ORIGINAL RESEARCH

MORTALITY RISK DETERMINANTS IN ACUTE CORONARY SYNDROME: AN EVIDENCE-BASED LITERATURE REVIEW

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ABSTRACT	Keywords
Acute Coronary Syndrome (ACS) remains a major global health problem and a leading cause of mortality, particularly in low- and middle-income countries where delays in treatment and limited access to reperfusion persist. Early identification of mortality determinants is essential for optimizing management and improving outcomes. This evidence-based review aimed to summarize contemporary predictors of mortality in ACS, incorporating clinical, demographic, laboratory, and hemodynamic factors. A comprehensive search was conducted using PubMed, Scopus, and Google Scholar for articles published between 2017 and 2025. Eleven studies met the eligibility criteria and were synthesized narratively. The findings show that hemodynamic instability, including hypotension, tachycardia, and cardiogenic shock, is the most consistent predictor of early and in-hospital mortality. Renal impairment, high Killip class, reduced left ventricular ejection fraction, and cardiac arrest at presentation also substantially increase risk. Age and comorbidities such as diabetes, hypertension, and chronic kidney disease contribute to both short- and long-term mortality. System delays, including prolonged symptom-to-door and door-to-balloon times, further worsen outcomes, particularly in resource-limited settings. The Simple Risk Index (SRI) emerges as a practical early risk-stratification tool. Strengthening early recognition, ensuring timely reperfusion, and improving management of comorbidities are crucial steps to reduce ACS-related mortality.	**Acute Coronary Syndrome, Mortality Predictors, Risk Factors, Simple Risk Index**

INTRODUCTION

Acute Coronary Syndrome (ACS) remains a leading cause of global morbidity and mortality, significantly exacerbating the burden of cardiovascular disease despite progress in diagnostic and treatment approaches. Ischemic heart disease, including acute coronary syndrome, is responsible for over 9 million fatalities per year, rendering it the foremost cause of mortality globally. Recent epidemiological estimates indicate that the global incidence of Acute Coronary Syndrome (ACS) is 3-4

instances per 1,000 individuals yearly, with elevated rates in low- and middle-income countries where preventative and acute care infrastructures are inadequate. Globally, acute coronary syndrome (ACS) remains a significant cause of mortality, especially in instances of ST-elevation myocardial infarction (STEMI) and non-ST-elevation myocardial infarction (NSTEMI) that lack prompt and efficient intervention (Bergmark et al., 2022).

The clinical severity of ACS is exacerbated by consequences including heart failure, cardiogenic shock, and life-threatening arrhythmias, all of which substantially increase the risk of both short- and long-term death. Recent studies indicate that changing patterns of degenerative illnesses, along with a rise in comorbidities, worsen the clinical course of ACS and elevate mortality risk (Zheng et al., 2024). In developing countries like Indonesia, ACS management encounters significant obstacles, including delayed care-seeking behavior, limited access to PCI-capable facilities, and a high prevalence of major cardiovascular risk factors such as hypertension, diabetes mellitus, and dyslipidemia (Wahyuni et al., 2022). National health records indicate that the prevalence of coronary heart disease in Indonesia has attained 1.5% of the population, with acute coronary syndrome considerably contributing to emergency cardiovascular admissions. In-hospital mortality rates for ACS patients remain high, mostly due to delayed reperfusion, hemodynamic instability, and inequities in acute cardiac treatment (Juzar et al., 2022).

Timely and precise mortality risk evaluation is an essential element in the management of ACS. Risk classification enables doctors to prioritize therapies, select appropriate reperfusion techniques, and identify high-risk patients who require intensive monitoring. Multiple risk assessments have been formulated and verified, including the TIMI Risk Index, GRACE Score, and Simple Risk Index (SRI). Numerous studies indicate that the SRI is straightforward, usable during the pre-hospital phase, and effective in forecasting death, particularly in STEMI cases (Moriwaki et al., 2023). Nonetheless, variations in populations, comorbidity profiles, and clinical factors underscore the necessity to reassess the uniformity of mortality determinants across diverse contexts. Numerous international and national studies have investigated predictors of ACS mortality, yet the results differ significantly across nations and healthcare institutions.

Comprehensive studies in Europe show that early mortality in ACS is strongly linked to cardiogenic shock, ventricular arrhythmias, and impaired left ventricular function (Yang et al., 2024). While findings from Asia highlight reperfusion delay, diabetes, and renal impairment as key contributors (Oraii et al., 2024; Song et al., 2019). In Indonesia, mortality predictors vary among institutions, including higher Killip class, hypotension, prehospital delays, and limited PCI access (Pramudyo et al., 2022; Rante et al., 2025). These variations reflect the absence of a consistent understanding of factors influencing ACS mortality across regions. Therefore, the purpose of this review is to identify, summarize, and synthesize contemporary evidence on mortality determinants in Acute Coronary Syndrome, encompassing clinical, demographic, laboratory, and hemodynamic predictors that shape short- and long-term outcomes, while providing scientific guidance for improving clinical management and risk assessment, particularly in resource-limited settings.

METHOD

Search Strategy. A comprehensive literature analysis was conducted using PubMed, Scopus, and Google Scholar to identify relevant articles published from January 2017 to December 2025. The utilized keywords included: "acute coronary syndrome," "mortality," "risk factors," "mortality predictors," "Simple Risk Index," "STEMI," and "NSTE-ACS," employed in conjunction with Boolean operators (AND, OR). The reference lists of selected papers were manually examined to identify additional acceptable studies. This review aimed to identify, summarize, and synthesize current research on the determinants of mortality in Acute Coronary Syndrome, encompassing clinical, demographic, laboratory, and hemodynamic variables that affect both short- and long-term outcomes.

Inclusion and Exclusion Criteria. Studies were eligible if published between 2017 and 2025, accessible in full text, written in English, and categorized as original research papers, cohort studies, observational studies, systematic reviews, or meta-analyses. Eligible studies investigated mortality risk, mortality predictors, or risk stratification in patients with acute coronary syndrome (ACS), encompassing those with ST-elevation myocardial infarction (STEMI), non-ST-elevation myocardial infarction (NSTEMI), or unstable angina. Studies were rejected if they comprised conference papers, editorials, letters, or opinions; concentrated exclusively on pediatric or animal populations; failed to address mortality outcomes or were irrelevant to ACS; or were provided as case reports or single-case descriptions.

Screening and Selection Process. The database search initially produced 1,247 entries from PubMed, Scopus, and Google Scholar. Following the elimination of 312 duplicates, 935 articles were retained for title and abstract evaluation. A total of 842 papers were removed for being irrelevant to ACS mortality, non-original study types, pediatric populations, or unrelated outcomes. The remaining 93 articles underwent full-text screening. Following an assessment of methodological quality, result clarity, and mortality relevance, 82 papers were removed. Eleven studies met all eligibility criteria and were included in the final review.

Data Extraction and Synthesis. Data were retrieved from each included study, including author(s), year, country or study location, study design, sample size, type of ACS population, assessed risk factors, statistical methodologies, and principal conclusions regarding mortality determinants. The retrieved data were synthesized narratively, facilitating comparisons of consistent and variable mortality factors across diverse populations and healthcare environments. Particular emphasis was placed on mortality factors linked to prevalent risk scores, such as the Simple Risk Index, TIMI, and GRACE.

RESULTS

Table 1. Article Review

Author (Year)	Country / Setting	Objective	Method	Key Findings	Indexing
Yang et al (2024)	Europe; multicenter hospitals; population: adults with ACS	To analyze the timing and causes of death after ACS	Observational registry; >10,000 patients; analysis ACS survival (KM, Cox regression);	Cardiogenic shock, ventricular arrhythmias, cardiac arrest, and low LVEF predict early mortality. Late mortality driven by	Scopus-indexed

Author (Year)	Country / Setting	Objective	Method	Key Findings	Indexing
			outcome: early & late all-cause mortality	heart failure progression, recurrent ischemia, multi-organ decline, and older age	
Szabo & et al (2021)	Europe; tertiary cardiac centre; population: ACS with cardiogenic shock	To determine predictors of hospital mortality in ACS with cardiogenic shock	Retrospective cohort; several hundred ACS-shock cases; logistic regression; outcome: in-hospital mortality	Mortality associated with advanced age, persistent hypotension, renal dysfunction, high lactate, delayed reperfusion, multi-organ failure, and hemodynamic collapse	Scopus-indexed
Ulvenstam et al (2023)	Sweden; population-based registry; ACS survivors	To identify predictors of long-term outcomes post-ACS	Longitudinal cohort; >5,500 ACS survivors; Cox regression; outcome: long-term mortality	Mortality predicted by older age, prior CVD, diabetes, renal dysfunction, heart failure, previous stroke, and male sex	Scopus-indexed
Song et al (2019)	China; CAMI Registry; population: NSTEMI patients	To develop a simple risk score for predicting NSTEMI mortality	Prospective observational; 22,000+ NSTEMI; multivariate logistic regression; outcome: in-hospital mortality	Predictors: age, HR, SBP, Killip class, creatinine, ST deviation, biomarker elevation, cardiac arrest on presentation	Scopus-indexed
Rante et al (2025)	Indonesia (Jakarta); hospital-based; ACS patients	To identify mortality predictors among ACS patients	Retrospective cohort; ~200 ACS cases; logistic regression; outcome: in-hospital mortality	Higher mortality linked to STEMI, prehospital delay, cardiogenic shock, OHCA, renal impairment, low EF, and absence of reperfusion	SINTA-indexed
Pramudyo et al (2022)	Indonesia (Bandung); referral hospital; ACS patients	To determine in-hospital mortality predictors in ACS	Retrospective cohort; n = 1,011; logistic regression; outcome: in-hospital mortality	Determinants included Killip class ≥III, hypotension, tachycardia, CKD, older age, arrhythmias, cardiac arrest; early PCI improved survival	SINTA-indexed
Oraii et al (2024)	Iran; PCI center; population: STEMI undergoing PPCI	To assess mortality risks in STEMI treated with PPCI	Retrospective cohort; ~1,000 patients; Cox regression; outcome: in-hospital & short-term mortality	Predictors: symptom-to-door delay, door-to-balloon delay, low SBP, low LVEF, renal dysfunction, multivessel disease, cardiac arrest before PCI	Scopus-indexed
Moriwaki et al (2023)	Japan; EMS + hospitals; prehospital STEMI	To evaluate the prognostic value of prehospital SRI	Multicenter observational; n = 1,748 STEMI; logistic regression; outcome: 30-day mortality	High SRI predicted mortality via older age, tachycardia, low SBP, prehospital Killip ≥II, and long FMC-to-balloon time.	Scopus-indexed

Author (Year)	Country / Setting	Objective	Method	Key Findings	Indexing
Juzar et al (2022)	Indonesia, national referral hospital; ACS patients	To evaluate ACS management and mortality-associated factors	Observational analysis; several hundred ACS patients; descriptive + regression; outcome: in-hospital mortality	Mortality associated with late presentation, limited PCI access, hemodynamic instability, arrhythmias, cardiogenic shock, diabetes, and hypertension	SINTA-indexed
Marfianti et al (2020)	Indonesia; hospital-based; STEMI patients	To assess SRI as a predictor of STEMI mortality	Observational analytic; ~150 STEMI; logistic regression; outcome: in-hospital mortality	Mortality influenced by high SRI (age, HR, SBP), Killip III–IV, delayed reperfusion, diabetes, renal impairment	SINTA-indexed
Meutia & Nasution (2017)	Indonesia (RSCM); ICCU ACS population	To validate SRI and examine ACS mortality factors	Retrospective cohort; >300 ACS patients; logistic regression; outcome: ICU/hospital mortality	Predictors included high SRI, renal dysfunction, higher Killip class, hemodynamic instability, absence of PCI, and comorbid diabetes	SINTA-indexed

Table 2. Summary of Key Mortality Predictor Categories in Acute Coronary Syndrome

Category	Factors	Number of Supporting Studies
Hemodynamic	Shock, low SBP, high HR	10/11
Comorbidities	Diabetes mellitus, chronic kidney disease, advanced age	8/11
System-level	Reperfusion delay, limited PCI availability	7/11

Table 1 indicates that a review of eleven studies conducted in Europe, Asia, and Indonesia reveals that hemodynamic instability, patient comorbidities, and system-related delays significantly contribute to ACS mortality. Premature mortality is regularly associated with cardiogenic shock, ventricular arrhythmias, cardiac arrest, hypotension, and diminished left ventricular function. Comorbidities, including advanced age, diabetes mellitus, chronic renal illness, and previous cardiovascular conditions, considerably impact both short- and long-term mortality. Systemic delays, such as extended reperfusion durations and restricted access to percutaneous coronary intervention, continue to be significant predictors in numerous countries, especially in developing regions. Risk indices, such as the Simple Risk Index and Killip class, demonstrate significant and consistent efficacy in detecting high-risk individuals. The data suggest that clinical severity, underlying comorbidities, and healthcare system performance all influence mortality outcomes in acute coronary syndrome (ACS).

According to Table 2, the majority of research demonstrates that hemodynamic factors, specifically shock, reduced systolic blood pressure, and increased heart rate, are the most reliable predictors of death in acute coronary syndrome, as evidenced by 10 out of 11 studies. Comorbidities, including diabetes mellitus, chronic renal disease, and advanced age, significantly influence outcomes, as indicated in 8 of 11 studies. Moreover, system-level factors, such as reperfusion delays and limited PCI availability, exacerbate mortality risk, as evidenced by 7 of 11 trials. These data

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emphasize that a confluence of acute clinical severity, preexisting comorbidities, and the efficacy of the healthcare system influences mortality risk in ACS.
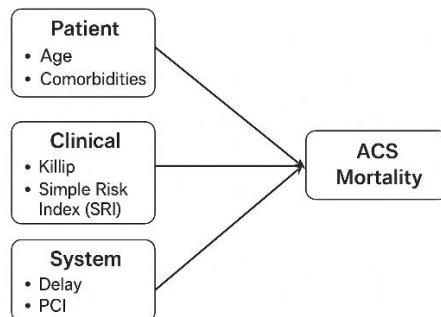

Figure 1. Conceptual Framework of Patient, Clinical, and System Level Determinants of Mortality in Acute Coronary Syndrome

Figure 1 illustrates the conceptual framework outlining how patient-related factors, clinical severity, and system-level variables collectively influence mortality in acute coronary syndrome. Patient attributes, including age and comorbidities, influence baseline susceptibility, but clinical indicators such as Killip class and the Simple Risk Index reflect acute physiological severity and directly affect prognosis. Systemic variables, such as delays in care and access to PCI, influence outcomes by impacting the timing and efficacy of treatment. Collectively, these interrelated areas constitute a holistic framework for comprehending mortality risk in acute coronary syndrome (ACS).

DISCUSSION

Key Predictors of Mortality in Acute Coronary Syndrome

A substantial body of research indicates that many hemodynamic and clinical indicators are strong predictors of mortality in patients with acute coronary syndrome (ACS). Cardiogenic shock is a significant predictor of early and in-hospital mortality, since research indicates that severe hypotension, ongoing tissue hypoperfusion, and multi-organ failure markedly elevate the risk of death (Arechkik, 2025; Szabo & et al, 2021). Reduced systolic blood pressure (SBP) and tachycardia, indicative of sympathetic activation and circulatory failure, are consistently recognized as significant predictors, especially in STEMI patients after primary PCI (Moriwaki et al., 2023; Oraii et al., 2024). These results correspond with traditional risk models, such as the Simple Risk Index (SRI), which utilize heart rate and systolic blood pressure as primary indicators of mortality (Song et al., 2019; Wiviott et al., 2004).

Furthermore, advanced Killip class (III–IV), particularly when associated with pulmonary edema or cardiogenic shock, is consistently linked to significantly elevated death rates across many populations (Ardining et al., 2022; Marfianti et al., 2020; Pramudyo et al., 2022). Numerous studies underscore the prognostic significance of renal impairment, which disrupts hemodynamic stability, affects medication metabolism, and indicates the underlying systemic disease burden. Renal dysfunction considerably elevates both short- and long-term mortality in ACS populations (Azzahra & Adnan, 2023; Fanta et al., 2021; Wita et al., 2024). Reduced left ventricular ejection fraction (LVEF), indicative of significant systolic dysfunction, similarly forecasts adverse outcomes and the advancement to fatal arrhythmias or worsening heart failure (Adam & et al, 2021; Yang et al., 2024). These studies collectively emphasize that the prompt identification of high-risk patients, especially those experiencing cardiogenic shock, low systolic blood pressure, tachycardia, elevated Killip class, renal impairment, and diminished left ventricular ejection fraction, is crucial for enhancing clinical decision-making, prioritizing early reperfusion, and improving survival rates in acute coronary syndrome.

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Key Predictors of Mortality in Acute Coronary Syndrome

Comorbidities significantly exacerbate the prognosis of acute coronary syndrome (ACS), with advanced age generally recognized as a primary predictor of mortality (Ulvenstam et al., 2023; Yang et al., 2024). Advanced age correlates with diminished physiological reserve, an elevated incidence of multi-organ dysfunction, and procrastination in pursuing medical attention, all of which heighten the probability of negative outcomes. Diabetes mellitus significantly contributes to the acceleration of atherosclerosis, affects endothelial function, and heightens the risk of multi-vessel coronary disease due to chronic hyperglycemia (Pramudyo et al., 2022). Diabetic patients often exhibit unusual symptoms, resulting in delayed identification and treatment, hence increasing mortality risk (Juzar et al., 2022).

Chronic kidney disease (CKD) markedly exacerbates the severity of acute coronary syndrome (ACS) by facilitating vascular calcification, persistent inflammation, and compromised medication elimination. Patients with impaired renal function frequently encounter complications, including fluid overload, electrolyte imbalances, and challenges in adhering to guideline-directed therapies, rendering chronic kidney disease a significant predictor of both in-hospital and long-term mortality (Meutia & Nasution, 2017; Szabo & et al, 2021). A history of cardiovascular disease, including prior myocardial infarction, heart failure, or stroke, indicates a significant atherosclerotic burden, diminished cardiac reserve, and heightened risk of recurrent ischemic events (Ulvenstam et al., 2023).

The influence of these comorbidities varies across populations, especially in underdeveloped nations, where access to early diagnosis, reperfusion therapy, and long-term secondary prophylaxis may be limited. In numerous low- and middle-income contexts, patients typically present at a younger age but exhibit a greater load of unmanaged risk factors, including diabetes, hypertension, and chronic kidney disease (Rante et al., 2025). Inadequate healthcare infrastructure, tardy hospital access, and financial obstacles exacerbate these hazards, leading to significantly elevated death rates relative to high-income nations. These discrepancies underscore the need for targeted prevention measures, enhanced chronic illness care, and early risk stratification tailored to resource-constrained settings (Juzar et al., 2022).

System Delays and Access to Reperfusion

System delays are a significant factor influencing mortality in acute coronary syndrome (ACS), especially in patients with ST-elevation myocardial infarction (STEMI) who necessitate prompt reperfusion (Moriwaki et al., 2023; Oraii et al., 2024). The interval between symptom onset and arrival at a medical facility often represents the initial phase of delay, as many individuals either do not recognize their symptoms or delay seeking assistance due to inadequate health literacy, transportation barriers, or financial constraints. A protracted symptom-to-door gap results in prolonged myocardial ischemia, increased infarct size, and a markedly elevated risk of cardiogenic shock and lethal arrhythmias (Rante et al., 2025). Door-to-balloon time, a critical component of system delay, directly affects the efficacy of percutaneous coronary intervention (PCI). Institutions that do not attain prompt reperfusion frequently encounter elevated in-hospital mortality rates, particularly in high-risk patients (Song et al., 2019). In many settings, particularly in developing countries, the lack of catheterisation laboratories and unequal distribution of PCI-capable centres limit

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immediate access to definitive treatment. Patients frequently require inter-hospital transfers, which further extend the time to reperfusion and increase avoidable deaths. The unavailability of 24/7 PCI services, limited emergency medical services (EMS), and inadequate prehospital triage contribute to delays that are less common in high-income countries (Juzar et al., 2022).

Prehospital delays are particularly significant in nations such as Indonesia, where topographical obstacles, insufficient ambulance availability, and inconsistent EMS response times impede swift access to medical care. A significant number of patients present to hospitals 6-12 hours after symptom onset, thereby diminishing their suitability for effective reperfusion interventions (Pramudyo et al., 2022). These limitations compel doctors to rely increasingly on delayed thrombolysis or conservative treatment, both of which are associated with inferior outcomes compared to initial PCI (Marfianti et al., 2020). Thus, the interplay of systemic barriers and postponed medical attention markedly increases mortality risk in STEMI patients within resource-constrained settings (Rante et al., 2025).

CONCLUSIONS

This review elucidates the primary factors influencing mortality in Acute Coronary Syndrome (ACS). The risk of mortality is significantly affected by cardiogenic shock, advanced Killip class, renal impairment, advanced age, and concomitant conditions like diabetes and chronic kidney disease (CKD). Extended symptom-to-door time and restricted PCI access are critical modifiable factors that increase risk. The Simple Risk Index (SRI) is an effective tool for early detection of high-risk patients. Addressing these variables through swift symptom identification, prompt reperfusion, and

effective management of comorbidities is crucial for decreasing ACS mortality, especially in resource-constrained environments.

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