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Prevalence and Risk Factors of Vitamin D Deficiency among Type 2 Diabetics and Non Diabetic Female Patients in Jordan

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ABSTRACT

To estimate the prevalence of vitamin D –deficiency among patients with type 2 DM, and to determine if there is any correlation between vitamin D –deficiency and number of independent variables. Serum 25(OH) D was measured in a cross-sectional sample of 625 cases among which 383were with type 2 DM. Fasting plasma glucose, insulin, HbA1c, calcium, phosphorous, Parathyroid hormones, and BMI were measured. Most diabetic patients in our study were obese (76%) with a mean BMI (SD) 33.6(5.54) Kg/m^2, Also 43.6% of them had diabetes for more than 5 years. According to non-diabetic subjects, there were 242 volunteers. Most of them were obese (53%) with a mean BMI (SD) 30.85(5.37) Kg/m^2 However, concerning sun exposure around 84.9 diabetic vs. 86.0 non-diabetics didn't receive enough sun exposure, concerning their diet around 23.0 diabetic vs. 36.4 non-diabetics do not frequently take cheese in their diet, on the other hand, when it came to milk, more than 80.9 diabetic vs. 81.4 non-diabetics did not frequently drink milk. The mean of serum level of 25-OHD among diabetics and non-diabetics were (18.67 ng/ml vs19.18 ng/ml) respectively. Vitamin D deficiency is highly prevalent among Jordanians with or without type 2 diabetes. It is now clear that the need for serious national efforts to prevent vitamin D deficiency and its associated morbidity is highly recommended.

Keywords: Vitamin D deficiency, Type 2 diabetes, Non-diabetic, Risk Factors.

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INTRODUCTION

Diabetes mellitus is increasing at an alarming rate all over the world. The prevalence of diabetes mellitus in developed countries among adults has been estimated to be about 5 % [1]. The prevalence of diabetes in developing countries such as the Arab world varies from 3% in Sudan to 35%in Bahrain [2].However, in Jordan the prevalence of diabetes and impaired fasting glucose (IGF) among adult Jordanians were 17.1% and 7.8% respectively [3]. In 2004, a panel of experts in the field found that the frequency of diabetes mellitus and impaired glucose tolerance in Jordan was 30.5% [4]. Which indicates that the prevalence of diabetes among Jordanians is high. According to the fact that the existence of diabetes mellitus is now considered to be a risk factor to induce bone loss and osteoporotic fracture [5] .Differences in the prevalence of vitamin D have been related to a variety of factors, including physiological changes with age, race, body mass index, sun exposure, and dietary vitamin D intake[6-8]. Vitamin D deficiency was also linked to IGT and type 2 diabetes in humans many years ago [9]. These observations were confirmed using animal models, which demonstrated that pancreatic insulin secretion is inhibited by vitamin D deficiency[10] .Several reports have also attributed to the active role of vitamin D in the functional regulations of the endocrine pancreas, particularly the beta cell, where receptors of 1,25 (OH)2D3 are found [11] . Moreover, also based on basic animal studies, vitamin D and calcium have also been suspected to be diabetes risk factors. There is also a strong evidence to suggest that altered vitamin D and calcium homeostasis have been suspected as a risk factor for type 1 diabetes based on animal and human observational studies [5]. Recently there has been accumulating evidence to suggest that altered vitamin D and calcium homeostasis may also play a role in the development of type 2 DM.A solid evidence suggesting a role for vitamin D in insulin secretion, that includes the presence of the vitamin D receptors VDR in beta cell and the vitamin D- dependent calcium –binding proteins (DBP) in pancreatic tissue was also detected [12]. On the other hand, vitamin D deficiency results in the decrease of pancreatic insulin secretion, but not other islet hormones, so this alteration does not affect the glucagon secretion [13].

Furthermore, it has also been suggested that hypovitaminosis D may be a significant risk factor for glucose intolerance. Demineralization process seems to be related to fasting blood glucose concentration and HBA1C [14-16]. On the other hand, it is well known that obesity is a major risk factor for diabetes mellitus, so the prevalence of type 2 DM increases when combined with obesity, which is often associated with hypovitaminosisD. This is especially noted when Vitamin D is efficiently deposited in body fat stores where it is no longer bioavailable, and that probably explains why a significant proportion of people with obesity are chronically vitamin D deficient [17,18].

The objectives of this study was to estimate the prevalence of vitamin D –deficiency among patientswith type 2 DM who attend The National Center for Diabetes, Endocrinology and Genetics (NCDEG).The other objective was to determine if there is any correlation between vitamin D –deficiency and a number of independent variables, including: duration of DM, educational level, body mass index, amount of milk and cheese intake, exposure to sun, physical activity, diet, sulfonylurea, metformin, insulin therapy, 24.25(HO) Vitamin D, calcium

(Ca), phosphorus (PO_4), albumin, Creatinine, parathyroid hormones (PTH), alkaline phosphates (ALK-PHOS), and HbA_{1C} levels.

METHODS

This study was conducted at the National Center for Diabetes, Endocrinology and Genetics (NCDEG).The center was established in Amman in 1998 as one of the centers of the Higher Council for Science and Technology. The center is considered to be the only specialized national center for diabetes, endocrinology and genetics in Jordan. The patients come to the center from all over the country, either directly, or referred from other clinics in the kingdom. The study group included all patients suffering from type 2 DM who attended the diabetic clinic at NCDEG from the 1^{st} of September 2007, till 15^{th} of January 2008.

Sample

The sample size was 625. Out of the mentioned sample, 383 diabetic patients were sufficient to provide 95% assurance that the margin of error in estimating the prevalence of vitamin D –deficiency would not exceed 3%, assuming that the most conservative estimation of the prevalence is 50%. Another 242 non-diabetics were also randomly selected, age- and gender-matched subjects, who visited the clinic for a routine medical check-up, agreed to participate in this study, and were checked for their biochemical parameters and serum 25-OHD level . The non-diabetic subjects were investigated with a protocol similar to that used for the diabetic patients' group, except for the parameter check and past/ present history of diabetes.

Since the study was approved by the NCDEG ethics committee, the study depended basically on confidentiality and data were used only for scientific aspects. Moreover, participation was optional and research was conducted after taking the verbal approval from the patients themselves.

Measurements and data collection

A structural questionnaire sheet was used to obtain socio-demographic data including level of education, income, medication, diet therapy, physical activity, menstrual cycle, bone ache, muscle ache, and bone fracture. An informed consent was obtained from each patient. Data was taken from the participants directly by the researcher.

Anthropometric measurements including weight, height, were measured with light clothes and no shoes. Weight was measured to the nearest 0.5kg while height was measured to the nearest 0.5 centimeter. Waist circumference was measured to the nearest one centimeter using-stretchable tailor measuring tape at the narrowest point between the umbilicus and the rib cage, hip circumference was also measured at the widest part of the body below the waist. Body mass index (BMI) was calculated dividing the weight (in kilogram) by the square of the height (in meters) (BMI=weight in kg/m2).

Laboratorial and biochemical analysis

Relevant sociodemographic data, medical history, and laboratory data was obtained from the medical records of the patients including: age, gender, duration of DM, current treatment, HbA1C level, Creatinine, calcium level, phosphorus level, albumin, parathyroid hormones, Alkaline phosphates, current medical problems, and medications prescribed for diabetes.

Measurement of the last recorded serum vitamin D level was also considered in the study .This information was recorded on the data sheet.

Statistical Analysis

Data was entered and analyzed using Statistical Package for Social Sciences (SPSS, version 11.5). Initially, the data were examined for data entry errors and outlying values. Detected errors were corrected as appropriate. Descriptive statistics were obtained, such as mean values for continuous variables and proportions for categorical variables. The prevalence of the vitamin D deficiency of Vitamin D was expressed as percentages, with 95% confidence interval. Association between vitamin D –deficiency and a number of variables were assessed for statistical significance using Chi square tests for categorical variable, and on independent T-test, for continuous variables.

Multivariate logistic regression was used to assess the independent effect of a given variable after adjustment for other potential confounders.

RESULTS

Table 1 shows the socio-demographic characteristics of the study population (383 diabetic patients diabetic and 242 non-diabetics patients). According to diabetic patients, there were 383, the mean age and standard deviation for the sample were (Mean (SD) = 52.15 (4.71) years, most of the study population were obese (76.0) and the mean and standard deviation were (Mean (SD) = 33.6 (5.54) Kg/m^2). Also more than 43.6 of them had had diabetes for more than 5 years, regarding the level of education; most of them are either High school graduates or less (65.8) and those with more than just High school education were (34.2). According to non-diabetic subjects, there were 242 volunteers. The mean age and standard deviation for them were 49.86(5.31) years, most of them were obese (53%) and the mean (SD) 30.85(5.37) Kg/m^2, also most of them had high school education or less (56.2).concerning lifestyle habits of 383 patients with Diabetes Mellitus vs 242 non-diabetics around 93.7vs 92.6 are inactive. However, concerning sun exposure around more than 84.9vs 86.0 didn't receive enough sun exposure, concerning their diet around 23.0vs 36.4 do not frequently take cheese in their diet, on the other hand, when it came to milk, around 80.9vs 81.4 of the sample did not frequently drink milk.

Table 1: Demographic and relevant characteristics of 383 diabetic's subjects and 242 non-diabetics subjects attending national center for Diabetes Endocrinology and Genetics (NCDEG)

Variable	Diabetics	Non-Diabetics
	n (%)	n (%)
Vitamin D(IU)		
<20	216(56.4)	139(57.4)
≥20	167(43.6)	103(42.6)
Mean (SD)	19.182(10.14)	18.67(9.72)
Age (year)		
≤50	137(35.8)	139 (57.4)
>50	246(64.2)	103 (42.6)
Mean (SD)	52.15(4.71)	49.86(5.31)
Body Mass Index (kg/m2)		
Mean (SD)	33.6 (5.54)	30.85 (5.37)
<25	13(03.0)	30(12.0)
25-30	80(21.0)	84(35.0)
>30	290(76.0)	128(53.0)
Frequency of milk drinking		
Frequent	73 (19.1)	45 (18.6)
Non-frequent	310 (80.9)	197 (81.4)
Frequency of eating cheese		
Frequent	295 (77.0)	154 (63.6)
Non-frequent	88 (23.0)	88 (36.4)
Frequency of practicing at least 30min exercise		
Frequent	24 (6.3)	18 (7.4)
Non-frequent	359 (93.7)	224 (92.6)
Frequent exposed to sun 15 minutes/day(10-15)% of body		
Frequent	58 (15.1)	34 (14.0)
Non-frequent	325 (84.9)	208 (86.0)
Education		
≤High school	252(65.8)	136(56.2)
> High education	131(34.2)	106(43.8)
History of Bone fracture		
Yes	16 (4.2)	32 (13.2)
No	367 (95.8)	120 (86.2)
History of Muscle ache		
Yes	203 (53.0)	121 (50.0)
No	180 (47.0)	121 (50.0)
Duration(year)		
≤5 years	216(56.4)	
>5 years	168(43.6)	
Diabetes treatment		
Oral hypoglycemic agents (OHA)	268(69.9)	
OHA+insulin	115(30.1)	
Glycosylated hemoglobin HBA1C (%)		
<7	171 (44.6)	
≥7	212(55.4)	

The biochemical characteristics of 383 diabetic subjects and 242 non- diabetic ones are shown inTable2. Almost all variables were close in both diabetics and non-diabetics except for the parathyroid hormone which showed a reliable difference between those who are diabetics and non-diabetics (105.3,165.99)respectively, and (P-value <0.005).

Table 2: Biochemical characteristics of 383 diabetics' subjects and 242 non-diabetics subjects attending National Center for Diabetes Endocrinology and Genetics

	Diabetics	Non Diabetics
Variable	Mean(SD)	Mean(SD)
Calcium mg/dl	9.26 (0.52)	9.10 (0.51)
Phosphorus mg/dl	3.53 (0.46)	3.42 (0.54)
Albumin g/l	34.75 (2.84)	34.79 (2.56)
Createnine	0.61 (0.12)	0.61 (0.12)
Parathyroid hormone pg/ml	105.30 (72.47)	165.99 (207.24) (P-value<0005).
Alkaline .Phosphates u/l	85.81 (36.62)	86.43 (46.40)
Magnesium mg/dl	1.92 (0.14)	2.06 (0.16)
Glycosylated hemoglobin HBA1C (%)	7.44 (1.64)	

The mean of serum level of 25-OHD among diabetics and non-diabetics were (18.67 ng/ml vs19.18 ng/ml) respectively, and the p-value was not significant (p=0.537)(Table3).

Table 3: Shows the T-test for vitamin D deficiency among diabetics and non-diabetics. It would better to delete this table and to include the results in the main text.

T-test for vitamin D deficiency among diabetics and non-diabetics				
		Vitamin D		
Variable	N	Mean	SD	P-value
Diabetics	383	19.18	10.14	0.537
Non-diabetics	242	18.67	9.72	

Prevalence of vitamin D deficiency by number of variables which significantly affected the prevalence of vitamin D deficiency (Table4):

Table4: The prevalence of Vitamin D, deficiency among diabetics according to socio-demographic and clinical characteristics.

Variable	Vitamin D deficiency		P-value
	yes	No	
	n (%)	n (%)	
Age (year)			
≤50	74 (54.0)	63 (46.0)	0.483
>50	142 (57.7)	104 (42.3)	
Body Mass Index (Kg/m^2)			
<25	3 (23.1)	10 (76.9)	<0.005
25-30	32 (40.0)	48 (60.0)	
>30	181 (62.4)	109 (37.6)	
Income (JDs)			
≤400JDs	114 (55.6)	91(44.4)	0.739
>400JDs	102(57.3)	76(42.7)	
Education			
≤High school	155(61.5)	97(38.5)	<0.005
> High education	61(46.6)	70(53.4)	
Frequent of milk drinking			
Frequent	36(49.3)	37 (50.7)	0.175
Non-frequent	180(58.1)	130(41.9)	
Frequency of eating cheese			
Frequent	170(57.6)	125(42.4)	0.374
Non-frequent	46(52.3)	42(47.7)	
Frequency of practicing at least 30min exercise			
Frequent	10(41.7)	14(58.3)	0.099
Non-frequent	206(57.4)	153(42.6)	
Frequent exposed to sun 15 minutes/day(10-15)% of body			
Frequent	22(37.9)	36(62.1)	0.002
Non-frequent	194(59.7)	131(40.4)	
Duration of DM (year)			
≤5 yrs	119(55.3)	97(44.7)	0.640
>5yrs	97(57.7)	71(42.3)	
Treatment of diabetes(DM)			
Oral Hypoglycemic Agent(OHA)	147(54.9)	121(45.1)	0.312
OHA+ Insulin	67(60.4)	44(39.6)	
Glycosylated hemoglobin HBA1C (%)			
<7	92(53.8)	79(46.2)	0.013
≥7	124(58.5)	88(41.5)	

Parathyroid hormone pg/ml			
≤55	8(22.9)	27(77.1)	<0.005
>55	208(59.8)	140(40.2)	
Calcium mg/dc			
<8.5	16(88.9)	2(11.1)	0.004
≥8.5	200(54.8)	165(45.2)	
Phosphorus mg/dl(PO4)			
<2.4	7(100)	0(0.0)	0.019
≥2.4	209(55.6)	167(44.4)	
Alkaline-Phosphates u/l			
<35	11(33.3)	22(66.7)	0.001
35-104	154(55.4)	124(44.6)	
>104	51(70.8)	21(29.2)	

Body mass index: Those with high body mass index tended to have higher prevalence of vitamin D deficiency among diabetic people only.

Alkaline phosphates: those who had higher alkaline phosphates among diabetics had higher prevalence of vitamin D deficiency.

Calcium: subjects with low calcium level had higher prevalence of vitamin D deficiency, among both groups.

Parathyroid hormones: subjects with higher level of parathyroid hormones tended to have higher prevalence of vitamin D deficiency.

Frequent amount of milk: people who did not frequently take milk had higher prevalence of vitamin D deficiency.

Number of days being exposed to the sun: people who did not have enough sun-exposure had higher prevalence of vitamin D deficiency.

Table 5: The prevalence of Vitamin D deficiency among non-diabetics.According to socio-demographic and clinical characteristics.

	Vitamin D deficiency		P-value
Variable	Yes	No	
	n (%)	n (%)	
Age (year)			
≤50	87(62.6)	52(37.4)	0.060
>50	52(50.5)	51(49.5)	
Body Mass Index (Kg/m^2))			
<25	16(53.3)	14(46.7)	0.657

25-30	46(54.8)	38(45.2)	
>30	77(60.20)	51(39.8)	
Education			
≤High school	84(61.8)	52(38.2)	0.123
> High education	55(51.9)	51(48.1)	
Frequent of milk drinking			
Frequent	20(44.4)	25(55.6)	0.051
Non-frequent	119(60.4)	78(39.6)	
Frequency of eating cheese			
Frequent	82(53.2)	31(35.2)	0.081
Non-frequent	57(64.8)	72(46.8)	
Frequency of practicing at least 30min exercise			
Frequent	6 (33.3)	12 (66.7)	0.032
Non-frequent	133(59.4)	91 (40.6)	
Frequent exposed to sun 15 minutes/day(10-15)% of body			
Frequent	15(44.1)	19(55.9)	0.090
Non-frequent	124(59.6)	84(40.4)	
Parathyroid hormone pg/ml			
≤55	13(38.2)	21(61.8)	0.005
>55	126(60.6)	82(39.4)	
Calcium mg/dl			
<8.5	25(78.1)	7(21.9)	0.011
≥8.5	114(54.8)	96 (45.7)	
Phosphorus mg/dl(PO4)			
<2.4	4(66.7)	2(33.3)	0.643
≥2.4	135 (57.2)	101(42.8)	
Alkaline-Phosphates' u/l			
<35	14(66.7)	7(33.3)	0.388
35-104	100(54.9)	82(45.1)	
>104	25(64.1)	14(35.9)	

The univariate logistic regression results (Table5), which have been used to assess the relative risk for vitamin D deficiency (<20ng/ml) for each potential risk factor. P value ≤0.05 was considered statically significant. P value was estimated for each risk factor. Only those with p-value ≤0.010 were included in a multivariate stepwise logistic regression analysis.

Table 6: Logistic regression analysis of factors associated with vitamin D deficiency among diabetics and non-diabetics

Variable	OR (95% confidence interval)	P value
Education		
≤High school Vs > High education	**2.0 (1.4,2.9)**	**<0.005**
Body Mass index		
Over weight	**1.26 (0.62, 2.53)**	**0.513**
Obese	**2.14 (1.09, 4.17)**	**0.026**
Sun exposure		
Frequent Vs Non-frequent	**2.1 (1.3,3.2)**	**0.003**

The logistic regression model included only the risk factors with P≤0.05are shown in Table 6. Because a 25-OHD concentration less than 20ng/ml was not a rare event, adjusted odds ratio was 95% confidence interval and level of significance P<0.005 of dependent variables after controlling the effect of age, type of diabetes, and drinking of milk . The only variables that significantly associated with vitamin D deficiency were education, obesity, and sun-exposure (table 6). Having diabetes was not significantly associated with vitamin D deficiency .Subjects with an educational level of high school or less were almost twice (OR=2.0,95% CI:1.4,2.9,P-value<0.005) more likely to have vitamin D deficiency compared to those with an educational level of more than high school. Compared to those with body mass index <25kg/m2, the obese were 2.14 times more likely to have vitamin D deficiency. Those who were not exposed to sun were 2.1 times more likely to have vitamin D deficiency compared to subjects who were exposed to sun.

DISCUSSION

This study measures the prevalence of vitamin D deficiency among diabetic women who attended the (NCDGE). As a national center receiving patients from all over the country either directly or referred from other clinics in Jordan, we believe that the patients included in this study are somehow representative of all diabetics in Jordan. This study is the first one to explore the relationship between vitamin D deficiency and type 2 diabetes mellitus in Jordan. In this study the prevalence of vitamin D deficiency among diabetics was (56.4) vs (57.4) for non-diabetics.

Comparison between studies is difficult. Since the prevalence of vitamin D deficiency can be defined according to population limit for serum 25-OHD, differences in the prevalence of vitamin D, deficiency have been related to a variety of factors, including physiological changes with age, race, body mass index ,sun-exposure, and dietary vitamin D intake.

The mean serum concentration of 25-OHD in our study for diabetic and non-diabetic were 19.18±10.14 and 18.28 ±9.86 respectively, which is considered to be relative hypovitaminosis D, though it is not statistically different from those whose age and gender matched the control subjects. Although the prevalence of vitamin D deficiency in this study is comparable to the [19], bearing in mind that the prevalence of hypovitaminosis D in diabetic population is still controversial [20,21] and recent findings suggest that the lower limit of normal value of serum 25-OHD concentration should be reevaluated [22-24]. Opinions regarding the optimal concentration of serum 25-OHD vary widely. Several studies have shown that serum concentration of at least 20-30 ng/ml are necessary to maximize intestinal calcium absorption and minimize perturbation in parathyroid hormones, calcium and phosphorus homeostasis[6-8,24] .

On the other hand it is yet uncertain what concentration of serum 25-OHD is optimal, it is so far suggested that the lower limit of serum 25-OHD concentration should be somewhere between 15-36ng/ml [6,22-24] .

The inconsistency between studies in result on vitamin D status and diabetes mellitus may be caused by the characteristics of the study populations, have shown that there was an independent association between 25-OHD and risk of diabetes in non-Hispanic white and Mexican-Americans, but no such association existed in non-Hispanic black [25] . According to our study, diabetes was significantly associated with vitamin D deficiency. which is consistent with the women health study, that reported an intake of 511IU/d of vitamin D, or more was associated with lower risk of incident type 2 diabetes mellitus compared to an intake of 159IU/d or less (2.7 vs 5.6 of cohort developed type 2 diabetes, respectively) our study also agreed with other studies [21,26-29] .On the other hand, many studies are inconsistent with these results [13, 20, 30, 31].

Education in our study showed a significant association with vitamin D deficiency. Subjects with an educational level of high school or less were almost twice (OR=2.0,95% CI:1.4,2.9,P-value<0.005) more likely to have vitamin D deficiency compared to those with an educational level of more than high school and this could be explained by the fact that higher educational level is associated with increasing awareness to the importance of sun exposure in providing adequate amount of vitamin D. This study doesn't agree with other studies which were held by [32].

Age in our study showed no significant association with serum 25-OHD, which is consistent with many studies [19,32-36].

Dairy intake showed no significant association with serum 25-OHD.On the other hand some studies reported a relationship between dairy intake and serum 25-OHD [37,38].

Our study showed no significant association with serum 25-OHD. Many studies had reported that vitamin D deficiency could contribute to the pathogenesis of hip fracture [39]. Moreover, some studies reported that significant reduction in hip fracture in elderly women living in retirement homes after daily supplementation with vitamin D3 and calcium [40-43]. However most of the studies had methodological weaknesses, the results were often inconsistent, and secure inferences from the available clinical trial were limited [21].

Although sun light is the most important source of vitamin D, Sun- exposure showed significant association with serum 25-OHD.This suggests that the contribution of sun-light may overcome the effects of other factors, such as occlusive clothing and dietary vitamin D fortification or restriction [16,22, 44,45].

Body mass index showed a significant association between body mass index and serum 25-OHD.Which is consistent with many studies [18, 46,47]. On the other hand, in the largest study using NHANS data serum 25-OHD was inversely associated with having metabolic syndrome among both genders; therefore, the result of this study may simply reflect the inverse association between serum 25-OHD and body weight or fatness [18,25].

HbA1c showed no significant association with serum 25-OHD. Our result doesn't match some studies results that's been done [16]. A variety of cohort reported inverse association between serum 25-OHD and the measurement of glycemic or presence of type 2 diabetes mellitus [25, 48, 49].

Showed no significant association with serum 25-OHD.Our study is consistent with the study held by [19], which showed that the duration of diabetes mellitus is not associated with serum 25-OHD.

Our study showed no significant association between serum 25-OHD and any type of diabetic treatment. This was inconsistent with many studies which reported a significant association between insulin treatment and serum 25-OHD [50,51].

Calcium in our study did not show a significant association with serum 25-OHD, in univariate , it shows a significant association but in multivariate model it failed to show a significant association after being adjusted for other confounder. On the other hand, many studies showed a significant relationship between calcium and serum 25- OHD [24,52].

PTH in univariate model showed a significant association with serum 25-OHD, this result is consistent with many studies which reported that PTH correlated negatively with serum 25-OHD [24, 53-56].

Alkaline phosphates in univariate model showed a significant association serum 25-OHD, this result is consistent with many studies which reported that alkaline phosphates correlated negatively with serum [57-59]. On the other hand, some studies reported that the measurement of alkaline phosphates is not a reliable predictor for vitamin D deficiency [45]. Some studies also showed that 25-OHD correlated inversely with alkaline phosphates [42,60].

Did not show a significant association with serum 25-OHD.our result was inconsistent with many studies which showed the opposite [61,62].

Our study showed no significant association between serum 25-OHD and exercise . This result is inconsistent with [47,48, 63], our result showed no significance rate which could be due to self recall bias.

This is a center-based study that explores the prevalence of vitamin D deficiency in patients attending the NGDEC in Amman-Jordan, a tertiary center with referrals from all over Jordan. Our study showed:

The main risk factors for the development of vitamin D deficiency in our study are; body mass index, sun exposure, and educational level.

Therefore we concluded that vitamin D deficiency is a common problem in diabetics and non-diabetics in Jordan. National plans for education, screening, control of risk factors (especially BMI, sun exposure and educational level) and treatment of vitamin D deficiency is highly recommended to reduce risks of vitamin D deficiency in Jordan.

The government should take the responsibility of treating the vitamin D deficient patients and try to increase the level of awareness concerning this topic.

Further studies concerning this problem should be held to highlight the risk factors resulting from vitamin D deficiency.

Recommendations

Many patients with hypovitaminosis D remain undetected, with bone chemistry values within the reference ranges, unless clinical suspicion is raised. Clinical suspicion based on history and awareness of risk factors should remain the gold standard for requesting vitamin D measurements. Although almost all Jordanian women have less than optimal vitamin D level, these results underscore the need for optimization of vitamin D status in the entire Jordanian population by fortification of food supplement (other than milk) with adequate amount of vitamin D and providing better education about the importance of sun exposure whenever possible in alleviating this condition. The link between vitamin D status and glucose metabolism is of great interest and potentially important. However, further extensive studies on vitamin D status and type 2 diabetes mellitus are needed to elucidate reasons for the varied results of studies in humans and to draw definite conclusions.

Conflicts of interest: There are no conflicts of interest.

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