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Frequency of Left Ventricular Dysfunction in Hypertrophic and Ischemic Cardiomyopathy Patients

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Abstract

Background: Cardiomyopathies are a significant cause of heart failure, arrhythmias, and cardiovascular mortality worldwide. Among them, hypertrophic cardiomyopathy (HCM) and ischemic cardiomyopathy (ICM) are the most prevalent, with distinct pathophysiological effects on left ventricular (LV) function. While LV dysfunction is a key determinant of prognosis, data on its frequency and demographic distribution in South Asian populations, particularly Pakistan, remain limited. **Objective:** This study aimed to determine the frequency of LV dysfunction in patients with HCM and ICM and to assess its distribution according to age and gender using echocardiography. **Methods:** A descriptive cross-sectional study was conducted at

Rehman Medical Institute, Peshawar, Pakistan, from July to December 2025. A total of 378 patients aged 30–70 years diagnosed with HCM, ICM, or both were included using convenience sampling. LV dysfunction was evaluated by transthoracic echocardiography, assessing systolic and diastolic function according to American Society of Echocardiography guidelines. Descriptive statistics were used to summarize frequencies and percentages of LV dysfunction across cardiomyopathy types, age groups, and gender. **Results:** Among 378 patients (54.5% males; mean age 54.4 ± 9.5 years), 159 (42%) had HCM, 183 (48.4%) had ICM, and 36 (9.5%) had both. Overall, LV dysfunction was observed in 77.8% of participants. In HCM patients, LV dysfunction was present in 64.5%, predominantly diastolic (39.4%), with 25.1% showing systolic impairment. ICM patients had a higher prevalence of LV dysfunction (87.7%), mainly systolic (64.8%), with 22.8% diastolic dysfunction. Patients with both HCM and ICM exhibited LV dysfunction in 87.2%. LV dysfunction increased with age, especially in patients aged 51–70 years, and was more frequent in males across both cardiomyopathy groups. **Conclusion:** LV dysfunction is highly prevalent in patients with cardiomyopathy in Pakistan, particularly in ICM, with distinct patterns by disease type, age, and gender. These findings highlight the importance of routine echocardiographic assessment for early detection and management of high-risk patients, and provide valuable regional data to guide clinical practice.

Keywords: Left ventricular dysfunction, Hypertrophic cardiomyopathy, Ischemic cardiomyopathy, Echocardiography, cardiomyopathy

Introduction

Cardiomyopathies constitute an important group of myocardial disorders that frequently lead to heart failure, arrhythmias, and increased cardiovascular mortality worldwide (1-3). Among them, hypertrophic cardiomyopathy (HCM) and ischemic cardiomyopathy (ICM) are the most commonly encountered forms in clinical cardiology practice. HCM is a genetically determined disease characterized by unexplained left ventricular hypertrophy and impaired ventricular relaxation, with an estimated prevalence of approximately 0.2–0.5% in the general population (4-6). In contrast, ICM develops as a consequence of coronary artery disease and myocardial ischemia and represents the leading cause of heart failure globally, accounting for nearly two-thirds of

heart failure cases in adults (7-9). Both conditions significantly affect left ventricular structure and function, making the assessment of left ventricular performance a central component of patient evaluation (10,11).

Left ventricular (LV) dysfunction, encompassing both systolic and diastolic impairment, is a key pathophysiological feature of cardiomyopathies and plays a crucial role in determining symptoms, disease progression, and prognosis. In hypertrophic cardiomyopathy, LV dysfunction is often dominated by diastolic abnormalities due to increased myocardial stiffness and impaired relaxation, while systolic function is usually preserved until advanced stages of the disease (12-14). Conversely, ischemic cardiomyopathy is primarily associated with systolic LV dysfunction resulting from myocardial infarction, chronic ischemia, and ventricular remodeling, although diastolic dysfunction may also coexist (15,16). Echocardiography is the most widely used, non-invasive imaging modality for evaluating LV function and allows reliable identification of systolic and diastolic dysfunction using standardized criteria (17,18).

The frequency of LV dysfunction varies between HCM and ICM and may also differ according to age and gender. Previous studies suggest that systolic dysfunction is more prevalent in older patients and in males with ischemic cardiomyopathy, whereas diastolic dysfunction is frequently observed across different age groups in hypertrophic cardiomyopathy (19). However, most available evidence originates from Western populations, and the reported frequencies show considerable variation across different regions and healthcare settings. In Pakistan and other South Asian countries, published data on cardiomyopathies largely focus on clinical presentation or electrocardiographic findings, while systematic evaluation of the frequency of LV dysfunction in HCM and ICM remains limited.

Moreover, studies that directly compare LV dysfunction patterns between hypertrophic and ischemic cardiomyopathy within the same study population are scarce. Local data examining LV dysfunction in relation to gender distribution are particularly lacking, despite gender being an important biological factor influencing cardiovascular structure and function. This gap in region-specific evidence limits the ability to apply international data to local patient populations and highlights the need for focused investigations in tertiary care settings. Therefore, the present study was designed to

determine the frequency of left ventricular dysfunction in patients with hypertrophic and ischemic cardiomyopathy and to evaluate its distribution according to gender and age groups using echocardiographic assessment. The findings aim to provide baseline local data that may assist clinicians in understanding disease patterns and support improved clinical assessment and management of cardiomyopathy patients.

In addition to its clinical relevance, understanding the frequency and pattern of LV dysfunction in HCM and ICM has important implications for risk stratification, therapeutic decision-making, and prognosis. Early identification of systolic or diastolic abnormalities can guide timely interventions, such as medical therapy optimization, device implantation, or consideration for advanced therapies, thereby potentially improving patient outcomes. Furthermore, characterizing LV dysfunction in a local population may reveal unique phenotypic expressions influenced by genetic, environmental, and socio-demographic factors, which are often underrepresented in global studies. By bridging this knowledge gap, the study not only contributes to the regional evidence base but also provides insights that may inform tailored management strategies for cardiomyopathy patients in Pakistan.

MATERIALS AND METHODS

Study Design, Setting, and Duration:

This study was conducted as a descriptive cross-sectional study in the Department of Cardiology, Rehman Medical Institute (RMI), Hayatabad, Peshawar, Khyber Pakhtunkhwa (KPK), Pakistan, over six months, from July 2025 to December 2025.

Ethical Approval:

Ethical approval was obtained from the Graduate Studies Committee (GSC) and the institutional Ethics Committee of Rehman Medical Institute (RMI) under reference number 37-2024/ADMIN/RCAHS before data collection. Informed consent was obtained from all participants before enrollment in the study.

Participants:

A total of 378 male and female patients diagnosed with hypertrophic cardiomyopathy (HCM) or ischemic cardiomyopathy (ICM) were included in the study. Eligible participants were between 30 and 70 years of age. Patients with congenital heart disease, valvular heart disease, incomplete echocardiographic data, or a history of cardiac

surgery were excluded. A convenience sampling (non-probability) technique was used, and eligible patients attending the cardiology department during the study period were selected consecutively.

Variables:

The primary outcome variable of this study was the frequency of left ventricular (LV) dysfunction in patients with hypertrophic cardiomyopathy (HCM) and ischemic cardiomyopathy (ICM). The exposure variables included the type of cardiomyopathy (HCM or ICM) and demographic characteristics such as age and gender. Left ventricular dysfunction was assessed using standard echocardiographic criteria, including left ventricular ejection fraction (LVEF) and wall motion abnormalities, as defined by the American Society of Echocardiography guidelines.

Procedure:

After obtaining informed consent from all participants, data for all variables were collected from patient medical records and echocardiographic reports. Demographic information and clinical history were obtained using a self-structured questionnaire. Left ventricular function was assessed through transthoracic echocardiography, performed by experienced cardiologists following standardized protocols. Left ventricular ejection fraction (LVEF) and wall motion abnormalities were measured consistently across all participants, ensuring comparability between patients with hypertrophic and ischemic cardiomyopathy. All measurements were recorded using the same echocardiography equipment and procedures to minimize variability. Ethical approval for the study was obtained from the Graduate Studies Committee (GSC) and the institutional Ethical Committee prior to data collection.

Sample size:

The sample size for this study was calculated using OpenEpi software, targeting the study population with a 95% confidence interval and a 5% margin of error. The calculation was based on the formula n=Z2×p(1−p)/E2n = Z^2 \times p(1-p) / E^2n=Z2×p(1−p)/E2, where the estimated prevalence (ppp) was 44% (20), ZZZ for a 95% confidence level was 1.96, and the margin of error (EEE) was 5%. Substituting these values yielded a sample size of **378** participants. A non-probability convenience sampling technique was used to select eligible participants from the target population.

Statistical Analysis:

Data were entered and analyzed using SPSS version 27.0. Descriptive statistics were used to calculate frequencies and percentages for all categorical variables, including the frequency of left ventricular dysfunction among patients with hypertrophic and ischemic cardiomyopathy. No advanced methods for controlling confounding were applied, as this study was descriptive in nature. Subgroup analyses were performed by stratifying patients according to type of cardiomyopathy (HCM vs. ICM) and age groups to observe differences in the frequency of LV dysfunction. Age-wise and gender-wise distributions were visualized using line graphs, presenting percentages across age groups (30–40, 41–50, 51–60, 61–70) for male and female patients in each cardiomyopathy category. Missing data were minimal and handled by excluding incomplete records from the analysis. Non-probability convenience sampling was accounted for by reporting results as descriptive statistics without inferential generalization. Sensitivity analysis was not performed due to the descriptive design of the study

Result:

A total of 378 patients diagnosed with hypertrophic cardiomyopathy (HCM), ischemic cardiomyopathy (ICM), or both were included in the study. The mean age of participants was 54.42 ± 9.47 years, with an age range of 30–70 years. The study population consisted of **206** males (54.5%) and 172 females (45.5%), indicating a slight male predominance. Age-wise, patients were distributed as follows: 30–40 years (n = 40, 10.6%), 41–50 years (n = 67, 17.7%), 51–60 years (n = 163, 43.1%), and 61–70 years (n = 108, 28.6%) (Table 4.1).

Among the total cohort, 159 patients (42%) were diagnosed with HCM, 183 patients (48.4%) with ICM, and 36 patients (9.5%) had both HCM and ICM. No participants were excluded during the study period, as all enrolled patients met the inclusion criteria of confirmed diagnosis and complete echocardiographic evaluation. Overall, 294 patients (77.8%) demonstrated some form of left ventricular (LV) dysfunction. The prevalence of LV dysfunction differed according to cardiomyopathy type. In HCM patients, 102 individuals (64.5%) showed LV dysfunction, predominantly diastolic dysfunction (62, 39.4%), with systolic dysfunction observed in 40 patients (25.1%) and severe impairment in 1 patient (0.8%). In contrast, ICM patients had a higher

burden of LV dysfunction, with 161 individuals (87.7%) affected, mainly due to systolic dysfunction (118, 64.8%), while diastolic dysfunction was observed in 42 patients (22.8%), and 16 patients (8.5%) had severe LV impairment. Patients with both HCM and ICM also showed a high prevalence of LV dysfunction (31, 87.2%), with 41.6% exhibiting systolic dysfunction and 44.5% showing diastolic dysfunction (Table 4.2).

Analysis of LV dysfunction by age groups revealed distinct trends between HCM and ICM. Among HCM patients, diastolic dysfunction was most frequent in the 51–70 years age group, accounting for the majority of LV impairment, whereas systolic dysfunction remained relatively stable across all age categories. For ICM patients, systolic dysfunction increased with age, being highest in the 61–70 years' age group (41 males, 55.5%; 21 females, 24.5%), while diastolic dysfunction was more common in the 51–60 years group. Patients with both HCM and ICM demonstrated a relatively uniform distribution of LV dysfunction across age groups, although absolute numbers were smaller (Table 4.3).

Gender-wise analysis showed a higher prevalence of LV dysfunction among males compared to females across all cardiomyopathy types. In HCM, males had 64.5% LV dysfunction, whereas females showed slightly lower prevalence, mainly in diastolic impairment. In ICM, systolic dysfunction predominated in males, reflecting known epidemiological trends of higher ischemic burden in men. The combined HCM + ICM group showed high LV dysfunction in both genders, indicating that overlapping cardiomyopathy phenotypes further exacerbate ventricular impairment.

Table 4.1: *Gender and Age Distribution of Cardiomyopathy Patients:*

Age Group (years)	Male (n, %)	Female (n, %)	Total (n, %)
30–40	22 (5.8%)	18 (4.8%)	40 (10.6%)
41–50	34 (9.0%)	33 (8.7%)	67 (17.7%)
51–60	77 (20.4%)	86 (22.7%)	163 (43.1%)
61–70	73 (19.3%)	35 (9.3%)	108 (28.6%)
Total	206 (54.5%)	172 (45.5%)	378 (100%)

N= number of cases (count), % = percentage of total

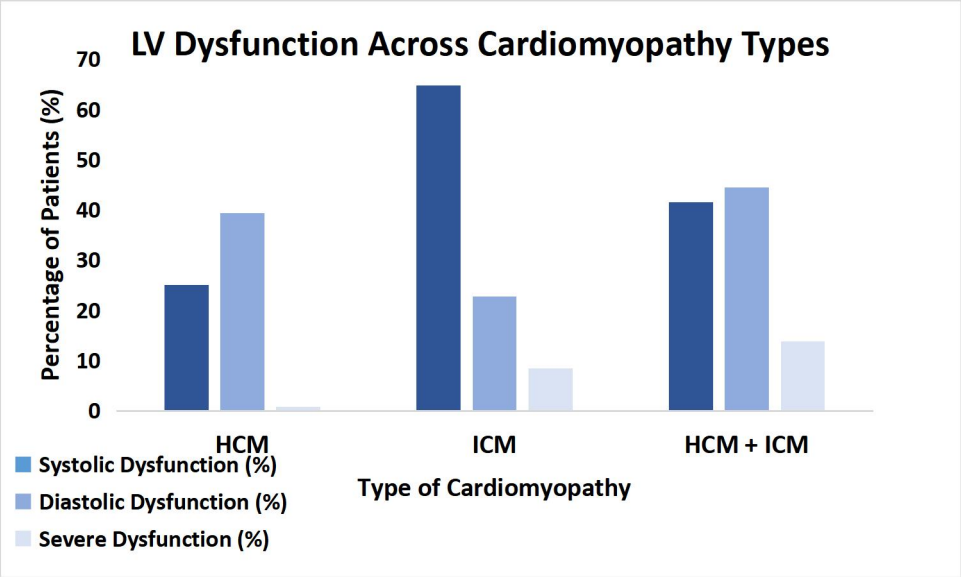
Table 4.2: *Frequency of LV Dysfunction in Cardiomyopathy Patients*

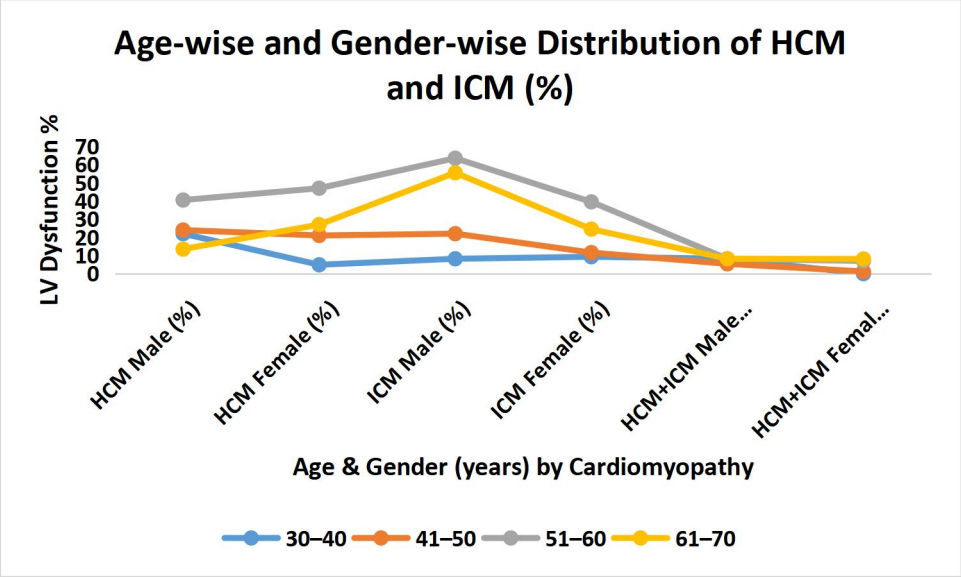
Cardiomyopathy Type	Total Patients (n)	LV Dysfunction (n, %)	Systolic Dysfunction (n, %)	Diastolic Dysfunction (n, %)	Severe Dysfunction (n, %)
HCM	159	102 (64.5%)	40 (25.1%)	62 (39.4%)	1 (0.8%)
ICM	183	161 (87.7%)	118 (64.8%)	42 (22.8%)	16 (8.5%)
HCM + ICM	36	31 (87.2%)	15 (41.6%)	16 (44.5%)	5 (13.8%)
Total	378	294 (77.8%)	173 (45.8%)	120 (31.7%)	22 (5.8%)

N= number of cases (count), % = percentage of total

Table 4.3: *Age- and Gender-Based Distribution of LV Dysfunction*

Cardiomyopathy Type	Age Group (years)	Male LV Dysfunction (n, %)	Female LV Dysfunction (n, %)	Total LV Dysfunction (n, %)
HCM	30–40	16 (22.0%)	4 (4.9%)	20 (26.9%)
	41–50	18 (24.0%)	18 (21.0%)	36 (45.0%)
	51–60	30 (40.5%)	40 (47.0%)	70 (87.5%)
	61–70	10 (13.5%)	23 (27.0%)	33 (40.5%)
ICM	30–40	6 (8.2%)	8 (9.3%)	14 (17.5%)
	41–50	16 (22.0%)	10 (11.6%)	26 (33.6%)
	51–60	47 (63.5%)	34 (39.5%)	81 (70.0%)
	61–70	41 (55.5%)	21 (24.5%)	62 (80.0%)
HCM + ICM	30–40	6 (8.2%)	0 (0%)	6 (8.2%)
	41–50	4 (5.4%)	1 (1.2%)	5 (6.6%)
	51–60	6 (8.2%)	6 (7.0%)	12 (15.2%)
	61–70	6 (8.2%)	7 (8.1%)	13 (16.3%)





DISCUSSION:

The present study evaluated the frequency of left ventricular (LV) dysfunction in patients with hypertrophic cardiomyopathy (HCM) and ischemic cardiomyopathy (ICM), with additional stratification by age and gender.

The findings demonstrate that LV dysfunction was highly prevalent overall (77.8%), with a substantially higher frequency observed in patients with ICM (87.7%) compared to those with HCM (64.5%).

As anticipated based on disease pathophysiology, systolic dysfunction predominated in ICM, whereas diastolic dysfunction was more common in HCM. Furthermore, LV dysfunction increased with advancing age, particularly in patients aged 51–70 years. Gender-based analysis revealed a higher prevalence of LV dysfunction among males in both cardiomyopathy groups. These results directly address the study objective of determining the frequency and demographic distribution of LV dysfunction in hypertrophic and ischemic cardiomyopathy patients.

The higher frequency of LV dysfunction in ICM observed in this study is consistent with the ischemic etiology of the disease, where chronic myocardial ischemia and infarction lead to irreversible myocardial damage, ventricular remodeling, and impaired systolic performance. Previous studies have reported LV dysfunction in up to 80–90% of patients with ischemic cardiomyopathy, supporting the findings of the present study (22,23). In contrast, hypertrophic cardiomyopathy is characterized by myocardial hypertrophy and increased ventricular stiffness, which primarily impair diastolic filling rather than systolic contraction. This explains the predominance of diastolic dysfunction among HCM patients in the current cohort, in line with ESC guidelines and prior literature (21,24).

Age-related trends observed in this study further support established evidence that LV dysfunction worsens with increasing age due to cumulative myocardial injury, prolonged disease duration, and associated comorbidities. The higher burden of systolic dysfunction in older ICM patients mirrors findings from large heart failure registries, which report increasing systolic impairment with advancing age (23). Gender differences noted in this study, with males showing a higher prevalence of LV dysfunction, may reflect the higher incidence of coronary artery disease, greater exposure to cardiovascular risk factors, and differences in myocardial remodeling between sexes, as reported in previous studies (25).

Importantly, patients diagnosed with both HCM and ICM demonstrated a very high frequency of LV dysfunction (87.2%), suggesting a compounded adverse effect on ventricular function when ischemic pathology coexists with structural myocardial abnormalities. This subgroup, though smaller, highlights the clinical importance of

careful functional assessment in patients with overlapping cardiomyopathy phenotypes (26).

The findings of this study are largely consistent with international literature but provide valuable regional data from a South Asian population. While Western studies have extensively documented LV dysfunction patterns in cardiomyopathies, comparable data from Pakistan are limited. Previous local studies have focused mainly on electrocardiographic features or clinical presentations, with minimal emphasis on echocardiographic functional assessment. By directly comparing HCM and ICM within the same population and healthcare setting, this study adds novel insight and strengthens the external relevance of international evidence to local clinical practice (27). Studies from Pakistan and neighboring South Asian countries have reported a similarly high burden of left ventricular dysfunction among patients with ischemic cardiomyopathy. Hospital-based echocardiographic studies from tertiary care centers in Pakistan have shown that the majority of ICM patients present with established systolic dysfunction, often at a relatively younger age compared to Western populations. This has been attributed to delayed diagnosis, limited access to preventive cardiology services, and a high prevalence of uncontrolled cardiovascular risk factors such as diabetes mellitus, hypertension, and smoking. The frequency of LV dysfunction in ICM observed in the present study is consistent with these regional findings, reinforcing the notion that ischemic cardiomyopathy in South Asia is frequently diagnosed at an advanced functional stage (28).

With respect to hypertrophic cardiomyopathy, data from Pakistan and South Asia remain scarce; however, available studies indicate that diastolic dysfunction is the predominant functional abnormality, while systolic function is often preserved until later stages of the disease (29). South Asian cohorts have reported male predominance and variable clinical presentation, ranging from asymptomatic individuals to patients presenting with heart failure symptoms. The comparatively lower frequency of LV dysfunction in HCM patients observed in this study aligns with these reports and supports existing evidence that ventricular dysfunction in HCM is primarily related to impaired relaxation and increased myocardial stiffness rather than reduced contractility (30).

Several limitations should be acknowledged. First, the descriptive cross-sectional design limits causal inference and temporal assessment of disease progression. Second, the use of non-probability convenience sampling may introduce selection bias, potentially overrepresenting patients with more severe disease who are more likely to present to tertiary care facilities. This may have resulted in an overestimation of the true frequency of LV dysfunction. Third, the study was conducted at a single centre, which may limit the representativeness of the findings. Additionally, advanced echocardiographic parameters such as strain imaging were not included, which could have provided a more sensitive assessment of subclinical LV dysfunction. Despite these limitations, the study offers meaningful insights applicable to similar tertiary care cardiology settings, particularly in resource-limited regions. The use of standardized echocardiographic criteria enhances the comparability of results with other studies.

Conclusion:

In summary, this study demonstrates a high frequency of left ventricular dysfunction among patients with cardiomyopathy, particularly ischemic cardiomyopathy, with distinct patterns based on disease type, age, and gender. These findings underscore the importance of routine echocardiographic evaluation for early detection of LV dysfunction and support the need for targeted management strategies in high-risk subgroups.

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