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ORIGINAL ARTICLE

Vitamin D Level in Diabetic Patients

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ABSTRACT

Background: Vitamin D, a fat-soluble vitamin, contributes to the metabolism of phosphorus and calcium in its active form (1,25-dihydroxy vitamin D). It might help prevent and manage autoimmune diseases such as diabetes mellitus. Diabetes has become a serious global health problem as its incidence and prevalence have increased. Recently, efforts to identify novel ways to treat and prevent diabetes have centered on vitamin D supplementation. The bulk of research relates both types of diabetes to the vitamin D receptor (VDR) gene. The study aimed to analyze how vitamin D affects type 2 diabetes.

Methods: A case-control study was conducted in Kirkuk City from September to November 2023. The study included 112 patients, 57 of whom had type 2 diabetes that wasn't under control and 55 who were in a control group after ethical concerns were addressed.

Results: The finding indicated that there is a significant relationship between vitamin D level and HbA1c and random blood sugar, The higher percentage of severe vitamin D deficiency in the diabetes group (22.8%) compared to the control group (9%) is statistically significant, highlighting a significant disparity in vitamin D status. Additionally, the mean vitamin D level is notably lower in the diabetes group (20.41 ng/ml) compared to the control group (31.23 ng/ml), with a T-test result of 3.10 and a p-value of 0.029. These findings suggest that people with diabetes are more likely to have lower vitamin D levels. Overall, the data support a strong association between diabetes and lower vitamin D levels, potentially implicating vitamin D deficiency as a factor in the management or pathogenesis of diabetes.

Conclusion: Patients with type two diabetes have much lower amounts of vitamin D than healthy people. In fact, 19.2% of these people have vitamin D deficiency. The results show that not getting enough vitamin D may play a part in getting type 2 diabetes. Supplementing with vitamin D could help prevent the disease and mitigate its effects.

Key words: Vitamin D; Diabetes Mellitus; Association.



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INTRODUCTION

People with type 2 diabetes mellitus, which used to be called diabetes mellitus, have high blood sugar, insulin resistance, and not enough insulin in their bodies [1]. Frequently using the restroom, experiencing extreme thirst, and experiencing unexplained weight loss are typical indicators. Additional symptoms include increased appetite, fatigue, and non-healing lesions [2].

Most of the time, symptoms develop gradually [3]. Chronic conditions such as heart disease, stroke, diabetic retinopathy (which can result in blindness), renal failure, and inadequate blood supply to the limbs may need amputation due to high blood sugar levels. While hyperglycemia can strike without warning, ketoacidosis is not common [4].

A combination of hereditary variables that exacerbate insulin resistance and production and environmental factors including being overweight, not exercising enough, stress, and aging contribute to the development of type 2 diabetes. A combination of genetic and environmental factors primarily causes type 2 diabetes. [5].

Among the factors that appear to influence its growth are genetics, culture, environment, and diet. Regarding nutrition, vitamin D is likely crucial for either preventing diabetes complications or regulating blood sugar [6].

Problems with pancreatic β -cells, systemic inflammation, and elevated blood sugar due to ineffective or poorly functioning insulin are characteristics of type 2 diabetes mellitus [7].

Long-term elevated blood glucose levels brought on by diabetes can result in heart disease, diabetic blindness, renal failure, and reduced blood supply to the limbs, which can cause amputation [7]. Additionally, insulin sensitivity results from reduced insulin synthesis, insulin resistance, and ultimately beta cell loss. As a result, glucose enters the liver, muscle cells, and fat cells more slowly. Those with hyperglycemia have a faster rate of fat breakdown. It was discovered very recently that malfunctioning alpha cells are the cause of type 2 diabetes [8].

The "sunshine vitamin," vitamin D, is becoming more and more well-known these days due to its connections to a host of illnesses, including cancer and diabetes. It has been demonstrated by several research that vitamin D is crucial for good health [9].

Numerous illnesses and health issues, such as osteomalacia/osteoporosis, cancer, multiple sclerosis, high blood pressure, type 2 diabetes, rheumatoid arthritis, tuberculosis, men-

tal illness, heart disease, infection, seasonal affective disorder, obesity, aging, and death overall, have been related to low vitamin D levels in the body [10].

This study aims to compile the most recent data on vitamin D and diabetes. Cholecalciferol (vitamin D₃) and ergocalciferol (vitamin D₂) are the two primary forms of vitamin D. When the skin is exposed to UV B rays from the sun, it produces vitamin D₃. Plants—mostly yeast and mushrooms—make vitamin D₂. Certain foods also contain vitamin D, such as fatty fish [11].

Unfortunately, getting adequate vitamin D from diet alone is difficult. In a lab, both vitamins D₂ and D₃ may be produced. They are used to create dietary supplements as well as added to meals like soy milk, margarine, and milk products to make them healthier. Synthetic vitamin D₃, derived from animal sources, is the most widely utilized form of vitamin D in vitamin D-enhanced meals and supplements [12].

The small intestine absorbs lipids and other fat-soluble vitamins together with vitamin D which is present in meals. In contrast, the skin spontaneously produces vitamin D₃ when it is exposed to the UV rays of sunshine. Before vitamins D₂ and D₃ can perform any molecular functions, they have to pass through two stages in the body's metabolism. The various forms of vitamin D are converted into active forms by the kidneys and liver. Before it may perform any cellular function, the active form of vitamin D, 1,25-dihydroxyvitamin D (calcitriol), must bind to vitamin D receptors (VDRs). Therefore, the likelihood of deficiency is higher in diabetics with liver or renal issues [13].

In the past, exposure to sunlight was the primary source of vitamin D for humans. One possible explanation for why so many individuals nowadays do not have adequate vitamin D is a lack of sun exposure. Lack of vitamin D intake from diet is another potential factor. It has been suggested that applying sunscreen-free skin care products to your face, arms, back, or legs for five to thirty minutes each day, between the hours of 10 a.m. and 3 p.m., or at least twice a week, is typically sufficient to produce vitamin D. When sunlight enters your home through a glass window, vitamin D is not produced by your skin [14].

The most precise method for determining a person's vitamin D level is to do 25-hydroxy vitamin D [(25(OH)D)] testing. A range of 25–80 ng/ml is ideal. However, recommended vitamin D₃ supplements to be used to increase the blood 25(OH)D level to 40 ng/ml or higher, preferably 60 ng/ml. There are two types of vitamin D supplements: D₂ (ergocalciferol) and D₃ (cholecalciferol) [15].

Numerous studies have suggested a potential connection be-

tween vitamin D deficiency and an increased risk of type 2 diabetes (T2D). The world has recently grown more aware of vitamin D's part in the onset of diabetes. Many individuals are curious about the effects of vitamin D on body parts other than bones [16]. In addition to the bone system, researchers have discovered that cells of the immune system, pancreatic beta cells, and many other organs express 1,25(OH)₂D₃ and 1-Alpha-Hydroxylase. This implies a role for vitamin D in the onset of type 2 diabetes. Chronic kidney failure and ischemic heart disease are two major health problems associated with diabetes that can lead to a great deal of suffering and death. Those with inadequate vitamin D levels released insulin at a rate that was 48% lower than that of those with enough vitamin D. This implies that the pancreas produces more insulin in response to vitamin D [17].

Insulin resistance and beta-cell degeneration are associated with low vitamin D levels as well. When the vitamin D deficiency is addressed, hemoglobin A1c (HbA1c) levels significantly improve. Vitamin D deficiency was associated with metabolic syndrome, worsened insulin resistance, and decreased insulin levels [18]. It is believed that vitamin D helps increase the body's sensitivity to the hormone insulin, which regulates blood sugar. Insulin resistance is less likely as a result. In individuals with DM2 who already have low vitamin D levels, restoring vitamin D levels reduces blood sugar and improves insulin release. [19]. This implies a role for vitamin D in the development of DM2. According to the study, only 36% of those with type 1 diabetes had poor vitamin levels, but the majority of those with DM2 had low levels [19]. This indicates that individuals with DM2 are more likely than those with type 1 diabetes to not acquire adequate vitamin D [20].

It has been shown that taking a vitamin D supplement may reduce insulin resistance in persons with type 2 diabetes. In a separate research, vitamin D levels were lower in individuals with T2D. Those with T2D may find that taking vitamin D supplements improves their blood sugar regulation. Even a connection between having more vitamin D and a decreased risk of developing type 1 diabetes has been discovered by researchers. This vitamin may also help prevent the pancreas from producing excessive amounts of insulin, according to some doctors. The International Diabetes Federation estimates that 285 million individuals worldwide, or 7% of the total population, are estimated to have diabetes. This number will probably exceed 435 million by 2030 [21].

The relationship between low blood vitamin D levels and diabetes and Body Mass Index (BMI) is influenced by several factors. BMI, a body composition metric calculated from height

and weight, has a strong correlation with diabetes risk, particularly in overweight or obese individuals. Individuals with a higher body mass index (BMI) are more likely to have excess fat in their bodies, which exacerbates inflammation and insulin resistance—two major risk factors for diabetes [22, 23]. The complexity of this relationship is further increased by low blood levels of vitamin D. A greater body mass index (BMI) indicates obesity, which might impede the body's ability to produce vitamin D due to lifestyle modifications such as less sun exposure and altered dietary patterns. Since vitamin D dissolves in fat, it may also be kept in adipose tissue. This might indicate that blood vitamin D levels are lower in those with greater body mass indexes [24].

Furthermore, the body may find it more difficult to consume glucose if it doesn't get enough vitamin D, which is crucial for the normal function of insulin. The intricate correlation between vitamin D levels and BMI provides more insight into the risk of developing diabetes. It is crucial to have strategies that account for both vitamin D deficiency and obesity in order to prevent and treat diabetes in individuals with varying BMIs. These can be achieved by targeted therapies and lifestyle modifications [25]. This study's primary goal is to examine the relationship between vitamin D and type 2 diabetes.

MATERIALS AND METHODS

A case-control study was conducted in Kirkuk City, Iraq, from October to November 2023. The research was conducted in a private laboratory where 5 mL blood samples were collected and analyzed by using a Cobas e 411 analyzer to compare the serum vitamin D levels and HbA1c levels between patients with controlled and uncontrolled type 2 diabetes mellitus (T2DM).

The study population comprised 112 patients divided into two groups: 57 patients with uncontrolled T2DM characterized by low serum vitamin D levels and 55 patients with controlled T2DM. All participants provided informed consent, adhering to the ethical standards approved by the local ethical committee.

The inclusion criteria for the Participants included in the study met the following criteria:

- Diagnosed with type 2 diabetes mellitus and a known serum level of vitamin D.
- Disease onset of more than 5 years.
- Aged between 30 to 70 years.

On the other hand, Patients were excluded from the study were:

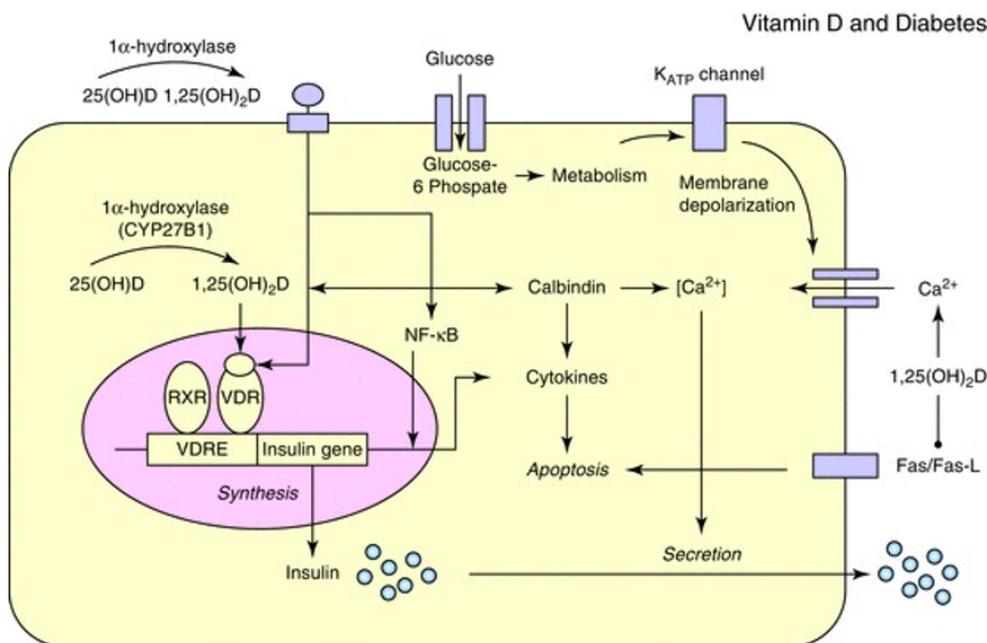


Figure 1. Role of vitamin D in glucose metabolism in type 2 DM

- Diagnosis of type 1 diabetes mellitus.
- Age beyond the 30–70 year range.
- Current pregnancy.
- Existing renal failure.

The data were collected on general demographics including name, age, gender, marital status, occupation, and education level. Medical history focusing on the onset of illness was also documented. Ethical approval for the study was obtained prior to data collection, ensuring compliance with local regulations and ethical standards.

The following parameters were measured for both study groups (uncontrolled T2DM) and control (controlled T2DM):

- Hemoglobin A1c (HbA1c) levels at baseline and after one month. The normal ranges used for evaluation were HbA1c: 4.2% to 6.6%.
- Vitamin D levels at baseline and after one month. The normal ranges used for Vitamin D level ≥ 30 ng/dl. These measurements aimed to ascertain the relationship between vitamin D levels and glycemic control in individuals with type 2 diabetes mellitus.

The data were analyzed by Minitab version 23 of the statistical software used to conduct computerized statistical analysis. T-test and Chi-square (X^2) were used for the comparison. P values lesser than 0.05 were regarded as statistically significant.

RESULTS

For the experimental study group patients after 3 months, the results are as follows:

Table 1. Distribution of patients' demographic data .

	Variables	Frequency	Percent
Gender	Female	70	62.5%
	Male	42	37.5%
	Total	112	100%
Case-Control	Case	57	77.6%
	Control	55	22.3%
	Total	112	100%
BMI	Normal weight	11	9.8%
	Overweight	62	55.3%
	Obese	39	34.9%
	Mean		Standard deviation
Age (Study group)	58.05		4.322

BMI=Body mass index

The finding in (Table 1) indicates that the average age of patients in the study group is (58.05±4.322) years, with 37.5% being male and 62.5% female, 50.8% with uncontrolled type 2 Diabetes mellitus, 49.2% controlled group, 9.8% normal weight, 55.3% overweight and 34.9% obese.

The study showed a significant difference in vitamin D levels between diabetes patients and a control group. The higher percentage of severe vitamin D deficiency in the diabetes group (22.8%) compared to the control group (9%) was statistically significant, highlighting a substantial disparity in vitamin D status. Additionally, the mean vitamin D level was notably lower in the diabetes group (20.41 ng/ml) compared to the control group (31.23 ng/ml), with a T-test result of 3.10 and a p-

Table 2. Serum Vitamin D level in DM patients and the control group.

Vitamin D level (ng/ml)	Diabetes patients	Control group	P-value
Severe case	22.8	9	0.003*
Deficiency	56.1	49	
Insufficiency	17.5	34.54	
Sufficiency	3.5	7.27	
Mean	20.41	31.23	0.029[†]
SD	3.99	4.45	

* Chi square, [†] T-test

Table 3. Hemoglobin A1c and Random Blood Sugar in the studied groups.

Parameters	Studied groups	Mean	SD	T test	P-value
HbA1c%	Diabetes patients	9.330	0.75	29.6	0.016
	Control group	6.330	0.55	25.6	0.011
RBS (mg/dl)	Diabetes patients	284.350	43.3	11.1	0.027
	Control group	244.350	39.3	12.1	0.024

value of 0.029. These suggests that individuals with diabetes are more likely to have lower vitamin D levels. Overall, the data supports a strong association between diabetes and lower vitamin D levels, potentially implicating vitamin D deficiency as a factor in diabetes management or pathogenesis. Consequently, the control group was investigated more thoroughly because their better vitamin D levels might provide insights into improving vitamin D status in the diabetes group (Table 2).

The data compares Hemoglobin A1c (HbA1c) and Random Blood Sugar (RBS) levels between diabetes patients and a control group, revealing significant differences in both parameters. For HbA1c, diabetes patients show a significantly higher mean value (9.33%) compared to the control group (6.33%) with a statistically significant p-value of 0.016, indicating a strong distinction between the two groups. Similarly, for RBS, diabetes patients have a higher mean (284.35 mg/dl) compared to the control group (244.35 mg/dl), with respective p-values of 0.027 and 0.024, underscoring the metabolic impact of diabetes.

DISCUSSION

Vitamin D insufficiency is linked with an increased risk of diabetes and related metabolic abnormalities. The level of vitamin D in the body may affect the likelihood of acquiring metabolic illnesses such as type 2 diabetes, metabolic syndrome, and insulin resistance [26]. our study aimed to establish a clear correlation between deficient levels of vitamin D in the bloodstream and the occurrence of Type 2 Diabetes. Our findings indicate a significant link between lower levels of vitamin D, as measured by plasma concentrations of 25-hydroxyvitamin D, and the results of the HbA1c test.

The study enrolled a total of 114 patients, with 57 patients classified as cases and 57 patients classified as controls. The majority of participants were over the age of 50, and there was a higher proportion of females in our study.

Our study revealed that individuals diagnosed with type 2 diabetes exhibited a deficiency in their blood vitamin D levels. Vitamin D insufficiency is prevalent among individuals with diabetes.

Research conducted by Khudayar M et al. found that individuals with DM2 had considerably lower vitamin D levels compared to non-diabetic individuals [27].

A separate study has shown that administering Supplementation of Vitamin D may reduce the risk of acquiring type 2 diabetes in those with low levels of Vitamin D and an increased susceptibility to the condition [28].

A meta-analysis by Pittas et al. [29] revealed that vitamin D insufficiency is prevalent among individuals with diabetes. Furthermore, the study found that diabetic complications can be postponed or averted with the use of vitamin D supplementation, These findings align with our research.

There is a significant difference in the HbA1c levels between patients with type 2 diabetes in the case group and the control group. This indicates an inverse relationship between Vitamin D and HbA1c levels in diabetic patients. This finding is consistent with a study conducted by Shukla et.al. [30], and a study conducted by Mehta et.al. [31], which both revealed a negative correlation between vitamin D and HbA1c.

Only a limited number of studies establish a significant link between type 2 diabetes and its consequences with a shortage of vitamin D. Our findings contribute to the existing body of research that emphasizes the significance of maintaining adequate levels of vitamin D in the general population [32, 33]. The current study strongly supports an association between

diabetes and vitamin D deficiency, suggesting that vitamin D status could play a role in the management or pathogenesis of diabetes. Given this potential link, addressing vitamin D deficiency in diabetic patients might be crucial for improving their overall health outcomes. The thorough investigation of the control group, who exhibited better vitamin D levels, offers valuable insights this finding is similar to the study done by usluogullari et al. [34]. Understanding the factors contributing to adequate vitamin D levels in the control group could inform strategies to enhance vitamin D status among individuals with diabetes, potentially aiding in better diabetes management and prevention strategies, studies have shown that low vitamin D levels can even predispose to other chronic diseases, like asthma [35].

CONCLUSION

Patients with type 2 diabetes have lower levels of vitamin D than controls, and it was revealed that the frequency of vitamin D deficiency in patients with type 2 diabetes was considerably high. This raises awareness of the need to detect vitamin D in people at increased risk of developing diabetes and in patients with type 2 diabetes to prevent or delay complications, Additional studies are needed on a larger sample size.

RECOMMENDATION

- It is important for type-2 diabetic patients to maintain their vitamin D level within a normal limit by taking supplements in appropriate doses.
- The sun is the main source of vitamin D, as adequate exposure to it daily for at least 30 minutes stimulates the production of vitamin D₃.
- We recommend Vitamin D supplements to be included in the routine tests in controlling type 2 diabetes patients.
- It is best to add vitamin D supplements in the therapeutic plan for type2 DM management.

ETHICAL DECLARATIONS

• Acknowledgements

None.

• Ethics Approval and Consent to Participate

This study was approved by the Research Ethics Committee, University of Kirkuk, College of Medicine. The concept of the study was discussed and verbal consent was taken from each participant.

• Consent for Publication

Non.

• Availability of Data and Material

The datasets are available from the corresponding author upon reasonable request.

• Competing Interests

The authors declare that there is no conflict of interest.

• Funding

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• Authors' Contributions

All stated authors contributed significantly, directly, and intellectually to the work and consented it to be published.

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