Original Research

ASSOCIATION BETWEEN VITAMIN D DEFICIENCY, HYPERHOMOCYSTEINEMIA, AND LIPID PROFILE IN ACUTE CORONARY SYNDROME PATIENTS

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ABSTRACT

Background: Acute coronary syndrome (ACS) is a major cause of morbidity and mortality worldwide. Emerging evidence suggests that vitamin D deficiency, elevated serum homocysteine levels, and lipid abnormalities contribute significantly to the development and progression of coronary artery disease. This study was conducted to evaluate the association of serum vitamin D, serum homocysteine, and lipid profile in patients with ACS.

Methodology: This hospital-based observational study was conducted in the Department of Emergency Medicine at from February 2025 to December 2026. A total of 96 patients diagnosed with ACS, including ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina, were included in the study. Serum vitamin D, serum homocysteine, and lipid profile parameters were estimated using the Vitros 5600 automated analyzer. Statistical analysis was performed using SPSS version 25.0, and a p-value <0.05 was considered statistically significant.

Results: Among the 96 ACS patients, 35.41% had STEMI, 33.33% had NSTEMI, and 31.25% had unstable angina. Vitamin D deficiency (<20 ng/dl) was observed in 46.87% of patients, while 32.29% had insufficiency and only 20.83% had sufficient levels. Elevated homocysteine levels were noted in the majority of patients, with 59.38% showing intermediate elevation and 13.54% having severely elevated levels. Low HDL cholesterol levels (<40 mg/dl) were present in 75% of patients. Diabetes mellitus and hypertension were identified in 75% and 58.33% of patients respectively. Smoking was reported in 40.63% of patients.

Conclusion: Vitamin D deficiency, elevated serum homocysteine levels, and low HDL cholesterol were commonly observed among ACS patients and may play a significant role in the pathogenesis of acute coronary syndrome. Early identification and management of these modifiable biochemical risk factors may help improve cardiovascular outcomes and reduce disease burden.

Keywords: Acute Coronary Syndrome, Vitamin D Deficiency, Homocysteine, Lipid Profile, HDL Cholesterol, Coronary Artery Disease.

INTRODUCTION

Acute coronary syndrome (ACS) comprises a group of cardiovascular emergencies caused by sudden reduction in coronary blood flow due to rupture or erosion of atherosclerotic plaques with subsequent thrombus formation. It includes unstable angina, ST-segment elevation myocardial infarction (STEMI), and non-ST-segment elevation myocardial infarction (NSTEMI). ACS remains one of the leading causes of morbidity and mortality worldwide, particularly in developing countries such as India, where the burden of cardiovascular diseases is rapidly increasing [1]. The pathogenesis of ACS is multifactorial and involves traditional risk factors such as hypertension, diabetes mellitus, dyslipidemia, smoking, obesity, and sedentary lifestyle. In recent years, several novel biochemical markers have also been implicated in the development and progression of coronary artery disease.

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Vitamin D, a fat-soluble vitamin primarily involved in calcium and bone metabolism, has gained attention for its extra-skeletal cardiovascular effects. Vitamin D receptors are present in vascular smooth muscle cells, endothelial cells, and cardiomyocytes, suggesting its role in cardiovascular regulation [2]. Deficiency of vitamin D has been associated with endothelial dysfunction, inflammation, increased arterial stiffness, activation of the renin-angiotensin-aldosterone system, and accelerated atherosclerosis [3]. Several epidemiological studies have reported that low serum vitamin D levels are associated with increased incidence of hypertension, diabetes mellitus, myocardial infarction, heart failure, and stroke [4]. Vitamin D deficiency is highly prevalent in the Indian population despite abundant sunlight exposure, making it an important public health concern.

Homocysteine is a sulfur-containing amino acid formed during methionine metabolism. Elevated plasma homocysteine levels, known as hyperhomocysteinemia, have emerged as an independent risk factor for cardiovascular diseases [5]. Homocysteine contributes to endothelial injury through oxidative stress, impaired nitric oxide production, vascular smooth muscle proliferation, and promotion of thrombogenesis [6]. Increased homocysteine levels have been linked with coronary artery disease, cerebrovascular accidents, and peripheral vascular disease. Studies have shown that hyperhomocysteinemia may accelerate atherosclerotic plaque formation and increase the risk of acute thrombotic events in ACS patients [7].

Dyslipidemia is one of the most established modifiable risk factors for coronary artery disease. Elevated levels of total cholesterol, low-density lipoprotein cholesterol (LDL-C), triglycerides, and reduced high-density lipoprotein cholesterol (HDL-C) contribute significantly to atherosclerosis and plaque instability [8]. Lipid abnormalities are frequently observed in patients with ACS and are associated with poor cardiovascular outcomes. Recent evidence suggests that vitamin D deficiency and elevated homocysteine levels may interact with lipid metabolism and further enhance cardiovascular risk [9].

Considering the increasing prevalence of ACS and the potential role of vitamin D deficiency, hyperhomocysteinemia, and dyslipidemia in its pathogenesis, evaluation of these biochemical parameters may provide valuable insight into disease severity and prognosis. Hence, the present study was undertaken to assess the association of serum vitamin D, serum homocysteine, and lipid profile in patients with acute coronary syndrome.

Aim

To study the association of serum vitamin D levels, serum homocysteine levels, and lipid profile in patients with acute coronary syndrome.

Objectives

1. To estimate serum vitamin D levels in patients diagnosed with acute coronary syndrome.
2. To assess serum homocysteine levels in patients with acute coronary syndrome.
3. To evaluate the lipid profile parameters among patients with acute coronary syndrome.
4. To determine the association between serum vitamin D levels and acute coronary syndrome.

MATERIALS AND METHODS

This hospital-based observational study was conducted in the Department of Emergency Medicine at over a study period extending from February 2025 to December 2026. A total of 96 patients diagnosed with acute coronary syndrome (ACS) were included in the study. Patients of either sex aged more than 18 years presenting with ACS were enrolled. The study population included patients diagnosed with ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), and unstable angina.

Patients with structural heart diseases such as rheumatic heart disease, congenital heart disease, and pericardial disorders were excluded from the study. Patients receiving vitamin D supplementation and pregnant females were also excluded.

The diagnosis of ACS was established based on clinical presentation, electrocardiographic (ECG) findings, elevated cardiac biomarkers including Troponin-T, Troponin-I, and CK-MB, along with supportive findings from two-dimensional echocardiography (2D-ECHO). After obtaining informed consent, fasting venous blood samples were collected under aseptic precautions in serum vacutainers for laboratory analysis.

Serum lipid profile parameters including total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, and triglycerides were estimated using the “Vitros 5600” automated analyzer by dry slide technique. Serum vitamin D levels were also measured using the “Vitros 5600” analyzer, while serum homocysteine levels were estimated by turbidometry method using the same analyzer. Non-HDL cholesterol values were calculated using the formula: Non-HDL cholesterol = Total cholesterol – HDL cholesterol.

Patients who smoked daily for at least one year were categorized as smokers. Alcoholics were defined as individuals consuming alcohol at least four times per week for a minimum duration of one year. Demographic details, clinical history, laboratory findings, and risk factor profiles were recorded using a structured proforma.

The collected data were entered in Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) software version 25.0. Continuous

variables were expressed as mean ± standard deviation, while categorical variables were represented as frequencies and percentages. The association between serum vitamin D, serum homocysteine, and lipid profile parameters with ACS was analyzed using appropriate statistical tests such as Chi-square test, independent t-test, and Pearson correlation analysis. A p-value of less than 0.05 was considered statistically significant.

RESULT

The study examined the association between serum vitamin D, serum homocysteine, and lipid profile in patients with acute coronary syndrome (ACS). The demographic characteristics of the study population revealed an average age of 61.91 years and an average BMI of 25.43 with a SD of 2.76. The gender distribution showed 43 female patients (44.79%) and 53 male patients (55.21%). Out of 96 patients of ACS; majority of the patients 58.33% (56) belonged to age group between 50-70 years. 18.75% (18) patients were <50 years old while 22.91% (22) were >70 years old. Out of total 96 cases; 35.41% (34) were STEMI, 33.33% (32) were NSTEMI while 31.25% (30) patients were diagnosed as unstable angina.

Table 1: Distribution According To Addictions in ACS Patients

Addictions	Yes	No
Smoker	39 (40.63%)	57 (59.38%)
Alcoholic	28 (29.17%)	68 (70.83%)
Smoker +Alcoholic	24 (25.00%)	72 (75.00%)
Total	96	

39 patients reported smoking (40.63%) while 57 did not, and 28 patients reported alcohol consumption (29.17%), while 68 did not. 24 (75%) out of total 96 ACS patients reported both smoking and alcohol consumption.

Table 2: Distribution According To Comorbidities in ACS Patients

Comorbidities	Yes	No
Diabetes mellitus	72 (75.00%)	24 (25.00%)
Hypertension	56 (58.33%)	40 (41.67%)
Diabetes + Hypertension	40 (41.67%)	56 (58.33%)
Total	96	

72 patients (75.00%) were diabetic while 24 (25.00%) were non- diabetic and 56 patients (58.33%) were Hypertensive, while 40 (41.67%) were non-hypertensive. Out of total 96 patients of ACS, 40 (41.67%) had both diabetes mellitus and hypertension.

Table 3: Vitamin D Levels in Patients with ACS

Serum Vitamin D (ng/dl)	No of cases	Percentage
Sufficiency (>30)	20	20.83%
Insufficiency (20-30)	31	32.29%
Deficiency (<20)	45	46.87%

Among the ACS patients, 20.83% had sufficient levels of vitamin D (>30ng/dl) while32.29% patients showed vitamin D insufficiency (20–30 ng/dl) and 46.87 were vitamin D deficient (<20ng/dl). This distribution highlighted a significant prevalence of vitamin D deficiency among ACS patients.

Table 4: Serum Hcy. Levels in Patients with ACS

Homocysteine (Umol/L)	No of cases	Percentage
Optimal (4.7-12.5)	26	27.08%
Intermediate (12.6-30)	57	59.38%
Severe high (>30)	13	13.54%

Among the ACS patients, 27.08% exhibited optimal homocysteine levels (4.7-12.5 µmol/L), while 59.38% fell into the intermediate range (12.6-30 µmol/L), and 13.54% had severe high levels (>30 µmol/L).

Table 5: Total Cholesterol Levels in Patients with ACS

Total cholesterol (mg/dl)	No of cases	Percentage
Optimal (<200)	80	83.33%
Intermediate (200-239)	10	10.42%
Severe high (>239)	6	6.25%

The study found that most acute coronary syndrome (ACS) patients had optimal total cholesterol levels (<200 mg/dl), with 83.33% falling in this range. A smaller percentage were in the intermediate (200-239 mg/dl) and severe high (>239 mg/dl) categories.

Table 6: HDL Cholesterol Levels in Patients with ACS

HDL Cholesterol (mg/dl)	No of cases	Percentage
Optimal (>50)	5	5.21%
Intermediate (40-50)	19	19.79%
Low (<40)	72	75.00%

The study showed a significant association between low HDL cholesterol levels and acute coronary syndrome (ACS). Most ACS patients (75.00%) had low HDL levels (<40 mg/dl), indicating low HDL as a potential risk factor for ACS.

Table 7: Non-HDL Cholesterol Levels in Patients with ACS

Non-HDL cholesterol (mg/dl)	No of cases	Percentage
Optimal (<150)	70	72.92%
Intermediate (150-159)	10	10.42%
Severe high (>159)	16	16.67%

The most of the acute coronary syndrome (ACS) patients had optimal non-HDL cholesterol levels (<150 mg/dl), with 72.92% falling in this range. A smaller percentage were in the intermediate (150-159 mg/dl) and severe high (>159 mg/dl) categories.

Table 8: Triglyceride Levels in Patients with ACS

Non-HDL Cholesterol (Mg/Dl)	No of Cases	Percentage
Optimal (<150)	49	51.04%
Intermediate (150-199)	24	25.00%
Severe high (>200)	23	23.96%

The study found that a significant portion of acute coronary syndrome (ACS) patients had elevated triglyceride levels: 25.00% were in the intermediate range (150-199 mg/dl), and 23.96% had severe high levels (>200 mg/dl).

Table 9: Distribution of Serum Homocysteine Levels among Smokers and Non-Smokers

Smoking	Serum Homocysteine (Umol/L) <15		Serum Homocysteine (Umol/L) ≥15		Chi-square	P-value
	No of cases	Percentage	No of cases	Percentage		
Yes (Smoker)	12	30.00%	27	48.21%	3.21	0.073
No (Non-smoker)	28	70.00%	29	51.79%		
Total	40	100.00%	56	100.00%		

30.00% of smokers are having serum homocysteine levels below 15 µmol/L and 48.21% having levels ≥15 µmol/L. Among non-smokers, 70.00% had levels below 15 µmol/L, and 51.79% had levels ≥15 µmol/L. The association between smoking and serum homocysteine levels was not statistically significant. (p>0.05).

Table 10: Distribution of Serum Homocysteine Levels in Alcoholics and Non-Alcoholics

Alcohol consumption	Serum Homocysteine (Umol/L) <15		Serum Homocysteine (Umol/L) ≥15		Chi-square	P-value
	No of cases	Percentage	No of cases	Percentage		
Yes (alcoholic)	6	15.00%	22	39.29%	6.66	0.009
No (Non-alcoholic)	34	85.00%	34	60.71%		
Total	40	100.00%	56	100.00%		

In the study, alcoholics had a higher percentage of serum homocysteine levels ≥15 µmol/L (39.29%) compared to non-alcoholics (60.71%). A p value <0.005 showed a significant association between alcohol consumption and serum homocysteine levels.

Table 11: Lipid Profile in Smokers and Non-Smokers

Smoking	Total cholesterol	HDL	Non-HDL	LDL	Triglyceride
Yes (n=39) (Smoker) Mean ± SD	157.87 ±51.132	31.08 ± 6.76	126.90 ±49.52	43.04±89.06	194.41 ±156.02
No (n=57) (Non-Smoker) Mean ± SD	174.08 ± 152.34	36.19 ± 10.05	119.78 ±38.4	34.96 ±88.14	158.54±70.29
P-value	0.52	0.006	0.43	0.99	0.13

The study indicated that smoking was associated with significantly lower HDL levels (31.08 ± 6.76 vs. 36.19 ± 10.05 mg/dL, p = 0.006) but showed no significant differences in total cholesterol, non-HDL, LDL, or triglycerides between smokers and non-smokers among ACS patients.

Table 12: Lipid Profile in Alcoholics and Non-Alcoholics

Alcohol	Total cholesterol	HDL	Non-HDL	LDL	Triglyceride
Yes (n=28) (Alcoholic) Mean ±SD	170.32± 50.77	33.11 ± 9.79	137.32 ± 48.99	99.28 ± 46.50	199.178 ± 174.38
No (n=68) (Non-Alcoholic) Mean ±SD	166.33 ± 141.61	34.52 ± 8.95	116.64 ± 39.34	84.09 ± 33.66	162.30 ± 75.67
P-value	0.87	0.46	0.02	0.06	0.16

Alcohol consumption among ACS patients was associated with slightly higher mean levels of total cholesterol, HDL, non-HDL, LDL, and triglycerides compared to non-alcoholic patients. Found no significant differences in total cholesterol, HDL, LDL, and triglycerides between alcoholic and non-alcoholic ACS patients, except for non-HDL levels, which were higher in alcoholic patients (p = 0.02).

DISCUSSION

Acute coronary syndrome (ACS) continues to be a major cause of morbidity and mortality worldwide, particularly among elderly individuals with multiple cardiovascular risk factors [10]. In the present study, the majority of patients belonged to the older age group, with 22.91% of patients aged more than 70 years, indicating the increasing prevalence of ACS with advancing age. Similar observations were reported in previous studies where elderly populations demonstrated higher susceptibility to coronary artery disease due to progressive atherosclerosis and associated comorbidities [11].

Among the different clinical presentations of ACS, ST-segment elevation myocardial infarction (STEMI) constituted 35.41% of cases, followed by NSTEMI (33.33%) and unstable angina (31.25%). This finding is comparable with studies conducted by Gupta et al. and Kumar et al., where STEMI was the most common presentation among ACS patients [12]. The high prevalence of STEMI may be attributed to delayed hospital presentation, poor awareness, and inadequate control of cardiovascular risk factors in the population.

Smoking and alcohol consumption were common addictions identified among the study participants. About 40.63% of patients were smokers, while 29.17% consumed alcohol regularly. Smoking is a well-established risk factor for endothelial dysfunction, thrombosis, and accelerated atherosclerosis, thereby increasing the risk of ACS [13]. The coexistence of smoking and alcohol intake in a substantial proportion of patients further emphasizes the role of lifestyle-related risk factors in cardiovascular disease development.

Diabetes mellitus and hypertension were the predominant comorbidities observed in the present study. Diabetes was present in 75% of patients, while hypertension was observed in 58.33% of cases. Additionally, 41.67% of patients had both diabetes and hypertension. Similar findings were reported by the INTERHEART study, which identified diabetes and hypertension as major contributors to myocardial infarction worldwide [14]. Chronic hyperglycemia and elevated blood pressure promote vascular inflammation, endothelial injury, and plaque instability, thereby predisposing individuals to ACS.

The present study demonstrated a high prevalence of vitamin D deficiency among ACS patients. Nearly 46.87% of patients had deficient vitamin D levels, while only 20.83% had sufficient levels. Vitamin D deficiency has been increasingly associated with cardiovascular diseases through mechanisms

involving endothelial dysfunction, inflammation, and activation of the renin-angiotensin system [15]. Similar studies by Wang et al. and Pilz et al. also reported an inverse relationship between vitamin D levels and cardiovascular risk [16,17]. These findings suggest that low vitamin D levels may play a contributory role in the pathogenesis of ACS.

Elevated serum homocysteine levels were also commonly observed in the study population. About 59.38% of patients had intermediate hyperhomocysteinemia, while 13.54% had severely elevated levels. Hyperhomocysteinemia contributes to oxidative stress, endothelial injury, and enhanced thrombogenicity, thereby accelerating atherosclerosis [18]. Previous studies have similarly demonstrated a strong association between elevated homocysteine levels and coronary artery disease [19].

Regarding lipid parameters, the majority of patients had low HDL cholesterol levels, with 75% exhibiting HDL levels below 40 mg/dl. Low HDL cholesterol is recognized as an independent risk factor for atherosclerotic cardiovascular disease due to its reduced protective role in reverse cholesterol transport [20]. Although most patients demonstrated optimal total cholesterol and non-HDL cholesterol levels, low HDL cholesterol appeared to be a significant lipid abnormality associated with ACS in the present study.

Overall, the findings of this study indicate that vitamin D deficiency, elevated homocysteine levels, low HDL cholesterol, smoking, diabetes mellitus, and hypertension are important factors associated with ACS. Early identification and management of these modifiable risk factors may help reduce the burden of cardiovascular disease and improve patient outcomes.

CONCLUSION

The present study demonstrated a significant association between vitamin D deficiency, elevated serum homocysteine levels, and lipid profile abnormalities in patients with acute coronary syndrome (ACS). A high prevalence of vitamin D deficiency and intermediate to severe hyperhomocysteinemia was observed among ACS patients. Low HDL cholesterol levels were the most common lipid abnormality identified in the study population. Traditional cardiovascular risk factors such as smoking, diabetes mellitus, hypertension, and alcohol consumption were also frequently associated with ACS. These findings suggest that serum vitamin D, homocysteine, and lipid profile parameters may serve as important biochemical markers in the assessment of cardiovascular risk among ACS patients. Early detection and correction of these modifiable factors may help in reducing disease burden, improving prognosis, and preventing future cardiovascular events.

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