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HIGH KILLIP CLASS (≥II), ITS PREDICTORS AND IN-HOSPITAL OUTCOMES AMONG PATIENTS WITH STEMI

[1]Dr Jaweria Malik, [2]Prof Dr Jawaid Akbar Sial, [3]Kinza, [4]Taqveem Ilyas, [5]Aasia

[1]FCPS Adult Cardiology, Department of Adult Cardiology, National Institute of Cardiovascular Diseases (NICVD), Karachi, Pakistan.
[2]Professor, Department of Cardiology, National Institute of Cardiovascular Diseases (NICVD), Karachi, Pakistan.
[3]FCPS Resident, Adult Cardiology, National Institute of Cardiovascular Diseases (NICVD), Karachi, Pakistan.
Email: kinzahussain11@gmail.com
[4]Cardiology Resident, Year 3, National Institute of Cardiovascular Diseases (NICVD), Karachi, Pakistan.
Email: taqveemilyas@gmail.com
[5]Cardiology Resident, Year 3, National Institute of Cardiovascular Diseases (NICVD), Karachi, Pakistan.
Email: Aasiajoyo@gmail.com
*Corresponding Author: Dr Jaweria Malik

ABSTRACT

Objective: To determine the incidence of high Killip class (≥II) and its associated risk factors and in-hospital outcome on admission for ST elevation myocardial infarction (STEMI) patients in a tertiary cardiac centre.

Background: ST-Elevation myocardial infarction (STEMI) continues to be one of the most important cardiac emergencies worldwide, and in-hospital outcome is sensitive to the extent of haemodynamic derangements at presentation. The Killip classification is a bedside assessment of the severity of the heart failure, which is a well established predictor of short-term mortality in STEMI. Adverse outcomes, like mortality and arrhythmias/cardiogenic shock, are independently associated with higher Killip classes (≥II) at admission. It has been, however, inadequately defined to have local predictors which correspond to the presence of high Killip class in the Pakistani STEMI population at high-volume centres, like NICVD Karachi.

Place & Duration of Study: Department of Cardiology, NICVD, Karachi from April 01, 2026 to July 03, 2026.

Methodology: This descriptive cross-sectional study was conducted in 196 patients with symptoms of first episode STEMI aged 18-80 years by non-probability consecutive sampling. Killip class category was found at admission and split into high (Killip class ≥II) or low (Killip class I). Demographic and clinical characteristics such as age, sex, diabetes mellitus, hypertension, dyslipidaemia, smoking, anaemia, chronic kidney disease (CKD) and symptom to door time were collected. Up to 7 days, in-hospital outcomes such as mortality, intubation, arrhythmias, inotropic support and the utilization of intra aortic balloon pump (IABP) were documented. We used multivariate logistic regression, using all available parameters, to determine if any parameters were independent predictors of high Killip class. IBM SPSS 21.0 was used for data analysis.

Results: The mean age was 58.4 ± 12.6 years and the incidence of male was higher (76.5%). High Killip class (≥II) was present in 18.4% (36/196) of patients. On multivariate analysis, independent predictors of high Killip class were female sex (OR 3.24; 95% CI: 1.47–7.13; p=0.004), anaemia (OR 3.42; 95% CI: 1.61–7.26; p=0.001), CKD (OR 2.89; 95% CI: 1.27–6.59; p=0.011), diabetes mellitus (OR 2.31; 95% CI: 1.08–4.96; p=0.031) and symptom-to-door time >12 hours (OR 3.87; 95% CI: 1.78–8.41; p<0.001). The high Killip group had significantly higher incidences of in-hospital mortality (22.2% vs 3.1%), arrhythmias (36.1% vs 13.1%) and inotropic support requirement (27.8% vs 5.0%) (all p<0.001).

Conclusion: Roughly 20% of STEMI patients at NICVD Karachi have high Killip class ≥ II which is independent of female sex, anaemia, CKD, delay or diabetes. It has been found to be associated with significantly poorer in-hospital outcomes, and early risk stratification of these patients and providing targeted intervention are imperative.

KEYWORDS: Killip classification, STEMI, ST-elevation myocardial infarction, Predictors, In-hospital outcomes, NICVD Karachi.

INTRODUCTION

Despite its vast body of research and efforts, acute myocardial infarction (AMI) remains the most important cause of morbidity and mortality worldwide and is one of the most common cause of burden of non-communicable disease (NCD) in LMICs like Pakistan [1]. In most people, AMI is the result of a

ruptured or eroded plaque, and ST elevation myocardial infarction (STEMI), which is the most severe and time-sensitive form of AMI, needs immediate reperfusion [2]. STEMI patients often come late to medical attention, and there is a high prevalence of risk factors like diabetes, hypertension, smoking, dyslipidaemia and an emerging risk factor of anaemia and chronic kidney disease in Pakistan [7].
In 1967, the Killip classification was developed that divides STEMI patients into four groups at presentation according to the severity of cardiac failure – remains one of the most useful and practical bedside risk scoring systems in STEMI [16]. Killip class I is no signs of heart failure, class II is having signs of heart failure with mild crackles and S3 gallow, class III has moderate haemodynamic compromise and class IV is a frank cardiogenic shock. Established progressively higher Killip class (II or ≥ II) at admission has consistently been proven to be an independent predictor of adverse events, need for mechanical circulatory support, and in-hospital mortality, regardless of the underlying coronary anatomy or an adopted reperfusion strategy [8,9].
Some factors have been identified as predictors of high Killip class in STEMI, which have been previously reported in various international studies and these include advanced age [7], female sex [7,8], prior heart failure [7], diabetes mellitus [8], anaemia [12], chronic kidney disease [12] and delayed presentation [14] to hospital. Multivariate analyses also suggest that proximal LAD lesions and cardiac arrest before hospital arrival are linked to Killip III–IV on admission to the hospital [13]. Yet, there is the lack of contextual information that is available from high-burden environment like Pakistan and from NICVD Karachi, one of the largest cardiac tertiary care centres in south Asia [7]. High prevalence and importance of high Killip-class, smoking rates unique to local STEMI populations and much longer symptom-to-door times compared to western cohorts could modify rate and predictive value of high Killip in local STEMI populations [14]. To find the frequency of Killip class ≥ II, its independent predictors and associated in-hospital outcomes in patients of STEMI who presented at NICVD Karachi, this study was conducted.

MATERIALS AND METHODS

The design and setting of the study

The study was designed as descriptive cross-sectional in the Department of Cardiology, National Institute of Cardiovascular diseases (NICVD), Karachi from April 01, 2026 till July 03, 2026. Consecutive recruitment of patients with first presentation to the emergency department, who met the inclusion criteria for first episode STEMI, was performed with written informed consent.

ETHICAL APPROVAL

The study protocol was reviewed and approved by the Institutional Review Board of the National Institute of Cardiovascular Diseases (NICVD), Karachi (Ref: IRB-133/2025, dated November 11, 2025). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Patient data was confidential, and could only be accessed by authorised persons. Before enrollment of participants in the study, written informed consent was taken.

Sample Size and Sampling Technique

The sample size was obtained from WHO sample size calculator version 2.0 [15] with an assumed frequency of high Killip class (≥Killip class II) of 15% from the previous literature [13] and with 95% confidence level and 5% margin of errors, we got the sample size of 196 patients. Non probability consecutive sampling was used.

Inclusion Criteria

- Patient aged 18 - 80 years of either gender.
- Patients first diagnosed with ST-elevation myocardial infarction (STEMI) as defined in the operational definition.
- Without regard to Killip class on admission.

Exclusion Criteria

- Patients with important non-cardiac diseases such as intracranial space-occupying lesions, advanced liver cirrhosis (cirrhosis) or end-stage renal disease (ESRD) with dialysis.
- Known previous coronary artery disease, myocardial infarction or heart failure.
- Any patient with a cardiac valve, cardiac congenital or cardiomyopathy disease.
- Patient who initiated lipid lowering therapy less than three months before admission.
- Patients who received transfusions of blood within 7 days preceding admission.

Operational Definitions

STEMI was diagnosed when presenting with dyspnoea or chest pain which radiated to either arm or to neck and/or jaw, and with ≥1 mm of ST-segment elevation detected on ECG in at least two contiguous leads. High Killip class was considered as Killip class ≥ II on admission. In-hospital outcomes were

defined as events within seven days of admission and comprised: mortality (all-cause death), mechanical ventilation (intubation) or arrhythmia (ventricular tachycardia, ventricular fibrillation or complete heart block), need for inotropic support, and insertion of IABP. Anaemia was taken as a Hb cut-off level of <13.0 g/dL in males and <12.0 g/dL in females. 194 × serum creatinine−1.094 × age−0.287 × 0.739 (if female) was used to calculate estimated glomerular filtration rate (eGFR); CKD was defined as eGFR <60 mL/ min/1.73 m². A known case of diabetes mellitus (DM) was defined as being on treatment for six months or longer. Hypertension was defined as a history of hypertension and being on antihypertensive medication for at least six months. Dyslipidaemia was characterized as LDL cholesterol ≥160 mg/dL, HDL cholesterol <40 mg/dL in men and <50 mg/dL in women, triglycerides ≥150 mg/dL, total cholesterol ≥240 mg/dL and the use of lipid lowering therapy.

Data Collection Procedure

The patients with STEMI presenting to the ED NICVD Karachi were evaluated for stabilisation by the principal investigator. Written informed consent was taken and baseline demographical data such as age, gender, time from symptom onset to hospital arrival, smoking status, diabetes, hypertension, dyslipidaemia and family history of cardiovascular disease was collected through filling up a predesigned questionnaire. Haemoglobin, serum creatinine and lipids profile were recorded from the admission samples and eGFR and anaemia and CKD were defined operationally. Clinical Killip class was determined at admission, and classified as high (≥II) and low (I). All the patients were treated according to the standard protocol of NICVD under the supervision of Prof. Dr Jawaid Akbar Sial. In-hospital outcomes were reviewed and documented daily for up to seven days. Patient identity related information was not released in the process of carrying out the study or sharing data outcomes of the study.

Statistical Analysis

IBM SPSS version 21.0 was used to analyse data. Normality of the quantitative variables such as the age, haemoglobin, serum creatinine and the symptom-to-door time were checked using the Kolmogorov-Smirnov test and presented as mean ± SD or median accompanied by its interquartile range as appropriate. Qualitative parameters such as gender, smoking, diabetes, hypertension, anaemia, CKD, dyslipidaemia, family history and intra-hospital events were provided as frequency and percentages. Independent samples t test and Mann-Whitney U test was used to compare quantitative variables and Chi square test was used to compare the categorical variables between high and low Killip groups. Logistic regression was performed in 2 stages: preliminary analysis included those variables with p<0.20 and multivariate logistic regression for those level of variables was performed to find independent predictors of high Killip class ≥II, results of which were expressed as odds ratio (OR) along with 95% confidence interval (CI). A p-value ≤0.05 was considered statistically significant.

RESULTS

196 patients who had STEMI for the first time were recruited. The mean age was 58.4 ± 12.6 years and male patients predominated (76.5%, n=150). High Killip class (≥II) was identified in 18.4% (n=36) of patients at admission, comprising Killip II in 10.7% (n=21), Killip III in 4.6% (n=9) and Killip IV in 3.1% (n=6). A histogram of Killip classes is shown in Fig. 1. Demographic and clinical characteristics of all participating population are presented in Table 1.

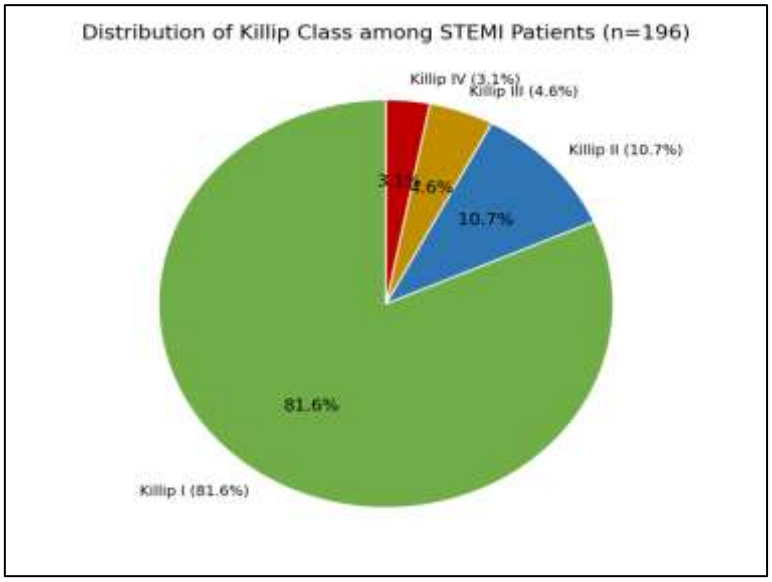

Figure 1. Figure 1. STEMI patients by Killip Classification at presentation (n=196).

Table 1: Demographic and Clinical Parameters at baseline of the study (n=196).

Variable	Overall (n=196)	High Killip ≥II (n=36)	Low Killip I (n=160)	p-value
Mean age (years)	58.4 ± 12.6	64.2 ± 9.8	57.1 ± 12.9	0.002
Male gender	150 (76.5%)	19 (52.8%)	131 (81.9%)	<0.001
Smoking (current/ex)	78 (39.8%)	14 (38.9%)	64 (40.0%)	0.900
Diabetes mellitus	96 (49.0%)	23 (63.9%)	73 (45.6%)	0.047
Hypertension	104 (53.1%)	25 (69.4%)	79 (49.4%)	0.032
Dyslipidaemia	88 (44.9%)	20 (55.6%)	68 (42.5%)	0.148
Family history of CVD	62 (31.6%)	12 (33.3%)	50 (31.3%)	0.806
Anaemia	58 (29.6%)	19 (52.8%)	39 (24.4%)	<0.001
Chronic kidney disease	51 (26.0%)	15 (41.7%)	36 (22.5%)	0.018
Symptom-to-door >12 hours	66 (33.7%)	22 (61.1%)	44 (27.5%)	<0.001

When comparing the high vs the low killip group, high Killip patients were significantly more likely to be older, female, have diabetes, hypertension, anaemia and CKD and a longer symptom-to-door time (>12 hours), (both p<0.001). Groups were not significantly different with respect to smoking history, dyslipidaemia or family history of cardiovascular disease. Anaemia, the presence of CKD, diabetes mellitus, sex-female and a symptom-to-door time >12 hours were independently associated with high Killip class (≥II) in multivariate logistic regression analysis. The results of the multivariate models are shown in Table 2.

Table 2: Multivariate Logistic Regression — Independent Predictors of High Killip Class (≥II) in STEMI (n=196).

Variable	Adjusted OR	95% CI	p-value
Female sex	3.24	1.47–7.13	0.004
Anaemia	3.42	1.61–7.26	0.001
Chronic kidney disease	2.89	1.27–6.59	0.011
Diabetes mellitus	2.31	1.08–4.96	0.031
Symptom-to-door time >12 hours	3.87	1.78–8.41	<0.001

The in-hospital outcomes were significantly inferior in high Killip group in all parameters listed in Table 3 and presented in Fig. 2. Mortality was 22.2% (8/36) in the high Killip group versus 3.1% (5/160) in the low Killip group (p<0.001). Arrhythmias (36.1% vs 13.1%; p=0.001), need for inotropic support (27.8% vs 5.0%; p<0.001), intubation (19.4% vs 1.9%; p<0.001) and IABP insertion (16.7% vs 2.5%; p<0.001) were all significantly more frequent in high Killip class patients.

Table 3: In-Hospital Outcomes Stratified by Killip Class.

Outcome	High Killip ≥II (n=36)	Low Killip I (n=160)	p-value
Mortality	8 (22.2%)	5 (3.1%)	<0.001
Arrhythmias	13 (36.1%)	21 (13.1%)	0.001
Inotropic support	10 (27.8%)	8 (5.0%)	<0.001
Intubation	7 (19.4%)	3 (1.9%)	<0.001
IABP insertion	6 (16.7%)	4 (2.5%)	<0.001

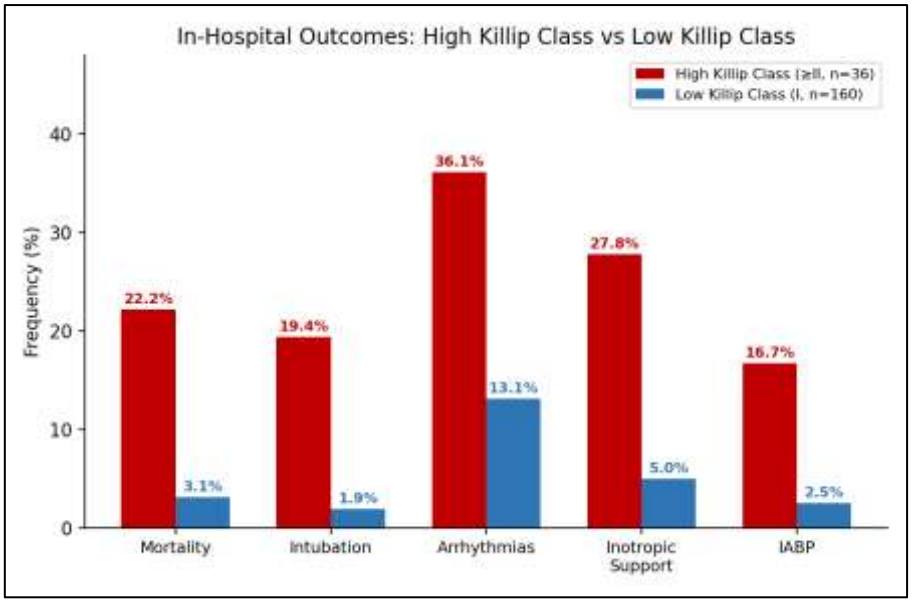

Figure 2. In-Hospital Outcomes: High Killip Class (≥II) vs Low Killip Class (I) among STEMI Patients.

DISCUSSION

In this study conducted in NICVD, Karachi, of 196 first episode of STEMI cases, the admission Killip class ≥II was 18.4%, In this study the female sex, anaemia, CKD, diabetes mellitus, were each identified as independent predictors of admission Killip class ≥II and all in-hospital outcomes were significantly poorer in these patients. The prevalence of Killip high reported in this study is similar with what registered in International registries. Among a Spanish cohort of STEMI patients in the era of primary Percutaneous Coronary Intervention (PCI) 17.9% had Killip class ≥II with female sex, advanced age, anterior location and prior antiplatelet therapy being the strongest predictors on multivariate analysis, which are broadly similar to those found in the present study [7]. In the first episode of anterior STEMI, high Killip class at admission was also a significant predictor of older age and female sex in addition to diabetes and high admission creatinine level, confirming the independent predictive value of these variables that were seen here in work [8,9]. In the current study, the female sex is also strongly associated with high Killip class (OR 3.24) which is consistent with the literature showing that women with STEMI tend to present later, have more comorbidities and experience higher rates of haemodynamic compromise, which may be attributed to the smaller coronary artery calibre and sex differences in plaque morphology and inflammatory burden [1,2]. Of note is the identification of anaemia as the most powerful predictor within the multivariate model and the fact that anaemia was very common in Pakistan, but remained an underestimated cardiovascular risk modifier. Thus, anaemia may directly contribute to haemodynamic deterioration, with an increased demand for myocardial oxygen delivery and compensatory increased cardiac output and resultant activation of neurohumoral pathways rapid left ventricular dysfunction that contribute to the rise in Killip class on admission [7]. A high proportion of this cohort (29.6% overall) were anaemic and this is corroborated by representative studies in Pakistan [3] which have underscored the need for routine haematological screening and pre-hospitalisation treatment of anaemia as part of cardiovascular risk reduction. Chronic kidney disease (OR 2.89) also proved to be an independent predictor of high Killip class with a similar conclusion to the results reported by Takasaki et al., in a Japanese population of STEMI patients undergoing HD in the modern era of interventional treatment, who reported that high Killip class was significantly more common and associated with worse outcomes in the HD group as compared to the non-HD group [12]. CKD reduces myocardial recovery post-ischaemia due to a variety of factors such as uraemic cardiomyopathy, fluid and electrolyte disturbances and further coronary artery calcium, which can lead to haemodynamic instability post-STEMI [12]. The high mortality rate which was seen in this study at high Killip class (22.2% vs. low Killip class: 3.1%) is in line with international data. A large Japanese registry analysis by Fukutomi et al. showed that in-hospital mortality was significantly higher in patients with STEMI in high Killip class than in those with NSTEMI in high Killip class, thus establishing that STEMIs are the most haemodynamically devastating of the group of patients presenting in high Killip class [11]. Moreover, Impellizzeri et al. have demonstrated that high Killip class is also of prognostic importance in patients with myocardial infarction with non-obstructive coronary arteries, thus indicating that compromise of the haemodynamic at presentation is of independent prognostic value, over and above the severity of the coronary obstruction [10]. High prevalence of arrhythmias (36.1%), use of inotropes (27.8%) and IABP (16.7%) in the high Killip group in this study is also in keeping with the severe haemodynamic derangements seen in large International STEMI registries [14]. High Killip class (OR

3.87) in relation to delayed presentation to hospital (symptom to door time >12 hours) highlights the need of public awareness programmes and improvement of the EMS system in Pakistan. Imaging studies have shown that long duration of ischaemia before reperfusion increases the size of the infarct, myocardial stunning and risk of mechanical complications and pump failure, all of which is directly related to a higher Killip class at admission [14]. This finding has direct health policy implications for NICVD as well as other large volume cardiac centers providing STEMI care in Pakistan, where a significant number of patients still arrive outside the time window for optimal reperfusion. Our findings are also consistent with studies conducted in Pakistan that reported delayed presentation, diabetes mellitus and renal dysfunction as important determinants of adverse outcomes among STEMI patients.

Limitations of the Study

The study was performed just one tertiary cardiac centre, thus its findings may not be applicable to community or secondary care hospitals with different patient population and management practices. This is a cross-section design, which means that it records a snapshot of the admission situation and in particular cannot be used to investigate what happens to Killip class over time after reperfusion. Imaging data such as echocardiographic ejection fraction, an important determinant of haemodynamic status was not systematically collected. The duration of the follow-up was relatively short (7 days), which does not allow for longer-term outcome measures such as 30-day or 1-year mortality. Conducting multicentre prospective studies with complete echocardiographic, angiographic, and longer follow-up periodic data collection would help to provide a more complete prognostic characterisation of high Killip class STEMI patients in the Pakistani population.

CONCLUSION

Patients with high Killip class (≥II) are present at NICVD Karachi almost one out of five patients presenting with STEMI for the first time which is independently associated with female sex, anaemia, chronic kidney disease, presence of diabetes mellitus and delayed hospital presentation. It is associated with increased in hospital mortality, arrhythmias, inotropic support, intubation and IABP use. Increased haemodynamic monitoring and priority reperfusion should be instituted once these risk factors are identified, targeted interventions should be instituted promptly.

CONFLICT OF INTEREST

None.

FUNDING

None.

ETHICAL APPROVAL

The study protocol was reviewed and approved by the Institutional Review Board of the National Institute of Cardiovascular Diseases (NICVD), Karachi (Ref: IRB-133/2025, dated November 11, 2025). The study was conducted in accordance with the ethical principles of the Declaration of Helsinki.

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