Journal of Techniques, ISSN: 2708-8383, Vol. 5, No. 3, 2023, Pages 207-212
DOI: https://doi.org/10.51173/jt.v5i3.1452

JOURNAL OF TECHNIQUES

Journal homepage: http://journal.mtu.edu.iq

*RESEARCH ARTICLE - MEDICAL TECHNIQUES*

# Assessment of Vitamin D3 Level Among a Sample of Type 2 Diabetic Patients Attending Diabetes and Endocrinology Center in Al-Hilla City

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**Article Info.**

*Article history:*

Received
20 April 2023

Accepted
02 June 2023

Publishing
30 September 2023

**Abstract**

Vitamin D is found in foods in two primary forms: cholecalciferol (vitamin D3) and ergocalciferol (vitamin D2), with vitamin D3 being a fat-soluble vitamin. that is necessary for calcium homeostasis and the maintenance of proper function in a variety of tissues. Humans get vitamin D from their diets or from being exposed to ultraviolet B radiation from the sun. Aside from its well-known effects on bone health, vitamin D has been hypothesized to play a role in various disease states and health situations, such as cardiovascular disease and type 2 diabetes. To assess vitamin D3 concentration in patients with type 2 diabetes, using the Vitamin D Total III kit on the Cobas E 411 device. A total of 300 people were recruited, with 150 people suffering from type 2 diabetes serving as cases and 150 healthy volunteers of the same gender and age being used as the control group. Both genders were represented, with an age group between 30 – 79 years. The collection of data lasts for five months, beginning Started in November 2022 to April 2023. The data was analyzed with the readily available statistical package SPSS-28, and Chi-square tests were used to evaluate the relationship among vitamin D, T2DM, and control. Data were provided in simple frequency, percentage, mean, standard deviation, and range measures. Type 2 diabetes patients' mean ± SD ages were 55.4 ± 10.1, while controls had a mean ± SD of age of 55.3 ± 10.0. the sociodemographic features of T2DM and participant control. Shows A statistically significant association was found in the variables of age groups, school level (P = 0.0001), and marital status (P = 0.008). The BMI: mean ± SD (29.69 ± 5.14) of T2DM was higher than the BMI: mean ± SD (24.41 ± 1.95) of controls, as well as the waist-to-height ratio, which showed that the mean ± SD (0.527 ± 0.046) of T2DM was greater than the control mean ± SD (0.483 ± 0.019) at level (P = 0.0001); T2DM patients had deficient and insufficient vitamin D3 levels (38.7% and 33.3%, respectively), whereas controls had deficient and insufficient vitamin D3 levels (28.7% and 30.0%, respectively). It was found that there is a significant difference between low vitamin D3 levels and individuals with type 2 diabetes, and A lack of vitamin D3 is related to an increased risk of developing T2DM.



Publisher: Middle Technical University

**Keywords**: Vitamin D3 (Cholecalciferol); T2DM; Educational Level.

## 1. Introduction

A serious health risk, diabetes mellitus type 2 is a complicated, enduring metabolic disorder. The illness came in at number seven on the list of leading causes of death, according to the "World Health Organization" evaluations. This caused the deaths of 2.2 million more individuals in 2030 than it did in 2012 [1]. Iraq has seen a substantial increase in the prevalence of diabetes over the past 40 years; it now stands at 20%. Furthermore, DM is thought to be a significant cause of death in the majority of poor countries, particularly in Iraq. This may be caused by uncontrolled glucose levels [2].

T2DM is characterized by systemic inflammation, dysfunction of the pancreatic beta cells, and elevated blood sugar levels brought on by insufficient insulin synthesis, action, or both [3]. 90% of patients with diabetes, which affects 422 million people worldwide, have type II diabetes. Because T2DM has impaired signaling as a result of insulin binding to its receptor, the stimulation of signals from proteins not dependent on insulin is reduced in several tissues, such as "the kidney, bone, liver, and skeletal muscle", which has several negative effects, most notably osteoporosis [4]. People with type 2 diabetes are more likely to be vitamin D3 deficient than the overall population of healthy people [5]. The epidermis produces vitamin D3 (cholecalciferol) endogenously as a result of UV-B's impact on 7-dehydrocholesterol [6]. Beta cell malfunction as well as insulin resistance are both linked to a lack of vitamin D [7]. Additionally, there is proof that certain blood levels of vitamin D receptor variations are connected to some indicators of glucose metabolism, including T2DM risk [8]. It is thought that vitamin D, or vitamin D3, which is derived from food and sunlight, is essential for managing the calcium and phosphorus balance during bone mineralization and for intestinal calcium absorption [9]. Provitamin D3 is transformed into previtamin D3 by solar radiation in humans, and

| Nomenclature & Symbols | | | |
|---|---|---|---|
| D3 | Cholecalciferol | SPSS -28 | Statistical Software Platform-28 |
| T2DM | Type 2 Diabetes Mellitus | x2-test | Pearson Chi-square test |
| SD | Standard Deviation | P Value | Probability Value |
| % | Percentage | BMI | Body Mass Index |
| UV-B | Ultraviolet-B | $Kg/m^2$ | Kilogram Force per Square Meter |
| VDRs | Vitamin D Receptor | cm | Centimeter |
| Vit D | Vitamin D | | |

vitamin D3 is then produced naturally through heat isomerization. Vitamin 25 (OH)D, the primary vitamin D circulating metabolite, correctly measures the amount of this vitamin in the body, regardless of whether it was ingested or synthesized in the skin [10].

Older people are more at risk for vitamin D deficiency than younger ones, which is very common all around the world. Lack of vitamin D increases the risk of acquiring several diseases, including T2DM and Between 70% and 90% of people with type 2 diabetes had low or inadequate levels of vitamin D in their plasma [11]. In addition to vitamin D levels, receptors for vitamin D polymorphisms are associated with inherited susceptibility to type 2 diabetes (T2D) [12].

D vitamin functions via vitamin D receptors, and it has been demonstrated that polymorphisms in the gene for vitamin D receptors affect vitamin D signaling [13]. The activation of vitamin D via VDRs is crucial for controlling the pancreas cells' ability to secrete insulin [14]. Since vitamin D (Vit D) regulates beta cells' calcium flow and concentration it appears to show a significant part in the directive of insulin secretion [8].

Vitamin D and its activated metabolite, 25-dihydroxyvitamin D3, are known to control some endocrine pancreatic activities, including the generation of insulin [15]. Since serum 25(OH)D3 is the most common vitamin D metabolite in humans, it also serves as the main indicator of vitamin D status [16]. It is vital to maintain adequate calcium and phosphate levels in the blood, which are required for all body cells to function normally, including muscle contraction, nerve conduction, and general cellular function [17].

## 2. Patients and Methods

The Al-Hilla Diabetes and Endocrinology Center in Iraq conducted the case-control study. From November 2022 to April 2023, five months of data collection took place. with the selection of cases and controls according to certain inclusion and exclusion criteria. By using a special questionnaire design. criteria for inclusion Cases: people between the ages of 30 and 79; all those present had type 2 diabetes. The controls were individuals attending Babylon Governorate's diabetic and endocrinology center / Murjan Hospital as healthy individuals who were age and gender-matched in a 1:1 ratio. Type 2 diabetics who declined to participate, those in inappropriate sample groups, and pregnant type 2 diabetics were also excluded [18].

### *2.1. Statistical data analysis*

The available statistical tool SPSS-28 (Statistics for Social Sciences, edition) was utilized to examine the information. "Simple frequency, percentage, mean, standard deviation, and range" Information was displayed using measurements (values ranging from minimum to maximum). The significance of mean differences (quantitative information) determined whether the student's t test is being used for differences between two separate ways, or the "ANOVA test." Regarding variations between several separate means to determine the significance of distinct percentage differences (qualitative data), Yate's correction applied to the Pearson Chi-square test (x2-test) or Test by Fisher Exact was utilized. It was statistically significant. determined when P = 0.05 or less was the P value [19].

### *2.2. Ethical considerations*

All procedures performed in this study were by the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration. The study was carried out with patients' verbal and analytical approval and with consent from the Babylon Health Department / Training and Human Development Center / Research and Knowledge Management Unit / Research Committee to carry out the research after fulfilling all the criteria approved by the Ministry of Health.

## 3. Results

Table 1 shows Out of 300 patients, 150 had T2D (85 females and 65 men) and 150 were Controls that were similar in age and sex. T2DM had an average age of 55.4±10.1 years, according to the age group the 50-59 age range had the greatest proportion of T2DM and control (33.3%), whereas the 30-39 age group had the lowest (6.7%). In terms of marital status, the highest percentage (93.3%) had T2DM and (98.7%) for controls, while Single/Widow the lowest percentage (6.7%) had T2DM and (1.3%) had control.

In terms of educational qualification, the majority (24.7%) were Read & Write, while the minority (13.3%) graduated from college and higher of T2DM. In terms of control, College and higher had the largest percentage (38.0%), while Illiterate had the lowest (7.3%).

Table 1. The demographics of T2DM and controls

| *Sociodemographic* | | *T2DM* | | *Control* | | *P value* |
|---|---|---|---|---|---|---|
| | | **No** | **%** | **No** | **%** | |
| Age (years) | 30---39 | 10 | 6.7 | 10 | 6.7 | - |
| | 40---49 | 28 | 18.7 | 28 | 18.7 | |
| | 50---59 | 50 | 33.3 | 50 | 33.3 | |
| | 60---69 | 47 | 31.3 | 47 | 31.3 | |
| | 70---79 | 15 | 10.0 | 15 | 10.0 | |
| | Mean ± SD(Range) | 55.4±10.1(30-77) | | 55.3±10.0(30-77) | | 0.986 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Gender | Male | 65 | 43.3 | 65 | 43.3 | - |
| | Female | 85 | 56.7 | 85 | 56.7 | |
| Educational level | Illiterate | 34 | 22.7 | 11 | 7.3 | 0.0001* |
| | Read & Write | 37 | 24.7 | 19 | 12.7 | |
| | Primary | 30 | 20.0 | 21 | 14.0 | |
| | Secondary | 29 | 19.3 | 42 | 28.0 | |
| | College & Higher | 20 | 13.3 | 57 | 38.0 | |
| Marital status | Married | 140 | 93.3 | 148 | 98.7 | 0.008* |
| | Unmarried | 10 | 6.7 | 2 | 1.3 | |

*Significant difference as determined by the Pearson Chi-square test (2-test) at the 0.05 level.
**Significant difference using Students' t-test at 0.05 level between two independent means.

Significance differences between type 2 diabetes and control groups according to signs and symptoms, the highest percentage for Numbness/pain/tingling of hands/feet at 81.3% followed by extreme fatigue at 75.3%, thirst at 74%, and vision problems at 72% table (P- value 0. 0001) Table 2.

Table 2. The distribution of the study sample according to signs and symptoms of diabetes and control group

| Signs and symptoms | | T2DM | | Controls | | P value |
|---|---|---|---|---|---|---|
| | | No | % | No | % | |
| Frequent Urination | Yes | 88 | 58.7 | 12 | 8.0 | 0.0001* |
| | No | 62 | 41.3 | 138 | 92.0 | |
| Eye or vision problems | Yes | 109 | 72.7 | 81 | 54.0 | 0.001* |
| | No | 41 | 27.3 | 69 | 46.0 | |
| Bruises or Wound that are slow to heal | Yes | 61 | 40.7 | 2 | 1.3 | 0.0001* |
| | No | 89 | 59.3 | 148 | 98.7 | |
| Dry itchy skin | Yes | 39 | 26.0 | 4 | 2.7 | 0.0001* |
| | No | 111 | 74.0 | 146 | 97.3 | |
| Thirsty | Yes | 111 | 74.0 | 5 | 3.3 | 0.0001* |
| | No | 39 | 26.0 | 145 | 96.7 | |
| Extreme fatigue | Yes | 113 | 75.3 | 96 | 64.0 | 0.033* |
| | No | 37 | 24.7 | 54 | 36.0 | |
| Numbness/pain/tingling of hands/feet | Yes | 122 | 81.3 | 61 | 40.7 | 0.0001* |
| | No | 28 | 18.7 | 89 | 59.3 | |

*Significant difference between percentages using Pearson Chi-square test ($\chi^2$-test) at 0.05 level.

Table 3 the distribution of the study sample to vitamine D3 level and diabetes-related complication, with a significant association between recurrent skin infection and Deficient vitamine D3 level in type 2 diabetes (P-value 0.041*) while non-significance association regarding other related complications.

Table 3. Vitamin D3 level and associated complications with diabetes patients

| Vitamin D3 (ng/mL) | | T2DM Deficient (<20) | | T2DM Insufficient (20-29) | | T2DM Normal (=>30) | |
|---|---|---|---|---|---|---|---|
| | | No | % | No | % | No | % |
| Associated complication. | | | | | | | |
| Loss or diminished sensation in the hands and feet | Yes | 16 | 27.6 | 15 | 30.0 | 10 | 23.8 |
| | No | 42 | 72.4 | 35 | 70.0 | 32 | 76.2 |
| | P value | | | 0.801 | | | |
| Foot problems associated with diabetes | Yes | 38 | 65.5 | 32 | 64.0 | 20 | 47.6 |
| | No | 20 | 34.5 | 18 | 36.0 | 22 | 52.4 |
| | P value | | | 0.153 | | | |
| Foot infection and ulceration | Yes | 11 | 19.0 | 7 | 14.0 | 3 | 7.1 |
| | No | 47 | 81.0 | 43 | 86.0 | 39 | 92.9 |
| | P value | | | 0.243 | | | |
| Recurrent urinary tract infection | Yes | 31 | 53.4 | 30 | 60.0 | 19 | 45.2 |
| | No | 27 | 46.6 | 20 | 40.0 | 23 | 54.8 |
| | P value | | | 0.368 | | | |
| Recurrent skin infection | Yes | 5 | 8.6 | 9 | 18.0 | 1 | 2.4 |
| | No | 53 | 91.4 | 41 | 82.0 | 41 | 97.6 |
| | P value | | | 0.041* | | | |

*Significant difference between percentages using Pearson Chi-square test ($\chi^2$-test) at 0.05 level.

Table 4 shows the distribution of the study sample according to Vitamine D3 and Diabetes-related comorbidities (obesity, Diabetic food, Hypertension, Heart diseases, kidney diseases, and Eye complications and the association was found to be non-significance (P-value > 0.05)

Table 4. Vitamin D3 level and Diabetes-related comorbidities

| Vitamin D3 (ng/mL) | | T2DM Deficient (<20) | | T2DM Insufficient (20-29) | | T2DM Normal (=>30) | |
|---|---|---|---|---|---|---|---|
| | | No | % | No | % | No | % |
| Diabetes-related comorbidities | | | | | | | |
| Obesity | Yes | 6 | 10.3 | 11 | 22.0 | 5 | 11.9 |
| | No | 52 | 89.7 | 39 | 78.0 | 37 | 88.1 |
| | P value | | | 0.195 | | | |
| Diabetic foot | Yes | 2 | 3.4 | 1 | 2.0 | 2 | 4.8 |
| | No | 56 | 96.6 | 49 | 98.0 | 40 | 95.2 |
| | P value | | | 0.762 | | | |
| Hypertension | Yes | 29 | 50.0 | 28 | 56.0 | 23 | 54.8 |
| | No | 29 | 50.0 | 22 | 44.0 | 19 | 45.2 |
| | P value | | | 0.804 | | | |
| Heart disease | Yes | 14 | 24.1 | 10 | 20.0 | 4 | 9.5 |
| | No | 44 | 75.9 | 40 | 80.0 | 38 | 90.5 |
| | P value | | | 0.173 | | | |
| Kidney disease | Yes | 2 | 3.4 | 5 | 10.0 | 2 | 4.8 |
| | No | 56 | 96.6 | 45 | 90.0 | 40 | 95.2 |
| | P value | | | 0.333 | | | |
| Diabetic eye complications | Yes | 24 | 41.4 | 24 | 48.0 | 18 | 42.9 |
| | No | 34 | 58.6 | 26 | 52.0 | 24 | 57.1 |
| | P value | | | 0.775 | | | |

*Significant difference between percentages using Pearson Chi-square test ($\chi^2$-test) at 0.05 level.

Table 5 shows the spread of T2DM and controls based on BMI (Kg/m2), waist circumference (cm), and other anthropometric measures, as well as the waist-to-height ratio. The present findings revealed that BMI: mean ± SD (29.69 ± 5.14) of T2DM was higher than BMI: mean ± SD (24.41 ± 1.95) of control; the highest percentage (44.0%) of T2DM was obese; 38.0% were overweight; while the comparison control group included obese and overweight (0.7%, 16.0%, respectively). Regarding waist circumference (cm) findings revealed: T2DM mean ± SD (86.44 ± 8.44) greater than the control mean ± SD (81.01 ± 4.82). Obesity was the most common cause of T2DM (17.3%), and all the controls were normal. Finally, the waist-to-height ratio showed that the mean± SD (0.527 ± 0.046) of T2DM was greater than the control mean± SD (0.483 ± 0.019), and the highest proportion (64.0%) of T2DM was found.

Table 5. Anthropometric Measures of Study Participants

| Anthropometric Measures | | T2DM | | Controls | | P value |
|---|---|---|---|---|---|---|
| | | No | % | No | % | |
| BMI (Kg/m$^2$) | Normal (18.5-24.9) | 27 | 18.0 | 125 | 83.3 | 0.0001* |
| | Overweight (25-29.9) | 57 | 38.0 | 24 | 16.0 | |
| | Obese (=>30) | 66 | 44.0 | 1 | 0.7 | |
| | BMI: Mean ± SD (Range) | 29.69±5.14 (18.72-43.50) | | 24.41±1.95 (19.96-42.35) | | 0.0001** |
| | Height (cm): Mean ± SD (Range) | 164.21±9.18 (145-188) | | 167.88±8.67 (140-190) | | 0.0001** |
| | Weight (Kg): Mean ± SD (Range) | 79.96±14.74 (45-135) | | 68.89±8.04 (50-88) | | 0.0001** |
| Waist Circumference (cm) | Obese (>102M/>88F) | 26 | 17.3 | - | - | 0.0001* |
| | Normal | 124 | 82.7 | 150 | 100 | |
| | Mean ± SD (Range) | 86.44±8.44 (70-113) | | 81.01±4.82 (70-93) | | 0.0001** |
| Waist to Height Ratio | healthy (0.40-0.49) | 40 | 26.7 | 131 | 87.3 | 0.0001* |
| | Overweight (0.50-0.59) | 96 | 64.0 | 19 | 12.7 | |
| | Obese (=>0.60) | 14 | 9.3 | - | - | |
| | Mean ± SD (Range) | 0.527±0.046 (0.407-0.697) | | 0.483±0.019 (0.400-0.579) | | 0.0001** |

*Significant difference as determined by the Pearson Chi-square test (2-test) at the 0.05 level.
**Significant difference using Students' t-test at 0.05 level between two independent means.

Table 6 The table shows serum vitamin D3 levels (deficient, insufficient, and normal) in T2DM and controls. The greatest percentage of people were deficient and insufficient for vitamin D3 (72%), followed by normal (28.0%) for T2DM. Compared to the controls, the greatest percentage was deficient and insufficient (58.7%) and normal (41.3%). There were lower levels of vitamin D3 in T2DM than controls, and at the P-value (0.42) level, the table demonstrates a significant difference.

Table 6. Association between T2DM and Control according to Vitamin D3

| | | T2DM | | Controls | | P value |
|---|---|---|---|---|---|---|
| | | No | % | No | % | |
| Vitamin D3 (ng/mL) | Deficient (<20) | 58 | 38.7 | 43 | 28.7 | 0.042* |
| | Insufficient (20-29) | 50 | 33.3 | 45 | 30.0 | |

| | | | | |
|---|---|---|---|---|
| Normal (=>30) | 42 | 28.0 | 62 | 41.3 |

* Using the Pearson Chi-square test (2-test) at the 0.05 level, there is a significant difference.

## 4. Discussion

Diabetes mellitus type II is a varied group of illnesses caused by a combination of risk factors, including genetic, behavioral, nutritional, and environmental factors. Diabetes mellitus is characterized by insulin resistance and a lack of insulin synthesis [20].

It is well known that patients with T2DM have a greater frequency of vitamin D3 insufficiency [5]. Vitamin D receptors (VDRs) are found in all tissues, including pancreatic cells. Vitamin D appears to be involved in the regulation of insulin secretion in response to glucose consumption. The binding of the active form 1,25(OH)D to cell VDR may mediate direct effects. Vitamin D may indirectly alter insulin secretion by controlling calcium influx via the cell membrane, which regulates calcium-mediated insulin release. Evidence has suggested that vitamin D plays a role in both the onset and treatment of type 2 diabetes mellitus (T2DM). There is now solid evidence that vitamin D plays a role in both pancreatic insulin secretion and insulin sensitivity and thus influences disease etiology [21]. The body of knowledge about how vitamin D impacts calcium metabolism, bone integrity, and other processes is expanding. Because vitamin D participates in several critical physiological pathways, epidemiologic studies have connected vitamin D deficiency to the emergence of metabolic syndromes such as T2D [22].

The findings of the study revealed a statistically significant difference in vitamin D levels between diabetic patients and healthy controls. In type 2 DM, vitamin D deficiency was also more prevalent. According to the current study's findings, a sample of 150 patients and 150 controls were chosen based on the age variable, and the case group's mean age was 55.4±10.1 years, while the control groups was 55.3±10 years. This finding is consistent with other reported investigations in India [23]. A sample of 150 patients and 150 controls was gathered. The mean age of the case group was 52.41±7.36 years, while the mean age of the control group was 51.54±7.51 years. Gender Statistics The study found that females with T2DM had the highest percentage (56.7%), whereas males with T2DM had the lowest rate (43.3%). The current study is comparable to previously reported investigations in Egypt [24], where the majority (55.3%) were female with T2DM and the minority (44.7%) were male with T2DM.

All signs and symptoms between T2DM and controls show high significance differences at a P-value of 0.0001. The highest percentage was for numbness, pain/tingling of hands/feet 81.3%. The new finding is not consistent with previous research. In addition, this high prevalence of T2DM symptoms can be explained by aging, weight gain, vitamin D3, and calcium deficits, which raised the percentage of these symptoms in the sample. Regarding vitamin D3 levels and diabetes-related complications, the result showed a significant association between recurrent skin infections and a deficient vitamin D3 level in type 2 diabetes. The new findings are not similar to those of previous studies, and this significant association may be because high sugar levels in your blood and tissues promote bacterial growth and illness development. This raises the likelihood of infection. In terms of vitamin D3 level and diabetes-related comorbidities, all results show non-significance (P-value > 0.05). The anthropometric measures for T2DM and controls show high-significance differences at a P-value of 0.0001. T2DM patients had a higher BMI (mean± SD 29.69±5.14) than controls (mean± SD 24.41±1.95). The current study is comparable to prior published studies in Nineveh Governorate, Iraq [25], where the T2DM BMI mean ± SD (32.23 ± 4.79) was greater than the control BMI mean ± SD (26.34± 20.27).

Our findings were that in terms of vitamin D3 levels, the highest percentages (38.7%) were found to be deficient in T2DM. While controls were lacking in the smallest amount (28.7%). This finding is consistent with other recent research in Pakistan [26], which found that the biggest percentage (54.1%) were T2DM deficient. While the lowest percentage (28.6%) lacked controls, Furthermore, the current study confirmed the findings of a prior study in Nigeria [27], which found that the biggest percentage (63.2%) were T2DM deficient. While the lowest percentage (53.3%) lacked controls.

Our findings were consistent with those of Rahmanian et al.'s Iranian study, which identified no link between gender differences and T2D [28]. and refutes Aregbesola et al.'s assertion in a Finnish study that there is a gender difference in T2D risk, with females having a higher T2D risk [29].

A Nigerian study found that living in a city increases the likelihood of older people getting new cases of diabetes [30]. Aside from a Polish study that discovered that the degree of metabolic control of diabetes was not significantly affected by sociodemographic differences between groups based on place of residence, there is research that contradicts our results [31]. Numerous empirical studies indicate that getting enough vitamin D can lower your risk of T2D, obesity, and metabolic syndrome. However, it is beneficial to confirm the hypothesis that hypovitaminosis D worsens these diseases.

## 5. Conclusions

It was found that there is a significant difference between low vitamin D3 levels and individuals with type 2 diabetes, and a lack of vitamin D3 is related to an increased risk of developing T2DM.

## 6. Recommendations

People with T2DM may need to be tested for vitamin D insufficiency and Supplementing with vitamin D3 helps those with type 2 diabetes and insulin resistance. In addition, they have been exposed to sunlight long enough to benefit from Vitamin D3.

## Acknowledgement

I would like to express my sincere gratitude to everyone who helped and supported me, including the medical, health, and nursing staff at Al-Murjan Hospital/Diabetes and Endocrinology Center in Babylon Governorate, finally, I would like to thank everyone who helped me write this work.

**References**


[1] A. Senyigit, "The association between 25-hydroxy vitamin D deficiency and diabetic complications in patients with type 2 diabetes mellitus," Diabetes Metab. Syndr. Clin. Res. Rev., vol. 13, no. 2, pp. 1381–1386, 2019, doi: 10.1016/j.dsx.2019.01.043.

[2] E. M. Mikhael, M. A. Hassali, S. A. Hussain, and N. Shawky, "Self-management knowledge and practice of type 2 diabetes mellitus patients in Baghdad, Iraq: A qualitative study," Diabetes, Metab. Syndr. Obes. Targets Ther., vol. 12, pp. 1–17, 2019, doi: 10.2147/DMSO.S183776.

[3] N. Alcubierre et al., "Vitamin D deficiency is associated with poorer satisfaction with diabetes-related treatment and quality of life in patients with type 2 diabetes," Health Qual. Life Outcomes, vol. 16, no. 1, pp. 1–8, 2018.

[4] Y. Liang et al., "1,25-Dihydroxy vitamin D3 treatment attenuates osteopenia, and improves bone muscle quality in Goto-Kakizaki type 2 diabetes model rats," Endocrine, vol. 64, pp. 184–195, 2020, doi: 10.1007/s12020-019-01857-5.

[5] T. S. Vuksanovic and V. Kneževic, "Prevalence of vitamin D3 deficiency in patients with type 2 diabetes and proteinuria," Vojnosanit. Pregl., vol. 78, no. 12, pp. 1292–1302, 2021, doi: 10.2298/VSP200220064S.

[6] A. G. Pittas et al., "Vitamin D Supplementation and Prevention of Type 2 Diabetes," N. Engl. J. Med., vol. 381, no. 6, pp. 520–530, 2019, doi: 10.1056/nejmoa1900906.

[7] M. Abusaib et al., "Iraqi Experts Consensus on the Management of Type 2 Diabetes/Prediabetes in Adults," Clin. Med. Insights Endocrinol. Diabetes, vol. 13, 2020, doi: 10.1177/1179551420942232.

[8] G. E. Fagundes et al., "Vitamin D3 as adjuvant in the treatment of type 2 diabetes mellitus: modulation of genomic and biochemical instability," Mutagenesis, vol. 34, pp. 135–145, 2019, doi: 10.1093/mutage/gez001.

[9] P. Saeedi et al., "Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition," Diabetes Res. Clin. Pract., vol. 157, p. 107843, 2019, doi: 10.1016/j.diabres.2019.107843.

[10] S. Wieder-Huszla et al., "Relationships between Vitamin D 3 and Metabolic Syndrome," 2019, doi: 10.3390/ijerph16020175.

[11] X. Hou et al., "Stronger associations of waist circumference and waist-to-height ratio with diabetes than BMI in Chinese adults," Diabetes Res. Clin. Pract., vol. 147, pp. 9–18, Jan. 2019, doi: 10.1016/j.diabres.2018.07.029.

[12] B. Angel, L. Lera, C. Márquez, and C. Albala, "The association of VDR polymorphisms and type 2 diabetes in older people living in community in Santiago de Chile," Nutr. Diabetes, vol. 8, p. 31, 2018, doi: 10.1038/s41387-018-0038-9.

[13] Y. Hao and Y. Chen, "Vitamin D levels and vitamin D receptor variants are associated with chronic heart failure in Chinese patients," J. Clin. Lab. Anal., vol. 33, no. 4, pp. 1–7, 2019, doi: 10.1002/jcla.22847.

[14] H. I. El Gendy, N. A. Sadik, M. Y. Helmy, and L. A. Rashed, "Vitamin D receptor gene polymorphisms and 25(OH) vitamin D: Lack of association to glycemic control and metabolic parameters in type 2 diabetic Egyptian patients," J. Clin. Transl. Endocrinol., vol. 15, no. November 2018, pp. 25–29, 2019, doi: 10.1016/j.jcte.2018.11.005.

[15] S. N. Dipti Sarma, Vikram Singh Chauhan, Kandarpa Kumar Saikia1 , Partha Sarma1, "Prevalence Pattern of Key Polymorphisms in the Vitamin D Receptor gene among Patients of Type 2 Diabetes Mellitus in Northeast India," 2018, doi: 10.4103/ijem.IJEM_213_17.

[16] G. Gembillo et al., "medicina Role of Vitamin D Status in Diabetic Patients with Renal Disease," Medicina (B. Aires)., vol. 55, p. 273, 2019, doi: 10.3390/medicina55060273.

[17] M. S. Aparna P1, B. Nongkynrih1, and Sanjeev Kumar Gupta1, "Vitamin D deficiency in India," 2018, doi: 10.4103/jfmpc.jfmpc_78_18.

[18] A. ah mousa alsarray Alaa Mehdi salih, "Practices regarding HPV and cervical cancer in asample of paramedical staff in al Najaf Governorate, Iraq," J. Tech., vol. 4, no. no., special, pp. 45–51, 2022.

[19] R. haider S. Atta ah mousa alsarray, "awareness of health care provider about CONID-19 vaccination in karbala city," J. Tech., vol. 4, no. no., special, pp. 91–96, 2022.

[20] Y. Gao et al., "Vitamin D and incidence of prediabetes or type 2 diabetes: A four-year follow-up community-based study," Dis. Markers, vol. 2018, 2018, doi: 10.1155/2018/1926308.

[21] A. D. Submitted et al., "VITAMIN D STATUS AND GLYCAEMIA IN TYPE 2 DIABETES MELLITUS SUBJECTS IN LAGOS , NIGERIA," no. November, 2013.

[22] M. ElJilani, H. Alemam, and A. Bashein, "Vitamin D and liver enzymes' levels in Libyans with type 2 diabetes," Libyan J. Med. Sci., vol. 5, no. 3, p. 116, 2021, doi: 10.4103/ljms.ljms_18_21.

[23] S. Narayanan and R. Gopikuttan, "The correlation of vitamin D with HOMA-IR and glycated hemoglobin in type 2 diabetes mellitus patients," Baghdad J. Biochem. Appl. Biol. Sci., vol. 3, no. 04, pp. 273–285, Nov. 2022, doi: 10.47419/bjbabs.v3i04.153.

[24] A. EL Ashiry, M. Gadallah, mohamed mashahit, E. Bayoumy, shahira El-Shafie, and D. Boulos, "Vitamin D status Association with newly diagnosed Type2 Diabetes Mellitus: A Case Control Study," Fayoum Univ. Med. J., vol. 1, no. 1, pp. 40–48, 2018, doi: 10.21608/fumj.2018.5505.

[25] S. F. Ogail, S. N. Muhsin, and W. I. Abbas, "Evaluation of vitamin D level among patients with type 2 diabetes in Nineveh Governorate-Iraq," vol. 140, no. 04, pp. 2279–2285, 2022.

[26] M. Khudayar et al., "The Association Between Deficiency of Vitamin D and Diabetes Mellitus Type 2 (DMT2)," Cureus, vol. 2, no. 2, pp. 1–5, 2022, doi: 10.7759/cureus.22221.

[27] A. Anyanwu et al., "Serum Vitamin D Levels in Persons with Type 2 Diabetes Mellitus in Lagos, Nigeria," Int. J. Diabetes Clin. Res., vol. 7, no. 4, pp. 1–7, 2020, doi: 10.23937/2377-3634/1410133.

[28] M. Shojaei, K. Rahmanian, and A. S. Jahromi, "Relation of type 2 diabetes mellitus with gender, education, and marital status in an Iranian urban population," Reports Biochem. Mol. Biol., vol. 1, no. 2, 2013, [Online]. Available: www.RBMB.net

[29] A. Aregbesola, S. Voutilainen, J. K. Virtanen, J. Mursu, and T. P. Tuomainen, "Gender difference in type 2 diabetes and the role of body iron stores," Ann. Clin. Biochem., vol. 54, no. 1, pp. 113–120, 2017, doi: 10.1177/0004563216646397.

[30] W. O. Balogun and O. Gureje, "Self-reported incident type 2 diabetes in the ibadan study of ageing: Relationship with urban residence and socioeconomic status," Gerontology, vol. 59, no. 1, pp. 3–7, 2012, doi: 10.1159/000340062.

[31] M. Dudzińska et al., "Type 2 diabetes mellitus in relation to place of residence: Evaluation of selected aspects of socio-demographic status, course of diabetes and quality of life - a cross-sectional study," Ann. Agric. Environ. Med., vol. 20, no. 4, pp. 869–874, 2013.