies are a significant factor in the aetiology of type 2 diabetes.

The results of a study by Hidayat et al. on senior Indonesians with type 2 diabetes showed that there is a substantial difference between the serum levels of vitamin D in men and women. [23]

The results of the current study are consistent with those of Bonakdaran and Varasteh's study in that the serum level of vitamin D decreases when BMI rises and that there is a statistically significant correlation between these two variables. [24]

The inverse linear association between vitamin D and HbA1C(p<0.37), FBS(0.64), BMI(p<0.59), and disease duration (P<0.1) was shown by Pearson's correlation coefficient test, however it was not statistically significant. Furthermore, HbA1C with FBS and disease duration had a direct linear relationship that was statistically significant (P<0.000 and P<0.000, respectively) according to Pearson's correlation coefficient. However, the inverse linear association between HbA1C and BMI was not statistically significant (P<0.41); instead, it was inversely correlated with BMI.

In the current study, the correlation between BMI and HbA1C was inverse. It was not, however, statistically significant. Diabetes and HbA1C had a substantial direct and indirect association.

No significant link between the duration of diabetes and vitamin D was found, according to Pearson's correlation coefficient (P<0.1 and r = 0.164). Also, this test revealed a significant linear association (r = 0.693, P<0.000) between the duration of diabetes and HbA1C. A higher HbA1C will result from the disease being present for a longer period of time. This is not surprising given the progressive nature of diabetes, which means that as the length of the condition increases, the patient will experience a more advanced stage of the illness and find it harder to manage. These results back up those from research by Simon et al.(1989), Patti et al.(1995), and Carter et al (2000). [25,26,27] However, statistical analysis revealed no correlation between HbA1C and variables such age, gender, BMI, and smoking in either the current study or that of Simon et al.[28].

There was no discernible connection between serum vitamin D levels and HbA1C in the current investigation. However, a strong inverse connection between serum vitamin D levels and haemoglobin A1C was found in the study by Danaei et al. (2014). [29]

Given the high prevalence of vitamin D deficiency in diabetic patients and other studies conducted in this area, it is advised to take special measures to make up for the deficiency of this vitamin in diabetic patients. Vitamin D is necessary for the human body and is obtained through sunlight, vitamin D supplements, and foods.

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