ARC Journal of Cardiology
Volume 10, Issue 1, 2025, PP 23-29
ISSN No. (Online) 2455-5991
DOI: https://doi.org/10.20431/2455-5991.1001004
www.arcjournals.org

Association of Vitamin D Level in Patients with Chronic Heart Failure

Prof. Md. Harisul Hoque[1], Prof. Khurshed Ahmed[2], Dr. Mohammad Al Mamun[3], Muhit Newaz[4], Dr. Nilufar Fatema[5]

[1]*Professor, Department of Cardiology, Bangladesh Medical University (BMU), Dhaka, Bangladesh*

[2]*Professor, Department of Cardiology, Bangladesh Medical University (BMU), Dhaka, Bangladesh*

[3]*Associate Professor, Department of Cardiology, Bangladesh Medical University (BMU), Dhaka, Bangladesh*

[4] *Senior Portfolio Manager, Eskaef Pharmaceuticals Limited, Dhaka, Bangladesh*

[5]*Assistant Professor, Department of Cardiology, Bangladesh Medical University (BMU), Dhaka, Bangladesh*

Received: 21 April 2025 Accepted: 07 May 2025 Published: 14 May 2025

Corresponding Author:** ***Prof. Md. Harisul Hoque, *Professor, Department of Cardiology, Bangladesh Medical University (BMU), Dhaka, Bangladesh.*

Abstract

Introduction: *Vitamin D deficiency has been increasingly recognized as a contributing factor in the progression and severity of chronic heart failure. This study aimed to assess the prevalence of vitamin D deficiency in heart failure patients and evaluate the association of low vitamin D levels in patients with chronic heart failure.*

Methods: *This cross-sectional observational study was conducted in the Clinical Cardiology Division, Department of Cardiology at Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, from July 2021 to June 2022. In this study, a total of 96 patients diagnosed with chronic heart failure and admitted to the Coronary Care Unit (CCU) during this period were included.*

Result: *The mean age of the study population was 61 ± 3 years, with a male predominance (70%). Dyspnea on exertion was the most common symptom. Tachycardia and hypotension were observed in 83.33% and 64.58% of patients, respectively. Clinical signs such as basal crepitations (51.04%) and dependent edema (33.33%) were frequent. Based on the NYHA classification, most patients were in class I (36.45%) or class II (33.33%). Echocardiographic findings revealed that 47.91% had reduced ejection fraction (EF < 40%). Vitamin D deficiency was found in 85.41% of patients. Among these, a higher NYHA class was associated with lower vitamin D levels, with 18.29% of deficient patients in class IV.*

Conclusion: *This study showed that Low levels of 25(OH)D and 1,25(OH)$_2$D are associated with heart failure in this cross-sectional analysis. These findings suggest that maintaining optimal vitamin D status may represent a valuable strategy in the prevention of myocardial disease and heart failure, potentially through appropriate vitamin D supplementation.*

Keywords: *Heart failure, Vitamin D deficiency, NYHA classification, Ejection fraction, Echocardiography*

1. Introduction

Heart failure (HF) is a growing global health concern with a significant impact on mortality, morbidity, and quality of life.

As of 2014, approximately 26 million individuals worldwide were living with heart failure. In the United States alone, the prevalence of HF is estimated at around 6.5 million, with projections suggesting a 46% increase from 2012 to 2030 and an annual incidence of approximately 960,000 new cases. HF also carries a substantial economic impact, with global costs estimated at $108 billion annually [1]. More than one million HF-related hospitalizations occur each year, and nearly half of all patients diagnosed with HF die within five years. Acute heart failure (AHF) arises when the heart is suddenly unable to meet the body's circulatory demands. This condition can be a new-onset (de novo) or an acute decompensation of chronic heart failure. Common symptoms include sudden shortness of

breath, swelling in the legs and abdomen, rapid weight gain from fluid retention (e.g., 2–3 pounds in 24 hours or 5 pounds in a week), nausea, and loss of appetite. Additional signs may include fatigue, weakness, irregular heartbeat, coughing, wheezing, and cognitive decline [1].

Advancements in the management of hypertension, smoking cessation, and lipid disorders, along with improved diagnostic and therapeutic strategies for cardiovascular diseases (CVD), have led to reductions in CVD mortality [1]. However, CVDs remain the leading cause of global morbidity and mortality and contribute substantially to chronic disability [2]. Biomarkers such as B-type natriuretic peptide (BNP) have become essential in the diagnosis and management of HF [3-5].

Epidemiological studies have linked chronic degenerative diseases such as diabetes mellitus and CVDs to early life environmental and epigenetic factors [6-10]. The "Foetal Programming Hypothesis," also known as Barker's Hypothesis, originates from epidemiological studies conducted in England and Wales and emphasizes the importance of in-utero conditions in the development of adult diseases. A comprehensive review has outlined how genetic, environmental, and nutritional factors—including vitamin deficiencies—impact fetal development and long-term cardiovascular health [11].

One of the most notable modifiable risk factors is vitamin D deficiency. A German study demonstrated that low maternal 25-hydroxyvitamin D levels were associated with adverse perinatal outcomes, including low birth weight, prematurity, increased perinatal mortality, and impaired glucose metabolism, all of which may contribute to renal and cardiovascular diseases in adulthood [12]. HF, often the final common pathway of various cardiac conditions, remains a major cause of hospitalization among the elderly [13].

A cohort analysis of 1,749 elderly individuals by Chen et al. affirmed that independent risk factors for HF include advanced age, male sex, diabetes mellitus, pulse pressure, and acute myocardial infarction [14]. There is growing evidence linking vitamin D deficiency with cardiovascular dysfunction, including HF [15]. Despite this, there remains a lack of data on the association between vitamin D levels and heart failure in the Bangladeshi population. In this study, we aimed to evaluate the association of low vitamin D levels in patients with chronic heart failure. This study may provide valuable insight into the role of vitamin D in heart failure and contribute to improved patient management strategies in our local context.

2. Methodology & Materials

This cross-sectional observational study was conducted in the Clinical Cardiology Division, Department of Cardiology at Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh, from July 2021 to June 2022. In this study, a total of 96 patients diagnosed with chronic heart failure and admitted to the Coronary Care Unit (CCU) during this period were included. All participants presented with shortness of breath and were admitted to the Department of Cardiology at BMU for evaluation and management.

These are the following criteria to be eligible for enrollment as our study participants:

2.1. Inclusion Criteria

a) Chronic heart failure patients who were 18 to 70 years of age;

b) Chronic heart failure patients with NYHA class I to IV;

c) Patients with shortness of breath in ischemic heart disease and cardiomyopathy patients with reduced EF (HFrEF);

d) Patients with shortness of breath in hypertensive patients with preserved EF (HFpEF).

2.2. Exclusion Criteria

a) Patients with congenital heart disease;

b) Patient with valvular heart disease;

c) Patients who were not willing to participate in the study

2.3. Working Definition

2.3.1. Chronic Heart Failure

Heart failure (HF) is a clinical syndrome that can result from any structural or functional cardiac disorder that impairs the ability of the ventricle to fill with or eject blood [16]. If a patient has suffered from a disease more than three months, then it is called a Chronic disease.

2.3.2. HFrEF or Systolic Heart Failure

A clinical syndrome with classic symptoms of breathlessness, fatigue, and exercise intolerance whereby the dominant cardiac feature is a large, dilated heart and impaired systolic performance [17].

2.3.3. HFpEF or Diastolic Heart Failure

This is a clinical syndrome characterized by breathlessness, fatigue, and exercise intolerance whereby the dominant cardiac feature is impaired diastolic function (usually diagnosed by echo) and normal or near normal ejection phase indices. There is often LV hypertrophy and impaired filling of the heart due to altered LV stiffness or other evidence of diastolic dysfunction [17].

2.4. Data Collection Procedure

A total of 96 patients presenting with shortness of breath were included in this study, all of whom were admitted to the Department of Cardiology at BSMMU. Detailed medical history, clinical examination, and relevant investigations were performed for each participant. The diagnosis of heart failure was established using B-type natriuretic peptide (BNP) levels, chest X-ray (posteroanterior view), and color Doppler echocardiography.

All echocardiographic assessments were performed by a single operator using a GE Vivid 7 echocardiography machine equipped with an M4S transducer. Left ventricular ejection fraction (EF) was measured using the Modified Simpson Method. Systolic dysfunction was categorized as follows: EF ≤30% indicated severe systolic heart failure, EF between 31–40% was classified as moderate left ventricular systolic dysfunction, and EF between 41–54% was considered mild dysfunction. Tissue Doppler Imaging (TDI) was also performed to assess diastolic dysfunction, which may present as chronic heart failure. In addition, blood samples were collected from each patient to measure serum vitamin D levels. All data were recorded using a structured data collection sheet. Written informed consent was obtained from all participants.

2.5. Statistical Analysis

All data were recorded systematically in a pre-formatted data collection form. Quantitative data was expressed as mean and standard deviation, and qualitative data was expressed as frequency distribution and percentage. The data were analyzed using SPSS 22 (Statistical Package for Social Sciences) for Windows version 10. This study was ethically approved by the Institutional Review Board (IRB) of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh.

3. RESULTS

Table 1. *Clinical features of chronic heart failure (N=96)*

Clinical feature	Number	Percentage
Short of Breath at rest	15	15.62%
Tachycardia (>100 bpm)	80	83.33%
Bradycardia (<60 bpm)	16	16.66%
Low BP (<90/60 mm of Hg)	62	64.58%
Raised JVP	15	15.62%
Basal Creps	49	51.04%
Hepatomegaly	13	13.54%
Ascitis	17	17.70%
Dependent Oedema	32	33.33%

Table 1 shows that among 96 patients, 68 (70%) were male and 28 (29%) were female, with a mean age of 61 ± 3 years. Fifteen patients (15.62%) reported shortness of breath at rest, while the remaining experienced dyspnea on exertion. Tachycardia was observed in 83.33% of patients, while 16.66% had bradycardia. Hypotension was present in 64.58% of cases, and raised jugular venous pressure (JVP) was noted in 15 patients. On respiratory system examination, basal crepitations were found in 49 patients (51.04%), hepatomegaly in 13 (13.54%), ascites in 17 (17.70%), and dependent edema in 32 patients (33.33%).

Table 2. *Stages of chronic Heart Failure (N=96)*

NYHA	Number	Percentage
Class I	35	36.45%
Class II	32	33.33%
Class III	14	14.58%
Class IV	15	15.62%

In table 2 we showed that based on the New York Heart Association (NYHA) classification of dyspnea, 35 patients (36.45%) were classified as NYHA class I, 32 (33.33%) as class II, 14 (14.58%) as class III, and 15 (15.62%) as class IV.

Table 3. *Types of Heart Failure (N=96)*

	Number	Percentage
Systolic Heart Failure (HFrEF): EF< 40%	46	47.91%
Diastolic Heart Failure (HFpEF): EF>50%	40	41.66%
EF -41-50%	10	10.41%

Table 3 shows that Color Doppler echocardiography revealed 46 patients (47.91%) had a reduced ejection fraction (EF), 40 (41.66%) had a preserved EF (>50%), and 10 (10.41%) had a mildly reduced EF between 41–50%.

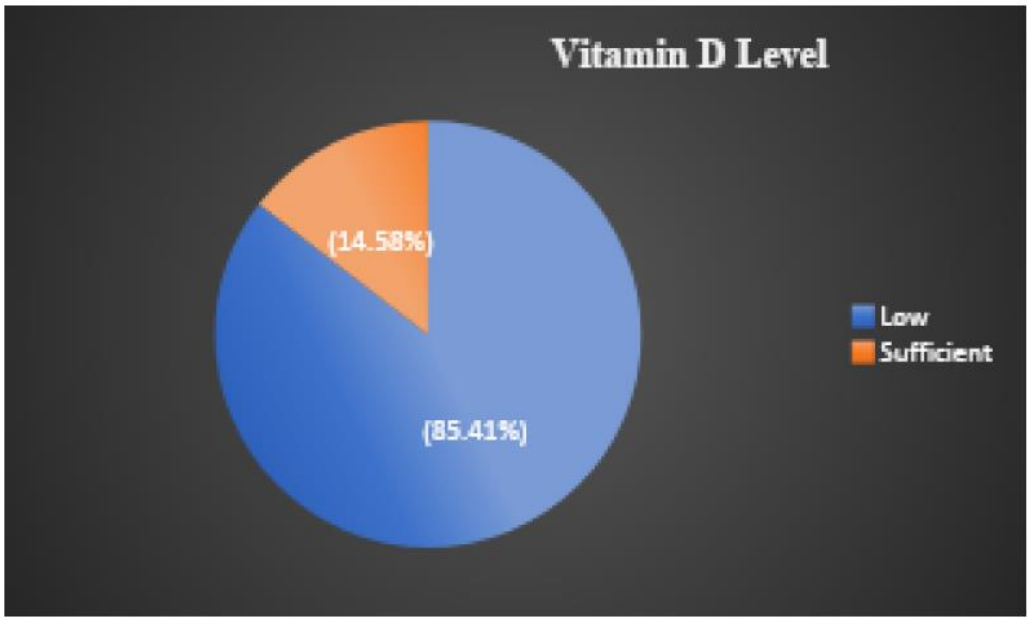

Figure 1. *Level of Vitamin D in chronic heart failure patients (N=96)*

The pie chart shows that vitamin D levels were assessed in all heart failure patients. Fourteen patients (14.58%) had sufficient vitamin D levels, while 82 (85.41%) were found to be deficient.

Table 4. *Grading of symptoms with Low Vitamin D level (n=82)*

	Number	Percentage
NYHA-I	26	31.70%
NYHA -II	28	29.16%
NYHA-III	13	15.85%
NYHA-IV	15	18.29%

Table 4 shows that among the 82 patients with low vitamin D levels, NYHA classification revealed that 26 (31.70%) were in class I, 28 (29.16%) in class II, 13 (15.85%) in class III, and 15 (18.29%) in class IV.

4. Discussion

In our study, the association between vitamin D metabolites and left ventricular (LV) dysfunction remained significant. Both 25(OH)D and 1,25$(OH)_2$D levels were inversely related to higher NYHA functional classes, indicating that lower vitamin D levels were associated with more severe symptoms. Reduced physical activity, a common consequence of heart failure, is closely linked with NYHA classification and may not serve as an adequate covariate. It is also important to consider that vitamin D deficiency itself can cause muscle weakness and impaired mobility, effects shown to improve with vitamin D supplementation [18,19]. Vitamin D plays a role in myocardial calcium homeostasis, essential

for normal cardiac contractility and electrophysiology. This is mediated through its regulatory influence on ion channels and enzymatic processes [20–24]. While the underlying mechanisms require further investigation, current evidence suggests that maintaining adequate vitamin D levels may help prevent myocardial hypercontractility and support diastolic function [25,26].

Interestingly, we did not observe a strong association between low vitamin D status and the presence of coronary artery disease (CAD). Furthermore, neither 25(OH)D nor 1,25$(OH)_2$D levels (data not shown) were significantly linked with fatal myocardial infarction after multivariable adjustment. This may indicate that adequate vitamin D status is more critical for cardiomyocyte physiology than for coronary perfusion, even though CAD and myocardial dysfunction are often interrelated.

Our findings are supported by data from the Framingham Offspring Study, which followed 1,739 participants without pre-existing cardiovascular disease over 5.4 years. During this period, 120 nonfatal and fatal cardiovascular events occurred. Low vitamin D levels were independently associated with a greater risk of such events [27]. While this aligns with our results, we did not find a similar interaction between 25(OH) D levels and systemic hypertension in our population, unlike the Framingham study, where the association was mainly observed among individuals with arterial hypertension [27].

Additionally, our findings are consistent with those of Visser et al. [28], who demonstrated a relationship between low 25(OH) D levels and increased mortality in older adults. Several limitations should be acknowledged. Our study relied on a single measurement of vitamin D metabolites rather than serial assessments, which would offer a more accurate representation of an individual's vitamin D status over time. Moreover, our seasonal adjustment assumption, that individuals with high vitamin D levels in summer would remain in a similar percentile in winter, may not be fully reliable. Therefore, we cannot rule out the possibility that low vitamin D is merely a surrogate marker for other factors contributing to heart failure or sudden cardiac death (SCD).

While we cannot definitively conclude a causal relationship between vitamin D deficiency and heart failure or SCD, existing data, including meta-analyses demonstrating reduced overall mortality with vitamin D supplementation, highlight the urgent need for interventional trials [29-33]. Future studies should explore the use of adequately high doses of vitamin D, taking into account the updated safety data and the limitations of prior trials that used insufficient dosing. Achieving target 25(OH) D levels of at least 75 nmol/L (30 ng/mL) may be critical. Thus, in patients with severe vitamin D deficiency, supplementation could potentially raise both 25(OH) D and 1,25 $(OH)_2$D levels, offering a promising preventive strategy for heart failure.

5. Limitations of the Study

Our study was a single-center study. We took a small sample size due to the short study period. After evaluating those patients, we did not follow up with them for the long term and did not know other possible interference that may happen in the long term with these patients.

6. Conclusion and Recommendations

The study findings show that Low levels of 25(OH) D and 1, 25$(OH)_2$D are associated with heart failure in this cross-sectional analysis. These findings suggest that maintaining optimal vitamin D status may represent a valuable strategy in the prevention of myocardial disease and heart failure, potentially through appropriate vitamin D supplementation. Further study with a prospective and longitudinal study design, including a larger sample size, needs to be done to validate the findings of our study.

Acknowledgment

I would like to express my sincere gratitude for the invaluable support and cooperation provided by the staff, participants, and my co-authors/colleagues who contributed to this study.

Financial Support and Sponsorship

This study was funded by the Faculty Research Grant of Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh.

Conflicts of Interest

There are no conflicts of interest.

References

[1] Bovet P, Paccaud F. Cardiovascular disease and the changing face of global public health: a focus on low and middle income countries. Public Health Rev. 2013;33:397 415.

[2] Smith SC Jr, Collins A, Ferrari R, Holmes DR Jr, Logstrup S, McGhie DV, et al. Our time: a

call to save preventable death from cardiovascular disease (heart disease and stroke). Glob Heart. 2013;7:297–305.

[3] Maisel AS, Krishnaswamy P, Nowak RM, McCord J, Hollander JE, Duc P, et al. Rapid measurement of B-type natriuretic peptide in the emergency diagnosis of heart failure. N Engl J Med. 2002;347:161–7.

[4] Mueller C, Scholer A, Laule-Kilian K, Martina B, Schindler C, Buser P, et al. Use of B-type natriuretic peptide in the evaluation and management of acute dyspnea. N Engl J Med. 2004;350:647–54.

[5] Jourdain P, Jondeau G, Funck F, Gueffet P, Le Helloco A, Donal E, et al. Plasma brain natriuretic peptide-guided therapy to improve outcome in heart failure: the STARS-BNP Multicenter Study. J Am Coll Cardiol. 2007;49:1733–9.

[6] Hales CN, Barker DJ. The thrifty phenotype hypothesis: type 2 diabetes. Br Med Bull. 2001;60:5.

[7] Gillman MW. Prenatal famine and developmental origins of type 2 diabetes. Lancet Diabetes Endocrinol. 2015;3:751–2.

[8] Barker DJ, Osmond C. Infant mortality, childhood nutrition, and ischaemic heart disease in England and Wales. Lancet. 1986;1:1077–81.

[9] Osmond C, Barker DJP, Winter PD, Fall CHD, Simmonds SJ. Early growth and death from cardiovascular disease in women. BMJ. 1993;307:1519–24.

[10] Olsen J. David Barker (1938–2013)—a giant in reproductive epidemiology. Acta Obstet Gynecol Scand. 2014;93:1077–80.

[11] Reichetzeder C, Dwi Putra SE, Li J, Hocher B. Developmental origins of disease—crisis precipitates change. Cell Physiol Biochem. 2016;39:919–38.

[12] Reichetzeder C, Chen H, Föller M, Slowinski T, Li J, Chen YP, et al. Maternal vitamin D deficiency and fetal programming—lessons learned from humans and mice. Kidney Blood Press Res. 2014;39:315–29.

[13] Schmidt MI, Duncan BB, Chor D, Azevedo e Silva G, Menezes AM, Monteiro CA, et al. Chronic non-communicable diseases in Brazil: burden and current challenges. Lancet. 2011;377:1949–61.

[14] Chen YT, Vaccarino V, Williams CS, Butler J, Berkman LF, Krumholz HM. Risk factors for heart failure in the elderly: a prospective community-based study. Am J Med. 1999;106:605.

[15] Pareja-Galeano H, Alis R, Sanchis-Gomar F, Lucia A, Emanuele E. Vitamin D, precocious acute myocardial infarction, and exceptional longevity. Int J Cardiol. 2015;199:405–6.

[16] Braunwald E. Heart disease: a textbook of cardiovascular medicine. 7th ed. Philadelphia: Saunders; 2005.

[17] Fuster V, Alexander RW, O'Rourke RA. Hurst's The Heart. 11th ed. Vol 1. New York: McGraw-Hill; p. 698.

[18] Janssen HC, Samson MM, Verhaar HJ. Vitamin D deficiency, muscle function, and falls in elderly people. Am J Clin Nutr. 2002;75:611–5.

[19] Venning G. Recent developments in vitamin D deficiency and muscle weakness among elderly people. BMJ. 2005;330:524–6.

[20] Thomasset M, Parkes CO, Cuisinier-Gleizes P. Rat calcium-binding proteins: distribution, development, and vitamin D dependence. Am J Physiol. 1982;243:483–8.

[21] Selles J, Boland R. Rapid stimulation of calcium uptake and protein phosphorylation in isolated cardiac muscle by 1,25-dihydroxyvitamin D3. Mol Cell Endocrinol. 1991;77:67–73.

[22] Selles J, Boland R. Evidence on the participation of the 3′,5′-cyclic AMP pathway in the non-genomic action of 1,25-dihydroxyvitamin D3 in cardiac muscle. Mol Cell Endocrinol. 1991;82:229–35.

[23] Selles J, Bellido T, Boland R. Modulation of calcium uptake in cultured cardiac muscle cells by 1,25-dihydroxyvitamin D3. J Mol Cell Cardiol. 1994;26:1593–9.

[24] Green JJ, Robinson DA, Wilson GE, Simpson RU, Westfall MV. Calcitriol modulation of cardiac contractile performance via protein kinase C. J Mol Cell Cardiol. 2006;41:350–9.

[25] Tishkoff DX, Nibbelink KA, Holmberg KH, Dandu L, Simpson RU. Functional vitamin D receptor in the t-tubules of cardiac myocytes. Endocrinology. 2008;149:558–64.

[26] Bodyak N, Ayus JC, Achinger S, Shivalingappa V, Ke Q, Chen YS, et al. Activated vitamin D attenuates left ventricular abnormalities induced by dietary sodium in Dahl salt-sensitive animals. Proc Natl Acad Sci USA. 2007;104:16810–5.

[27] Wang TJ, Pencina MJ, Booth SL, Jacques PF, Ingelsson E, Lanier K, et al. Vitamin D deficiency and risk of cardiovascular disease. Circulation. 2008;117:503–11.

[28] Visser M, Deeg DJ, Puts MT, Seidell JC, Lips P. Low serum concentrations of 25-hydroxyvitamin D in older persons and the risk of nursing home admission. Am J Clin Nutr. 2006;84:616–22.

[29] Autier P, Gandini S. Vitamin D supplementation and total mortality. Arch Intern Med. 2007;167:1730–7.

[30] Hsia J, Heiss G, Ren H, Allison M, Dolan NC, Greenland P, et al. Calcium/vitamin D supplementation and cardiovascular events. Circulation. 2007;115:846–54.

[31] Michos ED, Roger S, Blumenthal RS. Vitamin D supplementation and cardiovascular disease risk. Circulation. 2007;115:827–8.

[32] Hathcock JN, Shao A, Vieth R, Heaney R. Risk assessment for vitamin D. Am J Clin Nutr. 2007;85:6–18.

[33] Bischoff-Ferrari HA, Giovannucci E, Willett WC, Dietrich T, Dawson-Hughes B. Estimation of optimal serum concentrations of 25-hydroxyvitamin D for multiple health outcomes. Am J Clin Nutr. 2006;84:18–28.

Citation: *Prof. Md. Harisul Hoque et al. Association of Vitamin D Level in Patients with Chronic Heart Failure. ARC Journal of Cardiology. 2025; 10(1):23-29. DOI: https://doi.org/10. 20431/2455-5991.1001004*