

Prevalence and Factors Associated with Diastolic Dysfunction of Left Ventricle in Patients with Newly Diagnosed Essential Hypertension

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ABSTRACT

Introduction: Hypertension causes chronic pressure overload on the left ventricle, and impaired ventricular relaxation (diastolic dysfunction) is often the first clinically silent cardiac complication of this process. This study aimed to assess the prevalence of Doppler-echocardiographically diagnosed left ventricular diastolic dysfunction (LVDD) and to identify the demographic and clinical characteristics associated with LVDD in patients with newly diagnosed essential hypertension. **Methods & Material:** This cross-sectional analytical study was carried out at the Department of Cardiology, Mymensingh Medical College Hospital, Mymensingh, Bangladesh from July 2025 to June 2026 on 80 patients with newly diagnosed, treatment-naïve essential hypertension. Demographic, anthropometric, and clinical data were collected, and all patients had a full Doppler transthoracic echocardiogram. Echocardiographic recommendations were followed to grade the diastolic function. Data were entered and analyzed on SPSS version 26.0. **Results:** LVDD was found in 45% of the participants, most frequently Grade I (impaired relaxation) (69.4%), followed by Grade II (pseudonormal filling) (25.0%) and Grade III (restrictive filling) (5.6%). Age ≥ 50 years (adjusted OR 2.71), overweight/obese (adjusted OR 2.43), Stage 2 hypertension (adjusted OR 2.89), and left ventricular hypertrophy (adjusted OR 3.74) were independently associated with LVDD ($p < 0.05$ for all). Dyslipidemia was important on univariable analysis but not as an independent predictor. **Conclusion:** Left ventricular diastolic dysfunction was present in almost half of patients with newly diagnosed essential hypertension with echocardiographic evidence. Older

age, overweight /obesity, higher stage of hypertension and left ventricular hypertrophy were independent predictors which further emphasizes the need for early echocardiographic screening and risk factor modification at the time of hypertension diagnosis.

Keywords: Essential hypertension, Diastolic dysfunction, Doppler echocardiography, Left ventricular hypertrophy

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INTRODUCTION

Population-based data from ninety countries have shown that hypertension is the most common modifiable risk factor for cardiovascular disease and its prevalence is still high and increasing in many parts of the world, despite the progress in detection and control [1]. Similar large national surveys have also revealed that a significant percentage of adults with hypertension are not diagnosed or treated until target organ damage has occurred [2]. If left untreated, the remodeling process of the left ventricle can continue to develop and eventually lead to overt heart failure, which may occur silently if not detected early [3]. One of the earliest of these adaptations is impaired myocardial relaxation and increased chamber stiffness, known as left ventricular diastolic dysfunction (LVDD), which often occurs before any measurable loss of systolic function⁴. Doppler echocardiography is the main non-invasive method for assessing diastolic function, and the recommendations of the American Society of Echocardiography and the European Association of Cardiovascular Imaging have established the criteria for the diagnosis and grading of LVDD, which have enhanced the diagnostic reproducibility between centers [5].

Community-based studies using these criteria have demonstrated that LVDD is already present in a significant number of people with hypertension, even before the onset of clinical heart failure symptoms, and is therefore an early subclinical marker of hypertensive heart disease [6]. Diastolic impairment may be clinically silent for many years and is often not recognized until patients develop exertional dyspnea, decreased exercise tolerance, or heart failure with preserved ejection fraction [7]. Data from older community-based populations support the notion that even modest levels of diastolic dysfunction are prognostic and are frequently unrecognized in routine practice [8]. Age, adiposity, degree of blood pressure elevation, and structural changes like left ventricular hypertrophy have been suggested as determinants of diastolic impairment in hypertensive populations, but their relative importance differs among populations [9]. The published evidence is largely from older or high-income populations, and there is relatively little from patients at the time of their first hypertension diagnosis in resource-limited settings, where structural cardiac changes may be more advanced [10]. Biological factors related to sex have also been suggested to contribute to the acceleration of diastolic impairment in

some subgroups, such as the loss of endogenous estrogen after menopause [11]. This regional variation in prevalence and risk factors reported makes it important to have locally generated data to inform early risk stratification and timely intervention. The aim of this study was therefore to assess the prevalence of Doppler-echocardiographically diagnosed left ventricular diastolic dysfunction and to identify the demographic and clinical factors associated with it in patients with newly diagnosed essential hypertension.

METHODS & MATERIALS

This cross-sectional analytical study was conducted at the Department of Cardiology, Mymensingh Medical College Hospital, Mymensingh, Bangladesh from July 2025 to June 2026, during which consecutive patients attending the outpatient and inpatient services were screened for eligibility. Patients with newly diagnosed essential hypertension, defined according to standard blood pressure criteria and confirmed on repeated measurements, who had not yet initiated antihypertensive therapy, were enrolled after obtaining informed written consent. Patients were excluded if they had secondary hypertension, known valvular heart disease, cardiomyopathy, prior

myocardial infarction or coronary artery disease, atrial fibrillation or other significant arrhythmia, moderate-to-severe renal or hepatic impairment, pregnancy, or technically inadequate echocardiographic windows precluding reliable Doppler assessment. A total of 80 eligible patients were recruited by consecutive sampling. Baseline demographic variables (age, sex, residence, socioeconomic status), anthropometric variables (body mass index), and clinical variables (hypertension stage, family history of hypertension, smoking status, dyslipidemia, diabetes mellitus, central obesity, and symptomatic status at presentation) were recorded using a structured proforma. All participants underwent comprehensive two-dimensional, M-mode, and Doppler transthoracic echocardiography performed by a trained sonographer, with assessment

of left ventricular ejection fraction, left ventricular hypertrophy, left atrial enlargement, mitral inflow E/A ratio, septal e' velocity, average E/ e' ratio, and left atrial volume index. Left ventricular diastolic dysfunction was diagnosed and graded (impaired relaxation, pseudonormal, and restrictive filling patterns) according to the 2016 American Society of Echocardiography/European Association of Cardiovascular Imaging recommendations. Data were entered and analyzed using SPSS version 26.0. Categorical variables were summarized as frequencies and percentages, and compared between groups with and without diastolic dysfunction using the chi-square or Fisher's exact test as appropriate. Variables significant on univariable analysis were entered into a multivariable logistic regression model to identify independent predictors of diastolic

dysfunction, with adjusted odds ratios and 95% confidence intervals reported. A p-value of < 0.05 was considered as statistically significant.

RESULTS

Table I shows socio-demographic characteristics of the study participants. Most were aged 50-59 years (37.5%), followed by 40-49 years (30.0%), ≥ 60 years (22.5%), and under 40 years (10%). Males predominated (60%) over females (40%). A little more lived in urban areas (55%) than rural areas (45%). Almost half of them were overweight (47.5%), 32.5% had normal BMI, and 20% were obese. The majority (60%) were middle class, 25% were lower class, and 15% were higher class.

Table I

Socio-demographic characteristics of the study participants ($n=80$).

Variables	Category	n (%)
Age (years)	<40	8 (10.0)
	40-49	24 (30.0)
	50-59	30 (37.5)
	≥ 60	18 (22.5)
Sex	Male	48 (60.0)
	Female	32 (40.0)
Residence	Urban	44 (55.0)
	Rural	36 (45.0)
BMI category	Normal, 18.5-24.9 kg/m ²	26 (32.5)
	Overweight, 25.0-29.9 kg/m ²	38 (47.5)
	Obese, ≥ 30.0 kg/m ²	16 (20.0)
Socioeconomic status	Lower	20 (25.0)
	Middle	48 (60.0)
	Upper	12 (15.0)

Table II shows the clinical and cardiovascular risk factor profile of the study participants. 57.5% had Stage 1 hypertension and 42.5% had Stage 2

hypertension. 42.5% had positive family history of hypertension and 32.5% were current smokers. 37.5% of the participants had dyslipidemia, 20% had diabetes

mellitus, and 37.5% had central obesity. Most of the patients were symptomatic (71.3%), and 28.7% were asymptomatic.

Table II

Clinical and cardiovascular risk factor profile of the study participants ($n=80$).

Variables	Category	n (%)
Hypertension category	Stage 1 hypertension	46 (57.5)
	Stage 2 hypertension	34 (42.5)
Family history of hypertension	Yes	34 (42.5)
	No	46 (57.5)
Current smoking	Yes	26 (32.5)
	No	54 (67.5)
Dyslipidemia	Present	30 (37.5)
	Absent	50 (62.5)
Diabetes mellitus	Present	16 (20.0)
	Absent	64 (80.0)
Central obesity	Present	30 (37.5)
	Absent	50 (62.5)
Symptoms at presentation	Symptomatic	57 (71.3)
	Asymptomatic	23 (28.7)

Table III shows the Doppler echocardiographic profile of the study participants. 95% had left ventricular ejection fraction $\geq 50\%$. Left ventricular

hypertrophy was found in 37.5% and left atrial enlargement in 31.3%. Mitral E/A ratio was 0.8-2.0 in 57.5%, < 0.8 in 38.8%, and > 2.0 in 3.8%. Septal e' velocity was

reduced (< 7 cm/s) in 40.0%, average E/ e' ratio was ≥ 14 in 18.8%, and left atrial volume index exceeded 34 mL/m² in 26.3%.

Table III
Doppler echocardiographic profile of the study participants (n=80).

Variables	Category	n (%)
Left ventricular ejection fraction	≥50%	76 (95.0)
	<50%	4 (5.0)
Left ventricular hypertrophy	Present	30 (37.5)
	Absent	50 (62.5)
Left atrial enlargement	Present	25 (31.3)
	Absent	55 (68.7)
Mitral E/A ratio	<0.8	31 (38.8)
	0.8-2.0	46 (57.5)
	>2.0	3 (3.8)
Septal e' velocity	Reduced, <7 cm/s	32 (40.0)
	Normal, ≥7 cm/s	48 (60.0)
Average E/e' ratio	<14	65 (81.3)
	≥14	15 (18.8)
Left atrial volume index	≤34 mL/m ²	59 (73.8)
	>34 mL/m ²	21 (26.3)

Table IV shows the prevalence and severity of left ventricular diastolic dysfunction in the study participants. Forty-five percent (36/80) had diastolic dysfunction and 55 percent (44/80) did not. Of the 36 patients with diastolic dysfunction, 69.4% had Grade I (impaired relaxation), 25.0% had Grade II (pseudonormal filling), and 5.6% had Grade III (restrictive filling).

Table IV
Prevalence and severity of left ventricular diastolic dysfunction of the study participants (n=80).

Variables	Category	n (%)
Left ventricular diastolic dysfunction	Present	36 (45.0)
	Absent	44 (55.0)
Grade of diastolic dysfunction, n=36	Grade I, impaired relaxation	25 (69.4)
	Grade II, pseudo normal	9 (25.0)
	Grade III, restrictive filling	2 (5.6)

Table V shows the association of demographic and clinical factors with left ventricular diastolic dysfunction of the study participants. Patients with diastolic dysfunction were significantly more likely to have age ≥50 years (p=0.014), overweight/obese status (p=0.024), Stage 2 hypertension (p=0.010), dyslipidemia (p=0.036), and left ventricular hypertrophy (p<0.001). There were no statistically significant differences in the distribution of sex (p=0.521), smoking (p=0.113), and diabetes mellitus (p=0.115) between patients with and without diastolic dysfunction.

Table V
Association of demographic and clinical factors with left ventricular diastolic dysfunction of the study participants (n=80).

Variables	Category	Diastolic dysfunction, n=36, n (%)	No diastolic dysfunction, n=44, n (%)	p-value
Age	<50 years	9 (25.0)	23 (52.3)	0.014
	≥50 years	27 (75.0)	21 (47.7)	
Sex	Male	23 (63.9)	25 (56.8)	0.521
	Female	13 (36.1)	19 (43.2)	
BMI	Normal	7 (19.4)	19 (43.2)	0.024
	Overweight/obese	29 (80.6)	25 (56.8)	
Hypertension category	Stage 1	15 (41.7)	31 (70.5)	0.010
	Stage 2	21 (58.3)	13 (29.5)	
Smoking	Yes	15 (41.7)	11 (25.0)	0.113
	No	21 (58.3)	33 (75.0)	
Dyslipidemia	Present	18 (50.0)	12 (27.3)	0.036
	Absent	18 (50.0)	32 (72.7)	
Diabetes mellitus	Present	10 (27.8)	6 (13.6)	0.115
	Absent	26 (72.2)	38 (86.4)	
LV hypertrophy	Present	21 (58.3)	9 (20.5)	<0.001
	Absent	15 (41.7)	35 (79.5)	

Table VI shows the multivariable analysis of factors independently associated with diastolic dysfunction. Age ≥50 years (adjusted OR 2.71, 95% CI 1.05-7.02), overweight/obese status (adjusted OR 2.43, 95% CI 1.01-5.87), Stage 2 hypertension (adjusted OR 2.89, 95% CI 1.14-7.34), and left ventricular hypertrophy (adjusted OR 3.74, 95% CI 1.42-9.86) remained independently associated with diastolic dysfunction. Dyslipidemia was not an independent predictor (adjusted OR 1.81, 95% CI 0.73-4.50).

Table VI
Multivariable analysis of factors associated with left ventricular diastolic dysfunction (n=80).

Variables	Category	Adjusted OR	95% CI	p-value
Age	≥50 vs <50 years	2.71	1.05-7.02	0.039
BMI	Overweight/obese vs normal	2.43	1.01-5.87	0.048
Hypertension category	Stage 2 vs Stage 1	2.89	1.14-7.34	0.026
Dyslipidemia	Present vs absent	1.81	0.73-4.50	0.200
Left ventricular hypertrophy	Present vs absent	3.74	1.42-9.86	0.008

DISCUSSION

Left ventricular diastolic dysfunction (LVDD) was identified by Doppler echocardiography in 45% of the 80 patients with newly diagnosed essential hypertension in this study. This ratio is in the broad range of ratios reported in different hypertensive cohorts worldwide, partly due to true differences in the severity of the disease, and partly due to differences in the diagnostic criteria and grading systems used by Kossaify et al [12]. Echocardiography is the main non-invasive tool that can detect such impairment at an early stage, before patients develop symptoms, and should be used as part of the initial evaluation of newly identified hypertensive patients, not just for those with obvious symptoms [13]. Age was a significant independent predictor of LVDD, as previously reported, progressive age-related changes in cardiac and arterial structure and function are exacerbated by the presence of coexisting hypertension [14]. The relationship between overweight/obese status and LVDD is similar to the relationship between obesity and left ventricular mass and geometry, which is independent of blood pressure, and is indicative of the combined hemodynamic burden of increased circulating volume and neuro-hormonal activation on ventricular filling [15]. In this study, diabetes mellitus was not independently associated with LVDD, but in diabetic populations from other studies, evidence of hyperglycemia-related myocardial stiffening would lead to a decrease in diastolic filling only after a more prolonged period of hyperglycemia, which may not have occurred in a relatively young, newly diagnosed cohort [16]. Patients with Stage 2 hypertension were almost three times more likely to have LVDD than those with Stage 1 disease, reflecting the dose-dependent relationship between the severity of hypertension and the pattern of ventricular filling, in which neurohormonal activation has been shown to play a role in treatment-naïve patients with hypertension [17]. Left ventricular hypertrophy (LVH) was the most significant independent predictor of LVDD, as has been observed in newly diagnosed African hypertensive populations where structural cardiac adaptation was already present as a marker of subclinical target-organ damage [18]. The left atrial enlargement, which is part of the diastolic assessment algorithm, has also

been demonstrated to closely follow the cumulative cardiovascular risk burden in large population cohorts and, as used here, the combination of blood pressure control status and functional Doppler parameters with structural indices enhances the sensitivity of the detection of diastolic dysfunction in community hypertensive populations [19,20]. Dyslipidemia was significantly associated with LVDD on univariable analysis but not after adjustment, indicating that the apparent association may be explained by the high prevalence of dyslipidemia in obese and more advanced hypertension, both of which are known to be associated with adverse ventricular structural change [15]. The high proportion of Grade I (impaired relaxation) in the patients with LVDD in this study is reassuring, as this is the earliest and most reversible stage, and is generally associated with good response to blood pressure control, consistent with grading systems that assign pseudonormal and restrictive filling patterns to a more advanced and less favorable stage [12]. These results are consistent with the global trend of increasing burden of hypertension and continued low awareness and control of hypertension and the global burden of cardiometabolic risk factors and are especially high outside high-income countries where uncontrolled and masked hypertension are prevalent [21-23]. Other modifiable lifestyle factors have also been shown to be independent risk factors for diastolic impairment in hypertensive patients, which further supports the need for systematic echocardiographic assessment and full risk factor modification at the time of hypertension diagnosis [24].

LIMITATIONS

This study was conducted in a single center with a small number of patients and was cross-sectional, so the results may not be generalizable and could not be used to determine the temporal relationship between risk factors and diastolic dysfunction.

CONCLUSION

In this study, almost half of the patients with newly diagnosed essential hypertension had left ventricular diastolic dysfunction. The most frequent pattern was grade-I (impaired relaxation) and suggested that most of the patients with the condition were in an early and potentially reversible

stage. Diastolic dysfunction was independently associated with older age, overweight/obese status, higher hypertension stage, and left ventricular hypertrophy. Diastolic dysfunction was associated with dyslipidemia on univariable analysis but not after adjustment. The results of this study support that subclinical diastolic dysfunction may occur before clinical cardiac symptoms and before treatment is initiated in patients with hypertension. Doppler echocardiographic screening of patients with hypertension should be done systematically at the time of diagnosis to identify at-risk patients and provide timely intervention.

RECOMMENDATION

The predictors of left ventricular diastolic dysfunction should be confirmed in larger, multicenter, longitudinal studies, and it is recommended that early intervention of modifiable risk factors, such as obesity, hypertension severity, and LVH, prevent progression of left ventricular diastolic dysfunction.

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CONFLICT OF INTEREST

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