

## Research Article

### Association Between Changes in Biochemical Parameters and Type 2 Diabetes Mellitus Among Iraqi Patients in Kerbala.

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#### Abstract:

**Background** :Diabetes mellitus has become a major global health concern and is associated with a wide range of metabolic and biochemical disturbances. The increasing prevalence of type 2 diabetes in Iraq, particularly in the Kerbala Governorate, highlights the need to better understand its contributing factors and biochemical correlates. This study aims to evaluate the metabolic profile of adult diabetic patients in Kerbala and to determine the association between diabetes and selected biochemical indicators. **Methods**: One hundred diabetic adults (40 patient and 10 control) were assessed through medical history, physical examination, and laboratory tests, including BMI, fasting blood glucose, HbA1c, insulin, zinc, and vitamin D. **Results** :Age and BMI showed strong correlations with diabetes. BMI distribution was 47.5% healthy weight, 37.5% overweight, 5% obese, and less than 10% underweight. Zinc and vitamin D showed a significant negative relationship, while fasting glucose and HbA1c showed positive correlations. About 65% of participants were on insulin therapy. Conclusion Age, BMI, and changes in zinc and vitamin D levels are important indicators linked to type 2 diabetes. Monitoring these markers may improve disease management.

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## INTRODUCTION

Chronic hyperglycemia and escalating metabolic dysregulation are hallmarks of type 2 diabetes mellitus (T2DM), a developing global public health issue. Due to advancing age, growing urbanization, rising obesity, and sedentary lifestyles, the incidence of type 2 diabetes has increased dramatically internationally in the past two decades. This trend is reflected in Iraq and neighboring countries, where recent population and hospital research findings show elevated and increasing incidences of this disease and prediabetes among the population.[1]

Ninety to ninety-five percent of all diabetics have type 2 diabetes, which is the kind that does not require insulin. It typically affects those who have a resistance to insulin because of a malfunction in their cells' hormone receptors or a deficiency with the production of insulin in amounts that are not treated with treatment with insulin. Insulin is still secreted by the pancreatic beta [2]. The majority of people with type 2 diabetes are obese, with a body mass index of over twenty percent of their optimal bodyweight. Overweight individuals exhibit resistance to insulin, which means the pancreas has to work harder to make additional insulin. Nevertheless, the amount of insulin secreted won't be enough to keep blood sugar levels regular. Regulating the kind and quantity of food and exercise, as well as managing body weight, may help manage diabetes, especially type 2 diabetes. Diabetic drugs are required as the condition worsens. The global population of people with diabetes is predicted to rise to around three hundred million in 2025 due in large part to the variety of dietary practices and lifestyle found in various nations and cultures [3]. For the identification, treatment, tracking, and assessment of risk of type 2 diabetes, accurate biochemical evaluation is essential. Fasting plasma glucose and glycated hemoglobin (HbA1c) are still

often used in both clinical and scientific studies to measure the degree of illness and development of illness. These are also standard markers for identifying and tracking glycaemic management. Variations in these indicators often correspond with other nutritional and metabolic indicators, such as zinc and levels of vitamin D, which have been linked to inflammatory processes, production of insulin, and the balance of glucose.[4]

essentially controlled experiments demonstrate conflicting results and the cause-and-effect relationship remaining up for debate, qualitative research and systematic reviews point to a link among inadequate levels of vitamin D as well as an increased risk about developing insulin resistance and type 2 diabetes [5,6]. Regardless, vitamin D is still a significant potential indicator to investigate in populations with high deficiencies incidence. Similarly to this, there is growing evidence that a lack of zinc is linked to oxidative damage, poor insulin signaling, and unfavorable glycemic results. As a result, supplementing with zinc has been investigated to be an addition to glycemic control in a number of experiments and systematic reviews. Examining the interactions between HbA1c, fasting glucose levels, zinc, vitamin D, and additional biochemical parameters in Iraqi patients can shed light on local illness trends, pinpoint changeable hazards, as well as guide focused preventative and medicinal plans. [7, 8, 9] The aim of the present research is to assess correlations between variations in important biochemical parameters (HbA1c, fasting blood glucose, vitamin D, zinc, and related measures) and T2DM status in Iraqi individuals. It also aims to ascertain that vitamin D and zinc levels are associated alongside anthropometric measurements (such as BMI) and glycemic management in this group of individuals.

## 2. Materials and Methods

This study was carried out in the private's laboratories in Kerbala-al hindyaa throughout the period from 1 November 2023 until the end of Julie 2024. This study included 50 blood samples equally divided into two groups, patients with T2DM and normal healthy controls. The age of patients and normal healthy controls was ranged between 25 to 70 years. Age, BMI, fasting blood glucose, D3,ZINC,HBA1C were evaluated in specimen of T2DM patients and normal healthy controls. Individuals with diabetes were among the research's subjects. Serum samples were taken to individuals with diabetes who have type 2 as well as the control group of participants. The duration of diabetes was between 5–15 years. Those taking vitamin D or zinc supplements, or whose use was documented, were excluded—as these may affect serum parameters.

- Those with an acute illness/active inflammation at the time of collection (infection, acute illness, seizure) were excluded—as this may alter biochemical values.
- Those with congenital or acquired liver, kidney, or glandular diseases were excluded. Confirmation of medication consistency (type of medication, recent changes, use of insulin, or additional medications) was ensured, as medications may affect biochemical parameters.
- A standardized fasting period before collection (e.g., 8–12 hours) was maintained for all participants

### Blood samples collection

The venous system was used to draw samples of blood, and five milliliters of sterile synergies then used. Several separate tubes with labels were specifically used to hold the specimen in question. EDTA, a drug that prevents blood from coagulating and is used to measure the amount of hemoglobin A1C, is present in

the first diabetes selection tube. The additional set for containers—gel tubes devoid of an anticoagulant—was utilized to prepare plasma for the subsequent biochemical examination. To produce a coagulating agent, the blood was spun through a centrifuge for 10 minutes at six thousand revolutions per minute. The resultant materials was subsequently separated and refrigerated at -80 oC until the experimental method for the investigation was completed.

### Body Mass Index (BMI)

A carefully calibrated online weight and height scale was used for determining the participants' weight and measurements while they were dressed properly for the conditions inside. The body mass index, also referred to as abbreviated body mass index ( B was calculated by multiplying the person's body bodyweight in kilogram by the square root of their elevations in meters, as shown in the subsequent equation: a body mass index = weight (kilograms) / height (meters)<sup>2</sup>.

### Estimation of HbA1C level

#### Principle of Assay:

The Basis for the Response In addition to producing fructose dipeptides. using the N-terminal amino groups of the beta-chain of the blood sugar, the protease-mediated mechanism also measures the concentration of hemoglobin at specific wavelengths of absorbance during this initial interaction. 10 (carboxymethyl-aminocarbonyl)-3,7-bis(dimethylamino), a substance known as sodium salt, reacts with fructosyl peptides oxidase (FPOX) by using fructosyl dipeptides to produce peroxide using hydrogen, which is why it forms a color that contains a peroxide quantity in the subsequent stage. To determine the HbA1c, a change in absorbance is assessed. The gadget computes and displays HbA1c(%) based on the findings of the combined HbA and HbA1c examinations.

### Vitamin D Measurement

Serum 25-hydroxyvitamin D [25(OH)D] levels were measured using an Electrochemiluminescence Immunoassay (ECLIA). This method provides accurate and reliable assessment of vitamin D status.

### Zinc Measurement

Serum zinc levels were determined using Atomic Absorption Spectrophotometry (AAS). This technique is commonly used to measure trace elements with high accuracy.

### Statistical Analysis

SPSS, a statistical software application, has been employed for the statistical examination of the data (SPSS, Version 23). The t-test was used to compare the averages and standard deviations of the

afflicted and unaffected groups. The two distinct groups were compared using one-way ANOVA by LSD and the correlation coefficient of Pearson according to the predefined parameters. The relationship between indicators and dependent variables was computed using a correlation factor analysis. The Microsoft Office 2016 Excel application was used to make the figures. A significant  $P < 0.05$  was used for statistical analysis of each of them.

## RESULT

### 1- Diabetes

Patients with type 2 diabetes were chosen for this study based on their gender. There are 40 patient and 10 control in the current study table (1).

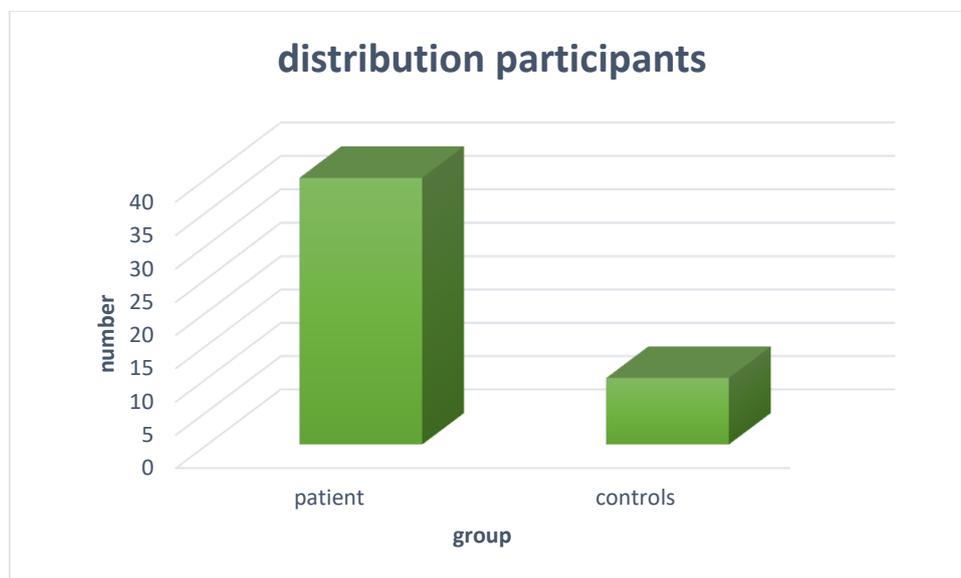


Figure (1):distribution in diabetes among study participants

The table(1) show a comparison of biochemical parameters between patients with type 2 diabetes mellitus and the control group according to age and gender. Overall, diabetic patients exhibited higher mean values of glycemic indicators (such as fasting blood sugar and HbA1c) and BMI compared with controls, indicating poorer glycemic control and increased

body weight. In contrast, serum vitamin D3 and zinc levels were generally lower in diabetic patients than in the control group. The differences observed between patients and controls were statistically significant in most parameters, suggesting that type 2 diabetes is associated with notable alterations in these biochemical markers.

**Table 1: Biochemical Parameters** and diabetes levels in patients and control.

Group Statistics						
Std. Error Mean	Std. Deviation	Mean	N	G		
0.593228	3.751904	23.2721	40	PATIENT		BMI
0.5	0.707107	19.5	10	CONTROL		
14.01	88.608	278.7	40	PATIENT		Diabetes Mg/dl
5	7.071	85	10	CONTROL		
0.454	2.869	4.35	40	PATIENT		hba1c%
0.25	0.354	2.25	10	CONTROL		
1.542	9.753	22.43	40	PATIENT		v D3 (ng/ml)
2	2.828	57	10	CONTROL		
1.254	7.929	22.9	40	PATIENT		ZINK Mg/dl
2.5	3.536	47.5	10	CONTROL		

The results indicate that patients with type 2 diabetes mellitus have significantly higher levels of fasting blood sugar, HbA1c, and BMI compared with the control group, reflecting poor glycemic control and increased obesity. Conversely, serum vitamin D3 and zinc levels were lower in diabetic patients than in controls. Correlation analysis shows a significant

positive association between BMI and HbA1c, while no significant correlations were observed between BMI and vitamin D3 or zinc. These findings suggest that type 2 diabetes is associated with metabolic imbalance, poor glycemic regulation, and reduced micronutrient levels.

**Table 2:** Independent t-test Comparison of Biochemical Parameters Between Type 2 Diabetes Patients and Control Group.

Variable	Levene's F	Levene Sig.	t-value	df	p-value	Interpretation
BMI	4.774	0.035	4.862	30.36	<0.001	Significant ↑ BMI
FBS / Diabetes	3.416	0.072	3.055	40	<0.01	Significant ↑ glucose
HbA1c	3.086	0.087	1.023	40	>0.05	Not significant
Vitamin D (V D3)	2.585	0.116	-4.95	40	<0.001	Significant ↓ Vit D
zinc	2.797	0.108		40	<0.001	Significant ↓zinc

The correlation analysis presented in the table shows different levels of association between Type 3 Diabetes and several biochemical parameters. table 2 The results indicate a significant negative correlation between diabetes and zinc levels ( $r = -0.465$ ,  $p = 0.002$ ), suggesting that higher severity of diabetes is associated with lower zinc concentrations in patients. A significant negative correlation was also observed between diabetes and Vitamin D3 levels ( $r = -0.369$ ,  $p = 0.019$ ), indicating that reduced Vitamin D3 levels may be linked to an

increased risk or progression of Type 2 Diabetes.

Regarding HbA1c, the findings show a significant positive correlation ( $r = 0.325$ ,  $p = 0.041$ ), which aligns with its established role as a direct indicator of long-term glycemic control; HbA1c levels increase as blood glucose levels rise.

In contrast, no significant relationship was found between diabetes and BMI ( $r = 0.130$ ,  $p = 0.423$ ), suggesting that body weight or obesity in this sample was not strongly associated with diabetes severity.

**Table (3):** Association between Type 2 Diabetes and Some Biochemical Pearson Correlation

ZINK Mg\dl	v D3	hba1c	Diabetes	BMI	
-.465**	-.369*	.325*	1	0.130	R
0.002	0.019	0.041		0.423	Sig. (2-tailed)

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

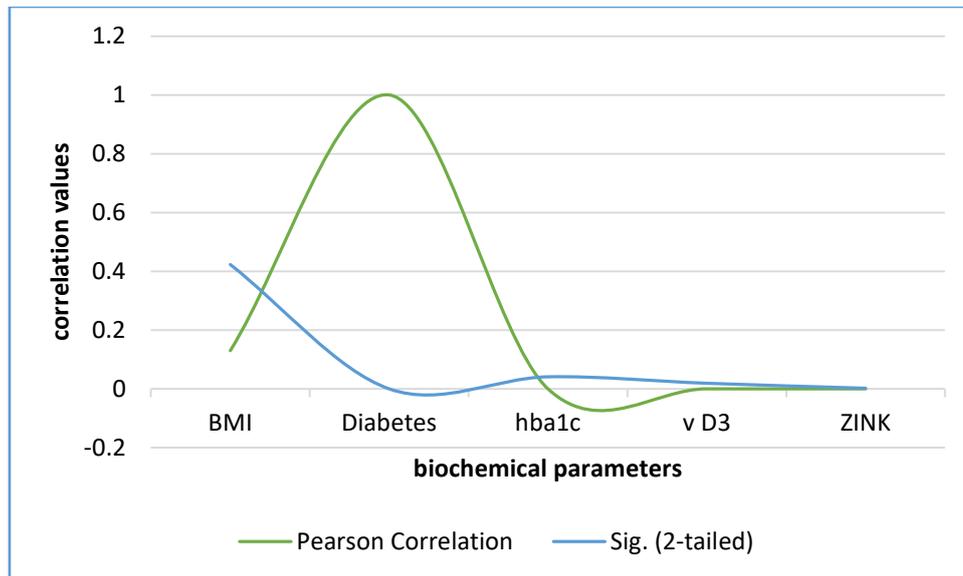


Figure (2): Association between Type 2 Diabetes and Some Biochemical Parameters changes

diabetes and zinc levels ( $r = -0.465$ ,  $p = 0.002$ ),  
 diabetes and Vitamin D3 levels ( $r = -0.369$ ,  $p = 0.019$ )  
 HbA1c, ( $r = 0.325$ ,  $p = 0.041$ ),

## 2-HBA1C

The study's findings demonstrated an immediate connection between HbA1c as well as diabetes, as well as a correlation alongside body mass index along with a negative connection between vitamin D and zinc. This indicates that patients with Type 2 diabetes and high HbA1c have lower vitamin intakes..

This indicates a moderate, statistically significant positive relationship. As BMI increases, HbA1c levels also tend to increase. Higher body weight or obesity is therefore associated with poorer glycemic control(table 4).

• HbA1c and diabetes status ( $r = 0.325$ ,  $p = 0.041$ ): This is a weak to moderate

significant positive correlation. Patients with type 2 diabetes tend to have higher HbA1c values. For the other biochemical parameters: • HbA1c and Vitamin D3 ( $r = -0.296$ ,  $p = 0.064$ ): There is a negative but non-significant correlation. This means patients with lower vitamin D levels may have higher HbA1c, but the association is not statistically significant. • HbA1c and Zinc ( $r = -0.205$ ,  $p = 0.205$ ): The correlation is weak negative and not significant, suggesting that zinc levels do not show a meaningful relationship with HbA1c in this sample.

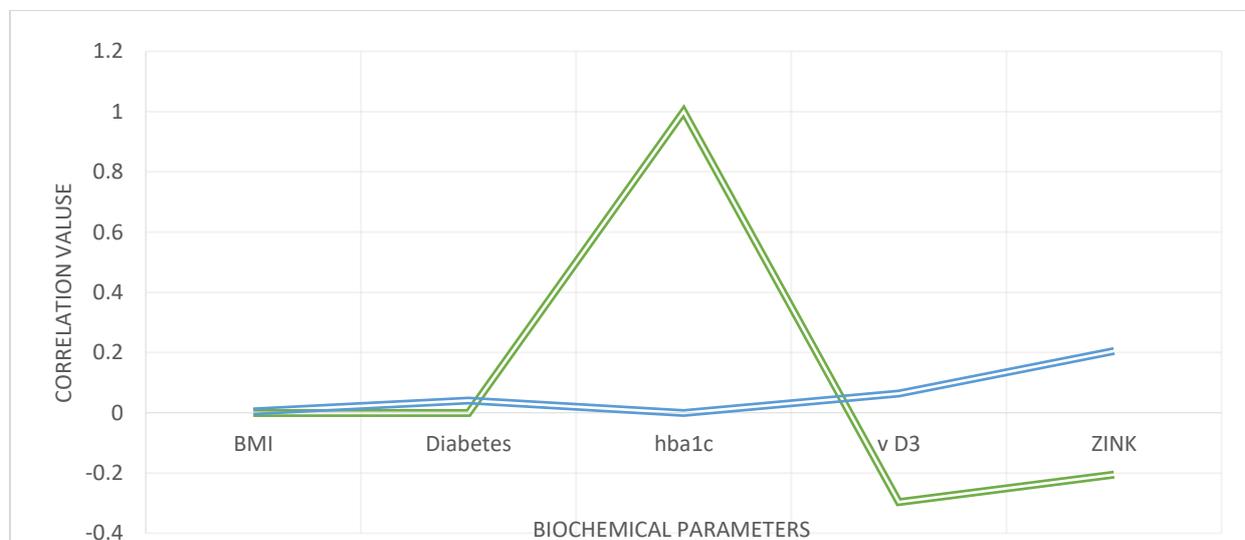
<b>Table (4):</b> Association between Hba1c in patients with Type 2 Diabetes and Some Biochemical Parameters changes						
ZINK	v D3	hba1c	Diabetes	BMI		
-0.205	-0.296	1	.325*	.433**	Pearson Correlation	hba1c
0.205	0.064		0.041	0.005	Sig. (2-tailed)	

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

The findings show that HbA1c has significant positive correlations with both BMI and diabetes status.

- HbA1c and BMI (r = 0.433, p = 0.005):



**figure (3):** Association between Hba1c in patients with Type 2 Diabetes and Some Biochemical Parameters changes

HbA1c and diabetes status (r = 0.325, p = 0.041)

HbA1c and Vitamin D3 (r = -0.296, p = 0.064)

HbA1c and Zinc (r = -0.205, p = 0.205)

The results show that Vitamin D3 has different levels of association with the studied biochemical parameters (table 5), but none of these correlations reach strong statistical significance, except one. • Vitamin D3 and Diabetes status ( $r = -0.369$ ,  $p = 0.019$ ): This is a moderate, statistically significant negative correlation. It means that patients with type 2 diabetes tend to have lower Vitamin D3 levels. Diabetes status is associated with a reduction in vitamin D concentration. • Vitamin D3 and HbA1c ( $r = -0.296$ ,  $p = 0.064$ ): This is a negative but non-significant correlation. Lower vitamin D levels may be linked to higher HbA1c (poorer glycemic control),

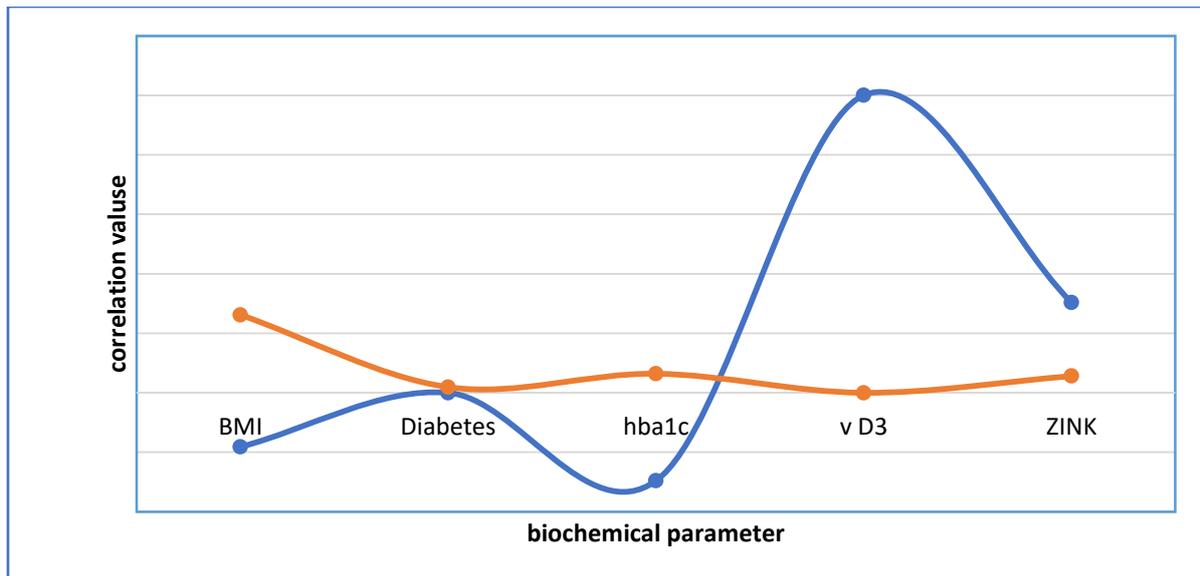
but this relationship is not statistically confirmed in your sample. • Vitamin D3 and BMI ( $r = -0.182$ ,  $p = 0.262$ ): This is a weak, non-significant negative correlation. It suggests that higher BMI may be associated with lower vitamin D, but the relationship is weak and not meaningful. Vitamin D3 and Zinc ( $r = 0.304$ ,  $p = 0.056$ ): This is a positive correlation, borderline significance. Higher vitamin D levels may be associated with higher zinc levels, but the p-value (0.056) indicates it is not statistically significant.

**Table (5):** relationship between vitamin D3 in patients with Type 2 Diabetes and Some Biochemical Parameters changes

ZINK	v D3	hba1c	Diabetes	BMI		
0.304	1	-0.296	-.369*	-0.182	Pearson Correlation	v D3
0.056		0.064	0.019	0.262	Sig. (2-tailed)	

\*\*Correlation is significant at the 0.01 level (2-tailed).

\*. Correlation is significant at the 0.05 level (2-tailed).



**figure (4):** relationship between vitamin D3 in patients with Type 2 Diabetes and Some Biochemical Parameters changes

Vitamin D3 and Diabetes status ( $r = -0.369$ ,  $p = 0.019$ )  
 Vitamin D3 and HbA1c ( $r = -0.296$ ,  $p = 0.064$ )  
 Vitamin D3 and BMI ( $r = -0.182$ ,  $p = 0.262$ )  
 Vitamin D3 and Zinc ( $r = 0.304$ ,  $p = 0.056$ )

BMI and Diabetes status ( $r = 0.130$ ,  $p = 0.423$ ) This is a very weak, non-significant positive correlation.

This means that BMI does not differ significantly between diabetic patients and the control group in your sample.

BMI and HbA1c ( $r = 0.433$ ,  $p = 0.005$ ) This is a moderate and statistically significant positive correlation.

As BMI increases, HbA1c levels also tend to increase.(table 6) This suggests that higher body weight is associated with

poorer glycemic control among the participants. BMI and Vitamin D3 ( $r = -0.182$ ,  $p = 0.262$ ) This is a weak, non-significant negative correlation. Lower Vitamin D3 levels may be seen in individuals with higher BMI, but the association is not statistically meaningful. BMI and Zinc ( $r = -0.048$ ,  $p = 0.771$ ) This is a very weak, non-significant negative correlation. There is no meaningful relationship between BMI and zinc levels in this sample.

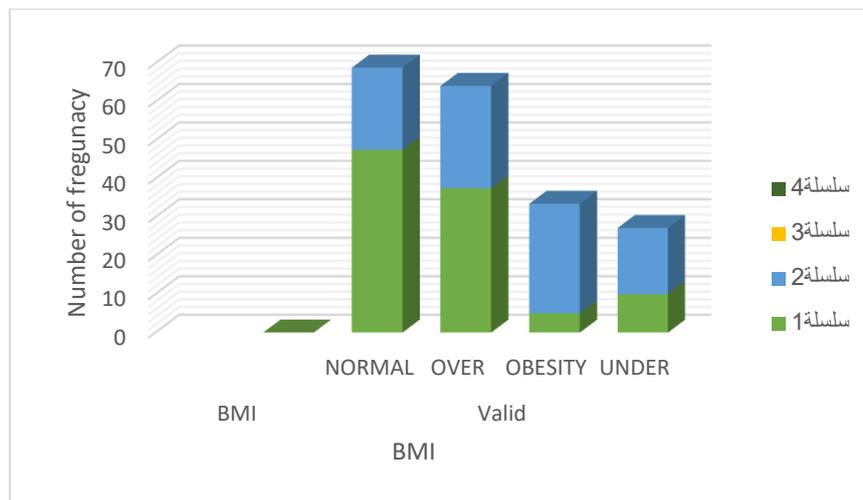


Figure (5): It is distribution of BMI in diabetes

**Table (6):** Correlation of BMI level between patients with Type 2 diabetes mellitus and control group

ZINK	v D3	hba1c	Diabetes	BMI		
-0.048	-0.182	.433**	0.130	1	Pearson Correlation	BMI
0.771	0.262	0.005	0.423		Sig. (2-tailed)	

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

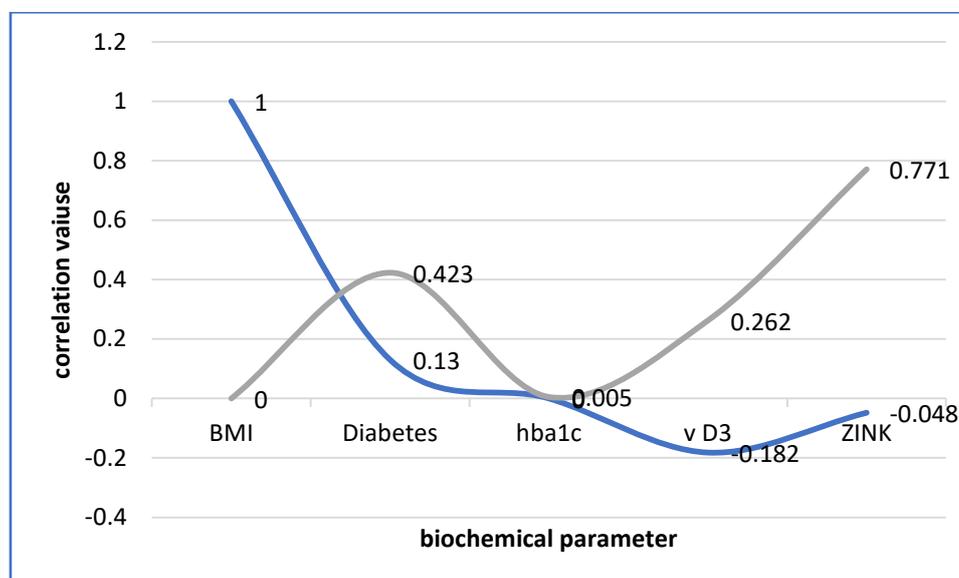


figure (6): Correlation of BMI level between patients with Type 2 diabetes mellitus and control group

BMI and Diabetes (r = 0.130, p = 0.423)
BMI and HbA1c (r = 0.433, p = 0.005)
BMI and Vitamin D3 (r = -0.182, p = 0.262)
BMI and Zinc (r = -0.048, p = 0.771)

The results of the study suggest that there may be a negative correlation between insulin resistance and the zinc vitamin. In addition to a direct link between sun exposure and the development of diabetes, individuals with diabetes type 2 generally seem to have zinc deficiencies. Additionally, studies indicate a negative

Zinc and BMI: Pearson correlation: -0.048  
Significance: 0.771

Interpretation: There is a very weak negative correlation between Zinc and BMI, but this relationship is not statistically significant (p > 0.05). This means that Zinc levels do not have a meaningful association with BMI in this sample. Zinc and Diabetes: Pearson correlation: -0.465 (\*\*)  
Significance: 0.002  
Interpretation: There is a moderate to strong negative correlation between Zinc and Diabetes, which is statistically significant (p < 0.05). This suggests that lower Zinc levels may be associated with higher diabetes severity or prevalence in patients with Type 2 Diabetes

Zinc and HbA1c: Pearson correlation: -0.205  
Significance: 0.205  
Interpretation:

correlation between body mass index and HbA1c. The table presents the Pearson correlation coefficients between Zinc (ZINK) and several variables in patients with Type 2 Diabetes, including BMI (Body Mass Index), Diabetes, HbA1c (glycated hemoglobin), Vitamin D3 (v D3), and Zinc (ZINK) itself.

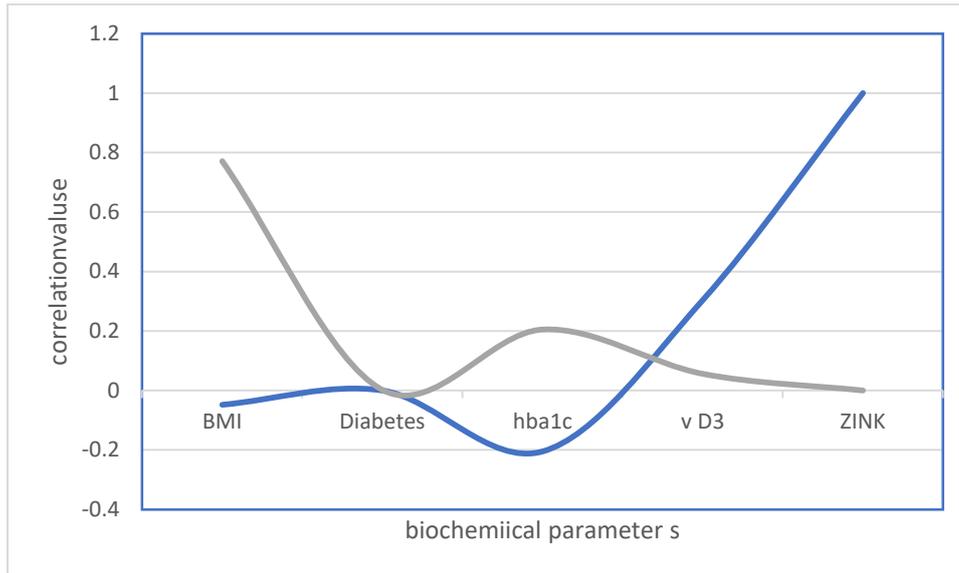
The correlation between Zinc and HbA1c is weak and not statistically significant (p > 0.05). This indicates that Zinc levels do not have a significant relationship with HbA1c levels, which is a marker of long-term blood glucose control. Zinc and Vitamin D3: Pearson correlation: 0.304  
Significance: 0.056  
Interpretation: There is a moderate positive correlation between Zinc and Vitamin D3, but the p-value is just above the typical significance threshold (0.05). While this suggests a potential positive relationship, it is not statistically significant, meaning that further research would be needed to confirm this link.

**Table (5):** Association between vitamin zinc in patients with Type 2 Diabetes and Some Biochemical Parameters changes

ZINK	v D3	hba1c	Diabetes	BMI		
1	0.304	-0.205	-.465**	-0.048	Pearson Correlation	ZINK
	0.056	0.205	0.002	0.771	Sig. (2-tailed)	

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).



**figure (7):**Relationship between vitamin zinc in patients with Type 2 Diabetes and Some Biochemical Parameters changes

Zinc and BMI: -0.048 Significance: 0.771

. Zinc and Diabetes: -0.465 (\*\*)Significance: 0.002

Zinc and HbA1c: -0.205 Significance: 0.205

Zinc and Vitamin D3: Pearson correlation: 0.304  
Significance: 0.056

### Discussion

Type 2 diabetes [DM] is a hazardous and long-term condition characterized by persistently elevated levels of glucose in the blood caused by inadequate production of insulin other the body's incapacity to utilize the insulin which is produced [33]. Diabetes problems were previously believed to be associated with increased production about free radicals or weakened antioxidant defenses. In individuals with type 2 diabetes, the present investigation found a strong positive connection among BMI and HbA1c values. In particular, a moderately positive link was shown by the correlation coefficient of Pearson analysis. Our investigation's finding of an association between BMI and HbA1c is consistent with many other research than

have looked into the connection among body weight and glycemic management. According according to a meta-analysis by Kodama et al. (2014), obesity worsens resistance to insulin, which in turn results in poorer glycemic management. The study found a strong correlation between greater BMI with higher HbA1c values throughout several generations.[10] In a similar vein, Guh et al. (2009) discovered that people who are overweight or obese are more likely to become insulin resistance, a condition therefore has been associated and elevated HbA1c levels.[11] The results we obtained are in line the results of several other research, especially when it comes to showing that patients who are obese have far worse control of their glucose levels than those who are

average in weight.[12] For instance, a cross-sectional investigation by Wildman et al. (2005) found that people with type 2 diabetes with greater body mass index (BMI) levels typically have raised HbA1c levels, supporting the theory that insulin resistance resulting from obesity leads to persistent high blood sugar levels. [13,14] Blüher et al. (2019), who highlighted which abdominal obesity particular serves an integral part for the development of insulin resistance and inadequate glycemic management, have further supported this.[15] Our research indicates HbA1c values are considerably higher among overweight patients than in people of average height and weight, whereas the obese category having the most elevated values. This research highlights the necessity for tiered weight management strategies that consider the level of obesity by indicating that blood sugar control gradually declines with rising BMI.[16] Furthermore, some research, including indicate conducted by Cohen et al. (2007), indicates that additional factors that cause confusion, including ages, plans for treatment, with the length of having diabetes, may have an impact on the association among BMI and HbA1c.[17] nevertheless, while concentrating on a comparatively homogenous population of patients having comparable disease durations and treatment patterns, the research we conducted took these factors into consideration. The reality that we identified a stronger, more direct connection between BMI and HbA1c compared to previous studies may be explained by such complicating component control. On the other hand, some research has revealed less correlations between BMI and HbA1c. For example, Buse et al. (2007) found that although BMI is a predictor of glycemic control, the association may be weaker in other groups, such as older adults or people with long-term diabetes.[18] These variances are probably due to differences

in study populations, sample sizes, and techniques, underscoring the need for more research to examine these intricate interactions among various patient groups. Numerous documented physiological processes can account for the significant relationship among BMI with HbA1c found in this study. A major factor with the emergence of resistance to insulin, which is a major cause of inadequate glucose control in type 2 diabetes, is obesity, especially overweight individuals. Obese people's higher free fatty acid, or FFA, values disrupt the signaling processes, especially in the liver and skeletal muscles, which results in greater production of glucose in the liver and impaired glucose absorption.[19] In order compensate for this decrease in tolerance to insulin, the cells in the pancreas must create greater amounts of insulin. However, as the resistance to insulin increases, it becomes more difficult to regulate high blood sugar, which raises HbA1c.[20]

Particularly, the tissue of the viscera is being found to be inflammation-promoting and active in metabolic processes, which contributes to widespread resistant to insulin.[18] Obese people's fatty tissue cells produce more inflammatory substances including interleukin-6 (IL-6) and tumor necrosis factor beta (TNF- $\alpha$ ), which disrupt the insulin receptor signalling therefore worsen diabetes.[19] Such persistent low-grade inflammation, sometimes referred to as "metabolic inflammatory disease," is a defining feature of obesity and a major contributor to glucose in type 2 diabetes.[20] Examining the relationship between T2DM and VDD has been the primary objective of the current study. With the present investigation, patients with type 2 diabetes had a lower amount of 1,25(OH)<sub>2</sub>D<sub>3</sub> than a control group, as well as there was a negative correlation between FBG and 1, 25(OH)<sub>2</sub> D<sub>3</sub> in the T2DM group. These findings suggest that 1,25(OH)<sub>2</sub> D<sub>3</sub> concentrations had an effect on glucose management in T2DM. Additionally, while

Type 2 diabetes patients as well as controls were studied collectively, an inverse connection among FBG and serum vitamin D concentrations was seen in the total population under investigation. The role of vitamin D and glucose management in type 2 diabetes seem to be connected.

From a statistically significant view, compared to the unaffected group, a greater proportion of people with type 2 diabetes exhibited vitamin D deficiency and inadequacy. (25.92) (70.38) (3.7) 43 33 9 85 (%) is what happens frequently 50.6 38.8 10.6 100 metabolism. Investigators are currently interested in the effects of sunlight on the additional skeleton.<sup>17</sup> The relationship between sunlight and immune function is hotly debated. This is being demonstrated that exposure to vitamin D increases immunity, and vitamin D deficiency is linked to a number of immune-mediated diseases, including T1DM, rheumatoid arthritis (RA), and multiple sclerosis (MS).<sup>18–21</sup> The relationship between vitamin D and metabolic syndrome and type 2 diabetes has lately been contested. The development of type 2 diabetes, the metabolic syndrome (MS), and the breakdown of carbohydrates have all been linked to vitamin D.<sup>[21, 22]</sup>

Within the present investigation, people with type 2 diabetes had a reduced amount of 1,25(OH)<sub>2</sub> D<sub>3</sub> than the control group. This is explained by the fact that vitamin D receptors were found in pancreatic beta cells, and these have been shown to produce the enzyme 1- $\alpha$ -hydroxylase.<sup>[24]</sup> The antioxidant vitamin D appears to regulate the production of insulin because it helps pancreatic  $\beta$ -cells secrete insulin.

[25] Because vitamin D increases the amount of insulin receptors, VDD may also be linked to IR in conjunction with decreased insulin production in T2DM

[28].<sup>[29]</sup> Based on the results obtained, it would be physiologically appropriate to suggest a vitamin D treatment in order to improve insulin management among people with type 2 diabetes.<sup>[30]</sup> Accordingly, patients with type 2 diabetes were given vitamin D.<sup>[31]</sup> The study's findings imply which insulin resistance and the zinc vitamin may be negatively correlated. Along with to a clear connection between sun exposure and the onset of disease, people with type 2 diabetes typically appear to have been zinc deficient. Furthermore, research shows that body mass index and HbA1c are negatively correlated. Zinc serves as a crucial trace element that is involved in the enzymatic degradation of glucose. Particles known as free radical are activated by metal and can be completely or partially generated by metal. A rise in the generation of reactive oxygen species may lead to type 2 diabetic <sup>[32]</sup>. Additionally, blood iron levels are thought to be linked to resistant to insulin causing diabetic <sup>[33], [34]</sup>. The results of the present investigation show that the categories of suffering had decreased zinc concentrations. Further studies found similar results. For example, <sup>[35]</sup> and <sup>[36]</sup> found that diabetic had lower amounts of zinc compared those in the control group.

## Conclusion

The study shows that Type 2 diabetes mellitus among patients in Kerbala is linked with meaningful alterations in multiple biochemical parameters. Poorer glycaemic control (higher fasting glucose and HbA1c) co-occurs with an adverse cardiometabolic profile .The biochemical parameters HbA1C, D3, ZINC have a strong association with the diagnosis of diabetes.

**Conflicts of Interest :**The authors declare no conflict of interes

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