Original Article

Association of Vitamin D Deficiency with Cardiovascular Disease Among Saudi Patients in Saudi Arabia

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Abstract

Background: Vitamin D deficiency has a far-reaching impact on several metabolic functions including cardiovascular health. This study aimed to test the association of serum 25 [OH]-vitamin D3 levels among cardiovascular disease (i.e., hypertension and ischemic heart disease) patients. **Methods:** A cross-sectional study was conducted among 360 participants from the tertiary care hospital. The simple random technique was used to select the participants. Only Saudi nationals were included in the study. Sociodemographic information, nutritional status, biochemical parameter (lipid profile, blood glucose level), and questions relating to cardiovascular disease were collected from the hospital record through data collection sheet. Serum Vit D level was determined by serum 25 (OH) blood test. Statistical package for social science (SPSS) software version 24 was used for data analysis. Binary logistic regression model was fitted to indentify the associated factors of vitamin D deficiency among cardiovascular disease patients. **Results:** Approximately 40.6% and 27.8% of study participants had vitamin D deficiency and insufficiency, respectively. After adjustment of covariates, among cardiac patients, vitamin D deficiency was associated with ischemic heart disease (OR 2.24, 95% CI 1.11–4.52), and blood triglyceride level (OR 2.27, 95% CI 1.22–4.22). **Conclusions:** Vitamin D deficiency and insufficiency are associated with ischemic heart disease, hyperglycemia, and hypertriglyceridemia. There is a need for the screening of cardiovascular disease patients for vitamin D levels.

Keywords: *Abnormality, blood, heart, patients, vitamin D*

Introduction

Vitamin D is essential for human health, it is derived from sterol by the exposure of sunlight.[1] Other major sources of vitamin D are natural food and fortified food.[2] A high prevalence (from 30% to 50%) of vitamin D among world population.[3] Countries in which population living near to equator line more likely to vitamin D deficiency.[4] Cardiovascular disease (CVD) is a major public health problem and the leading cause of death worldwide, and it is estimated that 17.7 million deaths occur from CVD.[4] There are many factors that contribute to the development of CVD. The nutritional factor is one of the most important factors which caused CVD.[5]

There are several studies that determined the association of vitamin D deficiency with CVD.[6-8] One of the previous studies found that vitamin D deficiency is associated with hypertension.[7] One of the previous studies[6] in the USA shows that the prevalence of CVDs is remarkably high in subjects with deficient vitamin D levels. Common risk factors for CVD, such as obesity, higher blood pressure, low high-density lipoprotein (HDL) cholesterol, insulin resistance, type 2 diabetes (T2D), high parathyroid hormone, dyslipidemia, hypertension, and urine albumin creatinine ratio (UACR) are discussed in this study.[8-12] In another US study, where 7674 participants' results showed that low vitamin D status has significant risk of development of CVD, in American adults.[13] Another American study found that vitamin D deficiency had direct association with angina, myocardial infarction (MI), and stroke.[14]

In another study[15] reported that vitamin D deficiency associated with hypertension (HTN) and CVD. Another study in which a 10-year follow-up for the elderly population consumed decreased intake of vitamin D and increase probability of acute MI and stroke.[16] Several meta-analyses show that vitamin D deficiency had association with CVD

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cases.[17-20] In previous study,[21] found that vitamin D deficiency had absolute risk for CVD among male gender.[22] Other study[22] concluded that lower serum 25 [OH] vitamin D levels were significantly associated with elevated levels of systolic blood pressure (SBP) (β = −0.07) and DBP (β = −0.06).

Another study[23] observed that improvements in 101 CVD patient outcomes after 6 weeks of vitamin D supplementation at the rate of 2000 IU. Another study[24] reported that there were improved cardiac functions in 229 patients of chronic heart disease after 4000 IU of vitamin D in 1 year.

In Saudi Arabia, to the knowledge of the researcher there is very few literature available about relationship of vitamin D deficiency with CVD. This study is expected to help identify the factors of vitamin D deficiency which contribute to CVD, and it is also expected to help improve measures and policymaking for prevention of these diseases.

Methods

Study setting, study design, and sampling technique

The study was conducted in a major tertiary care hospital in urban city of Kingdom of Saudi Arabia. This hospital average 1000 beds and daily patients' turnover of out-patient department is average 10,000. Participants were recruited from the department of cardiology. The study design was cross-sectional study. Participants were selected with simple random sampling. First, hospital record is taken from the hospital (inpatient, outpatient, ICU). Make a frame list of patents from the hospital record then selected the required study participants through random number from random number computer software. The independent variable is the serum vitamin D3 level, risk factors for CVD (e.g., diabetes and lipid profile), and certain comorbidities (e.g., cerebrovascular disease) while the dependent variables included CVD (e.g., ischemic heart disease and HTN),

Inclusion criteria and exclusion criteria

Confirmed cardiac patients by medical and laboratory tests. Those who have their serum vitamin D levels available in their medical records. Exclusion criteria: Those nationals who belong to other countries were excluded. Patients whose vitamin D levels are not available in their medical records.

Sample size

The sample size was calculated for the prevalence of obesity, as one of the CVD risk factors in the proposed study. A sample size of 360 was fulfilled to detect a difference of 12% in the prevalence of obesity between low vitamin D level (<20 ng/mL) and the high vitamin D level with the power of 80% and the level of significance at 5%. The prevalence of obesity was considered as 24% in low vitamin level and 12% in high vitamin level.[24]

Data collection tool and technique

Study participants selected from the hospital which is diagnosed cases of CVD from the inpatient, outpatients, and ICU. All patient's information included disease diagnosis, his personal, biochemical, hematological, and clinical data of all the CVD patients were retrieved from electronic medical records of the hospital, with the help of a study collaborator from the hospital. Personal data included patients' age, gender, height, and weight. Biochemical parameters such as lipid profile—triglycerides (TG), low-density lipoprotein (LDL), HDL, in addition to SBP , diastolic blood pressure (DBP), HbA1c, and serum 25 [OH] vitamin D3 levels were retrieved. Vitamin D serum level was measured through serum 25[OH] D test.

Ethical consideration

The research proposal was approved by the Institutional review board (IRB) of the Imam Abdul Rehman bin Faisal University and IRB no is PGS-2019-01-197. The confidentiality of patients was maintained. The informed consent was taken before starting the interview.

Statistical analysis

Statistical package for social sciences (SPSS version 23) was used for data entry and statistical analysis of study variables. Descriptive statistics (frequency and percentages) for categorical variables and mean and standard deviation for quantitative variables were calculated. The normality of data was checked through Kolmogorov-Smirnov Test. A Chi-square test was used to determine the difference between two subgroups such as male and female. For dichotomous outcomes, the odds ratio (OR) with 95% confidence interval (CI) was computed and compared. To determine the association of outcome variable and independent variable, logistic regression was used. *P* value was calculated at the 5% level of significance.

Results

The mean age of study participants was 61 years (±10 years). More (56.1%) than half of them between 61–85 years and 55.6% were females. The percentage of abnormal HbA1c, high blood glucose level, high random blood glucose level, hypercholesterolemia, low HDL level, high LDL level, diabetes, and hypertension, ischemic heart disease were 48.15%, 6.5%, 23.6%, 16.4%, 33.9%, 27.5%, 86.9%, 62.8%, 11.9%, 74.7%, and 18.1%, respectively [Table 1].

Table 2 shows the prevalence of vitamin D deficiency among participants. Vitamin D deficiency, insufficiency, and normal serum level of vitamin D were 40.6%, 27.8%, and 31.7%, respectively.

In univariate analysis, diabetic patients were significantly associated with vitamin D deficiency and insufficiency, but other factors are statistically insignificant [Table 3].

After adjustment of covariate, age group between 61 and 85 years had OR 3.16 (1.29–7.73) three times more likely association with vitamin D deficiency among cardiac patients, those who have abnormal triglyceride had OR 2.27 (1.22–4.22) more than two times more likely association with vitamin D deficiency among cardiac patients. Cardiac patients with diabetic had OR 1.32 (1.05–5.69) more than one time likely association with vitamin D deficiency [Table 4].

Cardiac patients were two times more likely associated with vitamin D deficiency and insufficiency. OR 1.99 (0.88–4.46) and OR 2.20 (1.05–4.61) respectively [Table 5].

Figure 1 shows the association of vitamin D levels with different types of CVDs.

Table 1: Baseline characteristics of study participants (*n*=360)

Characteristics	Frequency	Percent
Age (Mean±SD) years	61.38±9.54	
35-60	158	43.9
61-85	202	56.1
Gender		
Female	200	55.6
Male	160	44.4
Glycated hemoglobin (HbA1C)		
Normal (<6.5%)	187	51.9
Abnormal (>6.5%)	173	48.1
Fasting blood glucose		
Normal (<126 mg/dL)	275	76.4
Abnormal (>126 mg/dL)	85	23.6
Random blood glucose		
Normal (<200 mg/dL)	301	83.6
Abnormal (>200 mg/dL)	59	16.4
Blood cholesterol level		
Normal (<200 mg/dL)	238	66.1
Abnormal (>200 mg/dL)	122	33.9
Blood triglyceride level		
Normal (<150 mg/dL)	261	72.5
Abnormal (>150 mg/dL)	99	27.5
Blood high-density lipoprotein		
Normal (>55 mg/dL)	59	16.4
Abnormal (<55 mg/dL)	301	83.6
Blood low-density lipoprotein		
Normal (<100 mg/dL)	134	37.2
Abnormal (>100 mg/dL)	226	62.8
Diabetes		
Present	43	11.9
Absent	317	88.1
Type of disease		
Hypertensive	269	74.7
Ischemic heart	65	18.1
Cerebrovascular disease	26	7.2

Discussion

The result of the study found a strong positive association of vitamin D deficiency with CVD patients. Cardiac patients with age above 60 years, female gender, diabetic, hypertension, and abnormal lipid profile had more likely vitamin D deficiency.

Female cardiac patients were more vitamin D deficient in this study. This result is consistent with the previous study.[25] The reasons for this deficiency are lack of exposure to sunlight due to covering of body and hormonal changes.

In this study, result found that cardiac patients with abnormal Hb1c were more likely associated with vitamin D deficiency. This result is consistent with previous study which found that diabetes was associated with vitamin D deficiency since pancreatic function becomes affected with vitamin D deficiency.[26] Cardiac patients with abnormal fasting and random blood glucose levels were associated with vitamin D deficiency in this study. Several other studies also showed positive associations of high fasting and random blood glucose level among CVD patients with vitamin deficiency.[27,28] This

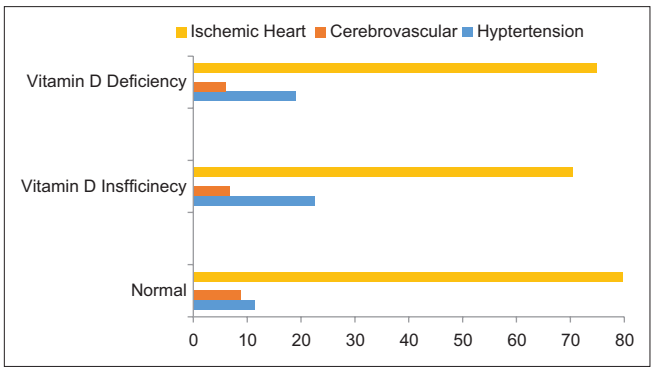

Figure 1: Vitamin D levels among different types of diseases

Table 2: Prevalence of vitamin D deficiency among participants (*n*=360)

Blood vitamin D levels	Males (*n*=160)		Females (*n*=200)		Total (*n*=360)	
	No.	%	No.	%	No.	%
Normal (>30 ng/mL)	53	33.1	61	30.5	114	31.7
Insufficiency (20-30 ng/mL)	43	26.9	57	28.5	100	27.8
Deficiency (<20 ng/mL)	64	40.0	82	41.0	146	40.6

χ^2=0.300, *P*=0.861

Table 3: Association of vitamin D deficiency with clinical characteristics of study participants (Univariate analysis)

Characteristics	Vitamin D insufficiency Odds ratio (95% CI)	Vitamin deficiency Odds ratio (95% CI)
Age (years)		
35-60	1	1
61-85	0.86 (0.52-1.41)	1.09 (0.63-1.87)
Gender		
Male	1	1
Female	1.15 (0.67-1.97)	1.11 (0.68-1.82)
Glycated hemoglobin (HbA1c)		
Normal (< 6.5%)	1	1
Abnormal (>6.5%)	0.73 (0.42-1.25)	1.26 (0.77-2.06)
Fasting blood glucose		
Normal (<126 mg/dL)	1	1
Abnormal (>126 mg/dL)	0.84 (0.47-1.48)	1.11 (0.58-2.53)
Random blood glucose		
Normal (<200 mg/dL)	1	1
Abnormal (>200 mg/dL)	1.51 (0.74-3.07)	1.68 (0.87-3.22)
Blood cholesterol level		
Normal (<200 mg/dL)	1	1
Abnormal (>200 mg/dL)	1.32 (0.74-2.34)	1.30 (0.77-2.20)
Blood triglyceride level		
Normal (<150 mg/dL)	1	1
Abnormal (>150 mg/dL)	0.97 (0.52-1.79)	0.79 (0.45-1.37)
Blood high-density lipoprotein		
Normal (>55 mg/dL)	1	1
Abnormal (<55 mg/dL)	0.98 (0.44-2.18)	1.77 (0.90-3.48)
Blood low-density lipoprotein		
Normal (<100 mg/dL)	1	1
Abnormal (>100 mg/dL)	1.57 (0.90-2.73)	1.00 (0.59-1.67)
Diabetes*		
Negative	1	1
Positive	1.44 (0.57-3.63)	2.18 (0.96-4.92)

*Clinically and lab diagnosed

study found that high blood cholesterol levels among CVD patients are most likely associated with vitamin D deficiency. This result contrasted with those of previous studies,[28,29] which showed that this association was not accounted for the low level of vitamin D among obese patients. The scientific reason is that low levels of parathyroid hormones increase the levels of intracellular calcium in adipocytes, which lead to obesity due to lipogenesis. A previous study of randomized controlled trial, vitamin D supplementation of 30000 IU/week for 1 year to a group of people aged between 20 and 65 years, resulted in no change of body weight after intervention of vitamin D.[30] Cardiac patients with diabetes were associated with vitamin deficiency in this study, and these results also consist of previous study which found that CVD and diabetes are more likely associated with each other.[31] The reason is that diabetes causes pathologic changes in the body like clotting of blood and structure changes in the heart which caused CVD.[31]

There are several points of strength of this study. It is the first study was conducted in the eastern province of Saudi Arabia that explores the association of heart disease and its risk factors associated with vitamin D deficiency. Second, a standardized data collection protocol was followed in addition to rigorous control of quality throughout the study from design to write-up. There were several limitations of this study, first, the cross-sectional study design, which cannot determine the exact causal inference or temporality of association between variables. Second, sample size was small which reduced the generalizability of results.

Conclusions

The finding of this study suggested that risk factors of vitamin D among cardiac patients should be monitored to prevent the consequences of CVD. Health promotion should be developed to increase awareness among general population, specifically heart disease patients regarding vitamin D deficiency.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Table 4: Association of vitamin D deficiency with clinical characteristics of study participants (multivariate analysis (*n*=360)

Variable	Vitamin D insufficiency odds ratio (95% CI)	Vitamin deficiency odds ratio (95% CI)
Gender		
Male	1	1
Female	0.73 (0.31-1.73)	0.26 (0.13-0.50)
Age		
35-60	1	1
61-85	3.16 (1.29-7.73)	0.72 (0.40-1.31)
HbA1C		
Normal	1	1
Abnormal	0.67 (0.27-1.64)	0.62 (0.34-1.13)
Fasting blood		
Normal	1	1
Abnormal	1.30 (0.50-3.357)	0.96 (0.47-1.96)
Random glucose		
Normal	1	1
Abnormal	0.96 (0.30-3.10)	0.87 (0.38-1.99)
Cholesterol level		
Normal	1	1
Abnormal	1.07 (0.41-2.79)	0.53 (0.25-1.14)
Blood triglyceride level		
Normal	1	1
Abnormal	1.33 (0.50-3.49)	2.27 (1.22-4.22)
HDL (high-density lipoprotein)		
Normal	1	1
Abnormal	0.48 (0.17-1.33)	0.86 (0.38-1.94)
LDL (low-density lipoprotein)		
Normal	1	1
Abnormal	2.61 (0.82-8.36)	1.34 (0.67-2.66)
Diabetic		
Negative	1	1
Positive	1.32 (1.05-5.69)	2.7 (1.98-4.80)

Table 5: Association of vitamin D insufficiency and deficiency with cardiovascular diseases among participants

Type of disease	Vitamin D insufficiency odds ratio (95% CI)	Vitamin D deficiency odds ratio (95% CI)
Hypertensive	1	1
Ischemic heart	1.99 (0.88-4.46)	2.20 (1.05-4.61)

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