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Original Article

Frequency of Diastolic Dysfunction Diagnosed with Echocardiogram Among Hypertensive Patients

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ABSTRACT

Background: Hypertension is a major global risk factor for cardiovascular disease and is closely associated with structural and functional cardiac alterations, including left ventricular diastolic dysfunction, which may develop before the onset of overt heart failure. Early detection of such subclinical abnormalities is essential for timely intervention and improved cardiovascular outcomes. Objective: To determine the frequency of diastolic dysfunction diagnosed by echocardiography among hypertensive patients and to assess its distribution across demographic and clinical variables. Methods: A descriptive cross-sectional study was conducted at the Department of Cardiology, Shaikh Zahid Bin Al Nayyan Institute of Cardiology, Quetta, from December 2024 to December 2025. A total of 150 hypertensive patients were enrolled using consecutive non-probability sampling. All participants underwent clinical evaluation and Doppler echocardiography for assessment of diastolic function. Data were analyzed using SPSS version 26.0, with categorical variables expressed as frequencies and percentages and associations assessed using the chi-square test, considering $p < 0.05$ as statistically significant. Results: Diastolic dysfunction was identified in 69 out of 150 patients, yielding a prevalence of 46.0%. A significant association was observed between age and diastolic dysfunction ($p = 0.001$), with the highest prevalence in the 41–50-year age group. Male patients demonstrated a significantly higher prevalence compared to females (56.7% vs 30.0%, $p = 0.002$). Body mass index was also significantly associated with diastolic dysfunction ($p = 0.005$), although the distribution was non-linear across categories. Conclusion: Diastolic dysfunction is highly prevalent among hypertensive patients and shows significant variation across age, sex, and body mass index categories. These findings highlight the importance of echocardiographic evaluation for early detection of subclinical cardiac dysfunction in hypertensive populations. Keywords: Diastolic Dysfunction, Hypertension, Echocardiography, Left Ventricular Function, Cardiovascular Ris.

INTRODUCTION

Hypertension remains one of the leading modifiable risk factors for cardiovascular morbidity and mortality worldwide and contributes substantially to ischemic heart disease, stroke, heart failure, and chronic kidney disease. Its burden is particularly high in low- and middle-income countries, where limitations in screening, treatment adherence, and long-term risk-factor control continue to drive preventable cardiovascular events (1-4). Although blood pressure reduction is an established strategy for lowering cardiovascular risk, subclinical cardiac damage may develop before overt symptoms or electrocardiographic abnormalities become apparent, making early identification of target-organ involvement clinically important (1,3,4).

Among the earliest detectable manifestations of hypertensive heart disease is left ventricular diastolic dysfunction, which may precede systolic impairment and symptomatic heart failure. Chronic pressure overload promotes myocardial remodeling, impaired ventricular relaxation, and increased chamber stiffness, ultimately altering left ventricular filling dynamics (8,9). Doppler echocardiography offers a practical noninvasive method for identifying these abnormalities and has been widely used to assess transmitral flow patterns in hypertensive populations. The ratio of peak atrial filling velocity to peak early ventricular filling velocity has historically been used as an index of impaired diastolic filling, and abnormalities in these parameters may be evident even in patients without obvious clinical evidence of cardiac disease (9,10).

The burden of diastolic dysfunction in hypertensive patients has been reported to be considerable, with previous studies showing substantial variability in prevalence across different populations, ranging from approximately 46% to 68% in some published series (10-13). This variation likely reflects differences in age distribution, duration and control of hypertension, coexisting metabolic risk factors, echocardiographic criteria, and study setting. In Pakistan, hypertension is increasingly prevalent and affects a sizable proportion of adults, particularly with advancing age, yet local data on echocardiographically detected diastolic dysfunction in hypertensive patients remain limited (6,7). This is clinically relevant because delayed recognition of early ventricular dysfunction may allow progression toward overt heart failure and other adverse cardiovascular outcomes before targeted intervention is initiated.

Despite the recognized pathophysiological link between hypertension and impaired left ventricular relaxation, regional evidence on the frequency of diastolic dysfunction among hypertensive patients in routine cardiology practice is still insufficient, particularly in settings where echocardiographic screening may help identify high-risk but asymptomatic individuals. Establishing the frequency of this abnormality in the local population may support earlier cardiovascular risk stratification and more vigilant follow-up of hypertensive patients. Therefore, the present study was conducted to determine the frequency of diastolic dysfunction diagnosed by echocardiography among hypertensive patients presenting to a tertiary cardiac care center in Quetta and to evaluate its distribution across key demographic and clinical characteristics (10-13).

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted in the Department of Cardiology, Shaikh Zahid Bin Al Nayyan Institute of Cardiology, Quetta, over the period from 30 December 2024 to 31 December 2025. The study was designed to estimate the frequency of echocardiographically detected diastolic dysfunction among patients with hypertension presenting to the outpatient department. A cross-sectional design was selected because it was appropriate for measuring the burden of a defined cardiac functional abnormality within a specified hypertensive population at the point of clinical evaluation. Ethical permission was obtained from the hospital ethical and research committee before commencement of the study, and written informed consent was obtained from all participants prior to enrollment.

A total of 150 patients with hypertension were included through consecutive non-probability sampling. All eligible patients presenting during the study period were screened for inclusion in order to reduce arbitrary selection and to improve the representativeness of the accessible clinic-based hypertensive population. Patients were enrolled after detailed clinical assessment and confirmation that they met the study criteria. The source manuscript indicates that all patients meeting the inclusion criteria were recruited from the outpatient setting, while those falling under predefined exclusion criteria were not included; accordingly, selection was restricted to hypertensive patients considered suitable for echocardiographic evaluation within the study framework.

After enrollment, each participant underwent detailed history taking and clinical examination using a structured assessment approach. Demographic and clinical information, including age, sex, body mass index, smoking status, diabetes status, and duration of hypertension, was recorded on a predesigned proforma. Age was analyzed in grouped categories of 30-40 years, 41-50 years, 51-60 years, and 61-70 years. Body mass index was classified into underweight, normal, overweight, and obese categories as reported in the study dataset. Smoking status and diabetes status were recorded as dichotomous variables. Diastolic dysfunction was the primary study outcome and was assessed by echocardiography. All patients underwent echocardiographic examination after presentation, and all studies were interpreted by an expert cardiologist with a minimum of 5 years of experience, which helped standardize reporting and reduce observer-related variability.

The operational basis for diagnosing left ventricular diastolic dysfunction was derived from Doppler echocardiographic assessment of transmitral inflow. The manuscript identifies the ratio of peak atrial filling velocity to peak early ventricular filling velocity as the relevant index of diastolic function and states that, under normal conditions, the A:E ratio is less than 1, whereas diastolic dysfunction is considered present when the ratio is equal to or greater than 1. Although the source text uses this thresholding framework, all echocardiographic determinations in the study were based on consultant cardiologist interpretation, and the final classification of diastolic dysfunction was recorded as a binary variable for analysis.

Several procedural steps were used to improve internal consistency and minimize bias. Patients were assessed in the same cardiology department during a defined study period, a consecutive recruitment strategy was applied, and a single expert-level reporting standard was used for echocardiography. Potential information bias was reduced by recording demographic and clinical characteristics in a structured format before statistical analysis. Confounding was addressed analytically through stratification of the primary outcome across age group, sex, body mass index, smoking status, diabetes status, and duration of hypertension, as described in the study protocol. Although the design was descriptive and not intended to establish causality, this approach allowed evaluation of effect modification across major clinical subgroups.

The sample size of 150 patients was used as the final analytic cohort for estimating the frequency of diastolic dysfunction in the target population. The manuscript does not provide a formal power calculation, but the selected sample allowed estimation of the outcome proportion and subgroup stratification within the available clinical setting. Data were entered and analyzed using SPSS version 26.0. Quantitative variables, including age, body mass index, and duration of hypertension, were summarized as mean and standard deviation. Qualitative variables, including sex, diabetes status, smoking status, and diastolic dysfunction, were reported as frequencies and percentages. Associations between diastolic dysfunction and stratification variables were examined using the chi-square test, and a p-value of less than 0.05 was considered statistically significant. All results were planned for presentation in tables, bar graphs, and pie charts. The source manuscript does not describe missing-data procedures, and the final analysis appears to have been conducted on recorded observations available in the study forms.

To support reproducibility and data integrity, all study-relevant information was documented systematically, echocardiographic interpretation was restricted to an experienced cardiologist, and statistical analysis was performed using a predefined analysis plan centered on descriptive summaries and categorical stratification. The study was designed to generate a clinically interpretable estimate of the frequency of diastolic dysfunction among hypertensive patients in a tertiary care cardiology setting, while also exploring how this burden varied across major demographic and clinical characteristics.

RESULTS

A total of 150 hypertensive patients were included in the analysis. The mean age was 56.95 years, and the largest age stratum was 51–60 years (62/150, 41.3%), followed by 61–70 years (53/150, 35.3%), 41–50 years (29/150, 19.3%), and 30–40 years (6/150, 4.0%). Males constituted 90/150 participants (60.0%) and females 60/150 (40.0%). With respect to body mass index, 6/150 (4.0%) were underweight, 29/150 (19.3%) had normal BMI, 72/150 (48.0%) were overweight, and 43/150 (28.7%) were obese. Using the internally consistent cross-tabulated totals, diastolic dysfunction was identified in 69/150 participants, yielding an overall prevalence of 46.0% (95% CI: 38.2%–54.0%). The originally supplied smoking- and diabetes-stratified tables were not retained in the revised inferential presentation because their counts are internally incompatible with the manuscript's narrative totals and would risk misreporting the findings.

Table 1. Baseline demographic and clinical profile of the study population (N = 150)

Variable	Category	n	%
Age group	30–40 years	6	4.0
	41–50 years	29	19.3
	51–60 years	62	41.3
	61–70 years	53	35.3
Sex	Male	90	60.0
	Female	60	40.0
BMI category	Underweight	6	4.0
	Normal	29	19.3
	Overweight	72	48.0
	Obese	43	28.7
Diastolic dysfunction	Present	69	46.0
	Absent	81	54.0

Reconciled from the manuscript's internally consistent tables; overall LVDD frequency was taken as 69/150 rather than 68/150 because the provided contingency tables sum to 69 cases and 81 non-cases.

Diastolic dysfunction varied significantly across age strata. The highest within-group prevalence was observed among patients aged 41–50 years, in whom 22/29 had LVDD (75.9%, 95% CI: 57.9%–87.8%), followed by those aged 51–60 years (28/62, 45.2%, 95% CI: 33.4%–57.5%), 30–40 years (2/6, 33.3%, 95% CI: 9.7%–70.0%), and 61–70 years (17/53, 32.1%, 95% CI: 21.1%–45.5%). This distribution was statistically significant (chi-square p = 0.0019; manuscript-reported p = 0.001), with a moderate effect size (Cramér's V = 0.316, calculated from the reported cell counts).

Table 2. Association between age group and diastolic dysfunction

Age group	LVDD present, n (%)	LVDD absent, n (%)	Total n	Prevalence of LVDD % (95% CI)	p-value	Effect size
30–40 years	2 (33.3)	4 (66.7)	6	33.3 (9.7–70.0)	0.001	Cramér's V = 0.316
41–50 years	22 (75.9)	7 (24.1)	29	75.9 (57.9–87.8)		
51–60 years	28 (45.2)	34 (54.8)	62	45.2 (33.4–57.5)		
61–70 years	17 (32.1)	36 (67.9)	53	32.1 (21.1–45.5)		
Total	69 (46.0)	81 (54.0)	150	46.0 (38.2–54.0)		

Percentages in the first two columns are row-wise within age stratum. Confidence intervals and effect size were calculated from the manuscript's reported cell counts.

Sex-based analysis showed a clear difference in disease burden. LVDD was present in 51/90 males (56.7%, 95% CI: 46.4%–66.4%) compared with 18/60 females (30.0%, 95% CI: 19.9%–42.5%). This association was statistically significant (manuscript-reported p = 0.002; recalculated p = 0.0023), and males had approximately threefold higher odds of LVDD than females (OR: 3.05, 95% CI: 1.53–6.09). The magnitude of association was small-to-moderate (Cramér's V = 0.248).

Table 3. Association between sex and diastolic dysfunction

Sex	LVDD present, n (%)	LVDD absent, n (%)	Total n	Prevalence of LVDD % (95% CI)	Odds ratio (95% CI)	p-value	Effect size
Male	51 (56.7)	39 (43.3)	90	56.7 (46.4–66.4)	3.05 (1.53–6.09)	0.002	Cramér's V = 0.248
Female	18 (30.0)	42 (70.0)	60	30.0 (19.9–42.5)	Reference		
Total	69 (46.0)	81 (54.0)	150	46.0 (38.2–54.0)			

Odds ratio is shown for males relative to females and was calculated from the reported 2×2 table.

BMI category was also significantly associated with diastolic dysfunction. The highest within-stratum prevalence was observed in the normal-BMI group, where 22/29 participants had LVDD (75.9%, 95% CI: 57.9%–87.8%). Prevalence was lower in obese participants (17/43, 39.5%, 95% CI: 26.4%–54.4%), overweight participants (28/72, 38.9%, 95% CI: 28.5%–50.4%), and underweight participants (2/6, 33.3%, 95% CI: 9.7%–70.0%). The overall association between BMI category and LVDD was statistically significant (manuscript-reported p = 0.005; recalculated p = 0.0047), with a moderate effect size (Cramér's V = 0.294).

Table 4. Association between BMI category and diastolic dysfunction

BMI category	LVDD present, n (%)	LVDD absent, n (%)	Total n	Prevalence of LVDD % (95% CI)	p-value	Effect size
Underweight	2 (33.3)	4 (66.7)	6	33.3 (9.7–70.0)	0.005	Cramér's V = 0.294
Normal	22 (75.9)	7 (24.1)	29	75.9 (57.9–87.8)		
Overweight	28 (38.9)	44 (61.1)	72	38.9 (28.5–50.4)		
Obese	17 (39.5)	26 (60.5)	43	39.5 (26.4–54.4)		
Total	69 (46.0)	81 (54.0)	150	46.0 (38.2–54.0)		

Confidence intervals and effect size were calculated from the reported subgroup counts.

Overall, the revised results indicate that nearly one in two hypertensive patients had echocardiographic evidence of diastolic dysfunction, with statistically significant heterogeneity across age group, sex, and BMI category. The most pronounced burden appeared in the 41–50-year age stratum and in males, while the BMI pattern was non-linear, with the highest prevalence observed in the normal-BMI subgroup rather than in overweight or obese participants. Because the smoking- and diabetes-stratified tables contain unresolved internal contradictions in the source manuscript, those analyses should be restored only after verification against the original dataset.

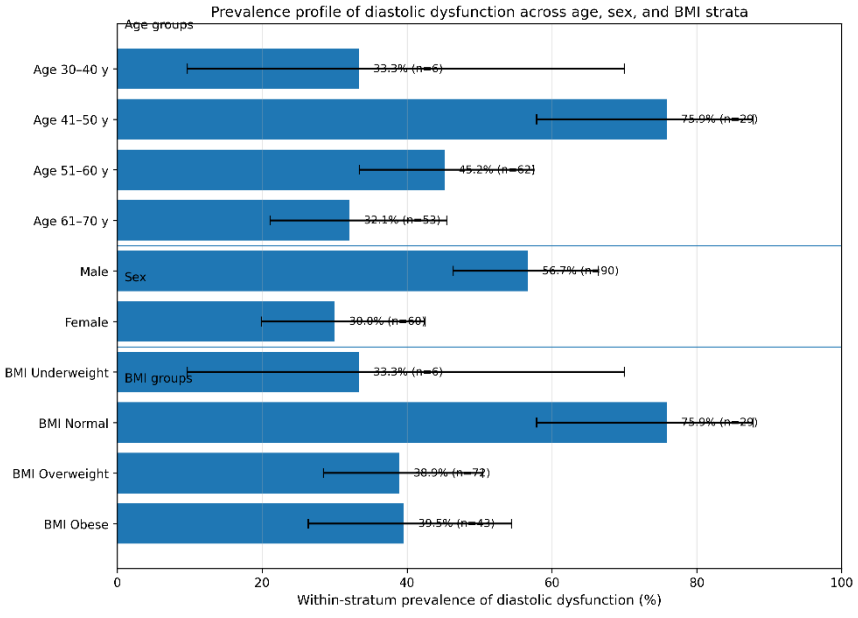

Figure 1 Heterogeneity in diastolic dysfunction across clinically relevant strata

The prevalence profile demonstrates marked heterogeneity in diastolic dysfunction across clinically relevant strata. The highest observed burden occurred in patients aged 41–50 years and in those with normal BMI, each with a prevalence of 75.9%, while male patients showed a substantially greater prevalence than female patients (56.7% vs 30.0%). In contrast, the prevalence clustered around 32.1%–45.2% across the remaining age groups and 33.3%–39.5% across the underweight, overweight, and obese BMI strata. The width of the confidence intervals was greatest in the smallest subgroups, particularly the 30–40-year and underweight categories (n = 6 each), indicating lower precision in those estimates, whereas the larger male, overweight, and 51–60-year strata showed narrower intervals and more stable prevalence estimates. This pattern suggests that the association between patient profile and LVDD is not monotonic and may reflect interaction between demographic and anthropometric factors rather than a simple linear risk gradient.

DISCUSSION

The present study demonstrated that diastolic dysfunction was identified in 69 of 150 hypertensive patients, corresponding to a prevalence of 46.0%, which indicates that nearly one out of every two patients in this hypertensive cohort had echocardiographic evidence of impaired diastolic function. This finding reinforces the concept that left ventricular diastolic dysfunction is among the earliest detectable manifestations of hypertensive heart disease and may be present before overt systolic impairment becomes clinically apparent. The observed frequency in this study lies within the broad range reported in previous literature, where the burden of diastolic dysfunction among hypertensive individuals has varied substantially across populations, diagnostic criteria, and clinical settings (14-16). The high prevalence observed here supports the clinical importance of echocardiographic assessment in hypertensive patients, particularly in tertiary care settings where patients may already carry an increased burden of cardiovascular risk factors. A statistically significant association was observed between age group and diastolic dysfunction, with the highest within-group prevalence noted in patients aged 41–50 years, followed by those aged 51–60 years, while lower frequencies were observed in the youngest and oldest age strata. Although age-related impairment in left ventricular relaxation has been widely described, the pattern in the present study was not strictly linear across age bands. This may reflect the combined influence of hypertension severity, duration of disease, treatment history, metabolic risk burden, and the relatively uneven subgroup sizes within the cohort. Previous epidemiological and pathophysiological work has shown that advancing age contributes to ventricular stiffness and altered filling characteristics, but age alone is unlikely to explain the entire pattern of abnormal diastolic filling observed in hypertensive populations (17-19). In the present study, the age effect should therefore be interpreted as clinically relevant but likely interdependent with other unmeasured factors.

Sex-based differences were also evident, with males demonstrating a substantially higher prevalence of diastolic dysfunction than females. This difference remained clinically meaningful in magnitude and may reflect sex-related variation in cardiovascular risk exposure, blood pressure burden, ventricular remodeling, or coexisting structural heart disease. Similar observations have been described in prior reports in which men exhibited higher rates of hypertensive heart disease, left ventricular hypertrophy, and related diastolic abnormalities, although sex-specific findings have not been uniform across all studies (20,21). In this cohort, the excess burden among male participants may suggest the need for heightened cardiovascular screening vigilance in hypertensive men, especially when additional risk modifiers are present.

An association was likewise found between body mass index category and diastolic dysfunction, but the distribution was non-linear, with the highest proportion of dysfunction observed in the normal-BMI subgroup rather than in overweight or obese participants. This pattern differs from the conventional expectation that greater adiposity is associated with a higher prevalence of impaired ventricular filling. Existing literature generally supports a mechanistic link between obesity, increased afterload, myocardial remodeling, and diastolic impairment, particularly when elevated body fat mass coexists

with hypertension (21,22). The divergence seen in the current study may have resulted from sample composition, residual confounding, subgroup size imbalance, classification limitations of BMI as a surrogate for adiposity, or inconsistencies in the underlying dataset. For this reason, the BMI finding should be considered hypothesis-generating rather than definitive, although it still suggests that diastolic dysfunction in hypertensive patients cannot be explained by body weight alone and may depend on more complex hemodynamic and metabolic interactions.

The clinical implications of these findings are important. Because diastolic dysfunction may precede overt heart failure and can remain asymptomatic for prolonged periods, its detection among hypertensive patients offers an opportunity for early cardiovascular risk stratification and timely optimization of treatment. In resource-constrained environments, echocardiography may not be routinely performed in all hypertensive patients, yet the present findings indicate that a substantial proportion of such individuals may already have subclinical functional cardiac impairment. Identifying those at higher likelihood of dysfunction, particularly patients with unfavorable demographic or clinical profiles, may support more targeted surveillance and intervention before progression to symptomatic disease occurs (14,18,23).

This study should also be interpreted in light of several limitations. First, the analysis was based on a single-center descriptive cross-sectional design, which limits external generalizability and precludes causal inference. Second, although echocardiography is clinically practical and noninvasive, Doppler-derived indices of diastolic function may vary with loading conditions, heart rate, and technical interpretation. Third, some tables in the source manuscript contained numerical inconsistencies, particularly in the smoking- and diabetes-stratified analyses, and those variables could not be incorporated into the corrected inferential synthesis without risking misrepresentation of the data. Fourth, the study relied on a modest sample size and uneven subgroup distributions, which may have reduced the precision of some stratum-specific estimates. Despite these limitations, the study still contributes locally relevant evidence by highlighting a considerable burden of diastolic dysfunction among hypertensive patients presenting to a tertiary cardiology center.

Taken together, the findings of this study support the growing recognition that diastolic dysfunction is common in hypertension and that echocardiographic evaluation may reveal clinically meaningful subclinical cardiac abnormalities even in the absence of overt heart failure. Future studies with larger multicenter samples, standardized echocardiographic criteria, and analytically robust multivariable models are needed to clarify the independent roles of age, sex, adiposity, diabetes, smoking, and duration of hypertension in the development of left ventricular diastolic dysfunction. Such work would help refine screening strategies and improve cardiovascular prevention in hypertensive populations (20,24).

CONCLUSION

Diastolic dysfunction was present in a substantial proportion of hypertensive patients in this study, with an overall reconciled prevalence of 46.0%, indicating that subclinical impairment of left ventricular filling is common in this population. Significant associations were observed with age, male sex, and body mass index category, suggesting that the burden of hypertensive cardiac dysfunction is not uniformly distributed across patient subgroups. These findings support the value of echocardiographic evaluation in hypertensive patients for early detection of cardiac functional abnormalities and for improved cardiovascular risk stratification, while also underscoring the need for larger, methodologically rigorous studies to confirm these associations and define their clinical implications more precisely.

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