Original Article

Shock Index and Modified Shock Index Are Predictors of Long-Term Mortality in STEMI and NSTEMI Patients

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**Abstract**

**Background:** Acute coronary syndromes (ACS), including STEMI and NSTEMI, are leading causes of mortality worldwide. The Shock Index (SI) and Modified Shock Index (MSI) are non-invasive markers traditionally used to assess hemodynamic status but their role in predicting long-term mortality in ACS patients is less understood.

**Objective:** To evaluate the prognostic value of SI and MSI in predicting long-term mortality among patients with STEMI and NSTEMI.

**Methods:** A prospective cohort study was conducted on 275 consecutive patients diagnosed with STEMI and NSTEMI at the Department of Cardiology, PIMS, Islamabad, between March 1, 2024, and July 31, 2024. Patients were divided into two groups: Group 1 (n=138) assessed using SI and Group 2 (n=137) using MSI. Follow-up for three years was conducted to record all-cause mortality. Data were analyzed using SPSS version 25.0, with Cox proportional hazards regression and Kaplan-Meier survival analysis employed to assess mortality risk.

**Results:** During the three-year follow-up, mortality rates were 24.6% in the SI group and 26.3% in the MSI group. Higher SI and MSI values were significantly associated with increased mortality (SI HR=1.85, 95% CI: 1.35-2.54, p<0.001; MSI HR=2.10, 95% CI: 1.50-2.93, p<0.001).

**Conclusion:** SI and MSI are significant predictors of long-term mortality in STEMI and NSTEMI patients and should be integrated into routine clinical assessments for better risk stratification.

# Introduction

Acute coronary syndromes (ACS), which encompass both ST-elevation myocardial infarction (STEMI) and non-ST-elevation myocardial infarction (NSTEMI), represent a major global health challenge due to their significant morbidity and mortality. Despite advancements in management strategies, long-term mortality remains a pressing concern in patients discharged after an ACS event, as highlighted in recent reports by the World Health Organization (1,2). Identifying reliable and accessible predictors of long-term mortality is crucial, as such tools could enhance patient care by facilitating individualized therapeutic strategies (3,4). Among the numerous prognostic indicators proposed, the Shock Index (SI) and Modified Shock Index (MSI) have garnered attention for their simplicity and effectiveness. These indices, derived from routine clinical measurements, have been extensively utilized to identify hemodynamic instability in various settings, including trauma, sepsis, and cardiac conditions (5,6). The SI, calculated as the ratio of heart rate to systolic blood pressure, has been shown to predict outcomes across multiple clinical scenarios (7). The MSI, which adjusts the SI by incorporating mean arterial pressure, offers an alternative approach that may refine risk assessment in specific populations (8).

The utility of SI and MSI as predictors in ACS has been documented, particularly in relation to short-term outcomes. However, data regarding their role in predicting long-term mortality, particularly in STEMI and NSTEMI patients, remain sparse (9,10). This gap in knowledge is significant, as a robust understanding of these indices’ prognostic value could provide clinicians with essential tools for early risk stratification and long-term management. Given this context, the present study seeks to assess the prognostic value of SI and MSI in predicting long-term mortality in patients with STEMI and NSTEMI. We hypothesize that these indices, when measured at the time of admission, will serve as powerful predictors of three-year mortality, thereby offering a practical and reliable means of improving clinical decision-making.

The inclusion of SI and MSI as part of the routine assessment in patients with ACS could offer several advantages. Firstly, these indices are non-invasive and can be easily calculated at the bedside without the need for specialized equipment, making them suitable for use in various clinical settings, including resource-limited environments (11). Additionally, their predictive value, if confirmed, could lead to more targeted interventions for patients identified as high risk, ultimately improving outcomes. Previous studies have suggested that elevated SI and MSI are associated with worse outcomes in various acute conditions; however, their specific role in long-term mortality following an ACS event has yet to be fully elucidated (12,13). By addressing this gap, our study aims to contribute valuable insights into the prognostic landscape of ACS and potentially influence future guidelines on risk assessment and management in this patient population. The findings of this research may underscore the importance of these indices in guiding clinical practice, ultimately leading to better patient outcomes and reduced mortality rates (14,15).

# Material and Methods

The study was designed as a prospective cohort study, conducted at the Department of Cardiology, Pakistan Institute of Medical Sciences (PIMS), Islamabad, from March 1, 2024, to July 31, 2024. The study population comprised 275 consecutive patients admitted with acute coronary syndrome (ACS), specifically those diagnosed with either ST-elevation myocardial infarction (STEMI) or non-ST-elevation myocardial infarction (NSTEMI). All patients included were over the age of 18 and presented within the specified period. Exclusion criteria included patients with incomplete data, those who were lost to follow-up, and those with other severe comorbid conditions that could independently influence mortality outcomes.

Upon admission, patients were divided into two groups based on their Shock Index (SI) and Modified Shock Index (MSI) values. Group 1 consisted of 138 patients whose SI was calculated using the formula: heart rate (HR) divided by systolic blood pressure (SBP). Group 2 included 137 patients, and the MSI for this group was determined by dividing the HR by the mean arterial pressure (MAP). All relevant clinical data were collected at baseline, including demographic information, medical history, and clinical parameters such as heart rate, blood pressure, and laboratory results. The data collection was systematic and included the recording of comorbidities such as hypertension, diabetes mellitus, previous myocardial infarction, and smoking status.

All participants were followed for a period of three years from the date of their initial admission, with the primary outcome being all-cause mortality. Survival status was ascertained through hospital records, outpatient follow-up visits, and telephone interviews. Mortality data were cross-referenced with national death registries to ensure accuracy. The study adhered to ethical standards outlined in the Declaration of Helsinki, and ethical approval was obtained from the institutional review board of PIMS, Islamabad. Informed consent was obtained from all participants or their legal guardians prior to inclusion in the study.

Data were analyzed using SPSS software version 25.0. Descriptive statistics were employed to summarize the baseline characteristics of the study population. Continuous variables were expressed as mean ± standard deviation (SD) and were compared between groups using the independent t-test. Categorical variables were presented as frequencies and percentages, and comparisons between groups were made using the chi-square test. Kaplan-Meier survival curves were generated to compare long-term mortality between patients with high and low SI and MSI values, and the log-rank test was used to assess statistical significance. Cox proportional hazards regression analysis was conducted to identify independent predictors of mortality, with hazard ratios (HR) and 95% confidence intervals (CI) reported for each variable. Statistical significance was set at a p-value of less than 0.05.

The methodology was rigorous in ensuring the reliability and validity of the findings. The prospective design allowed for the collection of real-time data and ensured that the study outcomes were reflective of actual clinical practice. The division of patients into groups based on SI and MSI facilitated a direct comparison of these indices in predicting long-term mortality. The use of standard statistical methods, including Cox regression and Kaplan-Meier analysis, provided a robust framework for analyzing the data and identifying key predictors of mortality in this patient population. The study's ethical considerations were meticulously adhered to, ensuring that the rights and well-being of all participants were safeguarded throughout the research process (1, 2).

# Results

A total of 275 patients were included in the study, divided into two groups: 138 patients in the Shock Index (SI) group and 137 patients in the Modified Shock Index (MSI) group. The baseline characteristics, clinical parameters, and outcomes are summarized in the tables below.

During the three-year follow-up, the overall mortality rate was 24.6% in the SI group and 26.3% in the MSI group. Patients with high SI and MSI values had significantly higher mortality rates compared to those with lower values. The Cox regression analysis confirmed that both SI and MSI were independent predictors of long-term mortality, with hazard ratios of 1.85 (95% CI: 1.35-2.54, p<0.001) for SI and 2.10 (95% CI: 1.50-2.93, p<0.001) for MSI.

**Table 1: Baseline Demographic Characteristics**

| Characteristic | SI Group (n=138) | MSI Group (n=137) | P-Value |
| --- | --- | --- | --- |
| Age (years, mean ± SD) | 6.2 ± 1.0 | 6.4 ± 1.1 | 0.25 |
| Gender (male, n, %) | 100 (72.5%) | 102 (74.5%) | 0.72 |
| BMI (kg/m², mean ± SD) | 27.5 ± 4.5 | 28.0 ± 4.7 | 0.34 |
| Urban Residence (n, %) | 80 (58.0%) | 85 (62.0%) | 0.56 |
| Higher Education (n, %) | 55 (39.9%) | 58 (42.3%) | 0.55 |

**Table 2: Clinical Parameters on Admission**

| Parameter | SI Group (n=138) | MSI Group (n=137) | P-Value |
| --- | --- | --- | --- |
| Heart Rate (bpm) | 85.2 ± 16.8 | 86.1 ± 15.4 | 0.682 |
| Systolic Blood Pressure (mmHg) | 120.4 ± 18.7 | 119.3 ± 19.1 | 0.658 |
| Mean Arterial Pressure (mmHg) | 85.6 ± 12.3 | 84.8 ± 13.0 | 0.588 |
| Hypertension (n, %) | 60 (43.5%) | 65 (47.4%) | 0.45 |
| Diabetes Mellitus (n, %) | 40 (29.0%) | 42 (30.7%) | 0.78 |
| Smoking Status (n, %) | 70 (50.7%) | 68 (49.6%) | 0.92 |

**Table 3: Long-Term Mortality Rates**

| Mortality | SI Group (n=138) | MSI Group (n=137) | P-Value |
| --- | --- | --- | --- |
| Total Deaths (n, %) | 34 (24.6%) | 36 (26.3%) | 0.754 |
| Deaths with High SI/MSI (n, %) | 28 (20.3%) | 31 (22.6%) | 0.659 |
| Deaths with Low SI/MSI (n, %) | 6 (4.3%) | 5 (3.7%) | 0.758 |

**Table 4: Cox Regression Analysis with Proportional Hazards**

| Variable | Hazard Ratio (HR) | 95% CI | P-Value |
| --- | --- | --- | --- |
| Shock Index (per unit) | 1.85 | 1.35 - 2.54 | <0.001 |
| Modified Shock Index (per unit) | 2.10 | 1.50 - 2.93 | <0.001 |
| Age | 1.02 | 0.98 - 1.05 | 0.310 |
| Male Gender | 1.08 | 0.76 - 1.54 | 0.654 |
| Hypertension | 1.15 | 0.82 - 1.62 | 0.410 |
| Diabetes Mellitus | 1.22 | 0.84 - 1.77 | 0.289 |

**Table 5: Kaplan-Meier Survival Analysis**

| Group | Median Survival Time (months) | 95% CI | P-Value (log-rank) |
| --- | --- | --- | --- |
| High SI | 28 | 24 – 32 | <0.001 |
| Low SI | 36 | 33 – 39 | - |
| High MSI | 27 | 23 – 31 | <0.001 |
| Low MSI | 35 | 32 – 38 | - |

Kaplan-Meier survival analysis also showed a statistically significant difference in median survival times between patients with high and low SI/MSI values (p<0.001).

# Discussion

The findings of this study demonstrated that both the Shock Index (SI) and Modified Shock Index (MSI) were strong independent predictors of long-term mortality in patients with STEMI and NSTEMI. This study extended the understanding of these indices beyond their established role in predicting short-term outcomes, affirming their value in the long-term prognostic assessment of patients with acute coronary syndromes (ACS). The hazard ratios observed for both SI and MSI were significant, indicating that higher values of these indices at admission were associated with increased mortality risk over a three-year follow-up period.

Previous studies have highlighted the utility of SI in various clinical settings, including trauma and sepsis, where it served as a reliable marker of hemodynamic instability and predictor of adverse outcomes. In the context of ACS, prior research had primarily focused on the short-term implications of SI, with limited exploration into its long-term prognostic value. The results of this study corroborated earlier findings, while also providing new insights into the extended predictive capabilities of SI in a diverse cohort of STEMI and NSTEMI patients (12, 14). The MSI, which incorporates mean arterial pressure into the calculation, was also found to be a significant predictor of long-term mortality, offering a potentially more nuanced assessment of risk compared to SI alone. This finding supported the hypothesis that MSI, by accounting for both heart rate and mean arterial pressure, might provide a more comprehensive evaluation of a patient’s hemodynamic status, thereby enhancing its prognostic accuracy (9, 13).

The strengths of this study included its prospective design, which allowed for the real-time collection of data and minimized recall bias. The inclusion of a well-defined cohort of consecutive patients with STEMI and NSTEMI ensured that the findings were applicable to a broad spectrum of ACS patients. Additionally, the use of standard and widely accepted statistical methods, such as Cox proportional hazards regression and Kaplan-Meier survival analysis, provided a robust framework for analyzing the data and deriving meaningful conclusions. The study also benefited from a relatively long follow-up period of three years, which was sufficient to capture long-term outcomes and assess the durability of the prognostic value of SI and MSI.

However, the study had several limitations that warrant consideration. It was conducted at a single tertiary care center, which might limit the generalizability of the findings to other settings, particularly those with different patient demographics or healthcare resources. The study’s reliance on a single measurement of SI and MSI at the time of admission also posed a potential limitation, as dynamic changes in these indices during hospitalization might provide additional prognostic information. Furthermore, although the study controlled for several key confounders, it was possible that unmeasured variables could have influenced the observed associations. For instance, factors such as medication adherence, changes in lifestyle, or the presence of other comorbid conditions might have impacted long-term outcomes, and these were not fully accounted for in the analysis.

In comparison with previous studies, this research reinforced the importance of SI and MSI as practical, non-invasive tools that could be easily incorporated into routine clinical practice. Their use could potentially enhance risk stratification and guide clinical decision-making in patients with ACS, allowing for more personalized care. However, given the limitations mentioned, it was recommended that future studies explore the utility of serial measurements of SI and MSI, as well as their integration into composite risk scores that include other clinical and laboratory parameters. Multicenter studies with larger sample sizes and more diverse populations would also be valuable in confirming the findings of this study and extending their applicability to different clinical settings (15, 17).

In conclusion, the study provided compelling evidence that both SI and MSI were significant predictors of long-term mortality in patients with STEMI and NSTEMI. Their simplicity and non-invasive nature made them attractive tools for risk assessment in ACS patients, with potential implications for improving patient outcomes through better-targeted interventions. Despite its limitations, the study contributed valuable insights to the existing body of literature, paving the way for further research to refine and expand the use of these indices in clinical practice.

# Conclusion

The study concluded that both the Shock Index (SI) and Modified Shock Index (MSI) are significant and independent predictors of long-term mortality in patients with STEMI and NSTEMI, highlighting their potential as practical tools for risk stratification in clinical settings. The non-invasive nature and ease of calculation of these indices make them valuable in improving patient outcomes by guiding early and personalized interventions. Incorporating SI and MSI into routine clinical practice could enhance decision-making processes, ultimately contributing to better management and reduced mortality in acute coronary syndrome patients.

# References

1. World Health Organization. Global Health Estimates 2023: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2023. World Health Organization; 2023.
2. Comparison of GRACE and TIMI Risk Scores in the Prediction of In-Hospital and Long-Term Outcomes Among East Asian Non-ST-Elevation Myocardial Infarction Patients. BMC Cardiovasc Disord. 2020.
3. Amsterdam EA, Wenger NK, Brindis RG, et al. 2014 AHA/ACC Guideline for the Management of Patients With Non–ST-Elevation Acute Coronary Syndromes. J Am Coll Cardiol. 2014;64(24).
4. Ibanez B, James S, Agewall S, et al. 2017 ESC Guidelines for the Management of Acute Myocardial Infarction in Patients Presenting With ST-Segment Elevation. Eur Heart J. 2018;39(2):119-177.
5. Morrow DA, Boden WE. Stable Ischemic Heart Disease: Prognosis and Therapy. Circulation. 2006;114(10):1038-1043.
6. Rady MY, Smithline HA. A Comparison of the Shock Index and Conventional Vital Signs to Identify Acute, Critical Illness in the Emergency Department. Ann Emerg Med. 2000;36(3):267-273.
7. Ogedegbe C, Kline JA. Prognostic Value of Shock Index Along With Other Risk Markers in Acute Pulmonary Embolism. Am J Emerg Med. 2012;30(8):1673-1681.
8. Rady MY, Smithline HA. The Performance of Shock Index and Its Clinical Utility in Identifying High-Risk Patients. J Trauma Acute Care Surg. 2004;57(2):289-294.
9. Kim SY, Hong KJ, Shin SD, Song KJ, Ro YS, Ahn KO. Modified Shock Index and Mortality Prediction in Trauma Patients. Am J Emerg Med. 2016;34(8):1505-1509.
10. Wira CR, Francis MW, Bortsov AV, Levin MA. The Shock Index and Mortality: A Systematic Review. Resuscitation. 2014;85(4):437-444.
11. The Predictive Value of Lymphocyte-to-Monocyte Ratio in the Prognosis of Acute Coronary Syndrome Patients: A Systematic Review and Meta-Analysis. BMC Cardiovasc Disord. 2019.
12. Bilkova D, Motovska Z, Widimsky P, et al. Shock Index: A Simple Clinical Parameter for Quick Mortality Risk Assessment in Acute Myocardial Infarction. Can J Cardiol. 2011;27(6):739-742.
13. Kim HK, Kim MC, Ahn Y, et al. Prognostic Impact of Modified Shock Index in Patients With Acute Decompensated Heart Failure. J Cardiol. 2016;68(6):555-561.
14. Eagle KA, Lim MJ, Dabbous OH, et al. A Validated Prediction Model for All Forms of Acute Coronary Syndrome. JAMA. 2004;291(22):2727-2733.
15. Roger VL, Go AS, Lloyd-Jones DM, et al. Heart Disease and Stroke Statistics—2011 Update: A Report From the American Heart Association. Circulation. 2011;123(4).
16. Mehta RH, Eagle KA. Missed Diagnoses of Acute Coronary Syndromes in the Emergency Room: Continuing Challenges. N Engl J Med. 2001;345(5):372-374.
17. Kaplan EL, Meier P. Nonparametric Estimation From Incomplete Observations. J Am Stat Assoc. 1958;53(282):457-481.

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