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THE CORRELATION OF VITAMIN D DEFICIENCY AND INSUFFICIENCY WITH TYPE TWO DIABETES MELLITUS: A CROSS SECTIONAL STUDY CONDUCTED IN MOSUL CITY

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ABSTRACT

Background: The pancreatic β cells have vitamin D receptors, and vitamin D has been correlated to the control of insulin production. HbA1C and vitamin D levels may be inversely correlated, and low vitamin D levels are linked to a higher risk of type 2 diabetes. **Objectives:** To measure vitamin D levels in type 2 DM patients who were managed and followed at an outpatient consulting clinic at Mosul general Hospital in Mosul/ Iraq and to record the correlation between glycemic control and hypovitaminosis D. **Methods:** This is a cross sectional study conducted at Mosul General Hospital during the period from the first of April 2023 to the first of April 2025, all patients were randomly chosen. All type 2 diabetes patients over the age of 18 who gave their consent were included in the trial. The study excluded patients with liver disease, multivitamin supplements, steroids, and anticonvulsants, as well as patients with renal disease. Patients who had used vitamin D pills or multivitamins over the six months before to the trial were also excluded. The questionnaire includes three parts, part one for sociodemographic information of the study participants. Part two for diabetes questions and part three for vitamin D details. **Results:** The study includes 228 patients with type 2 diabetes mellitus. Among them; it's evident that vitamin D deficiency was prevalent in 15 (6.58%) patients, while 156 (68.42%) patients had vitamin D insufficiency. The remaining 57 (25%) patients had normal vitamin D level. Moreover; among 171 patients with low vitamin D level (both insufficiency and deficiency), 96 (56.1%) are males and 75 (43.9%) are females. The majority of patients with low vitamin D level were aged 40-59 years. The study found that the majority of patients with low vitamin D level were had uncontrolled diabetes (82.46%). The study found weak positive but not significant correlation were found between vitamin D and patients' age, patients' body mass index and patients' active smoking state. While weak negative and not significant correlation was found between vitamin D and glycated hemoglobin. **Conclusion:** The study revealed an elevated prevalence of vitamin D deficiency and insufficiency in our community. The glycemic control had a negative correlation with vitamin D levels. For long-term diabetics with poor glycemic control, it's important to consider additional factors such as vitamin D levels.

KEYWORDS: Association, Diabetes, Iraq, Mosul, Type II.

1. INTRODUCTION

Nowadays, type 2 diabetes mellitus is exceedingly common in developing countries and is characterized by peripheral insulin resistance and pancreatic β-cell dysfunction.[1] It has a substantial mortality and morbidity costs because of both macrovascular and microvascular complications.[2] More than 300 million individuals worldwide suffer from diabetes, and by 2030, prevalence is predicted to double, with low and middle-income countries bearing up to 80% of the burden.[3]

Over the past two decades, type 2 diabetes treatments have significantly improved; yet, the disease's increasing prevalence necessitates more studies regarding its management and prevention.[4] It has been demonstrated that altering eating habits, exercising, quitting smoking,

and losing weight enhance glycemic control and lessen type 2 diabetes complications. The pancreatic β cells have vitamin D receptors, and vitamin D has been correlated to the control of insulin production.[5] HbA1C and vitamin D levels may be inversely correlated, and low vitamin D levels are linked to a higher risk of type 2 diabetes.[6]

Like diabetes, vitamin D insufficiency is quite common in the general population. Numerous studies have linked vitamin D insufficiency to the onset and progression of diabetes, whereas high plasma vitamin D levels are associated with a decreased risk of diabetes in high-risk individuals. A lack of vitamin D influences β-cell activity and insulin sensitivity, which are key pathogenetic pathways of diabetes mellitus.[7-10]

The aim of this study was to measure vitamin D levels in type 2 DM patients who were managed and followed at an outpatient consulting clinic at Mosul general Hospital in Mosul/ Iraq and to record the correlation between glycemic control and hypovitaminosis D.

2. PATIENT AND METHOD

Patients with type 2 diabetes who visited the Medical outpatient consulting clinic at Mosul General Hospital participated in this descriptive cross-sectional study. All type 2 diabetes patients over the age of 18 who gave their consent were included in the trial. The study excluded patients with liver disease (if Alanine Aminotransferase was more than five times the upper reference limit), multivitamin supplements, steroids, and anticonvulsants (particularly barbiturates and phenytoin), as well as patients with renal disease, as indicated by an estimated glomerular filtration rate of less than 30 ml/min/1.73 m2 derived from serum creatinine. Patients who had used vitamin D pills or multivitamins over the six months before to the trial were also excluded.

The questionnaire was utilized to gather information on the patient's age, gender, employment and glycated hemoglobin level. Anthropometric measures of all eligible study participants were done by wearing light clothes and without shoes. The study utilized an Agilent 1100 HPLC system with a quaternary pump. Four milliliters of blood were centrifuged and the serum separated for examination. Vitamin D levels were measured in ng/dl, with adequacy defined as ≥ 30ng/dl, insufficiency as 20.1-29.9ng/dl, and deficiency as < 20ng/dl. It was extracted from serum using acetronitryl and 0.4% acetic acid. The sample was injected into a Polaris C18-A 3µ 150 x 2.0mm chromatography column. HPLC operates in isocratic mode, using eluent (MeCN:0.4% Acetic acid) as the mobile phase. The oven temperature was 30 degrees Celsius, the flow rate was 0.3 milliliters per minute, and the UV-Vis detector had a wavelength of 280 nm. By comparing the retention of a pure standard with a calibration code, the quantity of vitamin D was calculated.

The collected data were coded, entered, and analyzed using the available data base software program statistical package of IBM SPSS-29 (IBM Statistical Packages for Social Sciences- version 29, Chicago, IL, USA). Data were presented in simple measures of percentage, mean, standard deviation, median and interquartile rang. Student's t-test was used to compare numerical variables between the two groups with application of chi square test was used for categorical variables. Statistical significance was considered whenever the P value was equal or less than 0.05.

3. RESULTS

The study includes 228 patients with type 2 diabetes mellitus. Among them; it's evident that vitamin D deficiency was prevalent in 15 (6.58%) patients, while 156 (68.42%) patients had vitamin D insufficiency. The remaining 57 (25%) patients had normal vitamin D level. As shown in figure 3.1.

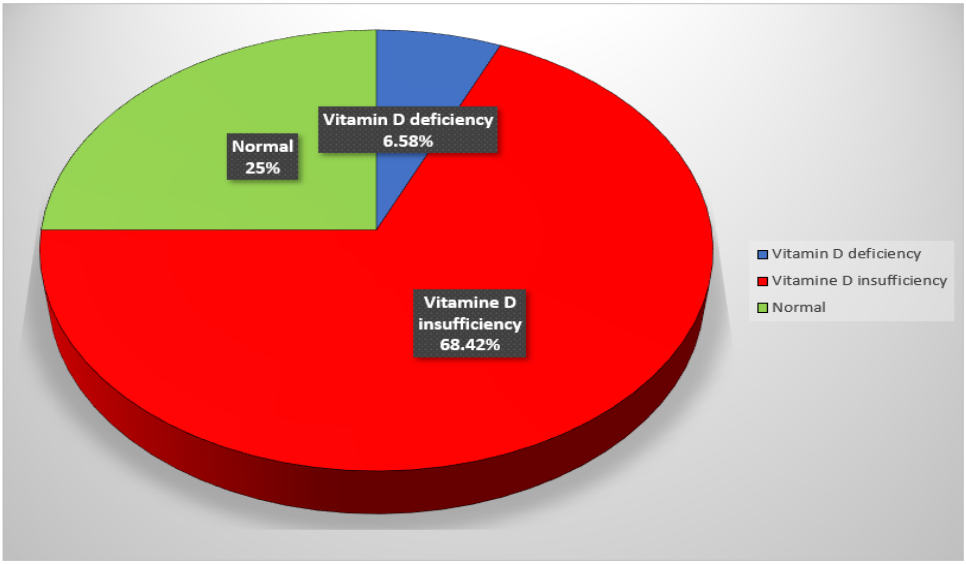

Figure 3.1: Pie graph showing distribution of the study participants according to their vitamin D levels.

Moreover; among 171 patients with low vitamin D level (both insufficiency and deficiency), 96 (56.1%) are males and 75 (43.9%) are females. As shown in figure 3.2.

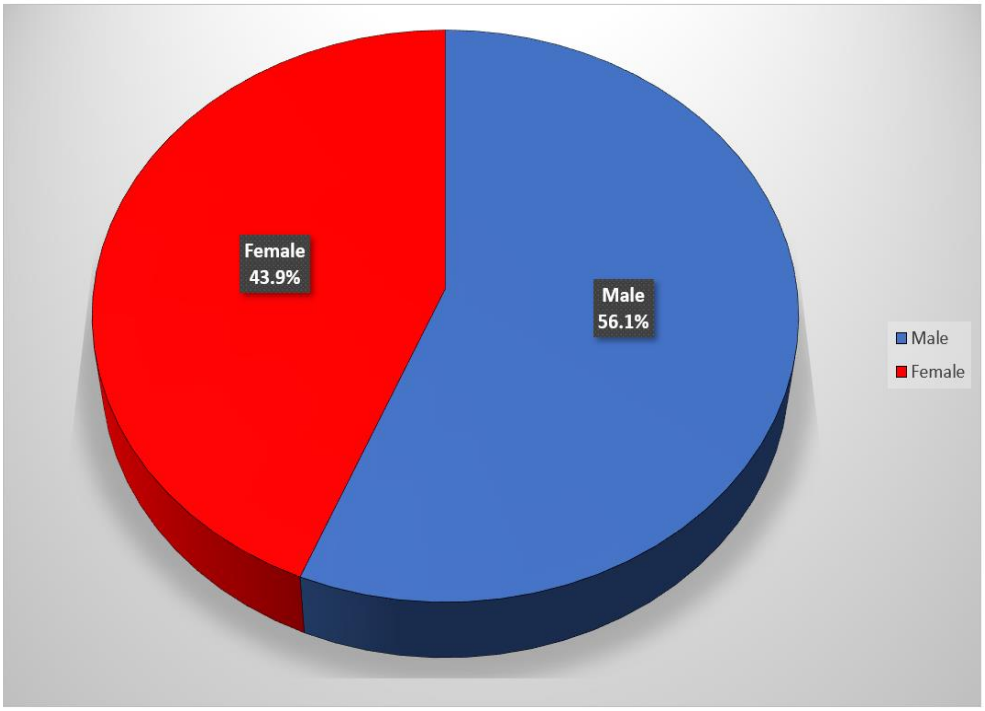

Figure 3.2: Pie graph showing distribution of patients with low vitamin D level according to their gender.

The mean ± standard deviation of the study participants ages was 48.93 ± 13.58 years. Moreover; the mean age of the male participants is 46.17 ± 13.09 years versus 53.41 ± 13.16 years for females. with male: female ratio of 1.62:1. Table 3.1 shows that the majority of patients with low vitamin D level were aged 40-49 years and 50-59 years. Followed by those aged more than 60 years. On the other hand; the mean age of patients with low vitamin D level was 47.98 ±13.73 years. Additionally; the mean age of males with low vitamin D level was 44.90 ± 13.21 years, while the mean age of females with low vitamin D level was 51.92 ± 13.38 years.

Table 3.1: Distribution of patients with low vitamin D levels according to their ages. (number = 171)

Age category (years)	Number	Percent
Less than 20 years	9	5.27
20-29	9	5.27
30-39	15	8.78
40-49	60	35.08
50-59	45	26.31
More than 60	33	19.29

Table 3.2 shows distribution of the patients with low vitamin D level according to their occupations. Generally; most of the study patients were not work (indoor sun exposure). From the other hand; among those who are working, the majority were teachers followed by employee.

Table 3.2: Distribution of the patients with low vitamin D levels according to their occupation. (number = 171)

Occupation	Number	Percent
Non	90	52.64
Employee	18	10.53
Teacher	24	14.04
Student	9	5.26
Medical staff	6	3.51
Housewife	9	5.26
Retired	6	3.51
Driver	3	1.75
Military	3	1.75
Lower	3	1.75

The study found that the majority of patients with low vitamin D level were had uncontrolled diabetes (in other word, have glycated hemoglobin more than 6.4), followed by patients with moderate control of diabetes (glycated hemoglobin between 5.7 and 6.4). As shown in table 3.3.

Table 3.3: Distribution of the patients with low vitamin D level according to their glycated hemoglobin. (number = 171).

Glycated hemoglobin	Number	Percent
Less than 5.7	12	7.01
5.7-6.4	18	10.53
More than 6.4	141	82.46

Table 3.4 shows comparison between males and females with diabetes type 2 and having low vitamin D level regarding their study variables. Statistically significant difference between them regarding their means of vitamin D level (lower in females) with (P-value = 0.017). In addition to that, statically significant difference between them regarding their active smoking state (more in males) with (P-value < 0.001). While no statistically significant differences were note regarding their glycated hemoglobin and body mass index (P value > 0.05).

Table 3.4: Comparison between males and females with low vitamin D level regarding their study variables. (number = 171).

Variable	Male = 96	Female = 75	P-value
Vitamin D level (ng/mL), mean ± standard deviation	18.59 ± 4.90	16.43 ± 5.66	**0.017**
Glycated hemoglobin (%), mean ± standard deviation	8.40 ± 2.27	7.88 ± 1.55	0.056
Active smoking state	51 (53.12%)	0 (0%)	**<0.001**
Body mass index, mean ± standard deviation	26.75 ± 3.96	27.59 ± 5.53	0.078

Table 3.5 shows correlation coefficient between vitamin D and other variables included in the study. Weak positive but not significant correlation were found between vitamin D and patients' age, patients' body mass index and patients' active smoking state. While weak negative and not significant correlation was found between vitamin D and glycated hemoglobin.

Table 3.5: Low vitamin D level correlation with other variables included in the study.

Variable	Correlation coefficient	P-Value
Patients' age	0.1684	0.210
Patients' body mass index	0.0194	0.867
Patients' active smoking state	0.1817	0.116
Glycated hemoglobin	-0.1851	0.180

4- DISCUSSION

Low vitamin D level is a global health problem that affects nearly every country, including Iraq, with estimates ranging from 40% to 99% of the population.[11] In this study the estimated prevalence of overall vitamin D insufficiency and deficiency among patients with type 2 diabetes was 75%. Studies consistently show that a large proportion of people with type 2 diabetes have vitamin D deficiency or insufficiency. For example, one study found that 74.14% of diabetic patients were vitamin D deficient.[12] Another study reported that 73.25% of patients with pre-diabetes[13], 72.5% of patients with newly onset diabetes.[14] This suggests a significant association between vitamin D status and type 2 diabetes. Moreover; evidence suggesting a link between lower vitamin D levels and an increased risk of developing type 2 diabetes, as vitamin D may play a role in insulin secretion and sensitivity, which are crucial for managing blood sugar levels.[15] Additionally; the high prevalence of vitamin D deficiency in this population highlights the importance of screening and addressing vitamin D levels in individuals with type 2 diabetes.

The study found that there is slight male predominance with regard to low vitamin D level among patients with diabetes mellitus type 2, while one study showed a slight male predominance in the context of low vitamin D levels among individuals with type 2 diabetes.[16] However, other study showed a higher prevalence of vitamin D deficiency in females with type 2 diabetes.[17] As the relationship between vitamin D deficiency and type 2 diabetes is complex and may vary based on factors like ethnicity, geographic location, and specific study populations.[18]

On the other hand; the study found that the majority of patients with type two diabetes are aged more than 40 years. As it was shown by many studies to be diagnosed commonly in middle-aged and older adults.[19-21] Additionally; this study found that females tended to be slightly older, on average, than males with regard to having diabetes type 2 and low vitamin D level. This finding raises the possibility that vitamin D deficiency might be more prevalent or detectable with advancing of age in females with type 2 diabetes in comparison to males, which warrants further investigation to understand the underlying reasons for this age difference and its implications for diabetes management and prevention. In contrast to the Leila Mahmodnia et al from Iran who found that males with type 2 diabetes and having low vitamin D level were older than females.[22] Anyhow; small sample size and ethnicity can lead to this difference.

The study found that type 2 diabetic patients who work outdoors and have more sun exposure tend to have higher vitamin D levels compared to those who work indoors. This is because sunlight is a primary source of vitamin D synthesis in the body, as the skin produces vitamin D when exposed to ultraviolet B (UVB) rays from the sun. However; sunlight exposure isn't the only factor influencing vitamin D levels. Other factors, like skin pigmentation, time of day, and duration of exposure, also play a role.[23] This result was consistent to Dler

Anwer Kakil and Mohammed Qader Meena[24] and Norizzati Amsah et al[25] studies' findings.

Regarding vitamin D levels in the study patients, the study found that patients with uncontrolled diabetes (HbA1c > 6.4) had more low vitamin D levels in comparison to those with moderate control (HbA1c between 5.7 and 6.4) and patients with good diabetes control (HbA1C less than 5.7). This is linked to the fact that vitamin D plays a role in insulin production and utilization, and low levels have been linked to an increased risk of developing type 2 diabetes and its complications.[26] Furthermore; This finding suggests that addressing vitamin D deficiency and insufficiency could be a potential area for improving diabetes management and potentially reducing the risk of complications. Several studies showed comparable findings.[27, 28, 17]

The study consistently shows that women with type 2 diabetes have lower vitamin D levels than their male counterparts. This highlights a potential gender-specific factor related to vitamin D levels in type 2 diabetes, which could be important for understanding disease progression and developing targeted interventions. Rudy Hidayat et al found comparable results[29], in contrast to Ali Salman Al-Shami et al who found that males with type 2 diabetes had lower vitamin D levels.[30] Additionally; the study found that approximately half of diabetic males with low vitamin D levels were smokers, which was significantly higher compared to the prevalence of smoking among diabetic females with low vitamin D levels. Smoking could decrease vitamin D level by several factors, including reduced sun exposure, poorer dietary habits, and potential interference with vitamin D metabolism.[31] This is in same way with Mohammed A. Jamali et al study results.[32] On the other hand; males and females with type 2 diabetes and low vitamin D level were comparable with regard to their mean of glycated hemoglobin and body mass index, this is in agreement with Hang Zhao et al study results.[33]

Concerning the correlation of vitamin D and different parameters of the study, the study found a weak positive but statistically non-significant correlation between vitamin D levels and patients' ages suggests that while there might be a slight tendency for vitamin D levels to increase with age, the relationship is not strong enough to be considered a reliable pattern across the entire population being studied. Comparably in one study which was found a weak positive correlation between serum vitamin D levels and patient age in women with breast cancer.[34] This indicates that age is not a strong predictor of vitamin D levels irrespectively to the disease in which vitamin D is related. Moreover; in this study, vitamin D levels also shown a weak positive but statistically non-significant correlation with patients' body mass indexes, which is meaning that the observed relationship is likely due to chance and not a true association, which is goes with Suhaib JS Ahmad et al study findings.[35] In same way; the current study found that vitamin D levels had a weak positive correlation patients' active smoking state, which is suggesting that smokers may have slightly lower vitamin D levels compared to non-smokers. However, the effect size was small, indicating that other factors likely play a more significant role in determining vitamin D levels. In contrast to a meta-analysis which was found that smoking negatively affects circulating vitamin D levels in adults.[36] This difference might be occurred due to different case definition, inclusion and exclusion criteria. On the other hand; a weak negative and statistically non-significant correlation was found in this study between vitamin D levels and glycated hemoglobin (HbA1c). This suggests that while there might be a slight tendency for higher vitamin D levels to be associated with slightly lower HbA1c, the relationship is not strong enough to be considered meaningful or reliable and other factors likely play a more significant role in influencing HbA1c levels, which is meant that vitamin D supplementation alone is unlikely to significantly improve HbA1c levels in most individuals, but other factors, such as diet, exercise, and medication, likely play a more dominant role in managing blood sugar levels. Comparable findings were reached by Dilgeer A. Jaf et al.[37]

The study's cross-sectional design limited its ability to directly assess causal relationships between variables, unlike longitudinal or interventional studies. The second limitation was it include a small sample size. Given the significant frequency of low vitamin D level needs a larger sample size. Moreover; the study didn't assess parathyroid hormone levels which can affect vitamin D level. Lastly; to analyze the effect of vitamin D on type-2 diabetes mellitus, more investigations are needed such as insulin secretion factor and insulin resistance. These investigations were not assessed in this study.

5. CONCLUSION

The study revealed an elevated prevalence of vitamin D deficiency and insufficiency in our community. The glycemic control had a negative correlation with vitamin D levels. For long-term diabetics with poor glycemic control, it's important to consider additional factors such as vitamin D levels.

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