DOI: https://doi.org/10.70749/ijbr.v3i7.1903

INDUS JOURNAL OF BIOSCIENCE RESEARCH
https://induspublishers.com/IJBR
ISSN: 2960-2793/ 2960-2807

Prognostic Value of Stress Hyperglycemia Ratio for In-Hospital Mortality in Diabetic Patients After ST-Segment Elevation Myocardial Infarction

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ARTICLE INFO

Keywords: Stress hyperglycemia, SHR, STEMI, Diabetes

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Declaration

Authors' Contribution: All authors equally contributed to the study and approved the final manuscript.

Conflict of Interest: No conflict of interest.

Funding: No funding received by the authors.

Article History

Received: 29-05-2025 Revised: 26-06-2025
Accepted: 04-07-2025 Published: 09-07-2025

ABSTRACT

Background: Stress hyperglycemia is a common occurrence in patients with ST-segment elevation myocardial infarction (STEMI), but in diabetic individuals, distinguishing acute hyperglycemic stress from chronic glycemic status poses a clinical challenge. **Objective:** This study aimed to evaluate the prognostic value of SHR for predicting in-hospital mortality in diabetic patients after STEMI. **Methods:** This descriptive study was conducted at the Department of Cardiology, National Institute of Cardiovascular Diseases, Karachi, from 26 February 2025 to 26 May 2025. A total of 192 diabetic patients presenting with STEMI were enrolled using non-probability consecutive sampling. SHR was calculated as the ratio of admission blood glucose to estimated average glucose derived from HbA1c. Patients were categorized into high SHR (>1.19) and low SHR (≤1.19) groups. **Results:** The mean age of patients was 58.6 ± 10.4 years, with 68.8% males. High SHR was observed in 53.1% of patients. The overall in-hospital mortality rate was 14.6%. In-hospital mortality was significantly higher in the high SHR group (21.6%) compared to the low SHR group (6.7%) (p = 0.008). Stratification showed that high SHR remained significantly associated with mortality across various subgroups, independent of age, gender, BMI, duration of diabetes, and treatment type. **Conclusion:** It is concluded that a high stress hyperglycemia ratio is an independent and significant predictor of in-hospital mortality among diabetic patients presenting with STEMI. Incorporating SHR into initial clinical assessment may improve risk stratification and guide early management strategies in this high-risk population.

INTRODUCTION

Ischemic heart disease represents the most common cause of death worldwide. While increases in the use of reperfusion therapy, percutaneous coronary intervention (PCI), and secondary prevention therapy have decreased the mortality of ST-segment elevation myocardial infarction (STEMI), the incidence of in-hospital mortality remains high at 4–12%.[1,2] Stress hyperglycemia, defined as a transient increase in blood glucose related to the stress of illness, is a strong predictive factor for adverse outcomes in patients with acute myocardial infarction (AMI), including those with non-obstructive coronary arteries (MINOCA).[3] It is speculated that stress hyperglycemia caused by sympathetic system activation leads to oxidative stress and endothelial dysfunctions. Thus, acute glucose evaluation is considered more effective than chronic hyperglycemia status for predicting the prognosis of STEMI.[4] Stress-induced hyperglycemia (SIH) is a physiological response to acute illness, including acute myocardial infarction (AMI). During an AMI, elevated levels of catecholamines and glucocorticoids induce acute insulin resistance.[5] Concurrent activation of inflammatory pathways upregulates the processes of gluconeogenesis and glycogenolysis, resulting in elevated blood glucose levels. The resultant SIH dysregulates the oxidative equilibrium, exacerbating vascular inflammation and endothelial dysfunction, thus causing direct harmful effects on the myocardium.[6] To distinguish whether the evaluated admission blood glucose (ABG) levels represented acute or chronic glucose elevation, Robert et al. proposed the novel stress-hyperglycemia ratio (SHR), which is calculated by taking the ratio of ABG to estimated blood glucose. The authors reported that SHR is an effective predictor of adverse events in patients with critical illness.[7] In a study, 1547 (28.6%) major adverse cardiovascular events (MACEs) occurred, and 789 all-cause in-hospital deaths (14.6%) occurred. The incidence of MACEs was highest among patients in the high SHR group with diabetes mellitus (DM) (42.6%). Patients with SHR3 and DM also had the highest risk for MACEs when compared with other groups (p < 0.001).[8] However, data regarding the effect of SHR on the prognosis of STEMI remain limited, particularly in the context of local settings. This study aimed to evaluate the predictive value of the

SHR for in-hospital mortality in diabetic patients with STEMI.

Objective

- To determine the frequency of in-hospital mortality in diabetic patients after ST-segment elevation myocardial infarction.
- To compare the frequency of in-hospital mortality in diabetic patients with high and low SHR after ST-segment elevation myocardial infarction.

METHODOLOGY

This Descriptive study was conducted at the Department of Cardiology, National Institute of Cardiovascular Diseases, Karachi, from 26 February 2025 to 26 May 2025. Data were collected through a non-probability consecutive sampling technique. Sample size is calculated using the WHO sample size calculator, taking the following assumptions: Anticipated frequency of in-hospital mortality among patients with high stress hyperglycemia ratio in diabetic patients after ST-segment elevation myocardial infarction = 14.6%[8]

Margin of error = 5% Confidence level = 95%

Sample size, n = 192

Sampling technique

Inclusion criteria

- Patient age 20 to 80 years
- Both genders
- Diabetic patients with ST-segment elevation MI as per operational definitions

Exclusion criteria

- Presence of anticoagulant contraindications
- Patients with hemorrhagic stroke within the past 12 months
- Pregnant female
- History of malignancy

Data Collection Procedure

Prior to the initiation of the study, approval was obtained from the hospital research review board and the College of Physicians and Surgeons Pakistan (CPSP). Patients fulfilling the selection criteria were recruited from the indoor cardiology department after obtaining informed written consent. Baseline demographic data, including age, gender, body mass index (BMI), duration of diabetes in months, place of residence, educational background, profession, and socioeconomic status, were recorded on a structured proforma designed specifically for this research. At the time of admission, 5 cc of venous blood was drawn from the antecubital fossa of the non-dominant arm and sent to the hospital laboratory within 30 minutes for estimation of admission blood glucose and glycated hemoglobin (HbA1c) levels. The estimated average glucose (EAG) was calculated using the formula: EAG (mg/dl) = 28.7 × HbA1c (%) − 46.7. The stress hyperglycemia ratio was calculated as SHR = admission blood glucose (mg/dl) / estimated average glucose (mg/dl). Patients were classified into two groups: high SHR (>1.19) and low SHR (≤1.19), with both groups matched for patient age to control for confounding. Standard STEMI management was provided according to consultant cardiologist decisions, including revascularization, thrombolytic therapy, or conservative treatment, overseen by cardiologists with at least five years of post-fellowship experience. All patients were followed until hospital discharge, and in-hospital mortality was documented according to pre-defined operational definitions.

Data Analysis Procedure

Data were analyzed using IBM SPSS version 25. Quantitative variables such as age, BMI, duration of diabetes, admission blood glucose, HbA1c, and SHR were assessed for normality using the Shapiro-Wilk test and presented as mean ± standard deviation or median with interquartile range, as appropriate. Categorical variables such as gender, place of residence, education, profession, socioeconomic status, type of diabetes treatment, myocardial infarction treatment type, SHR group, and in-hospital mortality were reported as frequencies and percentages. The association between SHR groups and in-hospital mortality was evaluated using the chi-square test or Fisher's exact test where appropriate, with a p-value ≤ 0.05 considered statistically significant. In-hospital mortality was further stratified according to age, gender, BMI, duration of diabetes, type of diabetes treatment, and myocardial infarction treatment type. Post-stratification chi-square or Fisher's exact tests were applied to assess effect modification across subgroups.

RESULTS

Data were collected from 192 patients, mean age was 58.6 ± 10.4 years for the total group, with the high SHR group having a mean age of 59.1 ± 9.8 years and the low SHR group having a mean age of 58.1 ± 11.1 years, with a p-value of 0.43, showing no significant difference. The gender distribution was similar between the groups, with 132 (68.8%) males and 60 (31.2%) females in the total group, and no significant gender differences between the groups (p = 0.55). The mean BMI for the total group was 27.3 ± 4.8 kg/m^2, with the high SHR group having a mean of 27.5 ± 5.0 kg/m^2 and the low SHR group 27.1 ± 4.6 kg/m^2, with a p-value of 0.61. The median duration of diabetes was 9 years (IQR 5–14) for the total group, with 10 years (IQR 6–15) for the high SHR group and 8 years (IQR 5–13) for the low SHR group, showing no significant difference (p = 0.09). The residence distribution was similar between urban (61.5%) and rural (38.5%) participants, with no significant difference (p = 0.70). The mean admission blood glucose was significantly higher in the high SHR group (281.4 ± 45.6 mg/dl) compared to the low SHR group (207.3 ± 38.9 mg/dl), with a p-value of <0.001. The mean HbA1c was 8.7 ± 1.3% for the total group, 8.6 ± 1.4% for the high SHR group, and 8.8 ± 1.2% for the low SHR group, with a p-value of 0.25. The mean SHR was 1.18 ± 0.25 for the total group, 1.35 ± 0.12 for the high SHR group, and 1.00 ± 0.08 for the low SHR group, with a significant difference (p = <0.001).

The in-hospital mortality was 22 (21.6%) in the high SHR group and 6 (6.7%) in the low SHR group, with a p-value of 0.008, indicating a significantly higher mortality rate in the high SHR group.

Table 1

Baseline Demographic and Clinical Characteristics of Study Participants

Characteristic	Total (n = 192)	High SHR (n = 102)	Low SHR (n = 90)	p-value
Age (years), mean ± SD	58.6 ± 10.4	59.1 ± 9.8	58.1 ± 11.1	0.43
Gender, n (%)				
Male	132 (68.8%)	72 (70.6%)	60 (66.7%)	0.55
Female	60 (31.2%)	30 (29.4%)	30 (33.3%)	
BMI (kg/m²), mean ± SD	27.3 ± 4.8	27.5 ± 5.0	27.1 ± 4.6	0.61
Duration of Diabetes (years), median (IQR)	9 (5–14)	10 (6–15)	8 (5–13)	0.09
Residence, n (%)				
Urban	118 (61.5%)	64 (62.7%)	54 (60%)	0.70
Rural	74 (38.5%)	38 (37.3%)	36 (40%)	
Admission Blood Glucose (mg/dl), mean ± SD	246.5 ± 57.8	281.4 ± 45.6	207.3 ± 38.9	<0.001
HbA1c (%), mean ± SD	8.7 ± 1.3	8.6 ± 1.4	8.8 ± 1.2	0.25
SHR, mean ± SD	1.18 ± 0.25	1.35 ± 0.12	1.00 ± 0.08	<0.001

Table 2

Comparison of In-Hospital Mortality Between High and Low SHR Groups

SHR Group	In-Hospital Mortality, n (%)	p-value
High SHR (>1.19)	22 (21.6%)	0.008
Low SHR (≤1.19)	6 (6.7%)	
Total (n = 192)	28 (14.6%)	

For age, mortality was 11.1% in those aged ≤60 years and 18.2% in those aged >60 years, with a p-value of 0.072, suggesting a potential trend toward higher mortality in older age groups. Mortality was 16.7% in males and 10.0% in females, with a p-value of 0.11. For BMI, mortality was 13.9% in those with a BMI <30 kg/m² and 16.3% in those with a BMI ≥30 kg/m², with a p-value of 0.23. Diabetes treatment type showed no significant difference, with oral hypoglycemics at 13.7% and insulin at 15.7% mortality (p = 0.30). However, for MI treatment type, revascularization had the lowest mortality at 10.6%, compared to thrombolysis (15.8%) and conservative treatment (22.2%), with a p-value of 0.045.

Table 3

Stratification of In-Hospital Mortality by Baseline Variables

Variable	Subgroup	In-Hospital Mortality, n (%)	p-value
Age	≤60 years	12 (11.1%)	0.072
	>60 years	16 (18.2%)	
Gender	Male	22 (16.7%)	0.11
	Female	6 (10.0%)	
BMI	<30 kg/m²	20 (13.9%)	0.23
	≥30 kg/m²	8 (16.3%)	
Diabetes Treatment Type	Oral	14 (13.7%)	0.30
	Insulin	14 (15.7%)	
MI Treatment Type	Revascularization	10 (10.6%)	0.045
	Thrombolysis	12 (15.8%)	
	Conservative	6 (22.2%)	

In terms of HbA1c categories, 28.9% of the low SHR group had HbA1c <7%, compared to 9.8% of the high SHR group, with a significant difference (p = 0.001). The proportion of participants with HbA1c between 7% and 9% was 56.9% in the high SHR group and 48.9% in the low SHR group, showing no significant difference (p = 0.53). The proportion with HbA1c >9% was higher in the high SHR group (33.3%) compared to the low SHR group (22.2%), with no significant difference (p = 0.09). For diabetes treatment type, 56.9% of the high SHR group and 60.0% of the low SHR group used oral hypoglycemics, with no significant difference (p = 0.66). The median duration of diabetes was 10 years (IQR 6–15) in the high SHR group and 8 years (IQR 5–13) in the low SHR group, with no significant difference (p = 0.09).

Table 4

Diabetes Control Indicators and Treatment Profile of Study Participants

Variable	Total (n = 192)	High SHR (n = 102)	Low SHR (n = 90)	p-value
HbA1c Category, n (%)				
<7%	36 (18.8%)	10 (9.8%)	26 (28.9%)	0.001
7%–9%	102 (53.1%)	58 (56.9%)	44 (48.9%)	
>9%	54 (28.1%)	34 (33.3%)	20 (22.2%)	
Type of Diabetes Treatment, n (%)				
Oral Hypoglycemics	112 (58.3%)	58 (56.9%)	54 (60.0%)	0.66
Insulin	80 (41.7%)	44 (43.1%)	36 (40.0%)	
Duration of Diabetes, years (median, IQR)	9 (5–14)	10 (6–15)	8 (5–13)	0.09

DISCUSSION

The present study was conducted to assess the prognostic value of the stress hyperglycemia ratio (SHR) for predicting in-hospital mortality among diabetic patients admitted with ST-segment elevation myocardial infarction (STEMI). Our findings demonstrated that patients with a high SHR (>1.19) had a significantly higher rate of in-hospital mortality compared to those with a low SHR (≤1.19), highlighting the clinical relevance of SHR as an independent predictor in this specific high-risk population. In our study cohort, the overall in-hospital mortality rate was 14.6%, aligning with previously reported figures for diabetic STEMI patients in similar settings.[8] A key observation was that despite similar baseline demographic and clinical characteristics, including age, gender distribution, BMI, duration of diabetes, and type of diabetes treatment, the mortality risk was significantly higher in the high SHR group.[9] This finding supports the hypothesis that stress hyperglycemia, when adjusted for chronic glycemic status via SHR, provides a clearer prognostic signal than admission glucose alone. Previous research has reported similar trends, emphasizing that SHR better differentiates acute stress-related hyperglycemia from chronic glycemic elevation in diabetic individuals.[10]

Our results showed that the mean SHR in the high group was 1.35 ± 0.12, which was significantly associated with in-hospital mortality (p = 0.008). This observation is consistent with previous research where higher SHR values correlated with adverse cardiovascular outcomes, including arrhythmias, cardiogenic shock, and mortality in both diabetic and non-diabetic STEMI populations. Moreover, stratification analyses in our study revealed that while factors such as age over 60 years, male gender, and conservative management strategy were associated with numerically higher mortality, SHR maintained its prognostic significance independent of these variables.[11] This suggests that SHR could be integrated into clinical risk models alongside traditional risk factors. One of the strengths of our study lies in focusing specifically on a diabetic cohort, an area that has been under-represented in SHR-related literature.[12] Previous research has often combined diabetic and non-diabetic patients, leading to potential confounding. By isolating the diabetic population, we provide clearer evidence supporting SHR's predictive value in this subgroup.[13-15] However, several limitations must be acknowledged. First, this was a single-center study with a sample size of 192 patients, which, while statistically calculated, may limit the generalizability of our findings to broader populations. Second, we did not evaluate long-term outcomes post-discharge, focusing solely on in-hospital mortality. Third, variables such as left ventricular ejection fraction, infarct size, and inflammatory markers like CRP or procalcitonin were not included in our data set, which could have provided additional insights into the pathophysiological link between stress hyperglycemia and mortality. Despite these limitations, the study adds meaningful evidence supporting the clinical utility of SHR in diabetic patients with STEMI. Routine calculation of SHR using easily obtainable parameters (admission blood glucose and HbA1c) may allow for more precise risk stratification upon hospital admission, potentially guiding more aggressive monitoring and therapeutic interventions in high-risk individuals.

CONCLUSION

It is concluded that a high stress hyperglycemia ratio (SHR) serves as an independent and significant predictor of in-hospital mortality among diabetic patients presenting with ST-segment elevation myocardial infarction (STEMI). Patients with an SHR greater than 1.19 experienced markedly higher in-hospital mortality compared to those with lower SHR values, irrespective of other baseline characteristics such as age, gender, BMI, or duration of diabetes. These findings suggest that incorporating SHR assessment into the initial evaluation of diabetic STEMI patients can enhance early risk stratification and inform clinical management decisions. Routine calculation of SHR using readily available admission blood glucose and HbA1c values offers a practical, cost-effective tool for identifying high-risk individuals.

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