

Assessment of Serum Vitamin D Deficiency and Its Correlation with Coronary Angiographic Severity in Acute Coronary Syndrome Patients

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Abstract

Background: Vitamin D deficiency has emerged as a potential risk factor for cardiovascular diseases, including coronary artery disease (CAD). Its role in determining the severity of CAD in patients with acute coronary syndrome (ACS) remains an area of active research. The study assessed the association between serum 25(OH)D levels and angiographic severity of CAD using SYNTAX score and vessel involvement, while also evaluating relationships with individual arterial involvement, LVEF, and other relevant clinical parameters. **Material and Methods:** This cross-sectional observational study included 150 ACS patients. Serum vitamin D was categorized by status, while coronary angiography assessed CAD severity using SYNTAX score and vessel involvement. Correlation, Chi-square, and ANOVA tests were applied, with $p < 0.05$ considered significant. **Results:** Most patients (78.7%) had vitamin D deficiency or insufficiency. Vitamin D levels inversely correlated with SYNTAX score ($r = -0.301$, $p < 0.001$) and diseased vessels ($r = -0.176$, $p = 0.031$). No significant associations were observed with arterial involvement or LVEF, while conventional risk factors were prevalent. **Conclusion:** Serum vitamin D levels were inversely associated with coronary artery disease severity in acute coronary syndrome. Vitamin D deficiency may help identify patients with severe CAD and represents a potentially modifiable risk factor. Large prospective studies are needed to establish causality and assess whether vitamin D supplementation improves cardiovascular outcomes.

Keywords: Vitamin D, Acute Coronary Syndrome, SYNTAX Score, Coronary Artery Disease, Angiographic Severity, LVEF.

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INTRODUCTION

Cardiovascular diseases (CVD) significantly contribute to global mortality and disability, currently ranking as the leading cause of death.^[1] Among these, Acute Coronary Syndrome (ACS) is a critical medical emergency characterized by myocardial ischemia due to an abrupt reduction in coronary blood flow. Notwithstanding the considerable advancements in pharmacological treatment and interventional cardiology, acute coronary syndrome continues to be a major contributor to illness and death, particularly in low- and middle-income nations.^[1] Recent studies have aimed to identify additional/lifestyle risk factors and novel modifiable risk factors, aside from classic cardiovascular risk factors like smoking, hypertension, diabetes mellitus, and dyslipidaemia. One such factor has been identified as a Vitamin D deficiency. Vitamin D has been known for its vital role in bone and mineral metabolism for a long time and is now known to have broad biological activities on cardiovascular, metabolic, and immune systems.^[2,3] Increasing evidence has linked low serum vitamin D concentrations to endothelial dysfunction, systemic inflammatory response, and activation of renin-angiotensin-aldosterone system (RAAS) thereby promoting atherogenesis and plaque instability.^[4,5] Nevertheless, the association of vitamin D deficiency with severity of coronary artery disease (CAD), especially in those with ACS, has not been sufficiently elucidated. The “gold

standard” for the assessment of the anatomical extent and severity of CAD is coronary angiography. Measuring the association between both the serum vitamin D level and the severity of the angiographic findings could assist in understanding whether there is an association between vitamin D deficiency and the disease burden of coronary disease in ACS patients. The study aimed to determine the inverse correlation between serum 25(OH)D levels and angiographic severity of CAD in ACS patients, assessed by the number of diseased vessels and SYNTAX score, and to evaluate its association with individual coronary artery involvement, LVEF, and independent predictors of high-severity CAD such as diabetes and lipid profile.

MATERIALS AND METHODS

Type of Study: An observational, cross-sectional study

Place of Study: Department of Cardiology of a tertiary care

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teaching hospital, namely Sri Rama Chandra Bhanja (SCB) Medical College & Hospital, Cuttack, Odisha, India

Study Duration: From April 2025 to March 2026

Sample Size: 150 patients

Inclusion Criteria

- Age 18 years or older
- Confirmed diagnosis of acute coronary syndrome (STEMI, NSTEMI, or unstable angina) based on clinical presentation, electrocardiographic changes, and cardiac biomarkers
- Patients who underwent coronaryangiographywithin48 hours of admission
- Patients who provided informed consent to participate in the study

Exclusion Criteria

- Chronic kidney disease with estimated glomerular filtration rate (eGFR < 30 mL/min/1.73 m²)
- Known parathyroid gland disorders
- Current vitamin D or calcium supplementation

- Chronic inflammatory or autoimmune diseases
- Malignancy.

Study Variables

- Age and sex
- Body mass index (BMI)
- Hypertension
- Diabetes mellitus
- Smoking status
- Lipid profile parameters.

Statistical Analysis: Data were entered into Excel and subsequently analyzed using SPSS and GraphPad Prism. Continuous variables were summarized as means with standard deviations, while categorical variables were presented as counts and percentages. Comparisons between independent groups were performed using two-sample t-tests, and paired t-tests were applied for correlated (paired) data. Categorical data were compared using chi-square tests, with Fisher's exact test applied when expected cell counts were small. A p-value of ≤ 0.05 was considered statistically significant.

RESULTS

Table 1: Sociodemographic Characteristics and Smoking Status of Study Patients

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	40–50	42	28
	51–60	39	26
	61–70	41	27.3
	>70	28	18.7
Sex	Male	82	54.7
	Female	68	45.3
Occupation	Homemaker	32	21.3
	Labourer	18	12
	Farmer	17	11.3
	Business	21	14
	Retired	20	13.3
	Teacher	14	9.3
	Clerk	10	6.7
	Engineer	9	6
	Driver	6	4
Smoking Status	Student	3	2
	Smokers	62	41.3
	Non-smokers	88	58.7

Table 2: Anthropometric and Clinical Characteristics of Study Patients (N=150)

Variable	Category / Criteria	Frequency (n)	Percentage (%)	P-value
BMI Category	Normal	54	36	0.009
	Overweight	63	42	
	Obese	33	22	
Pulse Rate Category	Low-normal (60–80 bpm)	52	34.7	<0.001
	High-normal (81–100 bpm)	98	65.3	
Blood Pressure Category	Normal (<120 and <80 mmHg)	14	9.3	<0.001
	Elevated (120–129 and <80 mmHg)	18	12	
	Stage 1 Hypertension (130–139 or 80–89 mmHg)	62	41.3	
	Stage 2 Hypertension (≥ 140 or ≥ 90 mmHg)	56	37.3	
FBS Category	Normal (<100 mg/dL)	34	22.7	0.006
	Prediabetes (100–125 mg/dL)	66	44	
	Diabetes (≥ 126 mg/dL)	50	33.3	

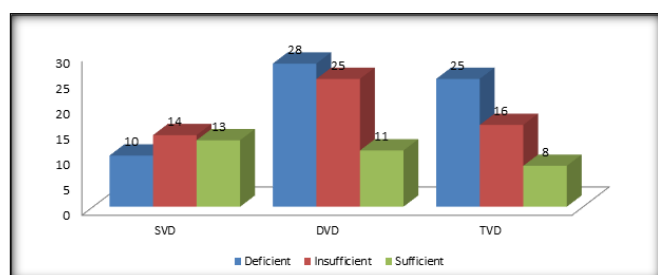
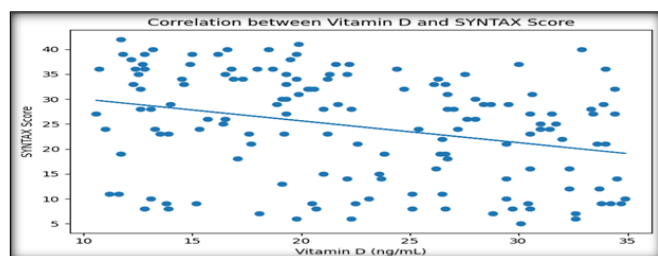
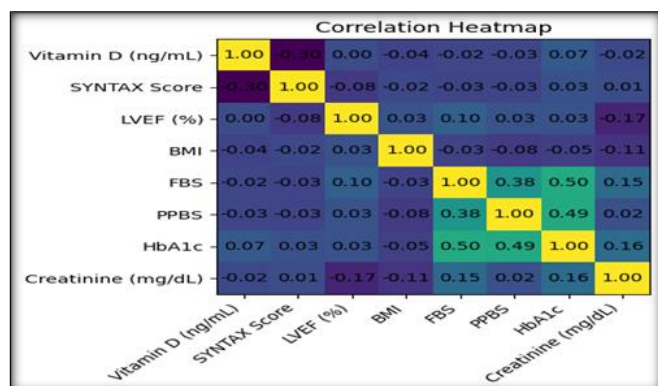
Table 3: Distribution of PPBS and HbA1c Categories among Study Patients (N=150)

Variable	Category	Range	Frequency (n)	Percentage (%)	P-value
PPBS Category	Normal	<140 mg/dL	2	1.3	<0.001
	Prediabetes	140–199 mg/dL	81	54	
	Diabetes	≥ 200 mg/dL	67	44.7	
HbA1c Category	Normal	<5.7%	15	10	<0.001

Prediabetes	5.7–6.4%	53	35.3
Diabetes	≥6.5%	82	54.7

Table 4: Distribution of Dyslipidemia, SYNTAX Score, Vitamin D Status, CAG Severity and LVEF among Study Patients (N=150)

Variable	Category	Score Range / Criteria	Frequency (n)	Percentage (%)	P-value
Dyslipidemia	Present (Yes)	—	64	42.7	0.072
	Absent (No)	—	86	57.3	
SYNTAX Score	Low	≤22	55	36.7	0.002
	Intermediate	23–32	52	34.7	
	High	>32	43	28.6	
Vitamin D Status	Deficient	—	63	42	0.006
	Insufficient	—	55	36.7	
	Sufficient	—	32	21.3	
CAG Severity	Single Vessel Disease (SVD)	—	37	24.7	0.026
	Double Vessel Disease (DVD)	—	64	42.7	
	Triple Vessel Disease (TVD)	—	49	32.7	
LVEF	Normal	—	68	45.3	<0.001
	Mild Dysfunction	—	56	37.3	
	Moderate Dysfunction	—	26	17.3	
	Severe Dysfunction	—	0	0	


Figure 1: Bar chart of Vitamin D vs CAG findings

Figure 2: Scatter plot of correlation between Vitamin D and Syntax Score

Figure 3: Correlation Heat map showing association between different parameters.

Among the 150 study patients, the largest proportion belonged to the 40–50 years age group (42, 28%), followed

by 61–70 years (41, 27.3%), 51–60 years (39, 26%), and >70 years (28, 18.7%). Males constituted 82 (54.7%) of the study population, while females accounted for 68 (45.3%). Regarding occupation, homemakers were the most common group (32, 21.3%), followed by businesspersons (21, 14%), retired individuals (20, 13.3%), labourers (18, 12%), farmers (17, 11.3%), teachers (14, 9.3%), clerks (10, 6.7%), engineers (9, 6%), drivers (6, 4%), and students (3, 2%). With respect to smoking status, 62 (41.3%) patients were smokers, whereas 88 (58.7%) were non-smokers. [Table 1]

Among the 150 patients, 54 (36%) had normal BMI, 63 (42%) were overweight, and 33 (22%) were obese, with a statistically significant distribution ($p=0.009$). Regarding pulse rate, 52 (34.7%) patients had a low-normal pulse rate of 60–80 bpm, while 98 (65.3%) had a high-normal pulse rate of 81–100 bpm ($p<0.001$). Blood pressure assessment showed that 14 (9.3%) patients had normal blood pressure, 18 (12%) had elevated blood pressure, 62 (41.3%) had Stage 1 hypertension, and 56 (37.3%) had Stage 2 hypertension, with a statistically significant distribution ($p<0.001$). For FBS, 34 (22.7%) patients had normal values, 66 (44%) had prediabetes, and 50 (33.3%) had diabetes, with a statistically significant difference ($p=0.006$). [Table 2]

Among the study patients, only 2 (1.3%) had normal PPBS levels, while 81 (54%) had PPBS in the prediabetic range and 67 (44.7%) had values in the diabetic range. The distribution of PPBS categories was statistically significant ($p<0.001$). Regarding HbA1c, 15 (10%) patients had normal values, 53 (35.3%) were in the prediabetic range, and 82 (54.7%) had HbA1c values suggestive of diabetes. The distribution of HbA1c categories was statistically significant ($p<0.001$). [Table 3]

Dyslipidemia was present in 64 (42.7%) patients and absent in 86 (57.3%), with no statistically significant difference ($p=0.072$). Regarding SYNTAX score, 55 (36.7%) patients had a low score, 52 (34.7%) had an intermediate score, and 43 (28.6%) had a high score, showing a statistically significant distribution ($p=0.002$). Vitamin D deficiency was observed in 63 (42%) patients, while 55 (36.7%) had insufficient levels and 32 (21.3%) had sufficient levels ($p=0.006$). Coronary

angiography showed single-vessel disease in 37 (24.7%), double-vessel disease in 64 (42.7%), and triple-vessel disease in 49 (32.7%) patients, with a statistically significant distribution ($p=0.026$). Regarding LVEF, 68 (45.3%) patients had normal LVEF, 56 (37.3%) had mild dysfunction, and 26 (17.3%) had moderate dysfunction. No patient had severe LV dysfunction. The distribution of LVEF categories was statistically significant ($p<0.001$). [Table 4]

Among the 150 participants, vitamin D deficiency was observed in 63 (42.0%), insufficiency in 55 (36.7%), and sufficient vitamin D status in 32 (21.3%). In the SVD group, 10 (27.0%) were deficient, 14 (37.8%) insufficient, and 13 (35.1%) sufficient, whereas in the DVD group, 28 (43.8%) were deficient, 25 (39.1%) insufficient, and 11 (17.2%) sufficient. In the TVD group, 25 (51.0%) were deficient, 16 (32.7%) insufficient, and 8 (16.3%) sufficient. Although vitamin D deficiency showed an increasing trend from SVD to TVD, the association between vitamin D status and diabetic retinopathy type was not statistically significant ($p = 0.103$). [Figure 1]

Vitamin D levels demonstrated a statistically significant inverse correlation with the SYNTAX score ($r = -0.301$, $p = 0.00018$). A lower vitamin D level was associated with a higher SYNTAX score, reflecting greater angiographic complexity of coronary artery disease. [Figure 2]

The correlation analysis demonstrated a moderate negative correlation between Vitamin D and SYNTAX Score ($r = -0.30$), indicating that higher Vitamin D levels were associated with lower SYNTAX Scores. Among the glycemic parameters, FBS showed a moderate positive correlation with HbA1c ($r = 0.50$) and PPBS ($r = 0.38$), while PPBS also showed a moderate positive correlation with HbA1c ($r = 0.49$). In contrast, Vitamin D showed very weak correlations with BMI, FBS, PPBS, HbA1c, and creatinine. LVEF, BMI, and creatinine also demonstrated mostly weak or negligible correlations with the other variables. Overall, the strongest associations were observed among the glycemic parameters, while the relationship between Vitamin D and SYNTAX Score was the main finding related to coronary disease severity. [Figure 3]

DISCUSSION

In the present study, the largest proportion of patients belonged to the 40–50 years age group (28%), followed by 61–70 years (27.3%) and 51–60 years (26%). Males constituted 54.7% of the study population, while females accounted for 45.3%. Smokers comprised 41.3% of patients. This predominance of middle-aged and older males is consistent with previous studies evaluating vitamin D status and coronary artery disease. Liew et al,^[6] reported a mean age of 66 years with male predominance among patients undergoing coronary angiography, while Bakır et al,^[7] reported a mean age of 63.3 years and 80.5% males among ACS patients. Similarly, Pillai et al,^[8] observed male predominance (67.2%) among patients undergoing coronary angiography. In the present study, 42% of patients were overweight and 22% were obese, while only 36% had

normal BMI, with a statistically significant distribution ($p=0.009$). Obesity is frequently associated with vitamin D deficiency and adverse cardiovascular risk factors. Candemir et al,^[9] demonstrated that lower serum 25(OH)D levels were associated with higher SYNTAX scores in obese patients undergoing coronary angiography, with vitamin D independently predicting CAD severity. Hypertension was also common, with 41.3% having Stage 1 and 37.3% having Stage 2 hypertension. Seker et al,^[10] similarly reported significant associations between vitamin D levels, hypertension and CAD severity. Abnormal glucose metabolism was frequent, with 44% having prediabetic FBS and 33.3% having diabetes. Postprandial glucose showed 54% prediabetic and 44.7% diabetic values, while HbA1c demonstrated 35.3% prediabetic and 54.7% diabetic values; both distributions were statistically significant ($p<0.001$). Bakthavatchalam et al,^[11] reported an association between vitamin D deficiency, diabetes and HbA1c among CAD patients, including a significant negative correlation between vitamin D and HbA1c ($r=-0.269$, $p=0.008$). Dyslipidemia was present in 42.7% of patients but was not statistically significant ($p=0.072$). The most important finding was the high prevalence of vitamin D deficiency. Deficiency was present in 42% of patients, insufficiency in 36.7%, and sufficient levels in only 21.3% ($p=0.006$). Dhibar et al,^[12] reported a high prevalence of vitamin D deficiency among Indian CAD patients and an association with angiographic severity. Liew et al,^[6] also observed progressively lower vitamin D concentrations with increasing CAD extent, particularly triple-vessel disease. Bakır et al,^[7] reported significantly lower vitamin D levels in patients with high SYNTAX scores (16.7 ± 6.8 vs. 21.0 ± 8.0 ng/mL, $p=0.005$), while Pillai et al,^[8] demonstrated a negative correlation between vitamin D and SYNTAX score ($r=-0.323$). Awasthi et al,^[13] in 101 Indian ACS patients, reported vitamin D deficiency in 43.56%, closely comparable to 42% in the present study, and found an association between deficiency and severe coronary involvement. Similarly, Rahman et al,^[14] reported significantly greater double- or triple-vessel disease among patients with vitamin D below 30 ng/mL, with inverse correlations with vessel score and Gensini score. A 2024 ACS study,^[15] also reported significantly higher Gensini and SYNTAX scores among vitamin D-deficient patients, with strong inverse correlations with vitamin D. In the present study, double-vessel disease was most common (42.7%), followed by triple-vessel (32.7%) and single-vessel disease (24.7%). SYNTAX scores were also significantly distributed, with 36.7% low, 34.7% intermediate and 28.6% high scores ($p=0.002$). Regarding LVEF, 45.3% had normal function, while 37.3% had mild and 17.3% moderate dysfunction ($p<0.001$). However, Bakthavatchalam et al,^[11] found no significant overall correlation between vitamin D and SYNTAX score ($r=-0.039$, $p=0.707$), despite an association with triple-vessel disease. Overall, the present findings support an inverse relationship between vitamin D status and coronary disease severity, although this association may vary according to population and clinical characteristics.

Vitamin D deficiency was the most common anomaly at 42.0%, succeeded by insufficiency at 36.7%. The incidence of deficiency rose steadily among SVD (27.0%), DVD (43.8%), and TVD (51.0%) cohorts; yet, this correlation did not reach

statistical significance ($p=0.103$). A statistically significant negative association was identified between vitamin D concentrations and SYNTAX score ($r=-0.301$, $p=0.00018$), indicating that diminished vitamin D levels correlate with increased angiographic complexity. Moderate positive associations were noted between FBS, PPBS, and HbA1c, while vitamin D exhibited weak relationships with BMI, glycemic metrics, and creatinine levels.

CONCLUSION

We concluded that vitamin D deficiency and insufficiency were common among patients presenting with acute coronary syndrome and were associated with a substantial burden of cardiovascular risk factors, including overweight/obesity, hypertension, abnormal glycaemic status, dyslipidemia, multivessel coronary artery disease, and left ventricular systolic dysfunction. Although vitamin D deficiency increased progressively from SVD to DVD and TVD, this association with the number of diseased vessels was not statistically significant. However, lower vitamin D concentrations were significantly associated with higher SYNTAX scores, indicating a relationship between suboptimal vitamin D status and greater angiographic complexity of coronary artery disease. Thus, assessment of serum vitamin D levels may provide additional information for cardiovascular risk stratification in ACS patients, while further studies are needed to clarify its clinical significance.

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Conflicts of interest

There are no conflicts of interest.

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