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Original Article

Left Ventricular Ejection Fraction and Associated Factors in St-Elevation Myocardial Infarction (Stemi) and Non-St-Elevation Myocardial Infarction (Nstemi) Patients: Impact on Early In-Hospital Outcomes

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ABSTRACT

Objective: To determine and compare Left Ventricular Ejection Fraction (LVEF) and its associated factors in STEMI and NSTEMI patients and to determine early hospital outcomes in STEMI and NSTEMI patients.
Study Design: Prospective observational study
Place and Duration of Study: Mardan Medical Complex, Mardan, Pakistan, from Sep 2024 to Feb 2025.
Methodology: A total of 178 research participants diagnosed and admitted with AMI (89 STEMI & NSTEMI each) of both genders were included. Data was collected using a predesigned questionnaire after informed consent and echocardiographic evaluation of left ventricular ejection fraction (LVEF%). Conventional risk factors were confirmed from history/investigations, and in-hospital outcomes were considered post-AMI consequences during patients' hospital stay. Data was analyzed using SPSS.
Results: Out of the total 178 patients, 57.30% were male. The mean age was 57.52 + 10.26 years. The mean LVEF (%) among STEMI & NSTEMI patients was 43.77 + 10.75 & 47.49 + 12.15, respectively. Mild and moderate LV systolic dysfunction was common among STEMI, while severe among NSTEMI. Obesity and diabetes were more common among females. Pericardial effusion, MR, and cardiogenic shock were more common among STEMI. Patients with heart failure, MR, cardiac arrest, and death had significantly ($p < 0.05$) reduced mean LEVF%.
Conclusion: Mean LVEF% was lower among STEMI, and in-hospital outcomes were higher with severely reduced ejection fraction. Transthoracic echocardiography can provide information on short- and long-term outcomes after AMI. Regular Echocardiography is advised, which guides management, improves prognosis, and reduces other complications.

Keywords: Acute Myocardial Infarction, Echocardiography, In-Hospital Outcomes, Left Ventricular Ejection Fraction

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INTRODUCTION

Acute myocardial infarction (AMI) is the major global cause of morbidity and mortality.[1] Around the world, 17.1 million fatalities are attributed to coronary heart disease (CHD). As a result, CHD is currently the major cause of death worldwide and continues.[2] The global incidence of MI was estimated to be 3.8% in people under 60 years and 9.5% in people over 60 years.1 In Pakistan, the prevalence of CVDs is still rising having high prevalence of rheumatic heart disease and early-onset CAD.[3] WHO data indicates that 19% of recorded fatalities in Pakistan's lower-middle-income group are attributable to CVDs, and that mortality or the age-standardized death rate per 100,000 population is greater in women than in men.[4]

STEMI and NSTEMI are the major presentations of AMI, and each year over three million individuals develop STEMI.[5] The yearly incidence of STEMI is 0.05–0.15%, and a considerable proportion of STEMIs (5.5–11.6%) occur in individuals who are under 45 years of age,[6] and approximately 70% of instances of ACS are NSTEMI6 and studies show 60%–70% of MI hospitalizations are due to NSTEMI.[7]

Evaluation of LV size and function is the key to cardiac diagnostics, and studies highlight the significance of LVEF% (left ventricular ejection fraction) as an early indicator of acute MI. SIMPSON and M-mode techniques are used to examine the echocardiogram to measure LVEF.[8] The American College of Cardiology (ACC) graded LV systolic function on base as, LVEF 50-70% as normal, LVEF 40-49% mild, LVEF 30-39% as moderate and LVEF <30% as severe systolic dysfunction.[9] LVEF is a prognostic predictor in managing STEMI & NSTEMI, as studies show various outcomes, and the mean EF/FS/and CO

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was significantly compromised in STEMI as compared to NSTEMI (42+10.02 vs 50.12+0.63) patients.[10]

Left ventricular ejection fraction is a key determinant of systolic function and a major prognostic indicator in myocardial infarction patients, but there is a gap in understanding how LVEF% differs between STEMI and NSTEMI and how it affects in-hospital outcomes. Understanding the LVEF% difference, associated factors, and early in-hospital outcomes helps to improve understanding of the disease severity and guide timely management of these conditions, which can decrease the duration of stay in hospital, recovery time, morbidity, treatment cost, hospital burden, expenses, improve hospital outcomes, and prevent complications. This study aims to determine and compare LVEF and its associated factors in STEMI and NSTEMI patients and to determine early hospital outcomes in STEMI and NSTEMI patients and their association with LVEF and associated factors.

METHODOLOGY

This prospective observational study was conducted in the Department of Cardiology, Mardan Medical Complex (tertiary care teaching hospital), Khyber Pakhtunkhwa, Pakistan, from Sep 2024 to Feb 2025, after Ethical approval was obtained from the ethical committee of BKMC, Mardan (No. 582/BKMC, Dated: 03/09/2024).

The sample size was 178 patients, calculated using OpenEpi, considering a 13.3% prevalence of acute MI,1 at a 95% confidence interval and 5% margin of error. Further, the sample size was equally divided into two groups (89 STEMI & NSTEMI each), and a convenience sampling technique was used for participant selection.

Inclusion Criteria: Patients with first-time acute myocardial infarction (STEMI and NSTEMI) aged 18 to 80 years of both genders (male and female) were included in the study.

Exclusion Criteria: Patients with a previous history of myocardial infarction, MI due to graft blockage, unstable angina, cardiomyopathies, and patients who refused to participate were excluded from this study.

Informed consent was obtained from all voluntary participants, and data privacy and confidentiality were confirmed to participants before data collection. Data was collected using a predesigned questionnaire after echocardiographic evaluation, which was conducted with a Toshiba Xario 200 ECHO-machine, utilizing 2D, M-mode, and Doppler assessment. The Simpson method was employed to measure the left ventricular ejection fraction (LVEF%) and was categorized as follows: 50% to 70% as normal, 40% to 49% as mild systolic dysfunction, 30% to 39% as moderate, and less than 30% as severe left ventricular systolic dysfunction. Echocardiographic evaluations were performed by an experienced cardiologist and an expert echocardiographer, adhering to the guidelines set forth by the American Society of Echocardiography. Conventional risk factors were confirmed from history/investigations, and in-hospital outcomes considered post-AMI consequences during patients' hospital stay, such as heart failure, arrhythmias, pericardial effusion, MR, ventricular septal rupture, cardiogenic shock, cardiac arrest, and death.

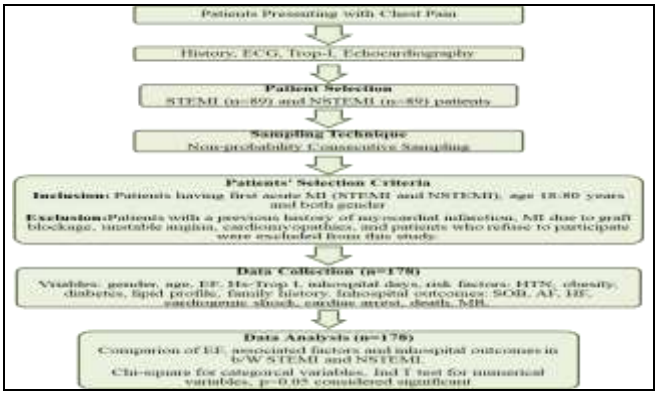

Figure-1: Patient Flow Diagram (n= 178)

The primary dependent variable in this study was the LVEF%, which was assessed using echocardiography in patients with STEMI and NSTEMI. Additionally, other variables such as age and gender, as well as associated factors including smoking, diabetes, obesity, and others, were examined. The variable in-hospital outcomes include atrial fibrillation, mitral regurgitation, cardiogenic shock, death, and others. The main quantitative variables in this study included LVEF%, age, and length of hospital stay in days.

All echocardiographic evaluations were conducted by expert and trained professionals to minimize bias. To ensure accurate comparisons, the sample size was equally divided into STEMI and NSTEMI groups. Patients with conditions known to affect ejection fraction, such as previous comorbidities, were excluded, and strict inclusion and exclusion

criteria were applied to guarantee the accuracy of the data.

Data were analyzed using Statistical Product and Service Solutions (SPSS) version 26. Descriptive statistics like mean and standard deviation were calculated for normally distributed data like age, EF%, and length of hospital stay. A chi-square test was used to examine the association between categorical variables, such as STEMI & NSTEMI groups, with risk factors and in-hospital outcomes. Additionally, for normally distributed variables, an independent t-test was employed to compare the mean LVEF% between STEMI and NSTEMI patients, as well as between patients with and without in-hospital outcomes. A p-value ≤ 0.05 was considered statistically significant.

RESULTS

The Mean ejection fraction (EF%) was significantly lower in STEMI patients compared to NSTEMI patients (43.77 ± 10.72 vs 47.49 ± 12.15, p = 0.03). The distribution of LV systolic function categories was significantly different (p = 0.01), with a higher proportion of mild and moderate LV systolic dysfunction among STEMI and severe LV systolic dysfunction among NSTEMI. A significant difference was observed in the mean length of in-hospital stay between the groups (STEMI vs. NSTEMI, p = 0.44). Moreover, male gender was more prevalent in the STEMI group compared to NSTEMI (65.2% vs. 49.4%, p = 0.03) (Table-I).

with a significant difference (p < 0.001) between genders. Dyslipidemia affected 7.9% of the total patients, with no significant difference between males (64.3%) and females (35.7%) (p = 0.58). Family history of coronary artery disease was present in 45.5% of patients, with a higher distribution among males (56.8%) than females (43.2%), with no statistically significant difference by gender (p = 0.89) (Table-II).

Risk factors were further analyzed among STEMI and NSTEMI, which showed that hypertension was the most prevalent in both STEMI (67.4%) and NSTEMI (74.2%) patients, with a statistically non-significant difference (p = 0.32). Obesity was found to be more common in NSTEMI (12.4%) than in STEMI (5.6%), but the difference was not statistically significant (p = 0.12). Similarly, diabetes mellitus was slightly more common in the NSTEMI group (48.3%) than in the STEMI group (41.6%) (p = 0.37). Smoking was more common in STEMI patients (12.4%) compared to NSTEMI (6.7%), dyslipidemia was found in 7.9% of participants in both groups, and family history of coronary artery disease was found as STEMI: 43.8%, NSTEMI: 47.2%; all the above risk factors were not significantly different (p > 0.05) among STEMI and NSTEMI (Table-III).

Shortness of breath was significantly more frequent in NSTEMI patients (84.3%) than in STEMI patients (68.5%) (p = 0.013). Other in-hospital outcomes, including atrial fibrillation, pericardial

Table-I: Comparison Among ST-Elevation And Non-ST-Elevation Myocardial Infarction (n=178)

Variables		STEMI (n=89)	NSTEMI (n=89)	Total	*p*-Value
EF (%) (Mean + SD)		43.77 + 10.72	47.49 + 12.15	178(100%)	0.03
In-hospital stay (Days) (Mean + SD)		2.80 + 0.54	2.88 + 0.78	178(100%)	0.44
Categories of LV Systolic dysfunction	Normal (50% - 70%)	31(34.8%)	50(56.2%)	81(45.5%)	0.01
	Mild (40% - 49%)	16(18.0%)	6(6.7%)	22(12.4%)	
	Moderate (30% - 39%)	29(32.6%)	19(21.3%)	48(27.0%)	
	Severe (<30%)	13(14.6%)	14(15.7%)	27(15.2%)	
Gender	Male	58(65.2%)	44(49.4%)	102(57.3%)	0.03
	Female	31(34.8%)	45(50.6%)	76(42.7%)	

**ST: ST segment, STEMI: ST-segment elevation myocardial infarction, NSTEMI: Non-ST-segment elevation myocardial infarction, EF: Ejection fraction, SD: Standard deviation, Ind: Independent, LV-Left Ventricular*

Hypertension was highly prevalent overall (70.8%), and a statistically significant association (p=0.00) between hypertension and gender was found in this study. Obesity was present in 9.0% of participants, with a slightly higher proportion in females (56.3%) than males (43.8% with no statistically significant difference (p = 0.25). Diabetes was present in 44.9% of patients, with a significantly higher proportion in females (57.5%) compared to males (42.5%), with a statistically significant difference (p = 0.00). Smoking was reported only in males (9.6%),

effusion, heart failure, cardiogenic shock, cardiac arrest, death, and mitral regurgitation, showed no significant differences between the groups (p > 0.05) (Table-IV). Adverse in-hospital outcomes such as atrial fibrillation, heart failure, mitral regurgitation, cardiac arrest, and death were significantly associated with reduced LVEF (p < 0.05); mean LVEF% impacted these in-hospital outcomes, but no significant association was found between LVEF and shortness of breath, pericardial effusion, or cardiogenic shock (p > 0.05) (Table-V).

Table-II: Association of Risk Factors Among Gender (n=178)

Risk Factors	Males (n=102)	Females (n=76)	Total (n=178)	*p*-value
Hypertension	64(50.8%)	62(49.2%)	126(70.8%)	0.001
Obesity	7(43.8%)	9(56.3%)	16(9.0%)	0.250
Diabetes	34(42.5%)	46(57.5%)	80(44.9%)	0.001
Smoking	17(9.6%)	0(0.0%)	17(9.6%)	0.001
Dyslipidemia	9(64.3%)	5(35.7%)	14(7.9%)	0.580
Family History of CAD	46(56.8%)	35(43.2%)	81(45.5%)	0.890

**CAD: Coronary artery disease*

Table-III: Association of risk factors among ST-elevation and non-ST-elevation myocardial infarction (n=178)

Risk Factors	STEMI (n=89)	NSTEMI (n=89)	Total (n=178)	*p*-value
Hypertension	60 (67.4%)	66 (74.2%)	126 (70.8%)	0.320
Obesity	5 (5.6%)	11 (12.4%)	16 (9.0%)	0.120
Diabetes	37 (41.6%)	43 (48.3%)	80 (44.9%)	0.370
Smoking	11 (12.4%)	6 (6.7%)	17 (9.6%)	0.200
Dyslipidemia	7 (7.9%)	7 (7.9%)	14 (7.9%)	1.000
Family History of CAD	39 (43.8%)	42 (47.2%)	81 (45.5%)	0.650

**CAD: Coronary artery disease, STEMI: ST-segment elevation myocardial infarction, NSTEMI: Non-ST-segment elevation myocardial infarction*

Table-IV: Association Of In-Hospital Outcomes Between St-Elevation And Non-St-Elevation Myocardial Infarction (n=178)

In-Hospital Outcomes	STEMI (n=89)	NSTEMI (n=89)	Total (n=178)	*p*-Value
Shortness of Breath	61 (68.5%)	75 (84.3%)	136 (76.4%)	0.013
Atrial Fibrillation	0 (0%)	2 (2.2%)	2 (1.1%)	0.497
Pericardial effusion	4 (4.5%)	2 (2.2)	6 (3.4%)	0.682
Heart Failure	2 (2.2%)	7 (7.9%)	9 (5.1%)	0.168
Cardiogenic shock	1 (1.1%)	0 (0%)	1 (0.6%)	1.000
Cardiac arrest	0 (0%)	2 (2.2%)	2 (1.1%)	0.497
Death	1 (1.1%)	2 (2.2%)	3 (1.7%)	1.000
Mitral Regurgitation	69 (77.5%)	64 (71.9%)	133 (74.7%)	0.389

**STEMI: ST-segment elevation myocardial infarction, NSTEMI: Non-ST-segment elevation myocardial infarction*

Table-V: Mean Comparison of Left Ventricular Ejection Fraction Among Patients With and Without In-Hospital Outcomes (n=178)

In-Hospital Outcomes		Mean LVEF (%) + SD	*p*-value
Shortness of Breath	Present	45.15 + 11.73	0.320
	Absent	47.17 + 11.04	
Atrial Fibrillation	Present	55.30 + 1.41	< 0.001
	Absent	45.52 + 11.58	
Pericardial effusion	Present	43.47 + 11.45	0.640
	Absent	45.71 + 11.61	
Heart Failure	Present	29.23 + 3.83	< 0.001
	Absent	46.50 + 11.19	
Cardiogenic shock	Present	25.00 + 0.00	0.070
	Absent	45.75 + 11.50	
Mitral Regurgitation	Present	42.67 + 11.01	< 0.001
	Absent	54.38 + 8.41	
Cardiac arrest	Present	29.20 + 1.69	0.010
	Absent	45.82 + 11.50	
Death	Present	27.80 + 2.70	< 0.001
	Absent	45.94 + 11.43	

**LVEF: Left ventricular ejection fraction*

DISCUSSION

In this study, the mean age was 57.52+10.262 years, and the mean LVEF% among STEMI & NSTEMI patients were 43.77+10.716 & 47.49+12.154 respectively. Severe among NSTEMI. The majority of risk factors were more prevalent in NSTEMI, while obesity and diabetes were more common among females. Pericardial effusion, MR, and cardiogenic shock were more common among STEMI. Heart failure, MR, cardiac arrest, and death had significantly (p<0.05) reduced mean LVEF% in this study.

STEMI and NSTEMI are both types of AMI that lead to significant mortalities and morbidities. LVEF is a significant indicator of the long-term prognosis who had STEMI and NSTEMI. The mean age (57.52+10.262 years) of our research respondents was close to 54.03±10.163 years, as shown by a study done in Pakistan by Saddique et al., in 2024.[11] The little difference may be due to more (200) participants in the previous study.

In our study, the mean LVEF(%) in STEMI & NSTEMI patients were 43.77+10.716 & 47.49+12.154 with p-value <0.05 respectively, nearly close finding also shown by another study done in Mullana Ambala by Shah et al., in 2020, in which mean LVEF(%) in STEMI & NSTEMI patient was 42+10.02 and 50.12+0.63 respectively.[10] Similar to our results, a study in Pakistan by Ather *et al.,* and another study in 2020 by McClements *et al.,* reported the mean LVEF in STEMI patients as 45.3±9.5 and NSTEMI as 49±9.[4] with a significant difference (p-value <0.005), and the mean LVEF in STEMI patients as 44.8±11.5, respectively.[12,13] Other studies, such as in Turkey 2022 and in Pakistan 2024, also reported the mean LVEF of 47.28±8.76 and 47.77±9.24 among STEMI patients, respectively.[5,11] and 44.7±0.4 among NSTEMI, also found in a study in Saudi Arabia by Almohammadi et al., in 2024 14 and similar to this study, the majority of patients had LVEF between 40-50%.

In our study, hypertension was found in 126(70.8%) patients, 67.4% among STEMI and 74.2% among NSTEMI, which were close to the findings of 64.5% hypertension among STEMI and 72.6% hypertension among NSTEMI done in Japan by Fukutomi *et al.,* in 202115 and slight differences in hypertension in 51.9% of the STEMI and 65.4% of the NSTEMI group were also reported by Kanakakis *et al.,*[16] is nearly the same as our findings and also parallels our finding that diabetes is reported in 35.5% of STEMI and 43.8%.[15] Also, a previous study in Pakistan in 2024 reported 45% of smoking.[11] This is different from our study findings, which may be due to different countries; in Western countries, the prevalence of smoking and dyslipidemia is high compared to the Asian population, with smoking the most significant risk factor in all, as reported in Korea by Han *et al.,* in 2021.[17]

In our study, 45.5% had a positive family history, which is close to previous study findings of 41.7% in a study done in the Netherlands by Lenselink *et al.*, in 2024 8, which is the same as our study findings. Another study in Bangladesh by Siddique *et al.*, in 2023 reported that 48.33% of STEMI patients had a positive family history of IHD, which is also the same as our findings.[18]

In our study, the in-hospital stay of the AMI were between 1 and 4 days, with mean+SD 2.85+0.676 standard deviation. In a prior study in the Netherlands by Demirkiran et al., in 2022, the Mean± SD hospital duration was 3.0+3.1.[19] Heart failure, cardiogenic shock, cardiac arrest, and death were only found in patients who had severely reduced LVEF (p<0.05) similar to the findings by Nazrul *et al*.[20]

In another study in Bangladesh in 2019 and in the USA by Verghese *et al.*, in 2023, the in-hospital stays (days) were reported as 1-3 days in NSTEMI patients.21 This is nearly the same as our study findings, which are comparatively nearly the same as the previous study findings. LV failure was more prevalent, arrhythmia among 25%, MR in 43.33%, and pericardial effusion in 1.67%, and no death was recorded, which is different from our study findings,18 Another study by Veghese et al., showed, HF in 11.5% of patients (p= 0.003), arrhythmia in 15.4% (p=0.107), cardiogenic shock in 3.9% (p=0.254), and death occurred in 16.7% (p=0.002), and concludes that lower LVEF% causes worse in-hospital outcomes after the first attack of NSTEMI patients in 2019.21 A study in China by Yang *et al.*, in 2020 also reported the in-hospital outcomes in STEMI & NSTEMI patients; all-cause death was 1.2%, cardiogenic shock was 0.9% in STEMI and 0.8% in NSTEMI, and heart failure was 0.6% vs 0.8 among STEMI Vs NSTEMI, which is different from our study findings.[22]

LVEF is an important prognostic marker for patients who have experienced AMI. It is recommended to evaluate LVEF properly during the hospital stay, before discharge, and during follow-up visits. A severely reduced LVEF after an AMI is associated with a higher risk of long-term mortality. Therefore, it is crucial to give greater attention to this measurement in order to improve in-hospital outcomes and improve prognosis. Due to the differences in LVEF between STEMI and NSTEMI, we recommend a cohort study to investigate the recovery and improvement of left ventricular systolic function. This assessment should be performed using echocardiography to provide a more comprehensive evaluation of the recovery process and therapeutic outcomes in AMI patients.

For comprehensive comparative analysis, we equally divide the sample size for both STEMI and NSTEMI patients. The LVEF was evaluated by a senior experienced cardiologist and an expert echocardiographer, following the American Society of Echocardiography guidelines. Further, the study used the latest echocardiography machine (Xario200) to ensure high-quality imaging and accurate assessments.

LIMITATIONS OF THE STUDY

LVEF was assessed using echocardiography alone, without comparing the findings to other diagnostic tests such as coronary angiography or MIBI scans.

CONCLUSION

The mean LVEF (%) was less in STEMI than in NSTEMI. Pericardial effusion, MR, and cardiogenic shock were more common among STEMI patients, while SOB, HF, cardiac arrest, and death were higher among NSTEMI patients. In patients with In-hospital outcomes like heart failure, MR, cardiac arrest, and death, the mean LVEF was significantly reduced. Risk factors like hypertension, DM, obesity, and family history of CAD were higher among NSTEMI. Risk factor prevention and regular Echocardiography are advised for both in-hospital and out-of-hospital patients that guide management, improve prognosis, and reduce other complications.

Conflict of Interest: None.

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Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

AA & NUH: Data acquisition, data analysis, critical review, approval of the final version to be published.

AUS & AK: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

LJ & AAK & MHK: Conception, data acquisition, drafting the manuscript, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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