VITAMIN D DEFICIENCY AND RISK OF DIABETES MELLITUS IN ARAR, KINGDOM OF SAUDI ARABIA: A CROSS SECTIONAL STUDY

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Abstract

Over the past decade, numerous non-skeletal diseases have been reported to be associated with vitamin D deficiency including type2 diabetes mellitus (T2DM). Studies provide evidence that vitamin D may play a functional role in glucose tolerance through its effects on insulin secretion and insulin sensitivity, no previous community based studies have been conducted in Arar, northern border of Kingdom of Saudi Arabia (KSA) addressing this issue could be traced. This study was carried out to show the magnitude of the problem of vitamin D deficiency and how such a deficiency can eventually has associated with DM in Arar population, KSA. **Methods**: A cross-sectional study was carried out during the period from 1, March 2016 to 30, September 2016. A total of 439 subjects aged 20–45 years, attending five randomly selected primary healthcare centers were selected using a systemic random sampling procedure. Data were collected by personal interview using a predesigned questionnaire including the relevant questions for obtaining covering the medical history of diabetes, age, family history of diabetes and other relevant needed data. Blood sample is drawn under complete a septic conditions to determine random blood glucose level. Person considered diabetic if random blood sugar was ≥200 ml/dl. Serum levels of 25-OH vitamin D were measured by ELISA. Anthropometric examination included height and weight measurements was obtained. Body Mass Index (BMI) was calculated. **Results:** The majority (70.6%) of the participants had normal Vit. D level, 24.8% had deficient level - lower than 12 ng/ml and 4.6% had insufficient level (12-20 ng/ml). the prevalence of diabetes mellitus among the studied population was 12.1%. Diabetes mellitus was more prevalent among cases of Vit.D deficiency as it affects 16.3% of them and 10.3% of participants with normal Vit. D level with statistically significant difference ($P < 0.05$). there is also significant effect of sex and exposure to sunlight ($P<0.05$), but no significant effect of BMI, age, educational level, fast food consumption, milk and dairy products consumption, and frequent eating fruits and vegetables on occurrence of Vit. D deficiency among the studied population ($P>0.05$). **Conclusion**: In conclusion, vitamin D deficiency is a common problem in in Arar, KSA, vitamin D deficiency is significantly associated with diabetes mellitus. Health education programs and increased awareness of the health services providers are needed.

Keywords: Vitamin D deficiency; Diabetes mellitus; Arar; Kingdom of Saudi Arabia.

INTRODUCTION

Over recent decades, numerous non-skeletal diseases associated with vitamin D deficiency have been reported including T2DM(type2 diabetes melitus) [1].

The increasing prevalence of obesity is turning type 2 diabetes into one of the most frequent causes of death [2]. Similarly, vitamin D deficiency has recently been recognized as a worldwide concern [3], still linked to obesity. Approximately 1 billion people worldwide suffer from vitamin D deficiency [4], which may result from limited exposure to sunlight, long-term wearing of covering clothes, use of sunscreen, age as well as low consumption of food containing ergocalciferol, and mal-absorption syndrome [5].

Some studies have shown a relationship between vitamin D deficiency and T2DM [6]. Also some other studies have shown that vitamin D may play a functional role on glucose tolerance through its effects on insulin secretion and insulin sensitivity [7].

In comparison to healthy controls, subjects with T2DM have significantly lower circulating concentration of 25 (OH)D [8]. Also the prevalence of vitamin D deficiency in women with T2DM is more common and also, old men with vitamin D deficiency, secret higher insulin after glucose intake [9, 10].

In Southern Region, Saudi Arabia a study was carried out to estimate 25-OH vitamin D deficiency in patients with type-2 diabetes mellitus in comparison to normal age-matched non-diabetic control population. It was found that, the mean serum 25-OH vitamin D levels in the diabetic group were 15.7 ± 7.5 ng/mL as compared healthy non-diabetic group having 11.1 ± 5.9 ng/mL and a total of 340 patients (98.5%) from both groups were found to be deficient in 25-OH vitamin D [11].

The concomitant association of vitamin D deficiency with insulin resistance, impaired insulin secretion, and their important metabolic consequences has generated the hypothesis of a possible role of vitamin D in the pathogenesis of type 2 diabetes [11].

There is a link between 25(OH)D levels and insulin responsiveness of tissues as well as between glucose levels and glycosylated hemoglobin in people without diabetes mellitus type 2 [12].

In a study conducted in St. Petersburg (North-West region of Russia), to show if the glucose metabolism and body fat content depend on serum levels of 25-hydroxyvitamin D [25(OH)D], it was considered that, 25(OH)D levels were from 19.4 to 134.0 nMol/L (mean 52.9±22.7). Vitamin D deficiency (lower than 50 nMol/L) and insufficiency (50-75 nMol/L) was revealed in 59.1% and 27.8% of women, respectively. The study showed also that low 25(OH)D levels were associated with obesity, increased plasma glucose levels after OGTT and decreased insulin sensitivity index, 25(OH)D levels below 50 nMol/L were associated with obesity risk but not with risk of impaired glucose metabolism [13].

Aim of the study

This was carried out to show vitamin D deficiency and how such a deficiency can eventually has associated with type I and type II diabetes as well as overweight and obesity in Arar city, Northern Saudi Arabia.

Participants and methods

Study sitting: The present study was conducted in Arar. Arar is the regional headquarter of the Northern Border Province of Saudi Arabia.

Study type & period: A cross-sectional study was carried out over the period from 1, September 2015 to 29, May 2016.

Data collection methods: Data were collected by means of personal interview with the sampled population using a predesigned questionnaire covering the following items:

(1) Socio-demographic characteristics of the participants, including age, educational and marital status.
(2) Data related to Vit. D level and body weight as physical activity, exposure to sunlight, consumption of milk, dairy products and egg, performing muscular exercise, history of consumption of fatty meals, consumption of fruits and vegetables and family history of obesity was obtained.
(3) Anthropometric examination included height and weight measurements with the use of a calibrated balance beam scale and a wall-mounted stadiometer; calculation of body mass index (BMI); and measurement of waist circumferences (WC) using standard methods. Normal weight was defined as BMI<25 kg/m^2, overweight as 25≤BMI<30 kg/m^2 and obesity as BMI≥30 kg/m^2 [15].
(4) Fasting, random and postprandial plasma glucose was determined.
(5) Serum 25(OH)D was measured using immunoassay kits (Immunodiagnostic System Ltd, UK) with quality control materials provided by the manufacturer. Status of vitamin D was classified as: normal - 25(OH)D levels higher than 75 nmol/L; insufficient - 50 to <75 nmol/L; and deficient - low than 50 nmol/L [5].

The exclusion criteria were, significant liver or kidneys disease and mal-absorption syndrome.

Ethical considerations

This study was reviewed and approved by the Research Ethics Committee of Faculty of Medicine, Northern Border University. Participants were informed that participation is completely voluntary, and written consent was obtained from each participant before being subjected to the questionnaire and after discussing the objective with the participants. No names were recorded on the questionnaires. Adequate training of data collectors took place to ensure protection of confidentiality, and all questionnaires were kept safe.

Statistical analysis

Collected data were coded and analyzed using statistical package for the social sciences (SPSS, version 15). The X^2-test was used as a test of significance, and differences were considered significant at P value 0.05 or less.

RESULTS

Table (1) illustrates the socio-demographic characteristics of the studied participants. Most of studied participants (71.5%) were female. The 439 adult participants who took part in the research ranged in age from 18 to 50 years old with mean age (+SD) was 27(±4.3) years old. The highest percentage (49.0%) was in the age group (20-25) and only 11.6% were < 20 years. More than three quarters (81.3%) were university graduates .

Table (2) illustrate the Vit.D deficiency related characteristics of the studied participants. The majority (70.6%) of the participants had normal Vit. D level, 24.8% had deficient - lower than 12 ng/ml and 4.6% had insufficient level (12-20 ng/ml). the prevalence of diabetes mellitus among the studied population was 12.1%. As regards the BMI, only 37.4% of the

participants had normal body weight, more than third (32.6%) were overweight, while about (14.1%) were obese and 24.9% had morbid obesity with BMI >35 and only 5.0% of participants were underweight with Mean (± SD) of BMI was 28.11 ± 8.37. Majority of the participants (56.5%) performing muscular exercise, about half (42.1%) had family history of obesity, around half (53.5%) reported exposure to sunlight, 46.5% prefer eating fruits and vegetables, while (50.1%) consumed milk and dairy products daily, and 46.2% rarely consume fast food. Regarding chronic diseases, hypertension represent 5.4 %.

Table (3) illustrates the relationship between Vit.D deficiency and socio-demographic characteristics of the studied participants. There is significant effect of sex (P>0.05), but no significant effect of , age, educational level, on occurrence of Vit. D deficiency among the studied population (P>0.05).

Table (4) illustrate the relationship between Vit.D deficiency and related characteristics of the studied participants. Diabetes mellitus was more prevalent among cases of Vit.D deficiency as it affects 16.3% of them and 10.3% of participants with normal Vit. D level with statistically significant difference (P <0.05). there is also significant relation to exposure to sunlight (P<0.05), but no significant relation between BMI, fast food consumption, milk and dairy products consumption, and preferring eating fruits and vegetables and Vit. D deficiency among the studied population (P>0.05).

Table (1): socio-demographic characteristics of the studied participants

	Frequency (n=439)	**Percent**
Sex		
• Female	314	71.5
• Male	125	28.5
Age group		
• < 20 years	51	11.6
• 20 -	215	49.0
• 25 -	60	13.7
• 30 -	61	13.9
• 40 – 50	52	11.9
Mean age (+SD) was 27(±4.3)		
Education		
• Preparatory	10	2.3
• Secondary	72	16.4
• University or more	357	81.3

Table (2): Vit.D deficiency related characteristics of the studied participants

Vit.D level (ng/ml)	**Frequency (n=439)**	**Percent**
• Normal level (> 20 ng/ml)	310	70.6
• Low level (< 20 ng/ml)	129	29.4
○ Deficient - lower than 12 ng/ml	109	24.8
○ Insufficient level (12-20 ng/ml)	20	4.6
Mean±SD	19.55 ± 11.28	
Presence of DM		

• Yes	53	12.1
• No	386	87.9
Weight assessment by BMI		
• Underweight	22	5.0
• Normal	164	37.4
• Overweight	143	32.6
• Obese	62	14.1
• Morbid obesity	48	10.9
Mean±SD	28.11 ± 8.37	
Performing muscular exercise		
• No	248	56.5
• Yes	191	43.5
Family history of obesity		
• No	254	57.9
• Yes	185	42.1
Sunlight exposure		
• No	204	46.5
• Yes	235	53.5
Eating fruits and vegetables		
• Yes daily	99	22.6
• Weekly	154	35.1
• Rarely	175	39.9
• Not at all	11	2.5
Milk and dairy products consumption		
• Yes daily	220	50.1
• Weekly	124	28.2
• Rarely	82	18.7
• Not at all	13	3.0
Fast food consumption		
• Yes daily	51	11.6
• Weekly	171	39.0
• Rarely	203	46.2
• Not at all	14	3.2
Other chronic diseases		
• Liver disease	1	.2
• Chronic kidney diseases	4	0.9
• Immunity related diseases	8	1.8
• Hypertension	24	5.4

Table (3): relationship between Vit.D deficiency and socio-demographic characteristics of the studied participants

Parameter	Presence of vit.D deficiency		Total	Chi-Square	P value
	No (n=310)	Yes (n=129)			
	No. (%)	No. (%)	No. (%)		
Age group					
• < 20	35(11.4)	16(12.5)	51(11.7)	5.89	0.20
• 20 -	160(51.9)	55(43.0)	215(49.3)		
• 25 -	42(13.6)	18(14.1)	60(13.8)		
• 30 -	43(14.0)	18(14.1)	61(14.0)		
• 40 – 45	28(9.1)	21(16.4)	49(11.2)		
Sex					
• Female	209(67.4)	105(81.4)	314(71.5)	8.73	0.003
• Male	101(32.6)	24(18.6)	125(28.5)		
Education					
• Secondary	53(17.1)	19(14.7)	72(16.4)	0.89	0.73
• university	250(80.6)	107(82.9)	357(81.3)		
• Preparatory	7(2.2)	3(2.3)	10(2.3)		

Table (4): the relationship between Vit.D deficiency and related characteristics of the studied participants

Parameter	**Presence of vit.D deficiency**		**Total** (n=439)	**Chi-Square**	**P value**
	No (n=310)	**Yes (n=129)**			
	No. (%)	**No. (%)**	**No. (%)**		
Presence of DM					
• No	278(89.7)	108(83.7)	386(87.9)	3.04	0.059
• Yes	32(10.3)	21(16.3)	53 (12.1)		
Weight assessment by BMI					
• Underweight	15(4.8)	7(5.4)	22(5.0)	5.55	0.23
• Normal	126(40.6)	38(29.5)	164(37.4)		
• Overweight	98(31.6)	45(34.9)	143(32.6)		
• Obese	39(12.6)	23(17.8)	62(14.1)		
• Morbid obesity	32(10.3)	16(12.4)	48(10.9)		
Fast food consumption					
• Yes daily	38(12.3)	13(10.1)	51(11.6)	3.02	0.38
• Weekly	127(41.0)	44(34.1)	171(39.0)		

• Rarely	136(43.9)	67(51.9)	203(46.2)		
• Not at all	9(2.9)	5(3.9)	14(3.2)		
Milk and dairy products consumption					
• Yes daily	154(49.7)	66(51.2)	220(50.1)	1.99	0.57
• Weekly	90(29.0)	34(26.4)	124(28.2)		
• Rarely	55(17.7)	27(20.9)	82(18.7)		
• Not at all	11(3.5)	2(1.6)	13(3.0)		
Frequent eating fruits and vegetables					
• Yes daily	68(21.9)	31(24.0)	99(22.6)	2.95	0.39
• Weekly	115(37.1)	39(30.2)	154(35.1)		
• Rarely	121(39.0)	54(41.9)	175(39.9)		
• Not at all	6(1.9)	5(3.9)	11(2.5)		
Sunlight exposure					
• Yes	180(58.1)	55(42.6)	235(53.5)	8.71	0.002
• No	130(41.9)	74(57.4)	204(46.5)		

DISCUSSION

Accumulating evidence suggests vitamin D plays a role in the development of type II DM. there was evidence that vitamin D may play a functional role in glucose tolerance through its effects on insulin secretion and insulin sensitivity [16]. People usually do not used to supplementing vitamin D, since vitamin D can be produced when their skin is exposed to the sunlight. Nevertheless, even in highly sunny regions, vitamin D deficiency exists, suggesting vitamin D deficiency is a global problem.

This cross sectional study was conducted in Arar city, the capital of the Northern Province of Saudi Arabia, to show vitamin D deficiency and how such a deficiency can eventually has associated with type I and type II diabetes as well as overweight and obesity.

A total of 439 subjects with mean age (±SD) 27 years (±4.3), were included in the study. 25-hydroxy vitamin D (25(OH)D), was measured in blood samples. Body mass index (BMI) was calculated.

The majority (70.6%) of the participants had normal Vit. D level, 24.8% had deficient and 4.6% had insufficient level. the prevalence of obesity among Vit.D deficiency cases was 17.8% while it was 12.3% among Vit.D normal level subjects with statistically insignificant difference (P>0.05). This findings are less than findings of The Saudi Health Interview Survey (SHIS) which concluded that, 62.65% of female Saudis and 40.6% of male Saudis aged 15 years and above are deficient in vitamin D [25]. Also In a study conducted on Kuwaiti adults, it was found that, approximately 56 % of the Kuwaiti adults had vitamin D

inadequacy, and 27 % had vitamin D deficiency [26]. Russian study which reported that, vitamin D deficiency and insufficiency was revealed in 59.1% and 27.8% of subjects, respectively The study showed also that low 25(OH)D levels were associated with obesity [17] which is consistant with our result. Our findings are also in accordance with Kavadar, et al, (2015) who found that, obesity have been associated with the low vitamin D levels [18] .
As regards the BMI, only 37.4% of the participants had normal body weight, more than third (32.6%) were overweight, while about (14.1%) were obese and 24.9% had morbid obesity with BMI >35 and only 5.0% of participants were underweight with Mean (± SD) of BMI was 28.11 ± 8.37. These finding is in accordance with Kavadar, et al, (2015) who found Mean (± SD) of BMI in non diabetic population were 28.2 ± 3.16 kg/m². [18].

Diabetes mellitus was more prevalent among cases of Vit.D deficiency as it affects 16.3% of them and 10.3% of participants with normal Vit. D level with statistically significant difference ($P < 0.05$).

Our result is consistent with a study conducted in King Abdul Aziz University Hospital, KSA (Al-Agh et al, 2015). The findings of the study have shown that 77% of the diabetic patients had reduced level of vitamin D and 66% of the diabetic and vitamin D deficient participants were poorly controlled [21]. Also in KSA concluded that, the mean levels of 25OHD were significantly lower in the DMT1 adults than in the controls (28.1 ± 1.4 nmol/L versus 33.4 ± 1.6 nmol/L) [21]. in (Kabadi SM et al., 2012), it was found that the combination of vitamin D deficiency and obesity had an impact on the risk of insulin resistance. [22].

In Kuwait study, the prevalence of pre-diabetes and diabetes were 40 and 27 %, respectively. Vitamin D inadequacy and deficiency was each associated with prediabetes compared to sufficient vitamin D status. Vitamin D inadequacy and deficiency were also associated with increased diabetes [26]. Again, Bischoff-Ferrari et al., (2004) have shown a relationship between vitamin D deficiency and T2DM [6]. The case control study (Visser M et al., 2003) stated that, in comparison to healthy controls, subjects with T2DM have significantly lower circulating concentration of 25(OH) [8].

In the current study, (12.4) of cases of Vit.D deficiency were severely obese, 17.8% were obese, 34.9% were overweight and 29.5% were normal weight. These findings are supported with findings of Saudi study to show Vitamin D status in relation to obesity, in healthy Saudi pre-and postmenopausal women, it was concluded that, Vitamin D deficiency was highly prevalent among studied Saudi women with obesity [27]. Also findings of systematic review of Santos M et al. (2015) who reported that, the prevalence of vitamin D deficiency was higher in obese subjects compared to the eutrophic group and higher than in the overweight group. **[18]** These findings are also supported by other epidemiological studies as Li YX & Zhou L (2015) who have demonstrated that vitamin D deficiency is closely related to obesity **[20]**. Moreover, Meta-analysis results showed that the prevalence of vitamin D deficiency was different between obesity group and control group, and the prevalence of vitamin D deficiency was associated with obesity in Asians and European-Americans. [23**]**. In contrast, our results are not consistent with results of (Anitha & Ibrahim) in Arar city, KSA, as they reported the, no significant association was found between obesity and vitamin D deficiency indicating that vitamin D deficiency has no significant role in causing obesity in Saudi women above 40 years [25].

CONCLUSION AND RECOMMENDATIONS

In conclusion, vitamin D deficiency is a common problem in in Arar, KSA, vitamin D deficiency is significantly associated with diabetes mellitus. Health education programs and increased awareness of the health services providers are needed.

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