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Frequency of Diastolic Dysfunction in Patients of Essential Hypertension

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ABSTRACT

Background: Left ventricular diastolic dysfunction (LVDD) is a frequently underdiagnosed cardiac complication in patients with essential hypertension. Early identification of LVDD is crucial for preventing progression to heart failure with preserved ejection fraction (HFpEF). **Objective:** To determine the frequency of diastolic dysfunction in patients with essential hypertension and assess the association of LVDD with demographic and clinical risk factors. **Methods:** This cross-sectional study was conducted at the Department of Cardiology, NICVD, Karachi, from March 9, 2025, to June 15, 2025. A total of 166 patients aged 25–80 years with a history of essential hypertension for more than two months and currently on treatment were included via non-probability consecutive sampling. **Results:** Among 166 hypertensive patients, the frequency of LVDD was 28.3% (n = 47). Diastolic dysfunction was significantly associated with age ≥ 60 years (adjusted OR = 2.12; 95% CI: 1.01–4.44; p = 0.047) and BMI ≥ 30 kg/m^2 (adjusted OR = 2.34; 95% CI: 1.08–5.04; p = 0.03). Although higher prevalence was observed in diabetics and smokers, these associations were not statistically significant. **Conclusion:** It is concluded that LVDD is a common subclinical complication among patients with essential hypertension, particularly in those who are older or obese. Routine echocardiographic screening should be considered for early detection and risk stratification, enabling timely interventions to prevent adverse cardiac outcomes.

INTRODUCTION

Heart failure (HF) is a global pandemic and serious health concern affecting 64.34 million people all over the world, posing significant morbidity, mortality, and expenditure [1]. Approximately 1% of the world´s population is suffering from HF [2]. A 2020 study in Saudi Arabia, estimated the 1-year mortality rate for those with acute and chronic heart failure to be 19.5% and 9%, respectively.[2] The prevalence of HF is rising, and diastolic HF is a major cause of hospital admissions, especially among the elderly women [3]. Diastolic dysfunction refers to impaired ventricular relaxation or filling regardless of ejection fraction and symptoms [4]. Some of the major risk factors for diastolic dysfunction are increasing age, diabetes mellitus, ischemic heart disease, hypertension and left ventricular (LV) hypertrophy [5,6]. Diastolic dysfunction is more prevalent among hypertensive patients [7]. Approximately, 34% of patients with diabetes suffer from diastolic dysfunction [6]. Determinants of diastolic dysfunction include myocardial relaxation, myocardial stiffness, chamber geometry, wall thickness, preload and afterload, passive properties of the ventricular wall, and heart rate [4].

Diastolic HF causes lesser annual deaths as compared to that systolic HF [8]. However, diastolic dysfunction is important, and it should be recognized as early as possible to avoid its progression to diastolic failure. Diastolic dysfunction has been reported to be more prevalent in the patients with heart failure with preserved ejection fraction (HFpEF) as compared to those with heart failure with reduced ejection fraction (HFrEF) [9]. The reason is that the patients with HFpEF have extensive perivascular fibrosis as compared to those with HFrEF. The management of diastolic dysfunction is not codified. However, drugs like calcium channel blockers (CCBs), beta-blockers (BBs), angiotensin-converting enzyme inhibitors (ACEIs), and angiotensin-receptor blockers (ARBs) play beneficial roles in the management of patients with diastolic dysfunction. Similarly, risk factors for CVDs such as high blood pressure and consequential left ventricular hypertrophy are highly prevalent [10]. In a study, it was found that at baseline, 35 of the 283 hypertension were diagnosed with LVDD (12.3%) [11]. The other study showed that the most common abnormalities were left ventricular (LV) hypertrophy (44.2%, n = 46), and diastolic dysfunction, (35.6%, n = 37) [12]. In a local study, left ventricular diastolic dysfunction was 44%, 40% and 16% had grade I, II, and grade III [13]. The rationale of the study is that there are limited studies on this topic locally. Therefore, present study is designed to assess the magnitude of LVDD, thereby strategies could be made to screen such patients at regular intervals. Furthermore, the data of this study will be utilized for resource allocation.

Objective

To determine the frequency of diastolic dysfunction in patients of essential hypertension attending a tertiary care facility, Karachi

METHODOLOGY

This Cross-Sectional Study was conducted at the Department of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Karachi from 9 March 2025 to 15 June 2025. Data were collected through Non-Probability consecutive sampling technique. The sample size was calculated with the help of a World Health Organization (WHO) sample size calculator based on following parameters:
Confidence level; 95%
LVDD= 12.3%[11]
Absolute Precision: 5%
The sample size came out to be 166 patients with essential hypertension

Inclusion Criteria

- Patients with Essential hypertension of 2 months or more duration
- Patients on treatment
- Patients aged 25 to 80 years of either gender

Exclusion criteria

- Patients with significant valvular heart disease, cardiomyopathy, heart failure with reduced ejection fraction, and atrial fibrillation.
- History of prior ischemic stroke and coronary heart disease
- Patients with newly diagnosed hypertension, those with secondary hypertension

Data Collection

Approval from the ethical review committee of NICVD (already applied for it) as well as from the research department of the College of Physicians and Surgeons were taken. Patients attending the outpatient department of NICVD who fulfilled the inclusion criteria were invited to participate after being informed about the study objectives, procedures, potential risks, and benefits, followed by obtaining written informed consent. Demographic and clinical information, including age, gender, duration of hypertension, history of diabetes, and smoking status, were documented. Anthropometric measurements were obtained with standardized equipment: weight was measured in kilograms using an electronic scale with patients in light clothing and no shoes, and height was recorded in meters using a wall-mounted stadiometer. Body mass index (BMI) was calculated using the formula: BMI = weight (kg)/height^2 (m^2). Blood pressure was measured twice in the sitting position using a mercury sphygmomanometer, with a 5-minute rest period and a 1–2-minute interval between readings. The average of the two readings was recorded. All patients underwent transthoracic echocardiography performed by a trained sonologist with at least two years of experience. Left ventricular diastolic dysfunction was diagnosed based on standard echocardiographic parameters as defined in the operational criteria of the study. All clinical and echocardiographic data were recorded in a predesigned structured questionnaire.

Data Analysis

Data were entered and analyzed using SPSS version 24. The normality of quantitative variables such as age, height, weight, BMI, systolic and diastolic blood pressure, and duration of hypertension was assessed using the Shapiro-Wilk test. Mean ± standard deviation (SD) or median with interquartile range (IQR) was reported for continuous variables, depending on data distribution. Categorical variables including gender, smoking status, history of diabetes, and presence of LVDD were presented as frequencies and percentages. Logistic regression analysis was conducted to control for potential confounding variables such as age, gender, duration of hypertension, BMI, smoking status, diabetes, and blood pressure levels. Variables with a p-value <0.25 in the univariate model were included in the multivariate model. A p-value ≤0.05 was considered statistically significant, and adjusted odds ratios (OR) with 95% confidence intervals (CI) were calculated to determine the strength of associations.

RESULTS

A total of 166 patients were added in the study with a mean age of 54.2 ± 11.3 years, comprising 43.4% males and 56.6% females. The median duration of hypertension was 4 years with an interquartile range of 2 to 8 years. The average systolic blood pressure was 148.7 ± 12.4 mmHg, while the diastolic blood pressure averaged 92.3 ± 8.7 mmHg. The mean body mass index was 27.6 ± 3.8 kg/m^2.

Table 1
Baseline Characteristics

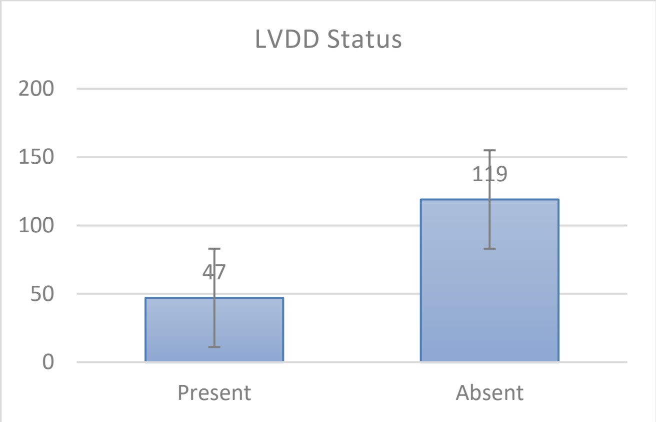
Variable	Mean ± SD / n (%)
Age (years)	54.2 ± 11.3
Male	72 (43.4%)
Female	94 (56.6%)
Duration of Hypertension (years)	4 (IQR: 2–8)
Systolic BP (mmHg)	148.7 ± 12.4
Diastolic BP (mmHg)	92.3 ± 8.7
BMI (kg/m^2)	27.6 ± 3.8

Left ventricular diastolic dysfunction was present in 47 out of 166 patients, accounting for 28.3% of the study population, while 119 patients, or 71.7%, did not exhibit diastolic dysfunction on echocardiographic assessment.

Table 2
Frequency of LVDD

LVDD Status	Number of Patients (n)	Percentage (%)
Present	47	28.3
Absent	119	71.7

Figure 1



Among patients aged 60 years or older, 38.7% had left ventricular diastolic dysfunction, showing a statistically significant association (p = 0.02). Diastolic dysfunction was present in 35.5% of diabetics and 36.8% of smokers, though these associations were not statistically significant (p = 0.08 and p = 0.14, respectively). A significant relationship was observed with obesity, as 42.9% of patients with a BMI ≥ 30 kg/m^2 had LVDD (p = 0.01).

Table 3
LVDD by Clinical Characteristics

Characteristic	LVDD Present n (%)	LVDD Absent n (%)	p-value
Age ≥ 60 years	24 (38.7%)	38 (61.3%)	0.02
Diabetes	16 (35.5%)	29 (64.5%)	0.08
Smoking	14 (36.8%)	24 (63.2%)	0.14
BMI ≥ 30 kg/m^2	18 (42.9%)	24 (57.1%)	0.01

On univariate analysis, age ≥ 60 years was associated with higher odds of having diastolic dysfunction (OR: 2.30; 95% CI: 1.14–4.62; p = 0.02), and this remained significant in the multivariate model (OR: 2.12; 95% CI: 1.01–4.44; p = 0.047). Similarly, BMI ≥ 30 kg/m^2 was significantly associated with LVDD on both univariate (OR: 2.59; 95% CI: 1.25–5.38; p = 0.01) and multivariate analysis (OR: 2.34; 95% CI: 1.08–5.04; p = 0.03). Systolic blood pressure ≥ 150 mmHg showed a significant association in univariate analysis (OR: 1.91; 95% CI: 1.01–3.59; p = 0.04), but the association was not statistically significant in the multivariate model (OR: 1.60; 95% CI: 0.82–3.13; p = 0.17).

Table 4
Logistic Regression Analysis

Variable	Univariate OR (95% CI)	p-value (Univariate)	Multivariate OR (95% CI)	p-value (Multivariate)
Age ≥ 60 years	2.30 (1.14–4.62)	0.02	2.12 (1.01–4.44)	0.047
BMI ≥ 30 kg/m^2	2.59 (1.25–5.38)	0.01	2.34 (1.08–5.04)	0.03
Systolic BP ≥ 150 mmHg	1.91 (1.01–3.59)	0.04	1.60 (0.82–3.13)	0.17

DISCUSSION

This study assessed the frequency of left ventricular diastolic dysfunction (LVDD) in patients with essential hypertension and identified key clinical and demographic predictors. Among 166 hypertensive patients, 28.3% were found to have LVDD on echocardiography, underscoring a significant burden of subclinical cardiac dysfunction even in patients under treatment. These findings align with previous studies that reported similar prevalence rates, such as the study by Kane et al., which documented a 25–30% prevalence of LVDD among asymptomatic hypertensive individuals. Advanced age and obesity were found to be significantly associated with LVDD [13]. Patients aged 60 years and above had more than twice the odds of diastolic dysfunction compared to younger patients (adjusted OR = 2.12, p = 0.047), consistent with findings by Redfield et al., who emphasized age-related myocardial stiffening and impaired relaxation as key contributors to diastolic dysfunction [14]. Similarly, patients with a BMI ≥ 30 kg/m^2 had significantly higher odds of developing LVDD (adjusted OR = 2.34, p = 0.03), in line with prior work by Alpert et al., which showed that obesity is independently associated with increased left ventricular mass and altered diastolic filling [15].

Although diabetes and smoking were more prevalent among those with LVDD, their associations did not reach statistical significance in this study, possibly due to sample size limitations or confounding factors. Nevertheless, these factors have been implicated in diastolic dysfunction in larger cohorts, with diabetes promoting myocardial fibrosis and microvascular ischemia [16]. Importantly, elevated systolic blood pressure (≥150 mmHg) was significantly associated with LVDD in univariate analysis but did not remain significant in the multivariate model. This suggests that while blood pressure elevation is crucial in the pathogenesis of diastolic dysfunction, its effect may be mediated through or confounded by other factors such as age or BMI [17].

The clinical implications of these findings are substantial. LVDD is a precursor to heart failure with preserved ejection fraction (HFpEF), a growing public health challenge with limited treatment options. Routine echocardiographic screening for diastolic function in hypertensive patients particularly those who are older or obese could facilitate early identification and risk stratification [18]. Moreover, lifestyle interventions targeting weight reduction and tight blood pressure control may mitigate progression to symptomatic heart failure [19,20]. This study is not without limitations. It was conducted at a single tertiary care center with non-probability sampling, which may limit the generalizability of findings. Additionally, the cross-sectional design precludes any causal inferences. However, the use of standardized echocardiographic criteria and trained personnel strengthens the reliability of the reported frequency.

CONCLUSION

It is concluded that left ventricular diastolic dysfunction (LVDD) is a common finding in patients with essential hypertension, with a frequency of approximately 28.3% in this study population. The prevalence of LVDD was significantly higher among older patients and those with elevated body mass index, indicating that age and obesity are strong predictors of diastolic dysfunction in hypertensive individuals. These findings emphasize the importance of routine echocardiographic evaluation in the management of hypertension, particularly in high-risk groups, to facilitate early detection of subclinical cardiac involvement and prevent progression to heart failure. Targeted interventions such as optimal blood pressure control, weight management, and lifestyle modifications should be prioritized in hypertensive patients to mitigate the risk of diastolic dysfunction and its associated complications.

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