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Association between Vitamin D Deficiency and Coronary Artery Disease in Libyan Patients

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Abstract:

Background:

coronary artery disease (CAD) remains a leading cause of mortality worldwide. Recent research suggests a potential link between vitamin D deficiency and the pathogenesis of CAD, potentially through mechanisms involving endothelial dysfunction, inflammation, and metabolic regulation.

Objectives:

To investigate the association between serum vitamin D levels and angiographically confirmed CAD in patients aged 30–70 years. The study also examines the relationship between vitamin D status and CAD severity, considering gender, diabetes, hypertension, smoking status, and specific coronary artery involvement.

Methods:

This cross-sectional observational study enrolled 100 patients who underwent coronary angiography and were found to have $\geq 50\%$ stenosis in at least one major coronary artery. Patients with systemic diseases, vitamin D supplementation, or other exclusion criteria were omitted. Demographic, clinical, and laboratory data including serum 25(OH)D levels were recorded. Statistical analyses included

t-tests, ANOVA, Chi-square, and Pearson's correlation, with significance set at $p < 0.05$.

Results:

Among 100 patients (75 males, 25 females), 77 were diagnosed with CAD. Mean serum vitamin D level was 19.46 ± 0.83 ng/ml. Patients with normal coronary arteries had significantly higher vitamin D levels ($p = 0.01$). Vitamin D deficiency was more common among diabetics ($p = 0.04$) and older patients ($p = 0.002$), and correlated with higher BMI ($p = 0.045$). Although no strong correlation was observed between vitamin D levels and CAD severity or number of vessels involved, the right coronary artery (RCA) was most frequently affected, and the left circumflex artery (LCX) showed the most severe stenosis.

Conclusion:

Vitamin D deficiency appears to be an independent risk factor for the presence of CAD, especially among older, diabetic males. While it does not correlate significantly with CAD severity, its high prevalence among CAD patients highlights the need for public health measures promoting vitamin D supplementation in at-risk populations.

Aim of the Study

This study investigates the association between vitamin D deficiency and CAD in patients aged 30–70 years. It explores the relationship between vitamin D levels and disease severity in relation to gender, diabetes, hypertension, smoking status, and angiographic findings. It also identifies the coronary arteries most susceptible to stenosis in males and females.

Keywords: Vitamin D, Coronary artery disease, Coronary angiography, Serum 25(OH)DI.

العلاقة بين نقص فيتامين د ومرض الشريان التاجي لدى المرضى الليبيين

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الملخص:

الخلفية:

لا يزال مرض الشريان التاجي (CAD) سبباً رئيسياً للوفاة في جميع أنحاء العالم. تشير الأبحاث الحديثة إلى وجود صلة محتملة بين نقص فيتامين د ومرض الشريان التاجي،

الأهداف:

دراسة العلاقة بين مستويات فيتامين د في المصل ومرض الشريان التاجي المؤكد بتصوير الأوعية الدموية لدى المرضى الذين تتراوح أعمارهم بين 30 و70 عاماً. ودراسة العلاقة بين حالة فيتامين د وشدة مرض الشريان التاجي، مع مراعاة الجنس، ومرض السكري، وارتفاع ضغط الدم، والتدخين، وإصابة الشريان التاجي.

المنهجية:

شملت هذه الدراسة 100 مريض خضعوا لتصوير الأوعية التاجية، ووجد أنهم يعانون من تضيق بنسبة $\leq 50\%$ في شريان تاجي رئيسي واحد على الأقل. استبعد المرضى الذين يعانون من أمراض جهازية، أو يتناولون مكملات فيتامين د. سُجلت البيانات الديموغرافية والسريرية والمختبرية، بما في ذلك مستويات (OH)D25 في المصل. شملت التحليلات الإحصائية اختبارات t، وتحليل التباين، ومربع كاي، وارتباط بيرسون، مع قيمة دلالة إحصائية > 0.05 .

النتائج:

من بين 100 مريض (75 ذكور، 25 أناث)، شُخص 77 منهم بمرض الشريان التاجي. بلغ متوسط مستوى فيتامين د في المصل 19.46 ± 0.83 نانوجرام/مل. كانت مستويات فيتامين د أعلى بشكل ملحوظ لدى المرضى ذوي الشرايين التاجية السليمة ($p = 0.01$) كان نقص فيتامين د أكثر شيوعًا بين مرضى السكري ($p = 0.04$) والمرضى الأكبر سنًا ($p = 0.002$)، وارتبط بارتفاع مؤشر كتلة الجسم. ($p = 0.045$) على الرغم من عدم ملاحظة ارتباط قوي بين مستويات فيتامين د وشدة مرض الشريان التاجي أو عدد الأوعية الدموية المصابة، إلا أن الشريان التاجي الأيمن (RCA) كان الأكثر تأثرًا، بينما أظهر الشريان المحيطي الأيسر (LCX) أشد تضيق.

الخلاصة: يبدو أن نقص فيتامين د عامل خطر مستقل للإصابة بمرض الشريان التاجي، وخاصة لدى كبار السن من الذكور المصابين بداء السكري. ورغم عدم ارتباطه ارتباطًا وثيقًا بشدة مرض الشريان التاجي، إلا أن ارتفاع معدل انتشاره بين مرضى الشريان التاجي يُبرز الحاجة إلى اتخاذ تدابير صحية عامة تُعزز تناول مكملات فيتامين د لدى الفئات الأكثر عرضة للخطر.

هدف الدراسة

تبحث هذه الدراسة في العلاقة بين نقص فيتامين د ومرض الشريان التاجي لدى المرضى الذين تتراوح أعمارهم بين 30 و 70 عامًا. وتستكشف العلاقة بين مستويات فيتامين د وشدة المرض من حيث الجنس، وداء السكري، وارتفاع ضغط الدم، والتدخين. كما تُحدد الدراسة الشرايين التاجية الأكثر عرضة للتضيق لدى الذكور والإناث. **الكلمات المفتاحية:** فيتامين د، مرض الشريان التاجي، تصوير الأوعية التاجية، (OH)DI25 في المصل.

1. Introduction

Coronary artery disease (CAD) is a major global health burden. Recent studies have shown that low vitamin D levels (<30 ng/ml) are associated with increased blood pressure and may contribute to CAD through vascular endothelial damage. However, results across studies are inconsistent.

Vitamin D is essential not only for calcium and bone metabolism but also for the innate immune system, cellular proliferation, and neuromuscular functions. It is known to inhibit the nuclear factor-kappa B pathway and reduce inflammation (Dziedzic et al., 2017).

In recent years, vitamin D has been implicated in the pathogenesis of several diseases including cancer, multiple sclerosis, diabetes, and cardiovascular disease. It plays a vital role in bone mineralization, muscle contraction, nerve conduction, and cellular function. Its role has extended to immune modulation and transcription regulation in various cell types. It is also used in treating psoriasis (Wang et al., 2017).

The World Health Organization projected that mortality due to cardiovascular diseases (CVD) would rise from 17.1 million in 2004 to 23.4 million by 2030, with CAD and hypertension being major contributors (WHO, 2019). Identifying new, modifiable, and preventable risk factors such as vitamin D deficiency could reduce CAD-related morbidity and mortality.

Most existing studies on vitamin D and CAD have been conducted in Western populations, where vitamin D deficiency is highly prevalent. In Libya, vitamin D deficiency is also widespread, yet studies exploring its association with angiographically confirmed CAD are lacking.

II. Materials and Methods

This cross-sectional observational study included 100 patients who underwent coronary angiography and had at least one major coronary artery stenosed $\geq 50\%$.

Inclusion criteria:

- Patients aged 30–70 years
- Both males and females

Exclusion criteria:

- Hemodynamic instability, shock, heart failure
- Use of vitamin D supplements
- Known cardiac, kidney, or liver disease
- Parathyroid disorders
- Pregnancy, infection, fever
- Anemia (Hb < 13 g/dl for males, < 12 g/dl for females)

Parameters recorded:

Age, sex, BMI, blood pressure, hemoglobin, serum calcium, phosphorus, lipid profile (HDL, LDL), renal function, and serum vitamin D (25(OH)D).

III. Statistical Analysis

Data were analyzed using SPSS v18. Results are presented as mean $\pm$ SE.

- T-tests were used for comparing means between two groups.

- One-way ANOVA analyzed differences among multiple groups.
- Chi-square test assessed independence among categorical variables.
- Pearson's correlation coefficient (PCC) evaluated relationships between variables.

Statistical significance was set at $p < 0.05$.

IV. Results:

1) Baseline Data of the Study Population & study parameters:

Out of 100 participants (75 males, 25 females):

- 23 had normal coronary arteries
- 77 had CAD
- 11.6% had 50–70% stenosis
- 36.3% had >70–90% stenosis
- 51.9% had >90% stenosis

About 50% had single-vessel disease; fewer had double, triple, or quadrantile involvement.

Average age: 59 years

Mean BMI: 29.6 kg/m²

No significant difference in age, BMI, hemoglobin, calcium, or lipid profiles between groups.

More severe CAD was observed in males ($p = 0.621$).

Hypertensive patients had more severe stenosis ($p = 0.273$).

Diabetics had significantly more severe CAD than non-diabetics ($p = 0.0068$).

2) Serum level of vitamin D:

- Mean vitamin D: 19.46 ± 0.83 ng/ml (range: 6–40 ng/ml)
- Males had slightly lower levels than females ($p = 0.607$)
- Smokers and non-smokers had lower levels than former smokers ($p = 0.12$)
- Hypertensive had higher vitamin D than non-hypertensive, not significant ($p = 0.66$)
- Diabetics had significantly lower levels than non-diabetics ($p = 0.04$) Figure 1: summarizes these patterns.
- Patients with normal coronaries had higher vitamin D than those with CAD ($p = 0.01$)

Table 1 displays all of the previous data.

Table 1 : Base line vitamin D level of the study population

Hypertensive (%)	63(63.0)	20.03 (1.01)	0.66
Non-hypertensive	37(37.0)	18.49 (18.49)	
Diabetic (%)	51(51.0)	18.71 (1.11)	0.04
Non-diabetic(%)	49(49.0)	20.24 (1.23)	

Normal coronary (%)	32 (32.0)	18.34 (0.87.)	0.01
CAD (%)	77 (77.0)	19.66 (0.90)	
50-70% stenosis (%)	9 (9)	18.22, (1.50)	0.44.
>70-90% stenosis (%)	28 (28)	21.96 (1.67)	
> 90% stenosis (%)	40 (40)	18.38, (1.20)	
Single vessel disease (%)	37(40)	19.81 (1.30)	0.882
Double vessel disease (%)	22(22)	20.05 (1.79)	
Triple vessel disease (%)	16(16)	19.50 (1.88)	
Quadrant vessel disease (%)	2(2)	14.00 (7.00)	

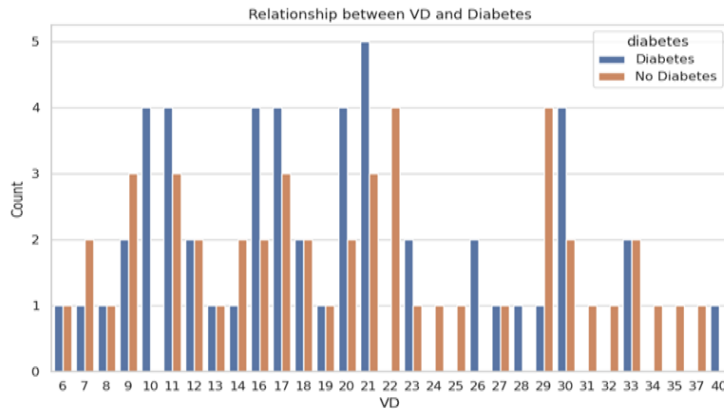


Figure 1: summarize the relationships between vitamin D levels, stenosis severity, and patient characteristics.

Severity Vitamin D Deficiency:

Among 77 CAD patients, 42 had vitamin D deficiency
CAD patients with deficiency were older (mean age 61 vs. 57.8 years; $p = 0.002$)

Higher BMI in deficient group (28.9 vs. 27.3 kg/m²; $p = 0.045$)

Slightly lower hemoglobin and higher calcium levels in deficient group

Deficiency was more common in males and diabetics, with diabetes being significantly associated ($p = 0.04$).

Severe stenosis (>90%) and single-vessel disease were more frequent in the deficient group ($p < 0.05$).

Figure 3 summarizes these patterns.

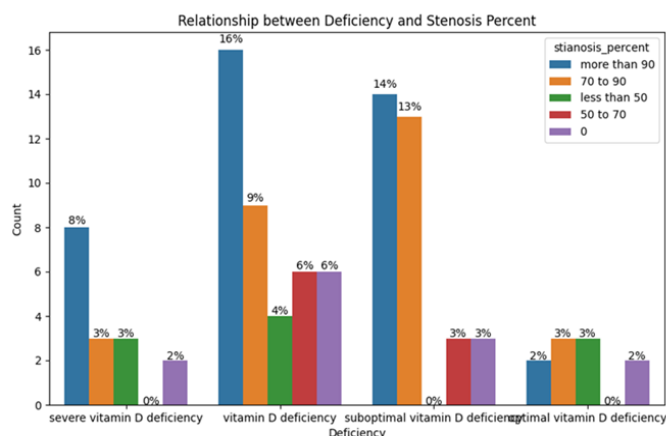


Figure 2: bar plot sowing the relationship between Deficiency and Stenosis Percent

Table 2 and Figure 4 present these findings

4) Type of Vessel Involvement:

Right coronary artery (RCA) had the highest stenosis prevalence (60%)

Most severe stenosis (70–90%) observed in the left circumflex artery (LCX)

Weak or moderate correlations were found between vitamin D levels and artery-specific stenosis (non-significant)

Table 3 summarizes these patterns.

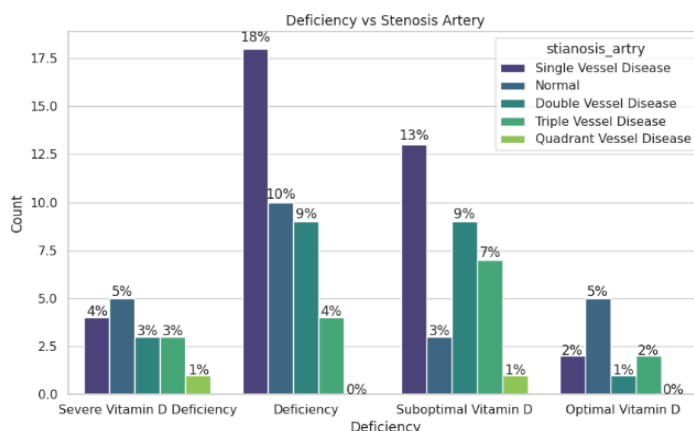


Figure 3: plot explain the effect of severity VD deficiency on the number of the artery stenosis incidence

Table 2 : Baseline Data of the Study of CAD patient with\without VDD

Base line data	CAD patient without deficiency	CAD patient with deficiency	p-value
Age (years) ($\pm$ SD)	57.81(1.40)	61.19 (1.84)	0.002
BMI(Kg/m ²)($\pm$ SD)	27.32(0.68)	28.91 (0.91)	0.045
Hb (g/dl) ($\pm$ SD)	14.23 (0.23)	14.01 (0.31)	0.037
Ca (mg/dl) ($\pm$ SD)	15.32 (0.68)	16.91 (0.91)	0.021

Baseline Data of the Study

Haemoglobin Levels

The mean haemoglobin (Hb) value, measured in grams per decilitre (g/dl) with standard deviation (SD), was 14.23 (0.23) in one group and 14.01 (0.31) in the other. The associated p-value was 0.037.

Calcium Levels

For calcium (Ca), measured in milligrams per deciliter (mg/dl) with standard deviation, the values were 15.32 (0.68) and 16.91 (0.91) respectively. The p-value associated with this comparison was 0.021. Table 2 displays all of the previous data.

Study Population and Gender Distribution

The population studied consisted of 77 individuals. Among them, 42 were CAD patients with a deficiency, and 35 were CAD patients without a deficiency.

The percentage of male participants in the study was 77.9% (60 out of 77). Among patients with the deficiency, 85.7% (36 out of 42) were male, while among those without the deficiency, 68.5% (24 out of 35) were male. The p-value for gender distribution was 0.105. table 3 explain the above data.

Table 3: incidence and the severity of the coronary artery Stenosis wihe deficiency status & Vitamin D level.

study parameter	Population (N= 77)	CAD patient with deficiency(42)	CAD patient without deficiency(35)	p-value
Male (%)	60 (77.9)	36 (85.7)	24 (68.5)	0.105
Female (%)	17 (22.0)	6 (14.2)	11 (31.4)	
post-smoker (%)	6 (7.7)	9 (21.4)	9 (25.7)	0.973
Smoker (%)	5 (6.4)	12 (28.5)	9 (25.7)	
Non-smoker (%)	12 (15.5)	21 (50)	17 (48.5)	
Hypertensive (%)	16 (20.7)	21 (50)	26 (74.2)	0.973
Non-hypertensive	6 (7.7)	21 (50)	9 (25.7)	
Diabetic (%)	5 (6.4)	27 (64.2)	19 (54.2)	0.004
Non-diabetic	18 (23.3)	15 (35.7)	16 (45.7)	
50-70% stenosis (%)	9(11.6)	6 (14.2)	3 (8.5)	0.00
>70-90% stenosis (%)	28(36.3)	12 (28.5)	16 (45.7)	
> 90% stenosis (%)	40(51.9)	24 (57.1)	16 (45.7)	
Single vessel disease (%)	37(48.0)	22 (52.3)	15 (42.8)	0.004
Double vessel disease (%)	22(28.5)	12 (28.5)	10 (28.8)	
Triple vessel disease (%)	16(20.7)	7 (16.6)	9 (25.7)	
Quadrant vessel disease (%)	2(2.5)	1 (2.4)	1 (2.8)	

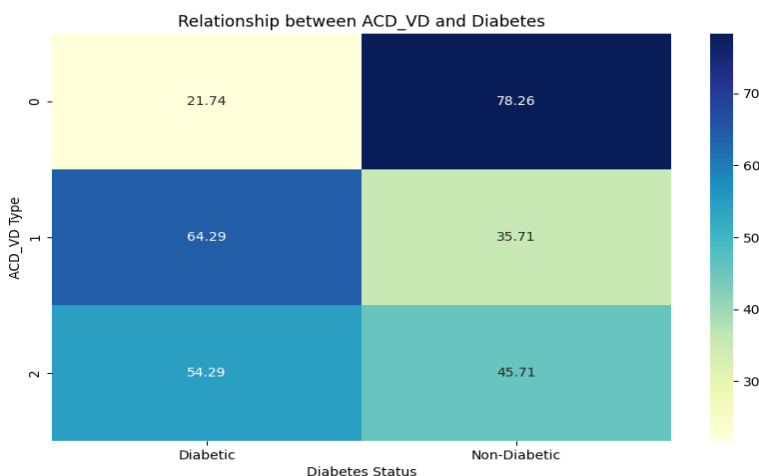


Figure 4: the relationship between the type of CAD with VDD and the presence of diabetes in patients.

V. Discussion:

The current study comprehensively explores the complex relationship between vitamin D deficiency and coronary artery disease (CAD), integrating findings from existing literature and presenting new insights. One of the key discoveries is the significant influence of diabetes on the incidence and severity of CAD, consistent with previous research (e.g., Browksi, 2019), which found that diabetic patients tend to have lower vitamin D levels and more extensive arterial involvement, emphasizing the need for nuanced understanding of diabetes' role in CAD.

Regarding vitamin D's role, the study confirms prior findings (Makoui et al., 2013; Mathew et al., 2021) that lower serum vitamin D levels are associated with higher prevalence and severity of CAD. Patients with normal coronary arteries exhibited higher vitamin D levels compared to those with obstructive disease. Interestingly, while vitamin D deficiency correlated with the presence of CAD, it did not significantly correlate with the angiographic severity measures such as percentage stenosis or the number of affected vessels, aligning with previous findings (Dhibar et al., 2016).

The research further examines the interaction between vitamin D deficiency severity and CAD, revealing no significant difference in deficiency levels relative to disease severity, which suggests the need for further detailed studies to understand these dynamics thoroughly. This aligns with earlier studies that also found no clear

association between deficiency level and disease severity, implying that other factors may mediate these relationships.

In comparing CAD patients with and without vitamin D deficiency, the study finds deficiency to be an independent predictor of CAD, with significant associations with risk factors such as hypertension, diabetes, and BMI. This supports prior research (Tajrishi and Norouzi, 2019), emphasizing that vitamin D deficiency may elevate the risk independently of other conventional factors.

Finally, regarding the impact of vitamin D on the type of stenosis artery, the findings diverge from some earlier studies (Gur et al., 2017). While previous research suggested that vitamin D deficiency influences specific arteries, particularly tortuosity in the LCX, the current results indicate that the right coronary artery (RCA) exhibits the highest frequency of stenosis, with the most severe (70-90%) stenosis observed in the LCX artery. This highlights the importance of further research to clarify how vitamin D deficiency differentially impacts various coronary arteries and their stenosis characteristics, indicating that the relationship between vitamin D and atherosclerosis is complex and warrants nuanced investigation.

VI. Limitations

- **Sample size:** Limited to 100 participants, reducing generalizability
- **Observational design:** Cannot establish causation
- **No healthy control group:** All subjects had symptoms requiring angiography
- Vitamin D supplementation status not fully tracked
- Medication history not accounted for

VII. Conclusion

This study suggests that low serum vitamin D is an independent predictor of CAD, especially among elderly males and diabetics. Although no significant correlation was found between vitamin D levels and CAD severity, the deficiency may contribute to disease onset. RCA is the most commonly affected artery, and the most severe stenosis is seen in the LCX. The high prevalence of vitamin D deficiency in Libya underscores the need for public health interventions.

Recommendation: Adults should receive at least 400 IU of vitamin D daily (range: 100–1000 IU).

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