EAS Journal of Radiology and Imaging Technology
Abbreviated Key Title: EAS J Radiol Imaging Technol
ISSN: 2663-1008 (Print) & ISSN: 2663-7340 (Online)
Published By East African Scholars Publisher, Kenya

OPEN ACCESS

Volume-8 | Issue-3 | May-Jun-2026 | DOI: https://doi.org/10.36349/easjrit.2026.v08i03.001

Original Research Article

Echocardiography Findings in Hypertensive Patients Presenting with Chest Pain at the University Teaching Hospital, Lusaka, Zambia

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Article History
Received: 16.03.2026
Accepted: 11.05.2026
Published: 14.05.2026

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: ***Background*:** Hypertension is a serious worldwide health concern, significantly contributing to cardiac complications such as myocardial ischemia and heart failure. Chest discomfort, in hypertensive patients, can be a sign of serious illnesses such as myocardial infarction or unstable angina. Echocardiography is a non-invasive imaging that is essential for assessing the structure and function of the heart. It can identify cardiac disorders like diastolic dysfunction and left ventricular hypertrophy (LVH), which are more prevalent in hypertensive patients. As such, an echocardiographic examination can improve cardiac diagnosis and offer insightful information about cardiac health. ***Aim*:** The aim of this study was to investigate echocardiographic findings of hypertensive patients who presented with chest pain at the University Teaching Adult Hospital (UTH-Adult Hospital). ***Methods*:** This study utilised a quantitative cross sectional study design. Purposeful sampling was used to select a total of 110 participants who were examined using echocardiography. Data was collected from July to September, 2025. ***Results*:** The majority of the research participants were females (80; 72.73%) and had abnormal echocardiography findings (95; 86.36%). The most predominate echocardiography finding in this study was diastolic dysfunction, grade 1 (89; 80.91%). This study also found that there were no significant associations between echocardiographic parameters and the clinical manifestation of chest pain. (RVOT, p=0.701; LVd, p=0.878; LA, p=0.728; F/S, p=0.740; EF, p=0.734; IVSd, p=0.352: LVPWd, p=0.688; AoR, p=0.442; Diastolic function, p=0.518). ***Conclusion*:** This study showed that most patients maintained sufficient left ventricular performance despite some functional alterations. This could be attributed to early hypertensive stage. It found no significant relationship between echocardiography parameters and the clinical presentation of chest pain. This suggests that chest pain, may be multifactorial and not solely attributable to structural cardiac changes detectable by echocardiography. ***Implications*:** Echocardiography remains a vital echocardiography examination tool. However, management of hypertensive heart disease should shift from solely structural assessment to more nuanced, functional approach to patient care. The higher prevalence of hypertension and cardiac abnormalities in women highlights a specific high-risk group.

Keywords: Echocardiography, Hypertensive, Patients, Chest Pain, Zambia.

INTRODUCTION

Hypertension is a condition that frequently results in cardiovascular and renal impairment. It affects millions worldwide and is a major risk factor for a number of heart problems, such as heart failure and myocardial ischemia [1]. Approximately 7.5 million deaths occur per annum globally and about 12.8% of these deaths are attributed to hypertension [1]. In 2019, the prevalence of hypertension in sub-Saharan Africa was estimated at 34% for males and 48% for women [2]. In Zambia, the prevalence was estimated at 30.7% for both gender [3].

Hypertensive patients frequently present with chest pain. The cause of this pain can be difficult to diagnose and treat. In these patients, chest pain may indicate a variety of cardiovascular issues, including

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myocardial infarction, angina, and heart failure [4]. With the rise in the burden of hypertension, particularly in low-and middle-income nations, it is critical to comprehend its consequences and ensure that they are averted.

Echocardiography is a non-invasive ultrasound imaging modality that is essential for assessing the structure and function of the heart. It is a very vital modality in patients presenting with cardiovascular symptoms [5]. This modality can help identify cardiac functional and structural changes which are frequently observed in hypertensive individuals [6, 7]. Examples of such changes include diastolic dysfunction, valvular abnormalities, and left ventricular hypertrophy (LVH). The identification of such abnormalities is crucial for the management of hypertensive patients [8]. Echocardiography assessments can therefore offer important insights into the cardiac health of hypertensive patients who present with chest discomfort.

This study aimed at investigating the echocardiography findings in hypertensive patients who presented with chest pain at the University Teaching Adult hospital (UTH-Adult Hospital), Lusaka, Zambia. By identifying the common cardiac alterations on echocardiography, the study provided valuable insights into the cardiac status of this population. It emphasises the importance of echocardiographic examination in early intervention in hypertensive patients.

METHODOLOGY

Study Design and Setting

This study used a quantitative cross-sectional research design. Data was collected prospectively as patients presented themselves for echocardiography examinations. Data were collected from July to September, 2025. This study's design enabled the methodical collection, analysis and presentation of numerical data [9].

The study was carried out at the UTH-Adult hospitals echocardiography department. The site was selected because it is the largest and main referral hospital in Zambia.

Population and Sampling

The population for this study consisted of adult hypertensive patients aged 18 and above with chest pain referred for echocardiography examinations at UTH-Adult hospital echocardiography department.

Purposeful sampling was used to select the study participants since they were hypertensive patients. A total of 114 patients were sampled in this study. The sample size was arrived at using the Cochrane formula, 1977. However, only 110 patients were recruited because the remaining 4 had missing data. The sample size was deemed appropriate to obtain a 95% confidence interval with a 5% margin of error thus representative of the study population.

Data Collection Tool

The data collection tool in this study collected the study participants' demographics, clinical and echocardiography information. The tool was developed by echocardiography experts in Zambia. It was also based on relevant literature, experience in teaching and echocardiography practice.

After obtaining ethical approval, a pilot study (n=10) was conducted to assess the feasibility and practicality of the study, evaluate the effectiveness of the study organisation, and determine the suitability of the research methods. The aim was to identify potential weaknesses of the research, including highlighting possible corrections to the questionnaire before the actual data collection took place. Minor changes were made to the questionnaire to enhance its validity and reliability.

Data Analysis

Data was analysed using Graph Pad Prism version 8.0.1. The first step was to assess continuous data for normality using the Shapiro-Wilk test. The variables that showed a p value =/<0.05 indicated a non-normal distribution while those that showed, p >0.05, indicated a normal distribution. Descriptive statistics used for normally distributed data included the mean and standard deviations. For skewed data, the median and interquartile range (IQR) was used. To assess frequencies and proportions, graphs and tables were used. Specifically, data on patients' blood pressure (BP) was categorised to identify which BP category had a high frequency of patients, thereby influencing clinical decision on patient management.

Spearman's correlation was used to assess associations between non-parametric and/or non-normally distributed data, while Pearson's correlations was used to determine associations for parametric data and/or normally distributed with p-value set at =/<0.05.

Ethical Considerations

Before commencing this study, ethical approval was sought and obtained from the Lusaka Apex Medical University Research Ethics Committee (LAMUREC No: 0344/14/01/2025). Permission to conduct the study was also sought from UTH-Adult hospital. This study was conducted according to the Code of ethics of the World Medical Association (Declaration of Helsinki) [10-12].

Participants were provided with the necessary information to make an informed consent before participating in this study. The principles of autonomy, beneficence, non-maleficence, and justice were adhered to. Additionally, participants were informed of their right to withdraw from the study at any time without consequences. The research findings will benefit

clinicians who manage hypertension and practitioners conducting echocardiography examinations. The ultimate beneficiary are the patients benefiting from the care provided by these patient care providers. There were no potential risks to the research participants. This is because there are no known risks arising from the use of ultrasound on patients. Further, the researchers treated participants fairly and equitably throughout the research process, providing them with the same information.

RESULTS

Demographics of Study Participants

The participants in this study had a mean age of 53 years with a standard deviation (SD) of 1.25, and a confidence interval (CI) 50.64 to 55.58 as shown in table 1. The majority of the participants in the study were females compared to the males (80:30; 72.73%: 27.27%).

Table 1: Study participants' demographics

Age (Mean and SD)	Sex	
53 (1.25) CI=50.64 to 55.58	Female	80(72.73%)
	Male	30(27.27%)

Clinical and Echocardiography Findings

Blood Pressure of the Study Participants

Blood pressure in this study was categorised. The Majority of the study participants had blood pressure in the range of 120-139/80-90 mm Hg. Normal blood pressure for adults is generally defined as less than 120/80mm Hg.

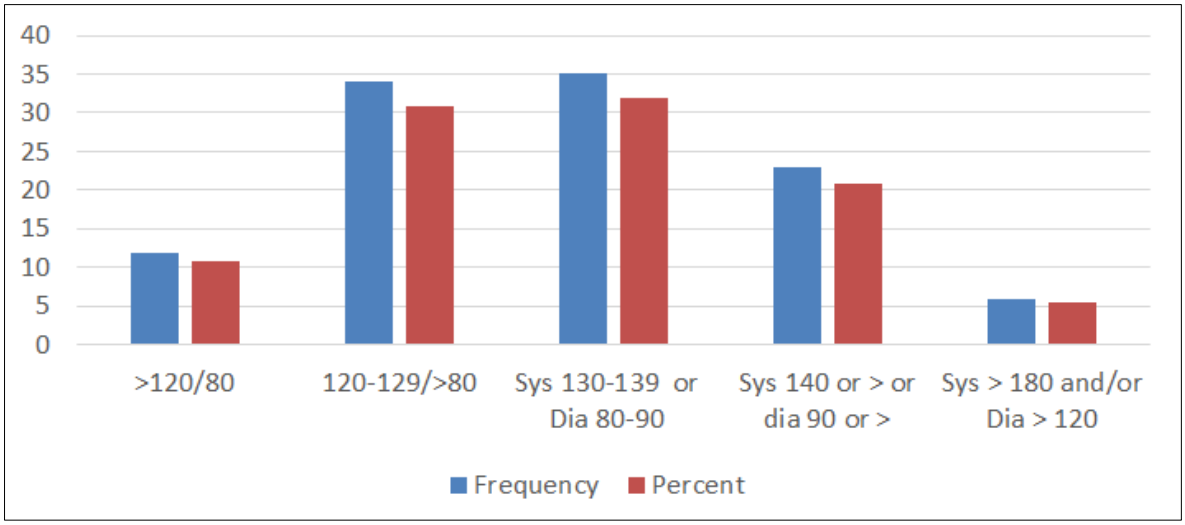

Figure 1: Blood pressure of the study participants

Echocardiography Parameters of Study Participants

The Echocardiography parameters of the participants in this study are shown in table 2 below. The various medians with their associated IQR, and mean with its SD are shown.

Echocardiography Findings of Study Participants

In this study, the majority of the participants had an abnormal echocardiography finding (95; 86.36%) compared to the normal (15, 13.64%) (Figure 2).

Table 1: Echocardiography parameters of study participants

Variable	Median	Interquartile Range (IQR)
Right ventricular outflow tract (RVOT)	3.2	2.2-3.6
Left atrium (LA)	3.850	3.5-4.1
Fractional shortening (F/S)	33.0	31-36
Ejection fraction (E/F)	61.0	58.75-65.00
Interventricular septal defect (IVSd)	0.9	0.8-1.0
Left ventricular posterior wall in diastole (LVPWd)	0.9	0.8-1.0
Aortic root (AoR)	2.8	2.5-3.0
Variable	**Mean**	**Standard Deviation**
Left ventricle in diastole (LVd)	4.900909	0.0625093

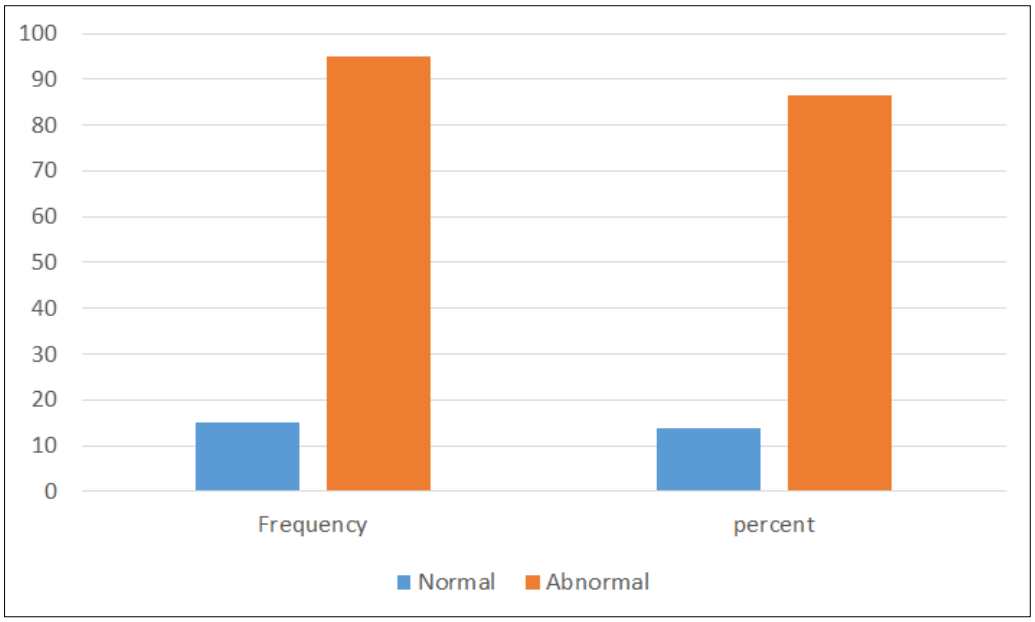

Figure 2: Echocardiographic abnormalities of study participants

Valve, Pericardium and Diastolic Functional Status

This study found that most of the participants showed normal valves (97; 88.18%), and did not present with pericardial effusion (105; 95.45%) on echocardiographic examination. However, the majority of them presented with grade 1 diastolic dysfunction (89; 80.91%) as shown in table 3.

Table 3: Valve, pericardium and diastolic functional status of study participants

Valve status		Pericardial effusion		Diastolic functional status	
Normal	97(88.18%)	Present	5(4.55%)	Grade 0	17(15.45%)
Aortic valve sclerosis	1(0.91%)				
Mitral regurgitation only	5(4.55%)			Grade 1	89(80.91%)
Tricuspid regurgitation only	1(0.91%)				
Aortic regurgitation only	1(0.91%)	Absent	105(95.45%)	Grade 2	1(0.91%)
Mitral and tricuspid regurgitation	3(2.73%)				
Tricuspid, mitral and pulmonary regurgitation	1(0.91%)			Grade 3	3(2.73%)
Calcified aortic valve	1(0.91%)			Grade 4	0

Correlation between Echocardiographic Parameters and Clinical Presentation of Chest Pain

There were no associations between the various echocardiography parameters and the clinical presentation of chest pain (table 4). Thus, no effect size was computed.

Table 4: Correlation between echocardiographic findings and the clinical presentation of chest pain

	Echocardiographic Findings								
	RVOT	**LVd**	**LA**	**F/S**	**E/F**	**IVSd**	**LVPWd**	**AoR**	**Diastolic Function**
Clinical presentation of chest pain	P=0.701	P=0.878	P=0.728	P=0.740	P=0.734	P=0.352	P=0.688	P=0.442	P=0.518

DISCUSSION

This study investigated the echocardiography findings of adult hypertensive patients presenting with chest pain at the UTH-Adult Hospital in Zambia. The average age of participants was 53 years, placing the majority of the cohort in middle adulthood. This demographic finding aligns with global data indicating that hypertension affects over half of adults aged 40 to 59 years, establishing it as a critical health concern for this age group [13, 14]. The high prevalence in this group is primarily driven by natural biological aging processes which facilitate the stiffening of large conduit arteries. This process is compounded by the cumulative, long-term impact of unhealthy lifestyles, including increased obesity, poor dietary habits, high psychological stress, and reduced physical activity. The preceding factors

interact with genetic predispositions to elevate blood pressure [15, 16].

A notable finding in this study was the higher prevalence of hypertension among women compared to men. This finding is consistent with other research findings [17, 18]. The gender disparity in hypertension can be explained by age-related decline in estrogen levels in females. Estrogen serves as a potent protective factor for the heart by promoting vasodilation and maintaining vascular flexibility. Therefore, as women transition into menopause and estrogen levels decline, blood vessels become narrow and also stiffen. This rise in systemic vascular resistance leads to higher blood pressure readings.

Crucially, both this study and preceding literature confirm that hypertensive patients are significantly more likely to present with at least one echocardiographic abnormality [18].

Grade 1 Left Ventricular Diastolic Dysfunction (LVDD) was the most prevalent cardiac functional abnormality identified in this study. This high frequency is consistent with findings from other studies [19, 20]. LVDD is a primary precursor to heart failure with Preserved Ejection Fraction [21]. It typically develops through pathways of myocardial ischemia and hemodynamic pressure overload. While this study established a LVDD prevalence of 84.55% at UTH-Adult hospital, a different study reported a lower prevalence of 50.3% 22. This discrepancy may be due to differences in study populations. However, literature universally acknowledges the intrinsic link between hypertension and impaired diastolic function [23]. Diastolic dysfunction is characterised by impaired cardiac filling [24]. This can result in patients presenting with symptomatic chest pain due to inadequate cardiac output during physical exertion or stress [24]. As a result, LVDD is a "classical" finding in hypertensive patients reporting chest discomfort. Therefore, this study emphasises that determining diastolic functional status is essential for clinicians. Early identification of LVDD not only reveals a potential underlying cause for chest pain of cardiac etiology but also allows for prompt therapeutic interventions to manage hypertension and prevent the progression to irreversible structural cardiac complications.

About slightly above a third of the participants in this study had left ventricular hypertrophy. This finding is comparable to findings in other studies who reported a similar prevalence in a cohort of newly diagnosed hypertensive Nigerians [25]. The finding of left ventricular hypertrophy in hypertensive patients can be explained by the chronic pressure overload imposed on the left ventricle. According to Laplace's Law, the myocardium thickens (concentric remodeling) to normalize wall stress in response to high systemic vascular resistance [26]. On the contrary, Kamran and Aqeel explain that the majority of hypertensive patients often have left ventricular hypertrophy [27]. This difference in explanation and finding between this study and preceding study may be explained by the duration and severity of hypertension in the patients; long-standing, poorly controlled hypertension. whereas our study population likely represents an earlier stage of hypertensive heart disease (where structural remodeling is not yet universal), the preceding study may represent chronic hypertension.

The majority of participants in this study exhibited normal systolic function. This observation is consistent with the natural history of hypertensive heart disease, where functional impairment typically follows a stepwise progression, with diastolic impairment generally manifesting well before systolic failure [28]. This explains why patients can maintain sufficient left ventricular performance and ejection fraction despite underlying functional alterations. Furthermore, the prevalence of a normal aortic root and normal-sized left ventricles among participants supports the structural patterns often linked to early or controlled hypertension, such as a normal left ventricular chamber [29]. These echocardiography parameters are clinically vital as they assist in differentiating hypertensive heart disease from other pathologies, such as ischemic heart disease. Such differentiation is essential for accurate risk stratification and informed clinical decision-making in patients presenting with chest pain [29].

In this hypertensive cohort, pericardial effusion was virtually absent, diagnosed in only 4.55% of the study participants. This finding is comparable with other studies and align with broader cardiovascular literature [30, 31]. Clinically significant pericardial effusion is rare in hypertensive populations. When present, it usually manifests as a mild, incidental finding with negligible hemodynamic consequences [32].

Perhaps the most striking finding of this study was the lack of an association between standard echocardiographic parameter (ejection fraction, fractional shortening, and chamber diameters) and the clinical manifestation of chest pain of cardiac etiology. However, this finding is comparable to findings by another study which noted that standard echocardiographic indices often fail to correlate with the subjective symptomatology of hypertensive individuals [33]. This lack of correlation suggests that the onset of chest pain in hypertensive patients may be driven by more intricate or extra-cardiac processes. For instance, echocardiographic abnormalities like left ventricular hypertrophy (LVH) may not be the direct trigger for chest pain with cardiac etiology. While this study's results differ from certain studies that found an association [34], the discrepancy highlights the complexity of the "hypertensive chest pain" profile. As Taylor *et al*., suggests, the mechanism behind this

association requires further investigation into microvascular resistance and metabolic changes.

This study provides preliminary evidence that standard echocardiography alone may be insufficient to explain the clinical presentation of chest pain of cardiac etiology in hypertensive patients. It underscores the necessity of considering multifactorial causes such as coronary microvascular dysfunction or non-cardiac etiologies when managing this population.

CONCLUSION

This study showed that most patients maintained sufficient left ventricular performance despite some functional alterations. This could be attributed to early hypertensive stage. It found no significant relationship between echocardiography parameters and the clinical presentation of chest pain. This suggests that chest pain, may be multifactorial and not solely attributable to structural cardiac changes detectable by echocardiography. Therefore, although echocardiography remains an essential tool in evaluating hypertensive heart disease, it should be complemented with other diagnostic modalities and thorough clinical assessment to accurately identify the underlying causes of chest pain in this population.

Clinical Implications

i. Echocardiography remains a vital echocardiography examination tool. However, management of hypertensive heart disease should shift from solely structural assessment to more nuanced, functional approach to patient care. This is because chest pain in hypertensive patients may be caused by mechanisms invisible to standard 2D-echocardiography, such as coronary microvascular dysfunction (where small vessels don't dilate properly) or non-cardiac causes.
ii. The higher prevalence of hypertension and cardiac abnormalities in women (potentially linked to the loss of oestrogens' cardio protective effects) highlights a specific high-risk group.

Study Limitations

i. Cross-Sectional Design. The nature of the study design implies that the study can only identify associations or the lack of it without establishing a causal relationship between hypertension and the development of chest pain or echocardiographic abnormalities.
ii. Sensitivity of Standard Echocardiography. The study relied on standard 2D-echocardiography indices (such as EF, FS, and chamber diameters). Thus, it may not be sensitive enough to detect subclinical myocardial dysfunction or coronary microvascular disease, which are common in hypertensive patients. This may explain why no association was found between the echocardiographic parameters and the clinical symptom of chest pain.
iii. Subjective Nature of "Chest Pain". Chest pain is a subjective clinical manifestation that can arise from various cardiac and non-cardiac sources (e.g., gastroesophageal reflux, musculoskeletal issues, or anxiety).
iv. Selection Bias and Setting. The study was conducted at a tertiary referral center (UTH-Adult Hospital) which often represent more severe or complex cases compared to the general population. This "referral bias" means the findings—such as the very high prevalence of LVDD (84.55%)—may not be fully generalizable to hypertensive patients managed in primary care or rural clinics in Zambia.

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Cite This Article: Oliver Sutherland, Grace Nkalamo, Nchimunya Gwaba (2026). Echocardiography Findings in Hypertensive Patients Presenting with Chest Pain at the University Teaching Hospital, Lusaka, Zambia. *EAS J Radiol Imaging Technol, 8*(3), 61-67.