Section: General Medicine

Original Research Article

MYOCARDIAL PERFORMANCE INDEX AND SERUM NT-PROBNP AS EARLY MARKERS OF SUBCLINICAL CARDIAC DYSFUNCTION IN TYPE 2 DIABETES MELLITUS

Sathish Kumar L[1], Amudhan M[2], Lenin P[3], Madhan Kumar V[4]

[1]Assistant Professor, Department of General Medicine, Government Thiruvarur Medical College and Hospital, Thiruvarur, Tamilnadu, India.
[2]Associate Professor, Department of Emergency Medicine, Government Thiruvarur Medical College and Hospital, Thiruvarur, Tamilnadu, India.
[3]Associate Professor, Department of General Medicine, Government Thiruvarur Medical College and Hospital, Thiruvarur, Tamilnadu, India.
[4]Associate Professor, Department of Community Medicine, Government Thiruvarur Medical College and Hospital, Thiruvarur, Tamilnadu, India.

Received : 09/05/2026
Received in revised form : 01/07/2026
Accepted : 16/07/2026

Keywords:
Type 2 diabetes mellitus; Myocardial performance index; Tei index; NT-proBNP; Diabetic cardiomyopathy; Echocardiography; Left ventricular dysfunction.

Corresponding Author:
Dr. Madhan Kumar V,
Email: madhankumarvelu1228@gmail.com

DOI: 10.47009/jamp.2026.8.4.198

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2026; 8 (4); 1175-1179

ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) predisposes patients to diabetic cardiomyopathy, which often remains asymptomatic until advanced stages. Early detection of subclinical myocardial dysfunction is crucial for preventing progression to overt heart failure. The Myocardial Performance Index (MPI or Tei index) is a Doppler-derived echocardiographic parameter that assesses global ventricular function by integrating systolic and diastolic performance. Serum N-terminal pro-B-type natriuretic peptide (NT-proBNP) is a sensitive biomarker of myocardial wall stress and may identify early cardiac dysfunction. This study evaluated the correlation between MPI and serum NT-proBNP levels in asymptomatic patients with T2DM. **Materials and Methods:** A hospital-based cross-sectional observational study was conducted in the Department of General Medicine, Government Thiruvarur Medical College, Tamil Nadu, from January to December 2025. A total of 100 asymptomatic adults with T2DM were enrolled by consecutive sampling. Patients with established cardiovascular disease, uncontrolled hypertension, chronic kidney disease, significant valvular or congenital heart disease, and other systemic illnesses affecting cardiac function were excluded. Clinical characteristics, duration of diabetes, body mass index, blood pressure, glycemic indices, lipid profile, renal function, serum NT-proBNP, and transthoracic echocardiographic findings were recorded. MPI was calculated using Doppler echocardiography. Statistical analysis was performed using SPSS version 25.0, and Pearson's correlation coefficient was used to assess the association between MPI and NT-proBNP. **Results:** The mean age of participants was 54.8 ± 8.9 years, with males comprising 58% of the study population. Patients with longer diabetes duration and poor glycemic control demonstrated significantly higher MPI and NT-proBNP values. A significant positive correlation was observed between MPI and serum NT-proBNP levels ($r = 0.68$, $p < 0.001$). MPI also showed significant associations with diabetes duration, HbA1c, and left ventricular diastolic dysfunction. **Conclusion:** MPI and serum NT-proBNP exhibit a significant positive correlation in asymptomatic patients with T2DM, indicating their complementary role in detecting subclinical diabetic cardiomyopathy. Combined assessment of these non-invasive markers may improve early cardiovascular risk stratification and facilitate timely intervention before the onset of symptomatic heart failure.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a major global health problem and one of the leading causes of cardiovascular morbidity and mortality. According to the International Diabetes Federation, more than 530 million adults worldwide are living with diabetes, and this number is expected to increase substantially in the coming decades. India has one of the highest burdens of T2DM globally, making the prevention and early detection of diabetes-related cardiovascular complications a public health priority.[1,2]

Cardiovascular disease accounts for nearly two-thirds of deaths among individuals with diabetes, emphasizing the need to identify myocardial dysfunction before the onset of clinical symptoms.[2,3] Diabetic cardiomyopathy is a distinct myocardial disorder characterized by structural and functional abnormalities occurring independently of coronary artery disease, hypertension, or valvular heart disease.[3,4] Chronic hyperglycaemia, insulin resistance, oxidative stress, inflammation, and myocardial fibrosis contribute to ventricular remodeling, resulting initially in diastolic dysfunction followed by systolic impairment and eventual heart failure.[4,5] Since these changes remain clinically silent during the early stages, sensitive diagnostic tools are required for timely detection.

Conventional echocardiographic parameters, particularly left ventricular ejection fraction, may remain normal despite early myocardial dysfunction.[5] The Myocardial Performance Index (MPI), also known as the Tei index, is a simple, reproducible, Doppler-derived parameter that evaluates global ventricular function by combining systolic and diastolic time intervals. Elevated MPI has been shown to identify subclinical myocardial dysfunction in asymptomatic patients with T2DM, even when systolic function is preserved.[6-8]

Serum N-terminal pro-B-type natriuretic peptide (NT-proBNP) is a sensitive biomarker released in response to myocardial wall stress and increased ventricular filling pressures. Elevated NT-proBNP levels have been associated with early ventricular dysfunction, future heart failure, and adverse cardiovascular outcomes in patients with diabetes.[9,10] The combined assessment of MPI and NT-proBNP may therefore improve the early identification of diabetic cardiomyopathy by integrating structural and biochemical evidence of myocardial dysfunction.

Although both MPI and NT-proBNP have been individually evaluated in patients with T2DM, studies examining their correlation in asymptomatic individuals, particularly in the South Indian population, remain limited.[8,11,12] Therefore, the present study was undertaken to evaluate the correlation between Myocardial Performance Index and serum NT-proBNP levels in asymptomatic patients with Type 2 Diabetes Mellitus attending Government Thiruvarur Medical College. The findings may help establish a practical approach for the early detection of subclinical diabetic cardiomyopathy and improve cardiovascular risk stratification in this high-risk population.

MATERIALS AND METHODS

Study Design

This hospital-based cross-sectional analytical observational study was conducted to evaluate the correlation between the Myocardial Performance Index (MPI) and serum N-terminal pro-B-type natriuretic peptide (NT-proBNP) levels in asymptomatic patients with Type 2 Diabetes Mellitus (T2DM).

Study Setting

The study was carried out in the Department of General Medicine, Government Thiruvarur Medical College and Hospital, Thiruvarur, Tamil Nadu, India, in collaboration with the Departments of Cardiology and Biochemistry.

Study Period

The study was conducted over a period of one year from **January 2025 to December 2025**.

Study Population

Adult patients with diagnosed T2DM attending the General Medicine outpatient and inpatient departments during the study period were screened for eligibility.

Sample Size

A total of 100 consecutive eligible patients were enrolled. The sample size was calculated based on the expected correlation between MPI and NT-proBNP with a 95% confidence level and 80% study power, and was increased to 100 to improve the precision of the estimates.

Sampling Technique

Participants were recruited using a consecutive sampling method until the required sample size was achieved.

Inclusion Criteria

Patients aged **30–70 years** with diagnosed T2DM, who were asymptomatic for cardiovascular disease and willing to provide written informed consent, were included in the study.

Exclusion Criteria

Patients with Type 1 diabetes mellitus, known coronary artery disease, heart failure, significant valvular or congenital heart disease, cardiomyopathy, uncontrolled hypertension, chronic kidney disease, chronic liver disease, thyroid disorders, active infection, pregnancy, significant arrhythmias, or any condition likely to influence serum NT-proBNP levels were excluded.

Study Procedure

After obtaining Institutional Ethics Committee approval and written informed consent, demographic details, clinical history, duration of diabetes, anthropometric measurements, blood pressure, and comorbidities were recorded using a structured proforma. Routine laboratory investigations including fasting and postprandial blood glucose, HbA1c, renal function tests, lipid profile, and complete blood count were performed. Serum NT-proBNP was estimated using a standardized chemiluminescent immunoassay. All participants subsequently underwent comprehensive two-dimensional and Doppler echocardiography by an experienced cardiologist who was blinded to the biochemical results.

The Myocardial Performance Index (Tei Index) was calculated using the formula **MPI = (Isovolumetric Contraction Time + Isovolumetric Relaxation Time) / Left Ventricular Ejection Time**.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Outcome Measures

The primary outcome was the correlation between MPI and serum NT-proBNP levels. Secondary outcomes included the association of MPI with glycaemic control, duration of diabetes, and echocardiographic evidence of left ventricular diastolic dysfunction.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using **IBM SPSS Statistics version 19.** Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Independent Student's *t*-test and Chi-square test were used for group comparisons. Pearson's correlation coefficient was used to determine the relationship between MPI and serum NT-proBNP levels. Multiple linear regression analysis was performed to identify independent predictors of MPI. A *p*-value of **<0.05** was considered statistically significant.

Ethical Considerations

The study was approved by the Institutional Ethics Committee of Government Thiruvarur Medical College prior to commencement. Written informed consent was obtained from all participants.

RESULTS

A total of 100 asymptomatic patients with Type 2 Diabetes Mellitus were included in the study. The mean age of the study population was 54.8 ± 8.9 years, with the majority of participants belonging to the 51–60 years age group. There were 58 (58%) males and 42 (42%) females, with a male-to-female ratio of 1.4:1. [Table 1]

The mean duration of diabetes was 8.2 ± 4.6 years, and 62% of participants had diabetes for more than five years. The mean body mass index was 27.1 ± 3.8 kg/m², with 46% of patients being overweight and 24% classified as obese. The mean HbA1c level was 8.4 ± 1.3%, indicating suboptimal glycaemic control in most participants. [Table 2]

The mean serum NT-proBNP level was 112.6 ± 48.5 pg/mL, while the mean Myocardial Performance Index (MPI) was 0.53 ± 0.08. Patients with a longer duration of diabetes (>5 years) demonstrated significantly higher MPI and NT-proBNP values compared with those having a shorter disease duration ($p<0.05$). Similarly, participants with HbA1c ≥8% had significantly elevated MPI and NT-proBNP levels than those with HbA1c <8% ($p<0.001$). [Table 3]

Doppler echocardiography revealed evidence of left ventricular diastolic dysfunction in 36% of patients despite preserved left ventricular ejection fraction. Patients with diastolic dysfunction had significantly higher mean MPI and serum NT-proBNP concentrations than those with normal diastolic function ($p<0.001$). [Table 4]

Correlation analysis demonstrated a strong positive correlation between Myocardial Performance Index and serum NT-proBNP levels ($r = 0.68$, $p < 0.001$), indicating that increasing myocardial dysfunction was associated with higher circulating NT-proBNP concentrations. A significant positive correlation was also observed between MPI and duration of diabetes ($r = 0.51$, $p < 0.001$) and between MPI and HbA1c ($r = 0.47$, $p < 0.001$). [Table 4]

Multiple linear regression analysis identified serum NT-proBNP level, HbA1c, and duration of diabetes as independent predictors of increased MPI after adjusting for age, sex, body mass index, and blood pressure ($p<0.05$). [Table 5]

Overall, the findings demonstrate that asymptomatic patients with Type 2 Diabetes Mellitus exhibit early impairment of myocardial performance, and serum NT-proBNP shows a significant positive correlation with MPI, supporting its role as a complementary biomarker for the early detection of diabetic cardiomyopathy.

Table 1: Baseline Demographic and Clinical Characteristics of the Study Population (n=100)

Characteristic	Category	n (%) / Mean ± SD
Age	Mean ± SD (years)	54.8 ± 8.9
	≤50 years	32 (32.0)
	51–60 years	41 (41.0)
	>60 years	27 (27.0)
Gender	Male	58 (58.0)
	Female	42 (42.0)
Duration of Diabetes	Mean ± SD (years)	8.2 ± 4.6
	≤5 years	38 (38.0)
	>5 years	62 (62.0)
Body Mass Index	Mean ± SD (kg/m²)	27.1 ± 3.8
	Normal (<25 kg/m²)	30 (30.0)
	Overweight (25–29.9 kg/m²)	46 (46.0)
	Obese (≥30 kg/m²)	24 (24.0)
Comorbidities	Hypertension	41 (41.0)
	Dyslipidaemia	36 (36.0)
	Obesity	24 (24)
	Coronary Artery Disease	11 (11)
Lifestyle Factor	Smokers	18 (18.0)
	Alcohol	22 (62)
	Both	18 (18)

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Table 2: Laboratory Characteristics of the Study Population

Laboratory Parameter	Unit	Mean ± SD
Glycaemic Parameters		
Fasting Blood Sugar	mg/dL	158.4 ± 34.7
Postprandial Blood Sugar	mg/dL	236.8 ± 46.2
HbA1c	%	8.4 ± 1.3
Lipid Profile		
Total Cholesterol	mg/dL	201.6 ± 38.9
Triglycerides	mg/dL	182.4 ± 49.7
LDL Cholesterol	mg/dL	124.8 ± 31.5
HDL Cholesterol	mg/dL	42.6 ± 8.4
Renal Function		
Serum Creatinine	mg/dL	0.92 ± 0.21
Cardiac Biomarker		
Serum NT-proBNP	pg/mL	112.6 ± 48.5

Table 3: Echocardiographic Findings

Parameter	Mean ± SD
Left ventricular ejection fraction (%)	59.8 ± 4.2
E/A ratio	0.89 ± 0.22
Isovolumetric contraction time (IVCT, ms)	52.8 ± 8.1
Isovolumetric relaxation time (IVRT, ms)	93.5 ± 10.7
Left ventricular ejection time (LVET, ms)	274.6 ± 18.9
Myocardial Performance Index (MPI)	0.53 ± 0.08
Left ventricular diastolic dysfunction, n (%)	36 (36.0)

Table 4: Correlation Between Myocardial Performance Index and Clinical Variables

Variable	Correlation coefficient (r)	p-value
Serum NT-proBNP	0.68	<0.001*
HbA1c	0.47	<0.001*
Duration of diabetes	0.51	<0.001*
Body Mass Index	0.22	0.028*
Age	0.19	0.054*
Left Ventricular Ejection Fraction	-0.38	<0.001*

P value <0.05 statistically significant

Table 5: Multiple Linear Regression Analysis for Predictors of Increased Myocardial Performance Index

Variable	β Coefficient	Standard Error	p-value
Serum NT-proBNP	0.46	0.08	<0.001*
HbA1c	0.28	0.07	0.002*
Duration of Diabetes	0.24	0.06	0.006*
Age	0.09	0.05	0.180
Body Mass Index	0.07	0.04	0.230
Male Gender	0.05	0.04	0.410

P value <0.05 statistically significant

DISCUSSION

The present study evaluated the correlation between Myocardial Performance Index (MPI) and serum NT-proBNP levels in asymptomatic patients with Type 2 Diabetes Mellitus (T2DM).

The mean age of the study population was 54.8 ± 8.9 years, with a predominance of males (58%), comparable to the findings of Goroshi and Chand, who reported that diabetic myocardial dysfunction is more common among middle-aged patients with longstanding diabetes.[13] Similarly, Jia et al. highlighted that prolonged metabolic exposure and ageing contribute to myocardial remodeling and ventricular dysfunction in patients with T2DM.[14]

The mean duration of diabetes was 8.2 ± 4.6 years, and MPI showed a significant positive correlation with disease duration. This finding agrees with previous studies demonstrating that chronic hyperglycaemia promotes oxidative stress, myocardial fibrosis, endothelial dysfunction, and impaired myocardial relaxation, resulting in progressive deterioration of cardiac function.[13-15] Patients with poor glycaemic control also had significantly higher MPI and NT-proBNP levels. Jia et al. and Murtaza et al. similarly reported that elevated HbA1c is associated with structural and functional myocardial changes, emphasizing the importance of optimal glycaemic control in preventing diabetic cardiomyopathy.[14,15]

Although the mean left ventricular ejection fraction was preserved, 36% of patients exhibited left ventricular diastolic dysfunction, confirming that diastolic impairment is an early manifestation of diabetic cardiomyopathy. Goroshi and Chand observed a higher prevalence of diastolic dysfunction, possibly because of differences in study population and disease severity.[13] Nevertheless, both studies support the superior sensitivity of MPI for detecting early myocardial dysfunction compared with conventional echocardiographic parameters.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

The mean MPI in the present study was elevated (0.53 ± 0.08), indicating impaired global ventricular performance despite preserved systolic function. Similar observations by Poirier et al. and Milwidsky et al. demonstrated that MPI is a simple, reproducible, and reliable index for identifying subclinical ventricular dysfunction in patients with diabetes.[16,17] By integrating systolic and diastolic function, MPI provides a more comprehensive assessment than conventional echocardiographic measurements.

Serum NT-proBNP levels were significantly higher in patients with longer diabetes duration and poor glycaemic control and showed a strong positive correlation with MPI. Previous studies by Whitburn et al. and McDonagh et al. identified NT-proBNP as a sensitive biomarker of myocardial stress and an effective predictor of asymptomatic ventricular dysfunction and future heart failure.[18,19] These findings support its complementary role alongside echocardiographic evaluation.

Multiple regression analysis identified NT-proBNP, HbA1c, and duration of diabetes as independent predictors of increased MPI, consistent with earlier reports demonstrating that metabolic control and myocardial stress independently influence cardiac function in T2DM.[14-20] Collectively, these findings suggest that combining MPI with serum NT-proBNP provides a practical, non-invasive strategy for detecting subclinical diabetic cardiomyopathy, enabling earlier cardiovascular risk stratification and timely intervention to reduce future heart failure and cardiovascular morbidity.

CONCLUSION

The present study demonstrated a significant positive correlation between Myocardial Performance Index (MPI) and serum NT-proBNP levels in asymptomatic patients with Type 2 Diabetes Mellitus. These findings indicate that both parameters can identify early myocardial dysfunction before the development of overt heart failure. Increased MPI and NT-proBNP levels were also associated with longer duration of diabetes and poor glycaemic control, emphasizing the importance of early cardiovascular assessment in patients with longstanding T2DM. The combined use of MPI and serum NT-proBNP offers a simple, non-invasive, and clinically useful approach for the early detection of diabetic cardiomyopathy. Incorporating these investigations into the routine evaluation of high-risk diabetic patients may facilitate timely intervention, improve cardiovascular risk stratification, and potentially reduce future cardiovascular morbidity and mortality.

REFERENCES

1. International Diabetes Federation. IDF Diabetes Atlas. 10th ed. Brussels: International Diabetes Federation; 2021.
2. American Diabetes Association. Standards of Care in Diabetes—2025. Diabetes Care. 2025;48(Suppl 1):S207-S300.
3. Jia G, Hill MA, Sowers JR. Diabetic cardiomyopathy: an update of mechanisms contributing to this clinical entity. Circ Res. 2018;122(4):624-638.
4. Murtaza G, Virk HUH, Khalid M, et al. Diabetic cardiomyopathy: a comprehensive updated review. Prog Cardiovasc Dis. 2019;62(4):315-326.
5. Tei C. New non-invasive index for combined systolic and diastolic ventricular function. J Cardiol. 1995;26:135-136.
6. McDonagh TA, Metra M, Adamo M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J. 2021;42:3599-3726.
7. 2023 ESC Guidelines for the management of cardiovascular disease in patients with diabetes. Eur Heart J. 2023.
8. Januzzi JL Jr, Camargo CA, Anwaruddin S, et al. The N-terminal Pro-BNP Investigation of Dyspnea in the Emergency Department (PRIDE) study. Am J Cardiol. 2005;95:948-954.
9. American Diabetes Association. Heart Failure: An Underappreciated Complication of Diabetes. Diabetes Care. 2022.
10. Frontiers review. Diabetic cardiomyopathy: Clinical phenotype and practice. Front Endocrinol. 2022.
11. Diabetic myocardial disorder: A clinical consensus statement of the Heart Failure Association of the ESC. Eur Heart J. 2024.
12. Diabetic cardiomyopathy: insights into pathophysiology, diagnosis and clinical management. J Mol Cell Cardiol. 2025.
13. Goroshi M, Chand D. Myocardial Performance Index (Tei Index): A simple tool to identify cardiac dysfunction in patients with diabetes mellitus. Indian Heart J. 2016;68(1):83-87.
14. Jia G, Hill MA, Sowers JR. Diabetic cardiomyopathy: an update of mechanisms contributing to this clinical entity. Circ Res. 2018;122(4):624-638.
15. Murtaza G, Virk HUH, Khalid M, Lavie CJ, Ventura HO, Mukherjee D, et al. Diabetic cardiomyopathy: a comprehensive updated review. Prog Cardiovasc Dis. 2019;62(4):315-326.
16. Poirier P, Bogaty P, Garneau C, Marois L, Dumesnil JG. Myocardial performance index in patients with early type 2 diabetes mellitus. Heart. 2001;85:318-323.
17. Milwidsky A, Maor E, Kivity S, et al. Diagnostic approaches for diabetic cardiomyopathy. Cardiovasc Diabetol. 2017;16:7.
18. Whitburn S, et al. Diagnostic and prognostic biomarkers reflective of cardiac remodelling in diabetes mellitus: A scoping review. Diabetes Metab Res Rev. 2023;39:e3606.
19. McDonagh TA, Metra M, Adamo M, et al. 2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure. Eur Heart J. 2021;42:3599-3726.
20. Boudina S, Abel ED. Diabetic cardiomyopathy revisited. Circulation. 2007;115:3213-3223.

ISSN (O): 2687-5365; ISSN (P): 2753-6556