

Prevalence of vitamin D3 deficiency among patients with acute coronary syndrome

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Abstract

Vitamin D3 deficiency is a prevalent condition, affecting nearly one billion people worldwide. Several studies have reported that vitamin D3 deficiency is common among patients with acute coronary syndrome and cardiovascular disease; however, this relationship remains unclear. This study aimed to evaluate the prevalence of vitamin D3 deficiency among patients presenting with acute coronary syndrome in Erbil, the Kurdistan Region of Iraq. This cross-sectional study was carried out at the Erbil Cardiac Center between July 2025 and January 2026. Data were gathered through direct interviews with participants using a structured questionnaire. Serum vitamin D, lipid profile, troponin, creatine kinase, and serum creatinine were measured. Data entry, processing, and analysis were performed using IBM SPSS Statistics Version 26.0. Informed consent was obtained from all participants. The prevalence of vitamin D3 deficiency was 49.9%, and insufficiency was 28.1%. Vitamin D3 deficiency was significantly associated with female gender, family history of ischemic heart disease, previous COVID-19 infection, stressful lifestyle, and abnormal body mass index ($P = 0.033, 0.004, 0.001, 0.002$, and 0.003 , respectively). Stepwise linear regression identified previous COVID-19 infection, obesity, family history, alcohol intake, and creatine kinase level as predictors of vitamin D level. Approximately half of the participants were vitamin D3 deficient. Vitamin D3 deficiency was significantly associated with female gender, obesity, previous COVID-19 infection, stressful lifestyle, and family history of acute coronary syndrome. Previous COVID-19 infection, obesity, family history, alcohol intake, and creatine kinase level were significant predictors of vitamin D3 level.

Keywords: Acute coronary syndrome, Cardiovascular, Deficiency, Vitamin D3

Introduction

Vitamin D₃ is a lipo-soluble vitamin acquired by humans in two ways: through synthesis in the skin following sun exposure, and through diet [1]. Vitamin D₃ is first converted in the liver to 25-hydroxyvitamin D (25OHD), a stable, inactive compound [2]. In the kidneys, 25OHD is converted by 1 α -hydroxylase to 1,25-dihydroxyvitamin D (1,25(OH)₂D), the metabolically active form of vitamin D₃, also called calcitriol [1–3].

The main function of vitamin D₃ in the body is to regulate calcium metabolism [3]. Vitamin D₃ increases the absorption of calcium and phosphate from the intestines and increases the reabsorption of calcium in the distal convoluted tubules of the kidneys [3]. Parathyroid hormone increases the activity of 1 α -hydroxylase to produce more 1,25(OH)₂D during states of hypocalcemia [3].

Serum vitamin D is used to measure vitamin D₃ status; serum levels < 12 ng/mL are considered deficient, 12–30 ng/mL insufficient, and > 30 ng/mL

sufficient [4]. Causes of vitamin D₃ deficiency include reduced dietary intake, reduced sunlight exposure, long-term liver disorders, side effects of specific medications, and end-organ resistance [4].

Vitamin D₃ deficiency can cause osteopenia and osteoporosis in adults, rickets in children, and muscle weakness in both [5]. It is a prevalent condition, affecting almost one billion individuals worldwide, and is more common in elderly, obese, and hospitalized individuals [4]. A study conducted in Erbil, Iraq, found half of the population to be deficient [6].

Vitamin D deficiency can adversely affect cardiovascular health through inflammation, oxidative stress, and interference with blood pressure, glucose, and lipid metabolism [7]. Several studies have reported that vitamin D₃ deficiency is common among patients with acute coronary syndrome and cardiovascular disease [8,9]. However, this relationship remains unclear.

This study aimed to determine the prevalence of vitamin D₃ deficiency among patients presenting with acute coronary syndrome in Erbil, the Kurdistan Region of Iraq.

Methods

Study setting, design, and time period

This was a cross-sectional observational study conducted at the Erbil Cardiac Center, Surgical Specialty Hospital, Erbil, Iraq, between July 2025 and January 2026. The study was reported in accordance with the STROBE guidelines for observational studies.

Sample size and selection criteria

The sample size was calculated using the standard formula for estimating a proportion with a specified precision, where n represents the sample size, Z is the standard normal variate for the desired confidence level (1.96 for 95% confidence), P is the estimated population proportion (set at 50%), and E is the desired margin of error (set at 5%).

$$N = Z^2 \times P \times (1 - P) / E^2$$

The sample size was calculated to be 384. Seven participants met the exclusion criteria and were removed, leaving 377 cases.

The inclusion criteria were adults ≥ 18 years of both sexes with acute coronary syndrome (STEMI, NSTEMI, or unstable angina) who agreed to participate and gave informed consent. The exclusion criteria were known chronic kidney or liver disease, vitamin D supplementation within the past 3 months, diagnosed malabsorption syndromes, active cancer, and pregnancy or breastfeeding.

Data collection

Data were gathered through direct interviews with participants using a structured questionnaire covering biodemographic factors, lifestyle habits, and previous medical history. Serum vitamin D was

measured for all participants, along with serum cholesterol, triglyceride, LDL, HDL, VLDL, troponin, CK-MB, and creatinine.

Statistical analysis

Data entry, processing, and analysis were performed using IBM SPSS Statistics, Version 26.0 (IBM Corp., Armonk, NY, USA). Numerical data are presented as means $\pm$ standard deviations, and categorical data as frequencies and percentages. Independent-samples t-tests were used to compare means between subgroups. The chi-square test was used to assess associations between categorical variables, with Fisher's exact test applied when more than 20% of cells had an expected count below 5. Stepwise multiple linear regression was used to determine predictors of vitamin D level. A P value < 0.05 was considered statistically significant.

Ethical considerations

Informed consent was obtained from all participants after thorough counseling, and anonymity was ensured. The study was conducted in accordance with the Declaration of Helsinki. Ethical approval was granted by the Kurdistan Higher Council of Medical Specialties Medical Research Scientific and Ethics Committee (approval no. 1916; July 22, 2025).

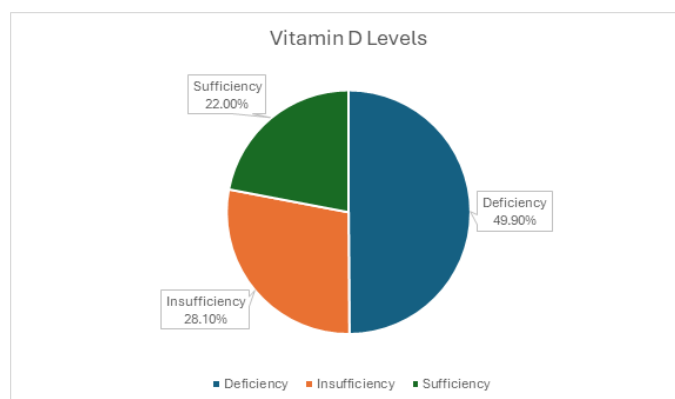
Results

This study included 377 participants, 56.8% male and 43.2% female. Most were in the 50–59 and 60–69 age groups (31.0% each), followed by the 40–49 group (25.2%), the ≥ 70 years' group (9.8%), and the ≤ 39 years' group (2.9%). Regarding occupation, 40.1% were housewives, 23.9% self-employed, 22.5% employees, 9.3% retired, and 4.2% unemployed. Most participants were married (96.8%), while 3.2% were unmarried. For education, 47.7% had primary-level education, 32.1% no formal education, 5.6% secondary degrees, 5.6% bachelor's degrees, 6.4% diplomas, and 2.7% PhDs. Socioeconomic status was good in 66.6%, fair in 24.9%, and very good in 8.5%. These data are shown in Table 1.

Table 1. Demographics of the study participants

Demographic	Frequency (N)	Percentage (%)
Gender		
Female	163	43.2
Male	214	56.8
Age (years)		
≤ 39	11	2.9
40–49	95	25.2
50–59	117	31.0
60–69	117	31.0
≥ 70	37	9.8
Occupation		
Unemployed	16	4.2
Housewife	151	40.1
Self-employed	90	23.9
Employee	85	22.5
Retired	35	9.3
Education		
None	121	32.1
Primary	180	47.7
Secondary	21	5.6
Bachelor	21	5.6
Diploma	24	6.4
PhD	10	2.7
Marital status		
Unmarried	12	3.2
Married	365	96.8
Socioeconomic status		
Fair	94	24.9
Good	251	66.6
Very good	32	8.5

Vitamin D levels were measured in all participants. The prevalence of vitamin D₃ deficiency was 49.9%, insufficiency 28.1%, and sufficiency 22.0% (Figure 1).

**Figure (1):** Prevalence of Vitamin D₃ deficiency, insufficiency and sufficiency

All participants had myocardial infarction and were acute coronary syndrome patients; 55.2% had STEMI and 44.8% had NSTEMI. Regarding comorbidities, 47.7% had hypertension, 44.0% previous ischemic heart disease, 31.8% diabetes mellitus, 37.1% dyslipidemia, 20.7% previous PCI, 48.3% previous COVID-19 infection, and 49.9% a family history of ischemic heart disease (Table 2).

Table 2. Comorbidities of the study participants.

Comorbidity	Frequency (N)	Percentage (%)
Type of MI		
STEMI	208	55.2
NSTEMI	169	44.8
Hypertension		
No	197	52.3
Yes	180	47.7
Previous IHD		
No	211	56
Yes	166	44
Diabetes mellitus		
No	257	68.2
Yes	120	31.8
Dyslipidemia		
No	237	62.9
Yes	140	37.1
Previous PCI		
No	299	79.3
Yes	78	20.7
Previous COVID-19		
No	195	51.7
Yes	182	48.3
Family history of IHD		
No	189	50.1
Yes	188	49.9

Table 3. Lifestyle habits of the study participants

Variable	Frequency (N)	Percentage (%)
Physical activity		
Inactive	228	60.5
Active	149	39.5
Stressful life		
No	200	53.1
Yes	177	46.9
Smoking		
Non-smoker	254	67.4
Ex-smoker	55	14.6
< 1 pack	14	3.7
1–2 packs	45	11.9
2–3 packs	9	2.4
Alcohol consumption		
No	354	93.9
Yes	23	6.1
Watching TV		
No	75	19.9
< 1 hour	22	5.8
1–2 hours	130	34.5
2–3 hours	42	11.1
3–4 hours	40	10.6
4–5 hours	44	11.7
> 5 hours	24	6.4
BMI		
Underweight	1	0.3
Normal weight	67	17.8
Overweight	144	38.2
Obese	165	43.8

The lifestyle habits and risk factors of the participants are shown in Table 3.

Regarding presentation, 2.9% of participants had atypical presentations for myocardial infarction. Several laboratory parameters were also measured (Table 4). The mean serum cholesterol was 136 ± 38 , HDL 34 ± 8.6 , LDL 82 ± 34 , triglyceride 153 ± 77 , VLDL 30 ± 19.9 , vitamin D3 22.7 ± 12.7 , creatinine 1.01 ± 0.69 , troponin 31.1 ± 103 , and CK-MB 17.7 ± 14.3 .

Table 4. Mean laboratory levels of the study participants

Laboratory value	Mean	Standard deviation
Serum cholesterol	136	38
S. HDL	34	8.6
S. LDL	82	34
S. triglyceride	153	77
S. VLDL	30	19.9
S. vitamin D3	22.7	12.7
S. creatinine	1.01	0.69
Troponin	31.1	103
CK-MB	17.7	14.3

Associations between vitamin D deficiency and clinical, lifestyle, and biodemographic factors were tested using the chi-square test. Statistically significant associations were found between vitamin D levels and BMI, gender, previous COVID-19 infection, stressful lifestyle, and family history of ischemic heart disease ($P = 0.003, 0.033, 0.001, 0.002$, and 0.004 , respectively) (Table 5).

Table 5. Chi-square test showing associations between categorical variables and vitamin D levels

Variable	Deficient N (%)	Insufficient N (%)	Sufficient N (%)	P value
Gender				
Female	86 (52.8)	35 (21.5)	42 (25.8)	0.033
Male	102 (47.7)	71 (33.2)	41 (19.2)	
Family history				
No	78 (41.3)	62 (32.8)	49 (25.9)	0.004
Yes	110 (58.5)	44 (23.4)	34 (18.1)	
Previous COVID-19				

Variable	Deficient N (%)	Insufficient N (%)	Sufficient N (%)	P value
No	107 (54.9)	60 (30.8)	28 (14.4)	0.001
Yes	81 (44.5)	46 (25.3)	55 (30.2)	
Stressful lifestyle				
No	93 (46.5)	71 (35.5)	36 (18.0)	0.002
Yes	95 (53.7)	35 (19.8)	47 (26.6)	
BMI				
Underweight	1 (100.0)	0 (0.0)	0 (0.0)	0.003*
Normal weight	22 (32.8)	18 (26.9)	27 (40.3)	
Overweight	74 (51.4)	45 (31.3)	25 (17.4)	
Obese	91 (55.2)	43 (26.1)	31 (18.8)	

*Fisher's exact test was used

An independent-samples t-test comparing laboratory means across the vitamin D groups showed a statistically significant difference in mean HDL. Mean HDL was 33.9 ± 7.45 and 33.5 ± 8.75 in the deficient and insufficient groups, respectively, and 36.6 ± 10.4 in the sufficient group ($P = 0.026$) (Figure 2).

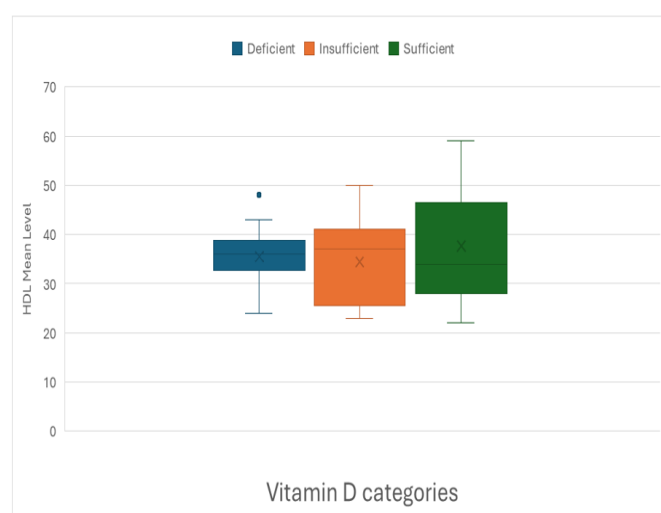


Figure (2): HDL mean level difference across the vitamin d groups

Stepwise multiple linear regression identified previous COVID-19 infection, BMI, family history of ischemic heart disease, alcohol intake, and CK-MB level as independent predictors of vitamin D level (Table 6).

Table 6. Stepwise multiple linear regression to determine predictors of vitamin D level

Model	B	Beta	P value
1			< 0.001
Constant	1.595		
Previous COVID-19	0.267	0.167	
2			< 0.001
Constant	1.985		
Previous COVID-19	0.268	0.167	
BMI	-0.173	-0.162	
3			< 0.001
Constant	2.065		
Previous COVID-19	0.278	0.174	
BMI	-0.159	-0.148	
Family history	-0.237	-0.148	
4			< 0.001
Constant	2.085		
Previous COVID-19	0.272	0.169	
BMI	-0.153	-0.143	
Family history	-0.246	-0.154	
Alcohol intake	-0.415	-0.122	
5			< 0.001
Constant	2.209		
Previous COVID-19	0.273	0.170	
BMI	-0.158	-0.148	
Family history	-0.262	-0.163	
Alcohol intake	-0.402	-0.118	
CK-MB	-0.006	-0.108	

Excluded variables were age, gender, address, height, weight, occupation, socioeconomic status, marital status, education, hypertension, ischemic heart disease, diabetes mellitus, hyperlipidemia, previous PCI, stressful lifestyle, watching TV, physical activity, smoking, serum cholesterol, triglyceride, HDL, LDL, troponin, creatinine, VLDL, atypical presentation, and type of myocardial infarction. B = unstandardized coefficient; Beta = standardized coefficient

Discussion

The most common age groups in this study were 50–59 and 60–69 years. Hypertension, dyslipidemia, and diabetes mellitus were the most common comorbidities. Sahani et al reported a median age of 56.5 years [10], and another study reported a mean age of 51.5 ± 9.93 years [11]. Other studies have reported similar comorbidity profiles; Sahani et al and Ahmad et al both reported hypertension, diabetes mellitus, and dyslipidemia as the most common comorbidities [10,12]. Only 22.0% of these patients had adequate vitamin D levels, with 49.9% deficient and 28.1% insufficient. A study by Ameen et al in the Kurdistan Region reported similar figures, with deficiency and insufficiency prevalences of 51.9% and 27.6%, respectively [6]. Studies specifically addressing vitamin D deficiency in acute coronary syndrome patients were also examined for comparison. Sahani et al reported that 33.3% of their participants had insufficiency (21–30 ng/mL), 35.4% deficiency (11–20 ng/mL), and 18.6% severe deficiency (≤ 10 ng/mL) [10]. By contrast, a study in Egypt reported deficiency and insufficiency rates of 16.6% and 45%, respectively, among an acute coronary syndrome cohort [11]. A study in Russia reported vitamin D deficiency in 78% of patients, severe deficiency (< 5 ng/mL) in a further 6%, and insufficiency in 20% [13]. A study in India reported a deficiency prevalence of 42% and an insufficiency rate of 34% [14]. Regional differences and variations in sun exposure likely contribute to these differences in prevalence.

This study found a significant difference in mean HDL levels between the vitamin D₃ subgroups. Gender, family history of ischemic heart disease, previous COVID-19 infection, and BMI were all significantly associated with vitamin D₃ levels; however, after multivariate regression, only previous COVID-19

infection, BMI, alcohol intake, and CK-MB level predicted vitamin D level. Ameen et al also noted associations between female gender, BMI, previous COVID-19 infection, and abnormal lipid profiles and vitamin D deficiency [6]. Shoukry et al similarly reported associations between vitamin D levels, CK-MB, and BMI [15]. Han et al reported significant associations between vitamin D levels, BMI, and alcohol consumption [16].

To our knowledge, few studies have addressed the prevalence and predictors of vitamin D deficiency in patients developing acute coronary syndrome, particularly in the Kurdistan Region. An adequate sample size was used to explore the aims of this study. Limitations include the cross-sectional design, which precludes causal inference, and the single-center setting; a multicenter approach would produce data that is more generalizable to the wider population. Future prospective cohort studies using multiple centers could address these limitations and further clarify the relationships described here.

Conclusion

Approximately half of the study participants were vitamin D₃ deficient. Vitamin D₃ deficiency was significantly associated with female gender, high BMI, previous COVID-19 infection, stressful lifestyle, and family history of ischemic heart disease. Participants with vitamin D sufficiency had higher HDL than those with deficiency. Previous COVID-19 infection, BMI, family history, alcohol intake, and CK-MB level were significant predictors of vitamin D level.

Declarations

Author contributions

This study was designed and implemented with equal contributions from both authors, as outlined in the CRediT (Contributor Roles Taxonomy) framework below:

H. F. and M. Y. conceptualized the study, designed the study, and supervised the study, providing oversight and guidance throughout the entire research process, from conception to completion.

D.S contributed to methodology, software, validation, formal analysis, investigation, resources, data

curation, visualization and project administration. This included the design of the methods, or other analytical tools used in the analysis, the verification and reproducibility of the results, the statistical and mathematical analysis, performing the research and data gathering, the availability of materials, samples and equipment, the management, annotation and storage of data, the generation of figures, tables and other means of communicating the data and keeping the project on schedule.

All authors contributed to the preparation of the original draft of the manuscript and its revision. All authors read and approved the final manuscript.

Declaration of generative AI and AI-Assisted technologies: During the preparation of this work, the author(s) did not use any generative AI tool or AI-assisted tools in the data analysis, interpretation, or drafting of the scientific text. The author(s) thoroughly reviewed, verified, and edited the content as needed, and accept full responsibility for the academic accuracy and scientific integrity of the final publication.

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Conflict of interest: The authors declare no conflict of interest.

Data availability statement: The data that support the findings of this study are available from the corresponding author upon reasonable request. The data are not publicly available due to privacy and confidentiality restrictions.

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