Natural Resources for Human Health
eISSN: 2583-1194

Original Research

Received 20 March 2026
Revised 24 April 2026
Accepted 22 May 2026

Natural Resources for Human Health 2026, Vol. 6 (2s): 155–166

KEYWORDS:
Vitamin D deficiency, Acute coronary syndrome, Coronary artery disease, Cardiovascular disease, Prevalence, Observational study, Myocardial infarction, Vitamin D

Prevalence Of Vitamin D Deficiency in Patients Presenting with Acute Coronay Syndrome: An Observational Study

[1]Dr. Bilal Ismail, [2]Dr. Raghavi Ravikumar, [3]Dr. Giridharan

[1]Post Graduate, Department of General Medicine, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth University, Pillaiyarkuppam, Puducherry, 607402, India E-mail Address: drbilalismail18@gmail.com 0009-0004-5851- 3885
[2]Assistant Professor, Department of General Medicine, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth University Pillaiyarkuppam, Puducherry, 607402, India E-mail Address: raghaviravi2011@gmail.com https://orcid.org/0009-0009-6872-3997 Corresponding Author
[3]Professor and HOD, Department of Cardiology, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth University Pillaiyarkuppam, Puducherry, 607402, India

ABSTRACT: Vitamins are essential micronutrients required for maintaining normal physiological functions. Among them, vitamin D is unique as it functions both as a vitamin and a hormone. Vitamin D deficiency has become highly prevalent worldwide, including in India, and has been implicated in several systemic disorders, particularly cardiovascular diseases. Recent evidence suggests that vitamin D deficiency may contribute to the pathogenesis of ACS through endothelial dysfunction, activation of the renin–angiotensin–aldosterone system, and pro-inflammatory mechanisms. However, the association between vitamin D levels and ACS, as well as its relationship with disease severity, remains inconclusive

Background:

Cardiovascular diseases (CVDs), more specifically Acute Myocardial Infarction is considered the leading cause of death globally.

More than 75% of CVD deaths take place in low- and middle-income countries. 38% of premature deaths due to noncommunicable diseases were caused by CVDs.

Traditionally, a number of risk factors have been recognised with regard to development of Myocardial infarction. Several studies done over the last 2 decades have identified new risk factors with potential relevant therapeutic implications. Vitamin D deficiency, amongst others has been the focus of recent interest.

Vitamin D deficiency occurs in 50% of the world's population. The Prevalence of Vitamin D deficiency in India ranges 50% to 94% and 37% to 99% in community-based and hospital-based studies respectively.(2) The causes for high prevalence of Vitamin D deficiency in Indians is attributed to dark-skin, lack of adequate direct skin exposure to sunlight and lack of vitamin D in predominant Indian diet.

Several recent studies have reported an association between Vitamin D deficiency and Cardiovascular disease; proposed mechanisms being varied. Nuclear Vitamin D receptors have been detected on cardiomyocytes and vascular endothelial cells which could possibly mediate the cardiovascular effects.

Natural Resources for Human Health
eISSN: 2583-1194

Not only is low Vitamin D levels, an independent risk factor for Acute Myocardial Infarction but is also associated with worse outcome; however the causal relationship between the latter needs to be further evaluated.

Considering the therapeutic implications in patients with CAD and its long term benefits if proven, we aimed to study the prevalence of Vitamin D deficiency in patients presenting with ACS; thereby paving the way for future interventional studies.

Aim: To evaluate serum vitamin D levels in patients presenting with acute coronary syndrome and compare them with age- and gender-matched controls, and to assess its association with occurrence and angiographic severity of coronary artery disease.

Materials and Methods:

A comparative case–control study conducted in a tertiary care hospital in Puducherry involving 130 participants, with 65 ACS patients and 65 age- and gender-matched controls. Patients aged >18 years were included after informed consent. Individuals on vitamin D supplementation and those with chronic kidney disease, liver disease, nephrotic syndrome, hypoparathyroidism, or drugs affecting vitamin D metabolism were excluded. About 2 mL of venous blood was collected for estimation of serum 25-hydroxyvitamin D along with routine investigations. Clinical data, including risk factors and coronary angiographic findings, were recorded. Statistical analysis was performed to compare vitamin D levels between groups and assess their association with ACS and number of coronary vessels involved. Multivariate logistic regression was used to identify independent predictors of ACS.

Results: The majority of participants in both groups belonged to the 61–75 years age group, with a male predominance (81.5%). Diabetes mellitus and hypertension were significantly more common among ACS patients compared to controls. The mean serum vitamin D level was lower in ACS patients (21.03 ± 7.29 ng/dL) compared to controls (23.27 ± 6.38 ng/dL), though the difference was not statistically significant. Vitamin D deficiency was more frequent in ACS patients (46.2%) than controls (32.3%). However, no significant association was observed between vitamin D levels and the number of coronary arteries affected. On multivariate logistic regression analysis, vitamin D deficiency was not an independent predictor after adjusting for confounders.

Conclusion: Vitamin D levels were lower in ACS patients than controls, but the difference was not statistically significant. Vitamin D deficiency was not an independent predictor of ACS or coronary vessel involvement after adjustment for confounders.

INTRODUCTION

Cardiovascular diseases (CVDs) represent the leading cause of morbidity and mortality globally, imposing an enormous burden on healthcare systems and societies worldwide. According to the World Health Organization (WHO), an estimated 17.9 million people died from cardiovascular diseases in 2019, representing 32% of all global deaths [1]. Of these deaths, 85% were due to myocardial infarction and stroke [1]. The burden of CVD is disproportionately high in low- and middle-income countries, where more than 75% of CVD deaths occur [1]. Premature deaths due to noncommunicable diseases, of which 38% are caused by CVDs, represent a significant loss of productive life years and economic potential [1].

In India, changes in health patterns have caused a big rise in heart disease in recent decades. The Indian Council of Medical Research (ICMR) has reported a sharp increase in deaths from heart disease. Ischemic heart disease is now the top cause of death in both cities and villages. Indians tend to get coronary artery disease at a younger age than people in Western countries. More people under 50 have early heart attacks. This pattern is due to a mix of inherited risks, lifestyle, and common health problems. These include high blood pressure, diabetes, high cholesterol, smoking, and not getting enough exercise.

Acute coronary syndrome (ACS) covers a range of heart problems caused by low blood flow to the heart muscle. These include heart attacks with and without ST elevation (STEMI and NSTEMI) and unstable angina (UA). In ACS, a fatty deposit in a heart artery either ruptures or wears away, forming a blood clot that can block blood flow and damage the heart. Well-known risk factors for ACS are high blood pressure, diabetes, high cholesterol, smoking, obesity, and family history. Still, these factors do not fully explain differences in how often ACS happens or how people do afterwards, leading researchers to look for new risk factors that can be changed.

Over the past two decades, low vitamin D levels have become a possible heart disease risk and have drawn a lot of scientific attention. Vitamin D has long been known for its role in maintaining bone and calcium health. Now, it is recognised to affect many body systems, including the heart and blood vessels. Finding vitamin D receptors in heart and blood vessel cells, immune cells, and pancreatic cells helps explain how vitamin D affects the heart [2]. The active form of vitamin D is called calcitriol. It controls the activity of over 200 genes that regulate body functions, including inflammation, cell growth, development, and immune responses [2].

Epidemiological studies have consistently shown an inverse association between blood vitamin D levels and the risk of heart disease. The Framingham Heart Study, a well-known long-term health study, found that people with low vitamin D levels (<15 ng/mL) had a 60% higher risk of heart disease than those with higher levels [3]. Later studies have confirmed these results, showing that lacking enough vitamin D is linked to a greater risk of heart attacks, heart failure, stroke, and deaths from heart disease [3]. Possible reasons for this link include activation of certain hormone systems (RAAS), more inflammation, unhealthy blood vessels, faster artery blockage, more blood clotting, and bad effects on blood sugar and fats [2],[4].

Vitamin D deficiency is a worldwide health problem, affecting around 1 billion people [5]. Strangely, it is very common in India, even though the country receives ample sunlight. Studies show that 50% to 94% of people in Indian communities and 37% to 99% of people in hospitals lack sufficient vitamin D [6]. This is due to several reasons: darker skin (which slows down vitamin D production in the skin), clothing and traditions that cover the skin, spending a lot of time indoors, air pollution (which blocks sunlight), and not eating enough foods with vitamin D. The usual Indian diet is low in vitamin D, and vitamin D fortification programs are rare [6].

Several studies have looked at the link between vitamin D deficiency and heart attacks. Roy et al. (2015) did a case-control study in India and found that severe vitamin D deficiency was linked to heart attacks in Indians [7]. Studies from other countries also show that people with acute coronary syndrome have lower vitamin D levels than healthy people. Not having enough vitamin D is also linked to worse short- and long-term outcomes, like higher death rates, heart failure, and repeat heart problems [4], [8], [9].

Despite more evidence linking low vitamin D to heart disease, key questions remain. First, we do not know for sure whether low vitamin D levels cause ACS. Most studies look at patterns, so other factors might explain the link. Second, there is not much clear data on Indian groups, especially for ACS. Third, we do not yet know if taking vitamin D helps prevent or treat ACS. Big studies have shown mixed results [10].

Given the high burden of both cardiovascular disease and vitamin D deficiency in India, and the potential for vitamin D supplementation to represent a cost-effective, safe, and widely accessible intervention, there is a compelling need for well-designed studies to characterise the prevalence of vitamin D deficiency in Indian ACS patients and to explore its association with disease occurrence and outcomes. Such studies are essential for informing clinical practice and public health policy and for providing a foundation for future interventional trials.

The present study aims to determine the prevalence of vitamin D deficiency in patients presenting with acute coronary syndrome at a tertiary care hospital in Puducherry and to investigate the association between vitamin D deficiency and the occurrence of ACS. By comparing serum vitamin D levels in ACS patients with those in age- and gender-matched healthy controls, this study aims to provide valuable epidemiological data to the existing literature and pave the way for future research on vitamin D supplementation as a potential strategy for cardiovascular disease prevention and management in the Indian population.

STUDY DESIGN AND POPULATION

This is a comparative study. All patients above the age of 18 years admitted to tertiary centre in south India, with or without acute coronary syndrome during the study period from April 2024 to October 2025.

METHODOLOGY

Patients from casualty and OPD were included in the study after fulfilling the eligibility criteria and equal number of control group (with age within 5 years and gender-matched individuals selected from relatives, attenders, or patients from non-cardiac wards with no previous history of cardiac disease/ chest pain and normal cardiac evaluation) were selected and informed consent were obtained.

After clinical assessment ACS cases were managed as per standard protocol.

Along with blood collected for routine investigations, additional 2cc blood sample was collected for vitamin D analysis.

All data were collected in predefined data form.

Inclusion Criteria:

- All patients who agree to participate in the study and sign the informed consent.
- All the patients who were above the age of 18 years.
- Patients presenting with new onset Acute Coronary Syndrome.

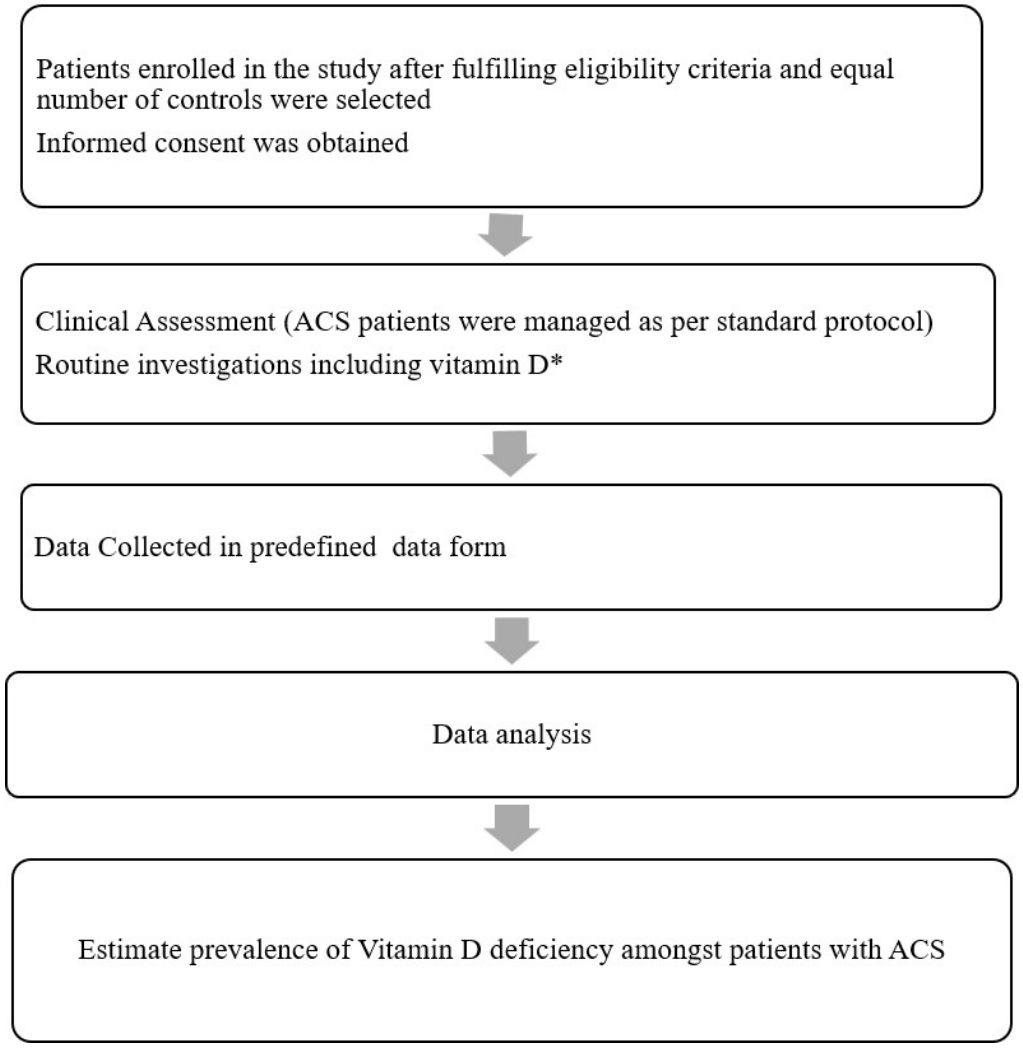
  (Controls will be age and gender-matched individuals selected from relatives, attenders, or patients from non-cardiac wards with no previous history of cardiac disease/ chest pain and normal cardiac evaluation)

Exclusion Criteria:

- Patient not willing to participate in study.
- Patients on vitamin D supplementation
- Patients using sun blocks
- Known case of chronic kidney disease
- Known case of nephrotic syndrome
- Known case of liver disease
- Patients on drugs-phenytoin , isoniazid
- Patients with hypoparathyroidism

Data Collection

Figure: Flow chart- Sequence of events



STUDY VARIABLES

No	Name of the dependent / independent variables	Scale of measurement (Quantitative / qualitative)	Descriptive / Inferential Statistics to be used
1	Troponin I	Quantitative	Mean + SD
2	CPK MB	Quantitative	Mean + SD
3	CPK NAC	Quantitative	Mean + SD
4	Vitamin D	Quantitative	Mean + SD
5	ECG	Qualitative	Frequency and percentage
5	Chest pain/ Anginal equivalent	Qualitative	Frequency and percentage

Statistical Analysis

Severe deficiency of vitamin D was 79.2% among patients with Acute Coronary Syndrome. By assuming α=0.05, precision = 10%, sample size was calculated to be **65**[3]

$$n = \frac{z^2 \times p \times (1-p)}{d^2} \quad \text{where } z = 1.96,\ p = 0.792,\ d = 0.1$$

- Total sample is 130 (equal number of age- and gender matched controls included)

RESULTS

Of the total 130 patients included in the study, 65 patients (50%) had acute coronary syndrome, while the remaining 65 patients (50%) had no acute coronary syndrome and are controls. Thus, both groups were equally represented.

The majority of participants in both groups belonged to the 61–75 years age group, accounting for 43.1% of cases and 38.5% of controls, followed by the 46–60 years age group with 40% of cases and 44.6% of controls. A smaller proportion of participants were in the 31–45 years category, while very few participants were aged above 75 years. No participants were observed in the 18–30 years age group in either cases or controls.

GENDER DISTRIBUTION BETWEEN TWO GROUPS

Table 5: Gender distribution between two groups

Gender	Cases (65)	Controls (65)	p-value
Male	53 (81.5%)	53 (81.5%)	1.000
Female	12 (18.5%)	12 (18.5%)	
Total	65	65	

COMPARISON OF COMORBITIES AND SUBSTANCE USE HISTORY BETWEEN TWO GROUPS

Table 7: Comparison of comorbidities and history of substance use

History		Cases (65)	Controls (65)	p-value
Diabetes mellitus	**Yes**	38 (58.5%)	23 (35.4%)	0.014*
	No	27 (41.5%)	42 (64.6%)	
HTN	**Yes**	31 (47.7%)	16 (24.6%)	0.010*
	No	34 (52.3%)	49 (75.4%)	
Tobacco use	**Yes**	21 (32.3%)	22 (33.8%)	1.000
	No	44 (67.7%)	43 (66.2%)	
Alcohol use	**Yes**	27 (41.5%)	36 (55.4%)	0.160
	No	38 (58.5%)	29 (44.6%)	

This table compares the prevalence of comorbidities and substance use history between cases and controls. Diabetes mellitus was significantly more common among cases (58.5%) than controls (35.4%) (p = 0.014). Similarly, hypertension was observed more frequently in cases (47.7%) compared to controls (24.6%), showing a statistically significant association (p = 0.010). Likewise, tobacco use and alcohol use did not differ significantly between cases and controls, with p-values of 1.000 and 0.160 respectively.

COMPARISON OF MEAN VITAMIN D LEVEL BETWEEN TWO GROUPS

Table 8: Comparison of vitamin D level between two groups

Vitamin D level	Cases Mean ± S. D	Controls Mean ± S. D	p-value
Vitamin D in ng/dL	21.03 ± 7.29	23.27± 6.38	0.07

This table and above figure show the the comparison of serum Vitamin D levels between the case and control groups. The mean Vitamin D level in the case group was 21.03 ± 7.29 ng/dL, which was lower than the mean level of 23.27± 6.38 ng/dL observed in the control group. Though, controls had higher value but it was not statistically significant (p->0.05)

COMPARISON OF VITAMIN D CATEGORY BETWEEN TWO GROUPS

Table: Comparison of vitamin D category between two groups

Vitamin D category	Cases (65)	Controls (65)	p-value
Deficiency (<20 ng/dl)	30 (46.2%)	21 (32.3%)	0.193
Insufficient (20 to 29 ng/dl)	31 (47.7%)	36 (55.4%)	
Sufficient (≥ 30 ng/dl)	4 (6.2%)	8 (12.3%)	

The above table explains vitamin D categories between cases and controls. Vitamin D deficiency (<20 ng/dl) was more common among cases (46.2%) compared to controls (32.3%). Vitamin D insufficiency (20–29 ng/dl) was observed in 47.7% of cases and 55.4% of controls. Only a small proportion of participants had sufficient vitamin D levels (>30 ng/dl), accounting for 6.2% of cases and 12.3% of controls.

Although a higher proportion of cases had deficient vitamin D levels, the difference in vitamin D status between the two groups was not statistically significant (p = 0.193). Overall, the findings indicate a high prevalence of suboptimal vitamin D levels in both cases and controls.

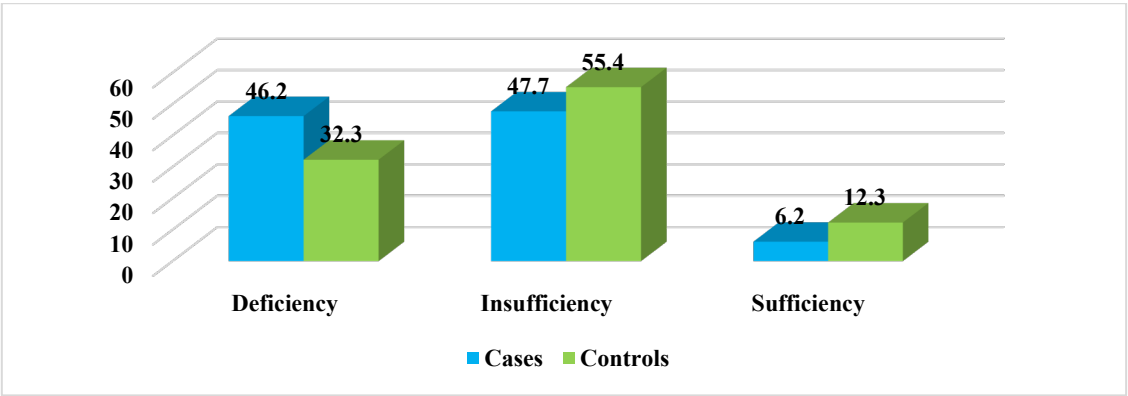


Figure : Comparison of vitamin D category between two groups

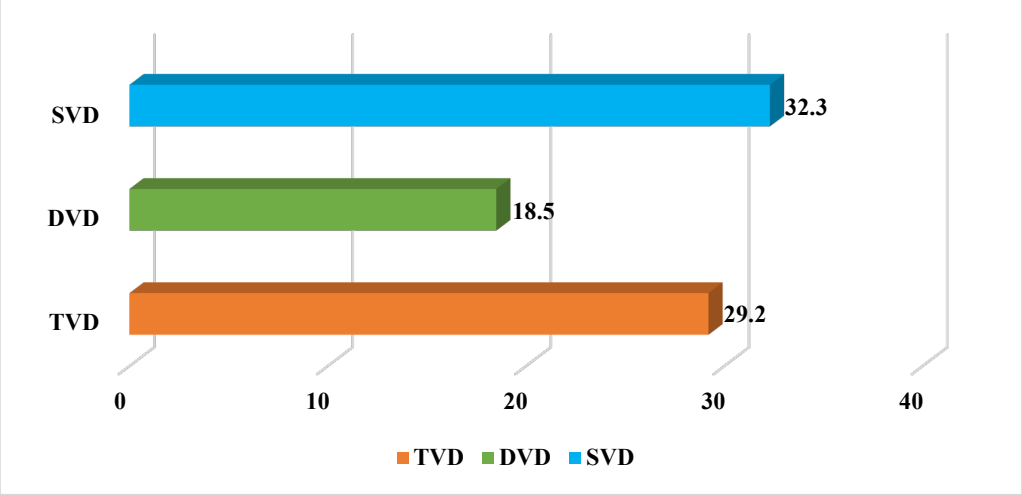
It is clear from the above column chart that the vitamin D deficiency was more common among cases (46.2%) compared to controls (32.3%). In contrast, sufficient vitamin D levels were observed more frequently among controls (12.3%) than cases (6.2%), indicating relatively lower vitamin D levels among cases.

DISTRIBUTION OF TYPE OF VESSEL DISEASE IN ACS PATIENTS

Table : Percentage of single, double and triple vessel CAD among ACS patients

Type of CAD	No, n (%)
Single vessel disease (SVD)	21 (32.3%)
Double vessel disease (DVD)	12 (18.5%)
Triple vessel disease (TVD)	19 (29.2%)
Total	52 (80%)

Figure : Distribution of type of CAD in ACS patients in %



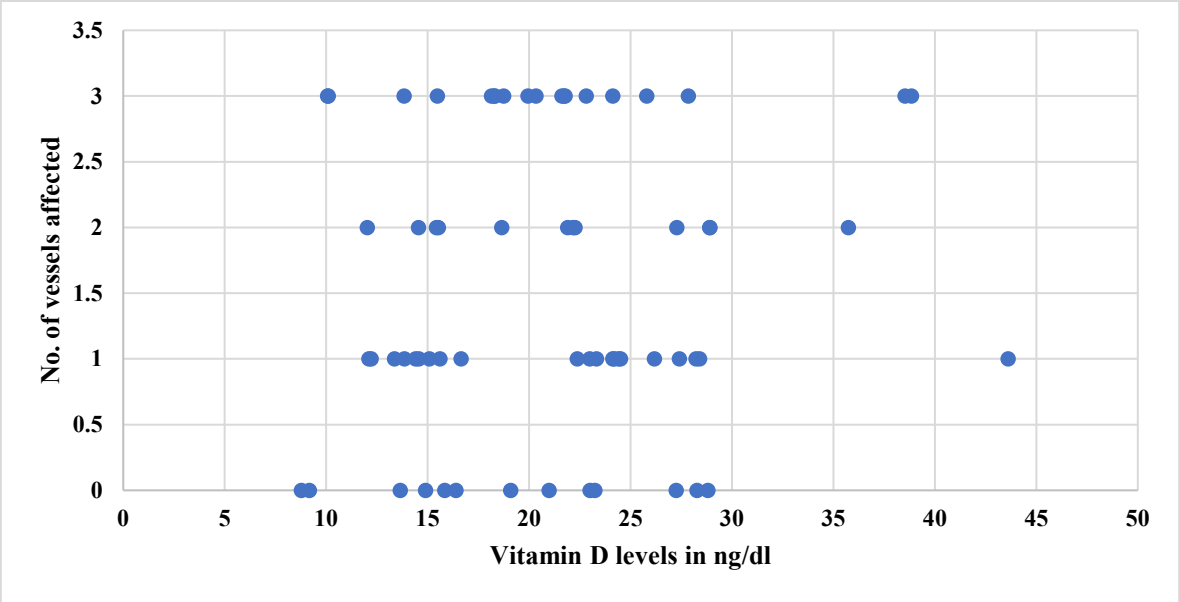
This table and bar chart explains that among the ACS patients, single vessel disease was the most common angiographic finding observed in 21 (32.3%) patients, followed by triple vessel disease in 19 (29.2%) patients. Double vessel disease was noted in 12 (18.2%) patients.

CORRELATION OF VITAMIN D LEVEL WITH THE NUMBER OF AFFECTED CORONARY ARTERIES

Table: Correlation between Vitamin D level and number of coronary artery affected

			Vitamin D	Vessel disease
Spearman's rho	Vitamin D	Correlation Coefficient	1.000	0.046
		Sig. (2-tailed)	.	.714
		N	65	65
	Vessel disease	Correlation Coefficient	.046	1.000
		Sig. (2-tailed)	.714	.
		N	65	65
*. Correlation is significant at the 0.05 level (2-tailed).				

Figure: Correlation between Vitamin D levels and number of vessels affected



Spearman correlation analysis showed a very weak positive correlation between serum vitamin D levels and the number of vessels involved in ACS patients ($\varrho = 0.046$). However, this association was not statistically significant ($p = 0.714$). This suggests that there is no relationship between serum vitamin D levels and number of affected vessels in this study population.

MULTIVARIATE BINARY LOGISTIC REGRESSION ANALYSIS OF FACTORS ASSOCIATED WITH ACUTE CORONARY SYNDROME

Table 17: Association of vitamin D deficiency with acute coronary syndrome after adjustment for potential confounding by logistic regression

Variable	B	S.E	Adjusted OR (Exp B)	95% Confidence Interval	p-value
T2DM	0.705	0.411	2.023	0.905 – 4.524	0.086
HTN	0.888	0.441	2.429	1.023 – 5.766	0.041
Tobacco use	-.105	0.462	0.901	0.364 – 2.223	0.821
Alcohol use	-0.918	0.476	0.399	0.157 – 1.015	0.054
Vitamin D deficiency	-0.479	0.413	0.620	0.276 – 1.392	0.246

Logistic regression analysis showed that hypertension was significantly associated with ACS (AOR: 2.429; 95% CI: 1.023–5.766, p=0.041). Diabetes mellitus showed increased odds of ACS but was not statistically significant. Vitamin D deficiency, tobacco use, and alcohol use were not independently associated with ACS after adjustment for confounding factors.

SUMMARY

A total of 130 participants were included in the study, comprising 65 ACS patients (cases) and 65 non-ACS individuals (controls). The overall findings of the study are summarized as follows:

- The majority of participants in both groups belonged to the 61–75 years age category, followed by the 46–60 years age group. The mean age was comparable between the two groups.
- Male predominance was observed in both groups, with males accounting for 81.5% of the study population.
- Diabetes mellitus and hypertension were significantly more common among ACS patients compared to controls.
- The mean serum vitamin D level was lower among ACS patients (21.03 ± 7.29 ng/dL) compared to controls (23.27 ± 6.38 ng/dL), although the difference was not statistically significant.
- Vitamin D deficiency was more common among ACS patients [30 (46.2%)] compared to controls [21 (32.3%)], whereas sufficient vitamin D levels were observed more frequently among controls [8 (12.3%)] than cases [4 (6.2%)].
- There is no significant association between vitamin D levels and number of coronary arteries affected.
- Multivariate logistic regression analysis showed that hypertension was independently associated with ACS, whereas vitamin D deficiency was not found to be an independent predictor after adjustment for confounding factors.

Limitations

The current study had the following limitations,

i) Small sample size (only 130 patients), may not be applicable to the wider population
ii) The study was carried out at just one institution and might not be applicable to the outcomes from other centers
iii) Other elements like BMI, lipid profile were not taken into account, which may impact the primary outcome
iv) Longer follow-up is not done
v) More men were included than women, which may have affected the results related to male patients

CONCLUSION

This study showed that serum vitamin D levels are lower in ACS patients compared to non-ACS individuals, although the difference was not statistically significant. Similarly, no significant association was found between vitamin D levels and the number of coronary arteries affected.

Multivariate logistic regression analysis showed that vitamin D deficiency was not independently associated with ACS after adjusting for confounding factors.

Overall, these findings indicate that while vitamin D deficiency is more common in ACS patients, it may not play an independent causal role when other risk factors are considered.

Further studies with larger, multicentric populations are needed to better clarify the role of vitamin D in ACS and to explore its interaction with other cardiovascular risk factors.

REFERENCES

[1] Milazzo V, De Metrio M, Cosentino N, Marenzi G, Tremoli E. Vitamin D and acute myocardial infarction. World J Cardiol. 2017 Jan 26;9(1):14–20. doi:10.4330/wjc.v9.i1.14 PubMed PMID: 28163832; PubMed Central PMCID: PMC5253190.

[2] Aparna P, Muthathal S, Nongkynrih B, Gupta SK. Vitamin D deficiency in India. J Family Med Prim Care. 2018;7(2):324–30. doi:10.4103/jfmpc.jfmpc_78_18 PubMed PMID: 30090772; PubMed Central PMCID: PMC6060930.

[3] Roy A, Lakshmy R, Tarik M, Tandon N, Reddy KS, Prabhakaran D. Independent association of severe vitamin D deficiency as a risk of acute myocardial infarction in Indians. Indian Heart J. 2015;67(1):27–32. doi:10.1016/j.ihj.2015.02.002 PubMed PMID: 25820047; PubMed Central PMCID: PMC4382524.

[4] Salari N, Morddarvanjoghi F, Abdolmaleki A, Rasoulpoor S, Khaleghi AA, Hezarkhani LA, et al. The global prevalence of myocardial infarction: a systematic review and meta-analysis. BMC Cardiovascular Disorders. 2023 Apr 22;23(1):206. doi:10.1186/s12872-023-03231-w

[5] Kannel WB, Abbott RD. Incidence and prognosis of unrecognized myocardial infarction. An update on the Framingham study. N Engl J Med. 1984 Nov 1;311(18):1144–7. doi:10.1056/NEJM198411013111802 PubMed PMID: 6482932.

[6] Singh A, Museedi AS, Grossman SA. Acute Coronary Syndrome. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2026 [cited 2026 May 23]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK459157/ PubMed PMID: 29083796.

[7] Kunadian V, Ford GA, Bawamia B, Qiu W, Manson JE. Vitamin D deficiency and coronary artery disease: a review of the evidence. Am Heart J. 2014 Mar;167(3):283–91. doi:10.1016/j.ahj.2013.11.012 PubMed PMID: 24576510.

[8] Pál É, Ungvári Z, Benyó Z, Várbíró S. Role of Vitamin D Deficiency in the Pathogenesis of Cardiovascular and Cerebrovascular Diseases. Nutrients. 2023 Jan 9;15(2):334. doi:10.3390/nu15020334 PubMed PMID: 36678205; PubMed Central PMCID: PMC9864832.

[9] Rai V, Agrawal DK. Role of Vitamin D in Cardiovascular Diseases. Endocrinol Metab Clin North Am. 2017 Dec;46(4):1039–59. doi:10.1016/j.ecl.2017.07.009 PubMed PMID: 29080634; PubMed Central PMCID: PMC5675035.

[10] Arnson Y, Itzhaky D, Mosseri M, Barak V, Tzur B, Agmon-Levin N, et al. Vitamin D inflammatory cytokines and coronary events: a comprehensive review. Clin Rev Allergy Immunol. 2013 Oct;45(2):236–47. doi:10.1007/s12016-013-8356-0 PubMed PMID: 23314982.

[11] Awasthi M, Rawal MP, Gupta S. Impact of Vitamin D Deficiency on Angiographic Severity in Patients with Acute Coronary Syndrome. SRMS JOURNAL OF MEDICAL SCIENCE. 2024 Jun 30;9(01):27–31. doi:10.21761/jms.v9i01.05

[12] De Metrio M, Milazzo V, Rubino M, Cabiati A, Moltrasio M, Marana I, et al. Vitamin D Plasma Levels and In-Hospital and 1-Year Outcomes in Acute Coronary Syndromes. Medicine (Baltimore). 2015 May 21;94(19):e857. doi:10.1097/MD.0000000000000857 PubMed PMID: 25984675; PubMed Central PMCID: PMC4602571.

[13] Naveed B, Fatima SA, Choudhry F, Saravanan P, Ahmed A, Sahar N, et al. Correlation Between Serum Vitamin D Levels and the Severity of Coronary Artery Disease in Patients With Myocardial Infarction. Cureus. 17(9):e93138. doi:10.7759/cureus.93138 PubMed PMID: 41141155; PubMed Central PMCID: PMC12552002.

[14] Nepal R, Karki P, Uraw S, Lamsal M. Prevalence of Vitamin D Deficiency among Patients of Acute Coronary Syndrome in a Tertiary Care Center of Eastern Nepal. JNMA J Nepal Med Assoc. 2021 Mar;59(235):225–30. doi:10.31729/jnma.5166 PubMed PMID: 34506449; PubMed Central PMCID: PMC8369531.

[15] Ismail HM, Algrafi AS, Amoudi O, Ahmed S, Al-Thagfan SS, Shora H, et al. Vitamin D and Its Metabolites Deficiency in Acute Coronary Syndrome Patients Undergoing Coronary Angiography: A Case–Control Study. Vasc Health Risk Manag. 2021 Aug 10;17:471–80. doi:10.2147/VHRM.S312376 PubMed PMID: 34408425; PubMed Central PMCID: PMC8364363.

[16] Mahdavi K, Amirajam Z, Yazdankhah S, Majidi S, Adel MH, Omidvar B, et al. The Prevalence and Prognostic Role of Vitamin D Deficiency in Patients with Acute Coronary Syndrome: A Single Centre Study in South-West of Iran. Heart, Lung and Circulation. 2013 May 1;22(5):346–51. doi:10.1016/j.hlc.2012.11.006

[17] Shoukry NS, Abdelsalam MM, Abdelsalam AM, Ali HM, Aoud MS. Assessment of Vitamin D Level in Patients with Acute Coronary Syndrome in CCU Patients. QJM. 2024 Oct 1;117(Supplement_2):hcae175.410. doi:10.1093/qjmed/hcae175.410

[18] Rahman MS, Alam MB, Islam AM, Ahmad T, Wareshuzzaman -Md, Shimu IJ. Vitamin D Status and Acute Coronary Syndrome – A Single-Centre Study. Cardiovascular Journal. 2021 Apr 15;13(2):183–8. Located at: Bangladesh. doi:10.3329/cardio.v13i2.52973

[19] Dror Y, Giveon SM, Hoshen M, Feldhamer I, Balicer RD, Feldman BS. Vitamin D levels for preventing acute coronary syndrome and mortality: evidence of a nonlinear association. J Clin Endocrinol Metab. 2013 May;98(5):2160–7. doi:10.1210/jc.2013-1185 PubMed PMID: 23533239.

[20] Brøndum-Jacobsen P, Benn M, Afzal S, Nordestgaard BG. No evidence that genetically reduced 25-hydroxyvitamin D is associated with increased risk of ischaemic heart disease or myocardial infarction: a Mendelian randomization study. Int J Epidemiol. 2015 Apr;44(2):651–61. doi:10.1093/ije/dyv078 PubMed PMID: 25981321.