

Vitamin D Level in Non-Diabetic and Type II Diabetic Patients KFU Health Center: A Cross Sectional Study

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ABSTRACT

Background: Widespread vitamin D deficiency all over the world has been documented by many previous studies including recent studies in KSA which revealed incidence reaching up to 100%. Also, number of people with diabetes mellitus is increasing (7% of the world's population in 2011, elevated to 9% in 2014). This number is expected to exceed 435 million by 2030. Compared to other areas of the world, diabetes prevalence was highest in Saudi Arabia (20.22%). In 2015, there were 3.4 million cases of diabetes in Saudi Arabia. Many studies showed high association between vitamin D deficiency and increased incidence of diabetes.

Aim of the work: This study is planned to assess the incidence of vitamin D deficiency in non-diabetic and type II diabetic patients in KFU health center in Al-Ahsa region.

Methods: Our study is a cross-sectional study done on 860 patients' data including plasma 25-hydroxy vitamin D3, fasting blood glucose and HbA1c levels.

Results: Our results showed that 89.53% of the patients have vitamin D level below normal. There was higher incidence of vitamin D deficiency in females (81.67%) than in males (65.27%). The incidence of vitamin D deficiency was greater in Saudi (82.19%) than non-Saudi (68.40%) and in diabetics (89.68%) than non-diabetics (76.12%) patients. Within each group, the incidence of vitamin D deficiency was higher in females than in males. Incidence of vitamin D deficiency was highest in the 21 – 40 years group (86.19%) and lowest in the 1 – 20 years group (66.1%). The results showed inverse relationship between vitamin D level and both fasting blood glucose and HbA1c. The mean fasting glucose was higher in the deficiency group (165.55) as compared to the insufficiency group (118.67). Also, the mean HbA1c was higher in deficiency group (8.06) as compared to the insufficiency group (7.23).

Conclusions: There is high incidence of vitamin D deficiency among KFU health center patients. Vitamin D level was inversely proportional to the level of fasting glucose and HbA1c. This is an evidence of the vitamin D role on glucose tolerance in diabetic patients.

Keywords: Vitamin D, Diabetes type II, non-diabetic, KFU health center.

INTRODUCTION

Diabetes mellitus (DM) is a syndrome of chronic hyperglycemia due to relative insulin deficiency, insulin resistance or both⁽¹⁾. In 2011, the International Diabetes Federation estimated the number of people with diabetes worldwide to be nearly 285 million, or 7% of the world's population elevated to 9% of the world's population in 2014. This number is expected to exceed 435 million by 2030⁽²⁾.

Vitamin D is a group of steroid hormones which are mainly formed in the skin under the effect of sun ultraviolet B rays and then modified in the liver and kidneys to produce the active form (1, 25-dihydroxy vitamin D3). It is also present in food as Vitamin D3 (animal source) and Vitamin D2 (plant source)⁽³⁾.

The active form of vitamin D functions by binding to intracellular vitamin D receptors (VDR) which modulate gene expression. It is now known that every cell within the body has a VDR. VDRs are also present in pancreatic β -cells and vitamin D is essential for normal insulin secretion⁽⁴⁾. Islet cell insulin secretion is reduced in vitamin D-deficient

animals and can be corrected by vitamin D supplementation⁽⁴⁻⁶⁾.

It is well known that obesity and sedentary life style predispose to diabetes⁽⁷⁻⁹⁾.

Meta- analysis of 21 prospective studies showed an inverse and significant association between circulating 25(OH) D levels and risk of type 2 diabetes. Higher 25(OH) D blood levels were always associated with a lower diabetes risk. Each 4 ng/ml increment in 25(OH) D levels was associated with a 4% lower risk of type 2 diabetes. Other studies provided prospective evidence that low levels of vitamin D also predict hyperinsulinemia. It has been suggested that vitamin D may act to prevent type 2 diabetes by decreasing insulin resistance. Moreover, Dalgård et al. reported an inverse association between HbA1c and 25(OH) D3 in the elderly and concluded that a high vitamin D status protects against type 2 diabetes in younger subjects to subjects older than 70 years⁽¹⁰⁾.

The National Health and Nutrition Examination Survey (NHANES) III study between 1988 and 1994 demonstrated a strong inverse association between low levels of 25(OH) D and

diabetes prevalence. Low vitamin D levels have also been shown to be predictive of the future development of type 2 diabetes.

It has been concluded that low vitamin D levels may play a significant role in the pathogenesis of type 2 diabetes. The NHANES group (2003–2006) evaluated 9,773 U.S. adults > 18 years of age and showed a strong link between serum vitamin D levels, glucose homeostasis, and the evolution of diabetes. Kositsawat et al. concluded that patients with elevated hemoglobin A1c levels should be evaluated for vitamin D insufficiency⁽¹²⁾.

Kumar et al. reported positive effect of vitamin D on beta-cell function and glucose tolerance⁽¹³⁾. Haroon et al. suggested that vitamin D supplementation had a positive impact on glycemic control and metabolic parameters such as insulin resistance and beta cell dysfunction⁽¹⁴⁾.

An observational study from the Nurses' Health Study that included 83,779 women more than 20 years of age found an increased risk of type 2 diabetes in those with low vitamin D status. A combined daily intake of > 800 IU of vitamin D and 1,000 mg of calcium reduced the risk of type 2 diabetes by 33%. Other study showed that increasing vitamin D serum levels to normal led to a 55% relative reduction in the risk of developing type 2 diabetes. Islet cell insulin secretion is reduced in vitamin D deficient animals and can be corrected by vitamin D supplementation^(4,5,6).

EURODIAB, the first case-control study on this topic, showed a reduced risk of developing type 1 diabetes by vitamin D supplementation during the first year of life (EURODIAB)⁽¹⁵⁾.

In 2013, Global diabetes Scorecard revealed that Diabetes Raw prevalence all over the world ranges from 1.55% - 20.22%. It was highest in Saudi Arabia (20.22%). In 2015, there were 3.4 million cases of diabetes in Saudi Arabia. The Diabetes prevalence in Saudi Arabia is higher than that calculated for the region (MENA) and for the world in all age groups. Moreover, there is high incidence of vitamin D deficiency in Saudi medical students (Bin Saeed)⁽¹⁶⁾. Al-Elq reported very high incidence of Vitamin D deficiency among males (92.64%) and females (99.03%) medical Saudi students⁽¹⁷⁾. In a recent study on pregnant Saudi women, Al-Faris reported Vitamin D deficiency in 50% and insufficiency in 43.8% of the study sample (total 93.8% have level lower than normal)⁽¹⁸⁾.

This study was conducted to assess the incidence of vitamin D deficiency in non-diabetic and type II diabetic patients in KFU health center in Al-Ahsa region. Also to assess the relationship between vitamin D and glucose tolerance indicators (fasting blood glucose and hemoglobin A1c).

METHODS

1. Research design:

Our study is a cross-sectional study done on KFU health center patients data. The study was conducted during the period from January to April 2016.

2. Procedure:

In our research, we collected the patients' data from the KFU health center, after permission from college of medicine higher authorities and KFU polyclinic administration. We collected patients' data including gender, age, nationality and blood analysis (vitamin D, fasting glucose and HbA1c levels).

3. Research population:

All patients having vitamin D measurement were included in our study. Data of 860 patient (167 male and 693 female) were collected. These patients were classified into subgroups according to fasting glucose and HbA1c levels into non-diabetics and diabetics. Each subgroup is subdivided according to nationality (Saudi and non-Saudi) and gender (males and females). The study was approved by the Ethics Board of Al-Azhar University.

4. Materials:

In the KFU health center, vitamin D level (ng/ml) was measured by vitros 350 chemistry analyzer. The fasting blood glucose was measured by reflotron plus chemistry analyzer. The Hb1ac (mg/dl) was measured by clover A1c analyzer.

5. Statistical analyses:

The data were analyzed by using SPSS program version 21.

RESULTS

Our results showed that 770 (89.53%) patients have vitamin D level below normal {675 (78.49%) have vitamin D deficiency, 95 (11.05%) have vitamin D insufficiency} and 90 patient (10.47%) have normal vitamin D levels. 91.63% of the females and 80.84 of males had abnormal Vitamin D level. There was higher incidence of vitamin D deficiency in females (81.67%) than in males (65.27%) (Table1, Figure 1). The incidence of abnormal vitamin D (below normal level) and vitamin D deficiency was greater in Saudi (91.41 and 82.19%) than non-Saudi (84.42% and 68.40%)

patients and the normal level was higher in non-Saudi (15.58%) than Saudi patients (8.59%). Within each nationality, the incidence of abnormal vitamin D level and vitamin D deficiency was higher in females than in males (Table 2 – Figure 2).

The incidence of abnormal vitamin D and vitamin D deficiency was greater in diabetics (87.27 and 76.12%) than non-diabetics (97.62% and 89.68%) patients and the normal level was higher in non-diabetic (12.73%) than diabetic patients (2.38%). Within each group, the incidence of abnormal vitamin D level and vitamin D deficiency was higher in females than in males (table 3 – Figure 3).

According to age, incidence of vitamin D deficiency was highest in the age group from 21 –

40 years (86.19%) and lowest in the group from 1 – 20 years (66.1%) – (Table 4 – Figure 4).

Table 5 shows the distribution of different vitamin D in all subgroups (each is classified by gender, nationality and presence or absence of diabetes).

The results showed inverse relationship between vitamin D levels with the fasting blood glucose and HbA1c levels. The mean fasting blood was higher in the deficiency group (165.55) as compared to the insufficiency group (118.67). Also, the mean HbA1c was higher in deficiency group (8.06) as compared to the insufficiency group (7.23) - (Table 6 and fig.6 a and b).

Table (1): Distribution of different vitamin D levels (normal, insufficiency and deficiency) in males and females patients.

Vitamin D levels	Male		female		Total	
	No	%	No	%	No	%
Normal	32	19.16	58	8.37	90	10.47
Abnormal	135	80.84	635	91.63	770	89.53
Insufficiency	26	15.57	69	9.96	95	11.05
Deficiency	109	65.27	566	81.67	675	78.49
Total	167	100.00	693	100.00	860	100.00

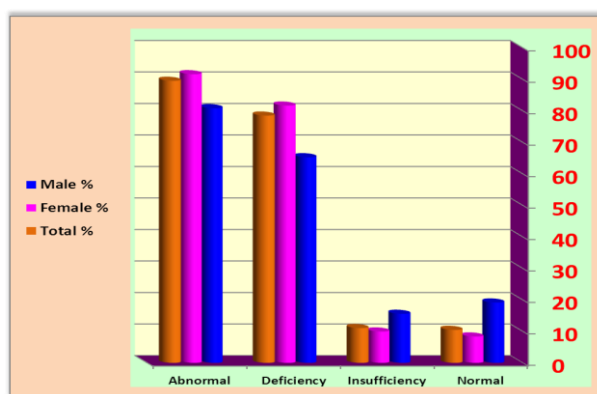


Figure (1): Distribution of different vitamin D levels (normal, insufficiency and deficiency) in males and females patients. The incidence of vitamin D deficiency is higher in females than males.

Table (2): Distribution of vitamin D levels in Saudi and Non-Saudi.

Vitamin D levels	Saudi						Non-Saudi					
	Male		Female		Total		Male		Female		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
Normal	18	16.67	36	6.91	54	8.59	14	23.73	22	12.79	36	15.58
Abnormal	90	83.34	485	93.09	575	91.41	45	76.27	150	87.21	195	84.42
Insufficiency	13	12.04	45	8.64	58	9.22	13	22.03	24	13.95	37	16.02
Deficiency	77	71.30	440	84.45	517	82.19	32	54.24	126	73.26	158	68.40
Total	108	100.00	521	100.00	629	100.00	59	100.00	172	100.00	231	100.00

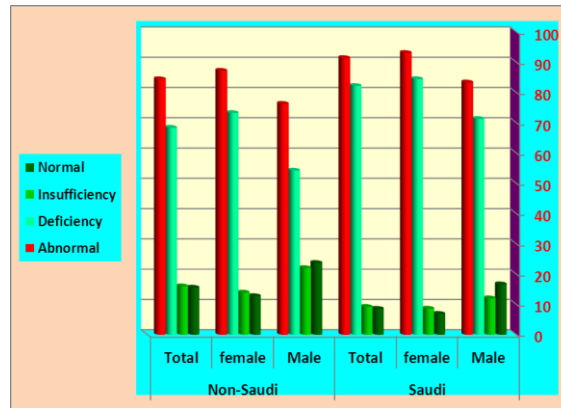


Figure (2): Distribution of vitamin D levels in Saudi and Non-Saudi males, females and total percentages. The incidence of vitamin D deficiency is higher in the Saudi than non-Saudi. The deficiency is highest in Saudi females followed by non-Saudi females, Saudi males and non-Saudi males.

Table (3): Distribution of vitamin D levels in non-diabetics and diabetic patients.

Vitamin D levels	Non- diabetics						Diabetics					
	Male		Female		Total		Male		female		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
Normal	41	25.79	56	9.29	97	12.73	1	5.56	2	1.85	3	2.38
Abnormal	118	74.21	547	90.71	665	87.27	17	94.44	106	98.15	123	97.62
Insufficiency	24	15.09	61	10.12	85	11.15	2	11.11	8	7.41	10	7.94
Deficiency	94	59.12	486	80.60	580	76.12	15	83.33	98	90.74	113	89.68
Total	159	100.00	603	100.00	762	100.00	18	100.00	108	100.00	126	100.00

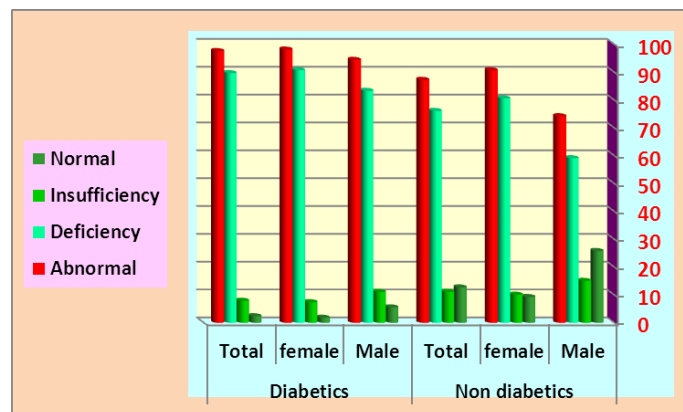


Figure (3): Distribution of vitamin D levels in non-diabetics and diabetics males, females and total percentages. The incidence of vitamin D deficiency is higher in the diabetics than non-diabetics. The deficiency is highest in diabetic females followed by diabetic females, non-diabetic females and non-diabetic males.

Table (4): Distribution of vitamin D levels according to age subgroups.

Age in years	1-20		21-40		>41		Total	
Vitamin D levels	No.	%	No.	%	No.	%	No.	%
Normal	53	18.15	18	5.41	19	8.09	90	10.47
Abnormal	239	81.85	315	94.59	216	91.91	770	89.53
Insufficiency	46	15.75	28	8.41	21	8.94	95	11.05
Deficiency	193	66.1	287	86.19	195	82.98	675	78.49
Total	292	100.00	333	100.00	235	100.00	860	100.00

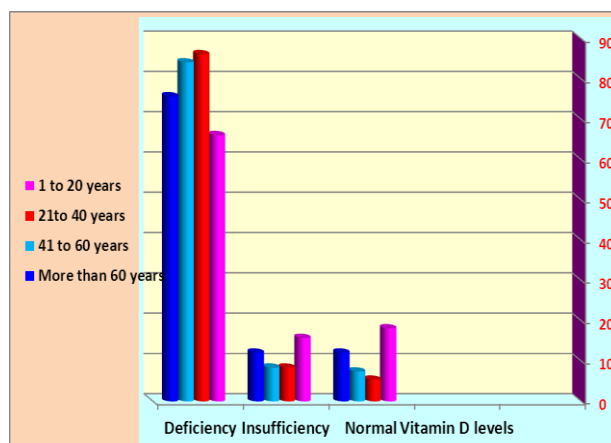


Figure (4): Distribution of vitamin D levels according to age subgroups (1 – 20, 21 – 40, > 40 years) arranged from right to left. The deficiency is highest in 21 – 40 age group followed by 41 – 60, > 60 and lowest in 1 – 20 age group.

Table (4): Distribution of vitamin D levels according to age subgroups. The deficiency is highest in 21 – 40 age group followed by 41 – 60, > 60 and lowest in 1 – 20 age group.

Age in years	1 to 20 years	21 to 40 years	41 to 60 years	More than 60 years
Normal %	18.15	5.41	7.43	12.12
Insufficiency%	15.75	8.40	8.41	12.12
Deficiency%	66.10	86.19	84.16	75.76
Abnormal%	81.85	94.59	92.57	87.88

Table (5): Distribution of vitamin D levels in all subgroups classified by gender, nationality and presence or absence of diabetes.

Vitamin D level	Non- diabetic								Diabetic							
	Saudi				Non- Saudi				Saudi				Non- Saudi			
	Male		Female		male		female		Male		female		male		female	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Normal	17	18.28	35	7.94	14	25.00	21	14.58	1	6.67	1	1.25	0	0	1	3.57
Insufficient	11	11.83	38	8.62	13	23.21	23	15.97	2	13.33	7	8.75	0	0	1	3.57
Deficient	65	69.89	368	83.45	29	51.79	100	69.44	12	80	72	90	3	100	26	92.86
Total	93	100	441	100	56	100	144	100	15	100	80	100	3	100	28	100

Table (6): Correlation between FBG (a) and HbA1c (b) levels in vitamin D deficient and insufficient diabetic patients. There is inverse proportion between vitamin D level and FBG & HbA1c levels.

Vitamin D levels	FBG level	HbA1c level
Insufficiency%	165.55	8.06
Deficiency%	118.67	7.23

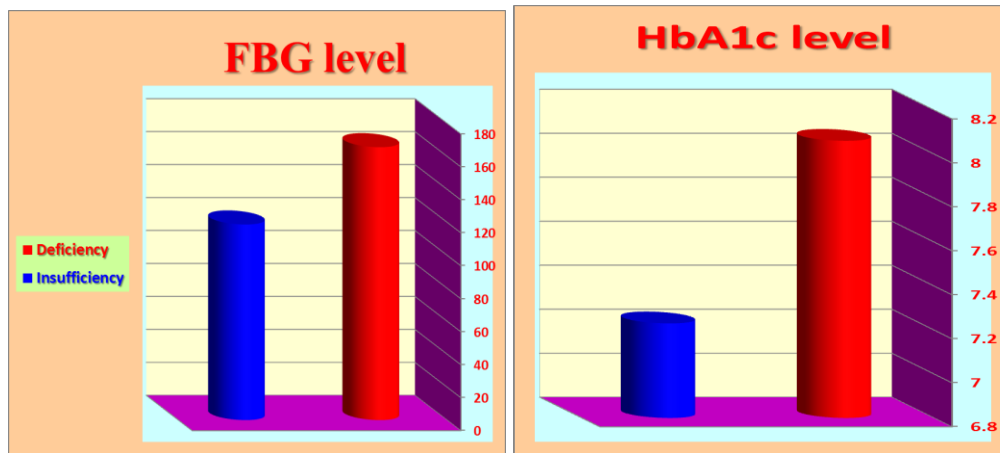


Figure (5): Correlation between FBG (a) and HbA1c (b) levels in vitamin D deficient and insufficient diabetic patients. There is inverse proportion between vitamin D level and FBG & HbA1c levels.

DISCUSSION

Our study revealed very high incidence of vitamin D deficiency in the overall group and subgroups of our patients. Higher incidence of vitamin D deficiency was found in females as compared to males, in Saudi as compared to non-Saudi and in diabetics as compared to Non-diabetic patients. Higher incidence of Vitamin D deficiency in females than males was found in Saudi and Non-Saudi and in diabetics and non-diabetics. These results confirm many previous studies done in different countries^(4-6,11).

Many studies reported high association between vitamin D deficiency and diabetes and suggested that vitamin D supplementation can reduce the incidence of diabetes.

Higher incidence of vitamin D deficiency in Saudi as compared to the non-Saudi can be explained by the variation in dress where Saudi people wear clothes limit their exposure to the sun. In a similar manner we can explain higher incidence of vitamin D deficiency in females as compared to males. In our community, the females wear long robes and head coverings for religious reasons, often have full time indoor occupations. These factors greatly limit the ability of the females to get any sun exposure and so they are unlikely to obtain any vitamin D from sunlight.

The lowest deficiency incidence in our study was (51.79 %) in the non-diabetic-non-Saudi males. Some studies have been conducted on non-diabetic young subjects in other regions of Saudi Arabia and showed very high incidence of vitamin

D deficiency even higher than our results. But their results showed also higher incidence in females than in males⁽¹⁶⁾.

Our results showed variation in vitamin D deficiency incidence in different age groups. The deficiency was lowest in 1 -20 years group and was highest in 21 – 40 years old group. The incidence of vitamin D deficiency in above 60 years group was less than the incidence in 21-40 and 40-60 groups. Actually, this result is against our expectation because these patients spent most of the time indoor with very limited activity. However, we explained this unexpected result on the basis that these patients may take vitamin D regularly as a prophylactic and therapeutic medication of osteoporosis. Adequate levels of vitamin D maintain bone strength and might help prevent osteoporosis in older adults, non-ambulatory individuals who have difficulty exercising, postmenopausal women, and individuals on chronic steroid therapy^(22,23).

We compared the mean values of vitamin D, fasting glucose level and HbA1c levels of diabetic patients. Lower vitamin D was associated with higher FBG and HbA1c levels and vice versa. These results confirm the finding described in previous literature. Based on these results, we can suggest a strong effect of vitamin D on the development and progress of diabetes.

There are many studies which recommended evaluation of vitamin D level in diabetics⁽¹³⁾. Presence of vitamin D deficiency is considered as a prediction factor and increases incidence of diabetes⁽¹³⁾. Moreover, some studies

proved that vitamin D supplementation and higher levels of vitamin D may decrease the incidence of diabetes or improve the glycemic control of diabetic patients^(12,14,24).

Based on our study and other studies done in Saudi Arabia we can conclude that vitamin D deficiency is a big problem but most of Saudi population are unaware of this problem.

To overcome this problem, many actions are organized and plans should be implemented. Although, there is variation in ultraviolet rays based on regional and seasonal variation, Saudi Arabia has sunny days nearly all over the year. So, what is remaining is to increase the awareness of the population about this problem, factors affecting vitamin D production and dietary sources of vitamin D and to guide them about the optimum time and period of exposure to sun⁽²⁴⁻²⁵⁾.

CONCLUSION

There is high incidence of vitamin D deficiency among KFU health center patients. Vitamin D level was inversely proportional to the level of fasting glucose and H_{1c}. Vitamin D level in human beings is an indicator of development of type 2 diabetes mellitus. There is an evident role of vitamin D deficiency on glucose tolerance in diabetic patients.

RECOMMENDATION

Vitamin D should be one of the medications prescribed to diabetic patients based on periodic measuring of vitamin D level in these patients. Increasing the population awareness (non-diabetic and diabetics) is essential to overcome the widely prevalent vitamin D deficiency. A program should be planned to encourage exposure to sun in the proper time and for adequate period.

Future research

A research project was already submitted to the KFU research deanship to determine the peak times of vitamin D production in summer and winter time, to evaluate Vitamin D level in healthy subjects of college of medicine and to evaluate the effect of programed sun exposure on the level of vitamin D on these subjects.

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