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Vitamin D level in children with type 1 diabetes in Misrata, Libya

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A B S T R A C T

Vitamin D deficiency can contribute to the pathogenesis of many autoimmune diseases, including type 1 diabetes. Therefore, this study aimed to determine the relationship between vitamin D deficiency and type 1 diabetes and some factors related to it. The study was conducted on 100 children with diabetes and 40 non-diabetic children from the city of Misurata. Samples were collected by using a questionnaire over a period of 4 months. The study showed a significant relationship (P-value <0.05) between the level of vitamin D and patients with type 1 diabetes. The percentage of vitamin D deficiency in sick children was higher compared to healthy children (59%) (55%), respectively, and the percentage of vitamin D deficiency did not constitute and its relationship to age, gender, residential area, duration of exposure to the sunlight, and seasons of the year, showed statistical significance (P-value > 0.05), and the most age groups suffering from vitamin D deficiency were those between the ages of (11-16 years) in patients and healthy people, The rate of vitamin D deficiency was higher in females than in males. The percentage of vitamin D deficiency and taking supplements was statistically significant, and there was an inverse relationship between fasting blood sugar and vitamin D levels. The percentage of vitamin D deficiency duration of diabetes, and HbA1c did not constitute any statistical significance. This current study concluded that vitamin D deficiency is common in children, whether in patients or healthy people.

1. Introduction

Diabetes is a common chronic metabolic disease, resulting from hyperglycemia, which is caused by a defect in insulin secretion or insulin action or both or the amount secreted is large, as in some obese individuals (Liu et al., 2015). Type 1 diabetes mellitus (T1DM) occurs as a result of the inability of the beta cells in the pancreas to produce insulin of sufficient quantities or their complete cessation of producing insulin. It is considered one of the most dangerous types and occurs in childhood and at the beginning of adolescence (Cernea and Herold, 2010). It can occur due to nutritional, genetic and environmental factors or due to better economic and social status and urbanization (Al-Abadi and Al-Najafi, 2018).T1DM affects millions of children around the world annually, and is on the rise among young children

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and increasing in European, Eastern and Arab countries, and their incidence is expected to rise to 3% annually (Guariguata, 2011). High blood sugar levels above the normal range for a long period of time cause several chronic complications and serious developments, such as retinopathy, nephropathy, peripheral or central nervous diseases, and Charcot joints with severe gastrointestinal disorders (Cooke and Plotnick, 2008).

Vitamin D is a group of fat-soluble secosteroids that plays a major role in the metabolism of calcium and phosphorus (Adamczaket al., 2014), and it can be obtained from foods from animal sources, and from foods from plant sources (Dominguez et al., 2021). It is also produced by the skin when it is exposed to direct sunlight. When vitamin D enters the body, it is not in the active form and is called hydroxyvitamin. Ultraviolet B rays stimulate cortisone in the skin and the formation of raw vitamin D. The blood transports it to the liver to be activated into hydroxyvitamin D(DOH 25), and this compound has a direct effect on most of the body's cells that receive it and convert it into the active vitamin compound, and part of it is transported to the kidneys to be activated into 1_25 hydroxyvitamin (Bikle, 2014). One of its most important functions is that it enhances the function of beta cells in the pancreas through various mechanisms and enhances insulin secretion (Savastioet al., 2018). Its importance also lies in maintaining adequate levels of calcium in the blood, and it has a role in regulating inflammation and strengthening immunity (Shaker and Deftos, 2018).

Recent evidence indicates a role for vitamin D in the pathogenesis and prevention of diabetes (Veldmanet al., 2000). As vitamin D regulates both innate and acquired immunity, this indicates its potential role in preventing and treating T1DM (Ahmaeet al., 2019). Vitamin D deficiency may predispose individuals to type 1 and type 2 diabetes (Mathieu et al., 2005). Many studies have found that vitamin D is associated with blood glucose metabolism and insulin resistance, and several studies have reported a high prevalence of vitamin D deficiency in patients with T1DM, indicating that vitamin D deficiency is strongly associated with T1DM. (Mutluet al., 2011), however, other studies reported results contrary to this (Simpson et al., 2011).

In 2014, Wulandari and others studied the association of low levels of vitamin D with HbA1c levels in type 1 diabetics between the ages of 1 and 18 years. Their study showed that vitamin D levels were significantly lower than in healthy controls, and it also showed that vitamin D levels were associated with HbA1c. And another study conducted by Slavcheva et al in 2013 on vitamin D levels in children and adolescents with type 1 diabetes and in healthy controls in the Bulgarian population showed that there were no statistically significant differences between vitamin D levels in diabetic patients and healthy people. and average levels of vitamin D are higher from May to September than from October to April. and no association was found between glycemic control and vitamin D levels. It was concluded from a study conducted by Hassan et al in 2016, on the vitamin D status of Egyptian children and adolescents with type 1 diabetes, that most of the study group suffered from vitamin D deficiency, and there was no significant correlation between vitamin D in the blood and anthropometric measurements, duration of diabetes, average glycatedhemoglobin percentage, insulin dose, and exposure to sunlight. A study conducted by Al-Abadi and Al-Najafi in 2018, the aim of which was to evaluate the vitamin D status in children suffering from type 1 diabetes, and the results showed that vitamin D decreased significantly in cases of diabetes. and study conducted by TAŞKIN and others in 2020, the aim of which was to evaluate the vitamin D status of type 1 diabetes patients in childhood. The results showed that the vitamin D sufficiency rate was 34.9% and the deficiency rate was 42.9%, and vitamin D levels decreased significantly with age. Hence the aim of this study was to find out whether there is a relationship between vitamin D levels and type 1 diabetes (T1DM), to evaluate the levels Vitamin D in patients with type 1 diabetes (T1DM) and healthy people, and to identify some factors that may be related to vitamin D deficiency in a sample of children with and without diabetes in the city of Misurata.

2. Materials and Methods

2.1 Experiment design:

This study was conducted on 100 children with diabetes and 40 non-diabetic children from the city of Misurata. The samples were collected over a period of 4 months from October 17, 2022 to January 30, 2023. The participants were divided into 3 age groups, and the percentage of vitamin D in each group was calculated. The duration of infection with the disease (for diabetics) was also divided into 3 groups, and the HbA1c rate was divided into 3 levels. In addition, the participants were divided into three groups according to the level of vitamin D:

Less than 20 ng/mL represents vitamin D deficiency

From 21 ng/mL to 30 ng/mL represents vitamin D insufficiency

More than 30 ng/mL represents the normal level or vitamin D sufficiency.

2.2 Sample collection:

Samples were collected from patients and healthy people using a questionnaire to find out specific data such as age, gender, duration of diabetes, residential area, duration of exposure to sunlight, also taking vitamin D supplements, in addition, months in which the analysis was performed, fasting sugar, and blood hemoglobin (HbA1C).

2.3 Collecting blood samples:

Each blood sample was drawn using sterile syringes and transferred to an anticoagulant tube. HbA1c sample was drawn into an EDTA tube, while the fasting glucose sample was drawn into EDTA sodium fluoride. Both analyses were performed on a Mindray BS-430 device. Vitamin D analysis was performed by using a Cobas device.

2.4 Statistical program:

The data was analysed statistically using SPSS26, where descriptive statistics were used, including averages and graphs, and the Pearson correlation coefficient and the Chi-square test were used for the purpose of comparison between groups. The results were considered meaningful and statistically significant if (P- value <0.05).

3. Results

3.1 Vitamin D level in patients

The results of the study, as shown in Table (1), showed a significant relationship between the level of vitamin D and type 1 diabetes, P-value = 0.000.The percentage of vitamin D deficiency in patients was 59% higher than the percentage of deficiency and normal.

Table (1) Vitamin D level in patients

Vitamin D	number	Percentage	Test statistics	P-value
Deficiency	59	59%	34.16	0.000
Insufficiency	23	23%		
Sufficiency	18	18%		

3.2 Vitamin D level and some factors associated with it:

It was noted, as in Table (2), that there were no significant differences in the average level of vitamin D between sick and healthy children (P = 0.639), where the mean level of vitamin D was 16.22 + 23.78 ng/ml in healthy children, and 21.70 + 11.56 ng/ml. In the T1DM group. Of the 100 affected children, (59%) of the children suffered from vitamin D deficiency, (23%) of the children suffered from insufficiency, and (18%) had sufficient levels of vitamin D. Of the 40 unaffected children, (55%) of the children suffered from vitamin D deficiency, (20%) of the children suffered from insufficiency, and (25%) had sufficient levels of vitamin D.

We noted from Table 2 that there was an inverse correlation between fasting blood sugar and vitamin D levels, where the value of the relationship was equal to - 0.26 with a significant level of P-value = 0.008. As for HbA1c (glycatedhemoglobin) and vitamin D levels, there was no statistical relationship between them, P-value = 0.394. The results also showed that the percentage of deficiency in vitamin D levels was greater in sick children whose HbA1c was more than 9 and less in children those whose cumulative was less than 6.5 and 6.5-9 (64.5%), (50%) and (50%) respectiv

Table (2) Vitamin D level in the two groups of patients and healthy people, and vitamin D level and its relationship to cumulative and fasting blood sugar in patients.

Vitamin D				Mean	standard deviation	Correlation coefficient	P-value
	deficiency	insufficiency	Sufficiency				
group							
control	(55%) 22	(20%) 8	(25%) 10	23.78	16.22	-	0.639
Infected	(59%) 59	(23%) 23	(18%) 18	21.70	11.56		
HbA1c							
< 6.5	(50%)2	(0%)0	(50%)2	9.92	2.17	-0.086	0.394
6.5 -- 9	(50%)17	(38.2%)13	(11.8%)4				
> 9	(64.5%)40	(16.1%)10	(19.4%)12				
Fasting sugar				182.48	91.46	-0.263	0.008

The results of the current study, as shown in Table (3), showed that there were no significant differences [p-value = 0.08] depending on the distribution of the sample members according to age groups and vitamin D level, and that most of the age groups suffering from vitamin D deficiency were amongthe patients or healthy people whose ages were from (11-16 years) with a percentage of (64.2%) and 70.6%, respectively. The normal values of vitamin D among patients and healthy people were higher among the age groups from (1-5 years) with (30%) and (40%) respectively.

The results showed that in all samples whether in patients or healthy people, the percentage of vitamin D deficiency was greater in females compared to males, and the percentage of deficiency in sick males was greater than the percentage of deficiency in healthy males (56.9%) and (53.3%) respectively. The percentage of deficiency in sick females is greater than the percentage of deficiency in healthy females (61.2%) and (56%) respectively. These differences in vitamin D levels between patients and healthy males and females were not statistically significant (P=0.747).

The results also showed that sick children residing in rural areas have a slightly higher percentage of vitamin D deficiency than children residing in urban areas (59.6%) and (58.1%), respectively, while healthy children residing in urban areas have a slightly higher percentage of vitamin D deficiency more than children residing in rural areas (59.3%) and (46.2%), respectively, and the result did not constitute any statistical significance (p-value = 0.800).

Table (3) Vitamin D level and its relationship to age, gender, place of residence in patients and healthy people:

	Vitamin D			number (%)	p- value
	deficiency	insufficiency	sufficiency		
Age (patients)					0.08
5 -- 1	(40%) 4	(30%) 3	(30%) 3	(10%)10	
10 -- 6	(56.8%) 21	(27%) 10	(16.2%) 6	(37%)37	
16 -- 11	(64.2%) 34	(18.9%) 10	(17%)9	(53%)53	
Age (healthy)					
5 -- 1	(33.3%) 5	(26.7%) 4	(40%) 6	(37.5%)15	
10 -- 6	(62.5%) 5	(25%) 2	(12.5%) 1	(20%)8	
16 -- 11	(70.6%) 12	(11.8%) 2	(17.6%) 3	(42.5%)17	
Sex (Patients)					0.747
male	(56.9%) 29	(21.6%) 11	(21.6%) 11	(51%)51	
female	(61.2%) 30	(24.5%) 12	(14.3%) 7	(49%)49	
Sex (Healthy)					
male	(53.3%) 8	(20%) 3	(26.6%)4	(37.5%)15	
female	(56%)14	(20%) 5	(24%) 6	(62.5%)25	
Housing (patients)					0.800
urban areas	(58.1%) 25	(23.3%) 10	(18.6%) 8	(43%)43	
rural areas	(59.6%) 34	(22.8%) 13	(17.5%) 10	(57%)57	
Housing (healthy)					
urban areas	(59.3%) 16	(14.8%) 4	(25.9%) 7	(67.5%)27	
rural areas	(46.2%) 6	(30.8%) 4	(23%)3	(32.5%)13	

The results of the current study were shown in Table (4). There were significant differences (p-value = 0.001) between the intake of vitamin D supplements by sick children and healthy children and the level of vitamin D, as the percentage of deficiency was greater in patients and healthy children who did not take supplements (66.7%) ((100%), respectively. Compared to sick and healthy children, they take supplements (55.2%) (25%), respectively, and the percentage of vitamin D insufficiency for patients who do not take supplements is higher than healthy children (24.2%) (0%), respectively. And the results of the study showed that sick children who were exposed to the sunlight for less than 15 minutes had a higher rate of deficiency and insufficiency in vitamin D (69%) (26.2%), respectively, than the children who were exposed to the sunlight for more than 15 minutes and 30 minutes. Also, in healthy children, the percentage of deficiency in Children who were exposed to the sunlight for less than 15 minutes had more exposure (58.8%) than children who were exposed to more than 15 minutes, but these results did not constitute any statistical significance, p-value = 268.

Vitamin D levels showed seasonal variation in our results. For sick children who had a vitamin D test performed in autumn and winter, the percentage of vitamin D deficiency was greater (63.6%) (65.7%) respectively, while healthy children had a higher percentage of vitamin D deficiency. More in the autumn and summer (62.5%) and (60%) respectively. Also, the percentage of vitamin D insufficiency, whether in patients or healthy people was higher in spring (30.8%) (27.3%), and this result did not constitute any significance. Statistical p-value=0.548.

Table (4) Vitamin D level and its relationship to taking vitamin D supplements, duration of exposure to the sunlight, seasons of the year in patients and healthy people

	Vitamin D			number (%)	p- value
	deficiency	deficiency	deficiency		
Vitamin D supplements (Patients)					
No	(%66.7) 22	(%24.2) 8	(%9.0) 3	(%33)33	0.001
Yes	(%55.2) 37	(%22.4) 15	(%22.4) 15	(%67)67	
Vitamin D supplements (Healthy)					
No	(%100) 16	(%0) 0	(%0) 0	(%40)16	
Yes	(%25) 6	(%33.3) 8	(%41.6) 10	(%60)24	
sunlight exposure (patients)					
<15 minutes	(%69) 29	(%26.2) 11	(%4.76)2	(%42)42	
>15 minutes	(%55.6) 10	(%16.7) 3	(%27.7)5	(%18)18	
>30 minutes	(%50) 20	(%22.5) 9	(%27.5)11	(%40)40	
sunlight exposure (healthy)					0.268
<15 minutes	(%58.8) 20	(%17.6) 6	(%23.5) 8	(%85)34	
>15 minutes	(%33.3) 2	(%33.3) 2	(%33.3) 2	(%15)6	
>30 minutes	(%0)0	(%0)0	(%0)0	(%0)0	
seasons (Patients)					
autumn	(%63.6) 21	(%18.2) 6	(%18.1)6	(%42)33	
winter	(%65.7) 23	(%25.7) 9	(%8.6) 3	(%18)35	
spring	(%38.5) 5	(%30.8) 4	(%30.7)4	(%40)13	
summer	(%52.6) 10	(%21.1) 4	(%26.3) 5	(%19)19	
seasons (Healthy)					0.548
autumn	(%62.5) 5	(%12.5) 1	(%25) 2	(%20)8	
winter	(%56.2) 9	(%18.8) 3	(%25) 4	(%40)16	
spring	(%45.5) 5	(%27.3) 3	(%27.3) 3	(%27.5)11	
summer	(%60) 3	(%20) 1	(%20) 1	(%12.5)5	

The results as shown in Table (5), showed that there is no relationship between the duration of diabetes and the level of vitamin D (p value = 0.972), and that the percentage of deficiency in the level of vitamin D in sick children is greater in children whose duration of diabetes was less than a year than in children whose duration of diabetes was for more than one year and more than 5 years (65%), (58.7%) and (55.9%) respectively

Table (5) Vitamin D level and its relationship to the duration of diabetes in patients:

Duration (infection)	Vitamin D				p- value
	deficiency	insufficiency	Sufficiency		
less than one year	(%65)13	(%20)4	(%15)3	(%20)20	0.972
5 - 1 years	(%58.7)27	(%23.9)11	(%17.4)8	(%46)46	
More than 5 years	(%55.9)19	(%23.5)8	(%20.6)7	(%34)34	

1 Discussion

Vitamin D deficiency and diabetes are two common conditions that receive great attention and are widespread. This research studied the level of vitamin D and focused on its deficiency in children with type 1 diabetes and in healthy children in the city of Misrata (Libya). Through the results we obtained, there was a significant relationship between the level of vitamin D and type 1 diabetes, and the percentage of vitamin D deficiency in patients was higher compared to insufficiency and normal. Vitamin D deficiency is common among both healthy and sick children, even though the study area is considered a relatively hot region. However, there were no significant differences in the level of vitamin D between the sick group and the healthy group, which was similar to the results of several other previous studies, such as (Rasoul et al .,2016;Greer et al., 2012),while it differed with studies that showed a significant difference in vitamin D levels between a sample of diabetic patients and healthy people, such as (Wulandar et al., 2014;Ahmad et al., 2019).

The present study's results reveal that (59%) and (55%) of sick and healthy children respectively, suffered from vitamin D deficiency. This percentage varied from one study to another, as vitamin D deficiency was found in 66.7% of Saudi T1DM patients compared to 41.7% of the control group (AL Daghri et al., 2014), and a study by (Al-Ghazal et al., 2018) found that the percentage of vitamin D deficiency was 72%, and in healthy people all samples were normal, while it was 58% in patients compared to 32% in healthy children in a study by(Borkar et al., 2010). 84% of infected Kuwaiti children suffered from vitamin D deficiency compared to 77% of unaffected children (Rasoul et al., 2016).

Differences in studies related to vitamin D deficiency can be explained by differences in the study area, stages of diagnosis, sample size, and may be due to differences in age, lighting, body mass index, diet, and physical activity, or in differences in skin colour, or genetic predisposition (Liu et al., 2015), it may also be explained by the fact that variation in vitamin D levels is associated with the occurrence of lunch malabsorption among patients (Svoren et al., 2009).

The results of this study showed an inverse correlation between fasting glucose and vitamin D levels. This is consistent with the study of (Alqudsi et al., 2019), which revealed a negative correlation between fasting glucose values and vitamin D levels in T1DM, and it did not agree with the study by (Al-Ghazal et al., 2018). There is no relationship between vitamin D and fasting blood sugar.

It became clear through the results of this study that the greater vitamin D deficiency, the higher the HbA1c level (a direct relationship) is, but the result was not statistically significant. This is consistent with many studies, such as (Alian et al., 2015;Carakushansky et al., 2020), while it contradicts the studies that showed an inverse correlation between vitamin D levels and HbA1c, such as (Savastio et al., 2018;Alasbil et al., 2024(.This connection between glycatedhemoglobin and vitamin D may occur due to the effect of vitamin D on insulin production from beta cells and their actions (Liu et al., 2015).The vitamin D receptor located in pancreatic B cells may play a role in insulin production and secretion, which may affect to control blood sugar levels in children (Wulandari et al, 2014).

According to the results obtained, it was found that the age group that suffers most from vitamin D deficiency is those between the ages of (11-16 years). The reason may be that this age period is a period of puberty and the body needs large amounts of vitamin D to meet the needs of growth and bone formation. This result is supported by several studies, including (Kafeshani et al., 2016; Novoa-Medina et al., 2023), which showed that increasing age is inversely related to vitamin D deficiency. In addition, there was no statistical significance for vitamin D deficiency between the sexes, and this result agreed with a study by(Carakushansky et al., 2020), and did not agree with a study conducted in Sweden, which showed significant differences in vitamin D levels between males and females (Littorin et al., 2006). This study showed that vitamin D deficiency was more prevalent in females than males, and this result was consistent with TAŞKIN and his group in 2020 and EL-ASHEER and his group in 2023 , but did not agree with (Littorin et al., 2006), who showed lower levels of vitamin D in males compared to females. The higher level of the vitamin in males can be explained by frequent exposure to sunlight. The deficiency in females may be due to a faster growth spurt during puberty and a greater need for vitamin D in bones, in addition to religious reasons, as females wear clothes that do not reveal the skin, which prevents the sunlight from reaching the skin (Razzaghy-Azar and Shakiba, 2010).

Sick children residing in rural areas had a slightly greater percentage of vitamin D deficiency than children residing in urban areas, while healthy children residing in urban areas had a higher rate of vitamin D deficiency than children residing in rural areas. This result was similar to another study that showed no guarantee for people who live in areas that easily reach the sunshine to avoid vitamin D deficiency (Gomez-Meade et al., 2016),), and a study by Zabeen et al. in 2021 and El-Asheer et al. in 2023 showed that patients from urban areas are more likely to have vitamin D deficiency than those from rural areas. Air pollution and limited outdoor activity may be responsible for this outcome in urban residents (Agarwal et al., 2002).

Several studies have suggested a relationship between vitamin D deficiency and TIDM risk and suggested that vitamin D supplementation can reduce the incidence of T1DM (Stene and Joner 2003). But our results showed significant differences between the group of patients and healthy controls who do not take vitamin D supplements compared to those who do. There are many similar studies, such as (Tunc et al., 2011) and (Ardestani et al., 2010), which showed that taking supplements has significant effects on vitamin D in the blood serum of children. Dietary vitamin D intake can be an important contributor to vitamin D status, but the study by (Ataie-Jafar et al., 2012) found no association between taking vitamin D supplements and vitamin D levels. These differences may be partly explained by differences in the food components used to estimate dietary intake, and differences in age groups (Ataie-Jafari et al., 2012).

The duration of exposure to the sunlight was also an essential factor in measuring the severity of the deficiency. The group of patients and controls exposed to the sunlight for less than 15 minutes was the most detrimental to vitamin D deficiency, but the results were not statistically significant. Our results agreed with (Hashemipur et al., 2004), which did not find statistically significant relationships between vitamin D and the duration of exposure to sunlight, and a significant relationship was found in some studies that showed important relationships between various measures of self-exposure to the sunlight and levels of vitamin D in the blood, such as the study by (Ardestani et al., 2010). The different results can be partly explained by the duration of exposure to different degrees of sunlight, different age groups, and different areas of the study. It can also be explained by the colour of the skin and the type of clothing during exposure to light (Ataie-Jafari et al., 2012).

The results of this study, which showed fluctuations from month to month in vitamin D levels, despite a lower concentration of vitamin D in winter and fall, agreed with a study by (Novoa-Medina et al., 2023), which showed seasonal variation with lower levels of vitamin D in winter compared to In the summer. A high prevalence of vitamin D deficiency was noted in our study, even during the summer, which agreed with a study by(Janner et al., 2010). The reason for this variation in the percentage of vitamin D and the seasons of the year may be due to the lack of vitamin D supplements in many foods. Also, outdoor activities may play a major role in vitamin D deficiency (Janner et al., 2010)

The duration of diabetes and vitamin D deficiency did not have any statistical significance in our study. Children with diabetes for less than a year had a greater percentage of vitamin D deficiency. This percentage decreased as the time of infection increased. The reason for this may be that those with diabetes for more than a year were given supplements for vitamin D, and therefore their vitamin D levels were higher. This result was similar to studies that showed that the duration of diabetes was not related to vitamin D deficiency, as the study by (Gomez-Meade et al., 2016;Zabeenet al., 2021), and other studies reported that patients with vitamin D deficiency have a significantly longer duration of diabetes, as in the study by(Haleem ,2019) and (Vojtkovet al., 2012).

The role of vitamin D in regulating diabetes is unclear, but many studies have shown that the vitamin can play a role in the prevention and development of type 1 diabetes. Therefore, understanding the nature of low vitamin D levels in children with T1DM is important because it may clarify the mechanisms of immune destruction of ß- cells, and may lead to interventions to prevent or delay insulin dependence using vitamin D or its analogues (Bin Abbet al., 2011).

1 Conclusions

1- There is a significant relationship between the level of vitamin D and type 1 diabetes, and there are no significant differences in the average amount of vitamin D between patients and healthy people. The level of vitamin D, age, gender, residential area, duration of exposure to the sunlight, and seasons of the year did not constitute any statistical significance, while the level of vitamin D and taking vitamin D supplements were statistically significant.The percentage of deficiency in children who did not take supplements was greater than in children who took vitamin D supplements.

2- The level of vitamin D, the duration of diabetes, and the HbA1c did not constitute any statistical significance. The percentage of deficiency was greater in children whose HbA1c was more than 9, while the levels of vitamin D and fasting blood sugar formed an inverse correlation.

Recommendations:

1- Focus on the importance of eating foods that contain vitamin D, and exposure to sunlight for their important role in the process of absorbing vitamin D, conducting educational seminars for parents about the dangers of vitamin D deficiency, encouraging parents of children with diabetes to constantly monitor vitamin D levels, and calling endocrinologists to regularly examine their patients who suffer from type 1 diabetes in search of vitamin D deficiency or insufficiency.

2- Conducting studies that include a larger number of patients with diabetes and the effect of taking vitamin D supplements on the level of hemoglobin sugar in the blood.

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