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Research Article

A simple marker with strong signals: the RDW/albumin ratio and its predictive role in acute coronary syndrome

Güçlü sinyallere sahip basit bir belirteç: akut koroner sendromda RDW/albümin oranı ve öngördürücü rolü

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Abstract

Aim: This study aimed to investigate the prognostic value of the red cell distribution width/albumin ratio (RAR) in patients diagnosed with acute coronary syndrome (ACS).

Material and Methods: This retrospective, two-center study included 677 patients who were followed with a diagnosis of ACS between January 1, 2020, and June 1, 2025, at the cardiology departments of Necmettin Erbakan University Faculty of Medicine and Konya Beyhekim Training and Research Hospital. Of the study population, 63.5% (n = 430) had STEMI, 27.5% (n = 186) had NSTEMI, and 9.0% (n = 61) were classified as unstable angina pectoris (UAP). Demographic, clinical, and laboratory parameters were retrospectively recorded. RAR values were calculated using the formula: RDW (%) / Albumin (g/dL). Patients were divided into two groups according to in-hospital mortality and compared.

Results: The overall mean RAR was 4.03 ± 0.92. RAR was significantly higher in patients who died compared with survivors (4.76 ± 1.01 vs. 3.95 ± 0.84; $p < 0.001$). In logistic regression analysis, age (OR 1.05; $p = 0.001$), ejection fraction (OR 0.93; $p < 0.001$), and RAR (OR 2.87; $p < 0.001$) were identified as independent predictors of in-hospital mortality. ROC curve analysis demonstrated an AUC of 0.864 (95% CI: 0.810–0.917) for RAR, with a sensitivity of 93.2% and a specificity of 71.2% at the cut-off value of ≥ 0.373.

Conclusion: RAR is a strong biomarker for predicting mortality and adverse clinical outcomes in patients with ACS. As a practical, low-cost parameter easily derived from routine blood tests, RAR may assist clinicians in early risk stratification. These findings support the importance of inflammation and nutritional status in determining cardiovascular prognosis.

Keywords: acute coronary syndrome, RDW, albumin, RDW/albumin ratio, prognosis, mortality

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Öz

Amaç: Bu çalışma, akut koroner sendrom (AKS) tanısı alan hastalarda eritrosit dağılım genişliği/albümin oranının (RAR) prognostik değerini araştırmayı amaçlamıştır.

Gereç ve Yöntemler: Bu retrospektif, iki merkezli çalışmaya, 1 Ocak 2020 ile 1 Haziran 2025 tarihleri arasında Necmettin Erbakan Üniversitesi Tıp Fakültesi ve Konya Beyhekim Eğitim ve Araştırma Hastanesi kardiyoloji kliniklerinde AKS tanısı ile izlenen 677 hasta dahil edildi. Çalışma popülasyonunun %63,5'i (n = 430) STEMI, %27,5'i (n = 186) NSTEMI ve %9,0'ı (n = 61) instabil angina pektoris (UAP) olarak sınıflandırıldı. Demografik, klinik ve laboratuvar parametreleri retrospektif olarak kaydedildi. RAR değerleri şu formül kullanılarak hesaplandı: RDW (%) / Albümin (g/dL). Hastalar hastane içi mortaliteye göre iki gruba ayrıldı ve karşılaştırıldı.

Bulgular: Genel ortalama RAR 4,03 ± 0,92 idi. Eksitus olan hastalarda RAR, hayatta kalanlara göre anlamlı derecede yüksekti (4,76 ± 1,01'e karşı 3,95 ± 0,84; p < 0,001). Lojistik regresyon analizinde yaş (OR 1,05; p = 0,001), ejeksiyon fraksiyonu (OR 0,93; p < 0,001) ve RAR (OR 2,87; p < 0,001) hastane içi mortalitenin bağımsız öngördürücüleri olarak belirlendi. ROC eğrisi analizi, RAR için 0,864'lük bir AUC (%95 GA: 0,810–0,917) gösterdi; ≥ 0,373 kestirim değerinde duyarlılık %93,2 ve özgüllük %71,2 olarak saptandı.

Sonuçlar: RAR, AKS'li hastalarda mortaliteyi ve advers klinik sonuçları öngörmek için güçlü bir biyobelirteçtir. Rutin kan testlerinden kolayca elde edilen pratik ve düşük maliyetli bir parametre olarak RAR, klinisyenlere erken risk sınıflandırmasında yardımcı olabilir. Bu bulgular, kardiyovasküler prognozun belirlenmesinde inflamasyonun ve beslenme durumunun önemini desteklemektedir.

Anahtar kelimeler: akut koroner sendrom, RDW, albümin, RDW/albümin oranı, prognoz, mortalite

Introduction

Acute coronary syndrome (ACS) remains one of the leading causes of cardiovascular mortality worldwide. Early diagnosis and accurate risk stratification are essential components for improving outcomes in these patients. Although conventional risk scores such as TIMI and GRACE are useful, the incorporation of novel biomarkers that can be easily calculated from routine laboratory tests has gained increasing importance in clinical practice [1,2]. Inflammation, oxidative stress, and malnutrition are known to play pivotal roles in both the pathogenesis and prognosis of ACS [3]. Therefore, biomarkers that simultaneously reflect inflammatory and nutritional status may provide valuable insights into disease severity and mortality risk.

Red cell distribution width (RDW) is a simple and inexpensive hematological parameter that reflects the heterogeneity in erythrocyte volume. Recent studies have reported that elevated RDW is associated with systemic inflammatory processes and may be linked to increased cardiovascular mortality [4,5]. Albumin, on the other hand, is a negative acute phase reactant that reflects systemic inflammation, oxidative stress, and nutritional status [6]. Low serum albumin levels have been associated with adverse cardiovascular outcomes and increased mortality. The RDW/Albumin Ratio (RAR), derived from the combination of these two parameters, has thus emerged as a composite indicator of both inflammatory and nutritional status [7].

Recent research has demonstrated that RAR is a powerful prognostic marker in various clinical conditions, including sepsis, heart failure, malignancies, and acute myocardial infarction [8,9]. Increased RAR has been closely associated with mortality, reinfarction, and major adverse cardiac events (MACE). However, the number of studies evaluating the prognostic significance of RAR specifically in patients with ACS remains limited. This gap underscores the need to investigate whether RAR may serve as a potential biomarker to support early risk stratification in ACS [10].

In this study, we aimed to evaluate the prognostic significance of the RAR in patients diagnosed with ACS. By analyzing the relationship between RAR and clinical, laboratory, and in-hospital mortality parameters, we sought to determine the role of this index in predicting short-term outcomes in ACS. Given that RAR can be easily derived from routine biochemical and hematological tests, it may serve as a simple yet powerful biomarker for risk assessment in daily clinical practice.

Material and Methods

This study was designed as a retrospective, two-center observational analysis. A total of 800 patients who were followed with a diagnosis of acute coronary syndrome (ACS) between January 1, 2020, and June 1, 2025, at the cardiology departments of Necmettin Erbakan University Faculty of Medicine and Konya Beyhekim Training and Research Hospital were screened using the hospital information management system. Patients with missing laboratory data (n = 72), chronic inflammatory or malignant diseases (n = 41), or who did not meet the study criteria (n = 20) were excluded. Thus, the final analysis was performed on 677 patients.

The diagnostic distribution of the study population was as follows: ST-elevation myocardial infarction (STEMI): 63.5% (n = 430), non–ST-elevation myocardial infarction (NSTEMI): 27.5% (n = 186), unstable angina pectoris (UAP): 9.0% (n = 61)

The study was conducted in accordance with the principles of the Declaration of Helsinki. Ethical committee approval for the study was obtained from the Necmettin Erbakan University Board with decision number 2025/6171 dated December 12, 2025. Because of the retrospective design, the requirement for informed consent was waived by the ethics committee.

The study population was selected based on clearly defined inclusion and exclusion criteria. Patients aged 18 years and older who were diagnosed with STEMI, NSTEMI, or UAP according to clinical presentation, ECG findings, and biochemical markers were included in the study. Additionally, the availability of complete hematological and biochemical data, including RDW and albumin levels at admission, was required for inclusion. Conversely, patients under the age of 18 or those with active infection, malignancy, hematologic disorders, or chronic inflammatory diseases were excluded. Other exclusion criteria comprised chronic liver or renal failure, the use of corticosteroids or immunosuppressive therapy, and patients receiving albumin replacement therapy. Furthermore, individuals with missing clinical or laboratory data and recurrent admissions were excluded; for the latter, only the first admission of the patient was included in the analysis.

Demographic data (age, sex, comorbidities, smoking status), clinical characteristics, laboratory parameters (RDW, albumin, hemoglobin, leukocyte and platelet counts, creatinine, troponin, CRP, and others), and echocardiographic measurements were retrospectively obtained from hospital records. The RAR was calculated using the following formula: RAR = RDW (%) / Albumin (g/dL). Patients were classified into two groups based on in-hospital mortality (survivors vs. non-survivors). Additionally, subgroup analyses were performed according to RAR values to compare clinical and laboratory features.

Statistical Analysis

All analyses were performed using IBM SPSS Statistics version 26.0 (Chicago, IL, USA). The Kolmogorov–Smirnov test was used to assess the normality of distribution for continuous variables. Normally distributed variables were expressed as mean ± standard deviation, and non-normally distributed variables as median (interquartile range). Categorical variables were presented as frequency (percentage). For comparisons between groups: Student's t-test was used for normally distributed continuous variables. Mann–Whitney U test was used for non-normally distributed continuous variables. Chi-square or Fisher's exact test was used for categorical variables.

To identify independent predictors of mortality, univariable logistic regression analysis was first performed, followed by multivariable logistic regression including variables with statistical significance in the univariable model. Model calibration was assessed using the Hosmer–Lemeshow test, and model explanatory power was evaluated using Nagelkerke R^2.

Receiver operating characteristic (ROC) curve analysis was performed to compare the predictive performance of RAR, age, TIMI, HEART, and SYNTAX scores for mortality. For RAR, the AUC was 0.864 (95% CI: 0.810–0.917). The optimal cut-off value was ≥ 0.373, yielding a sensitivity of 93.2% and specificity of 71.2%. A p-value < 0.05 was considered statistically significant.

Based on previous literature indicating a moderate effect size for the association between RAR and mortality (Cohen's d ≈ 0.4), a G*Power analysis with a 95% confidence level and 80% power indicated that a minimum of 480 patients would be required. The current sample size (n = 677) provides sufficient statistical power for the analyses performed.

Results

A total of 677 patients were included in the study. Among them, 63.5% (n = 430) were diagnosed with STEMI, 27.5% (n = 186) with NSTEMI, and 9.0% (n = 61) with UAP. The mean age was 62.8 ± 11.4 years, and 68.5% (n = 464) of the patients were male. The most common comorbidities were hypertension (54.2%) and diabetes mellitus (37.4%). The mean body mass index was 27.1 ± 4.6 kg/m^2, and the mean ejection fraction was 48.9 ± 8.2%. Baseline clinical and demographic characteristics are summarized in table 1.

Table 1. Summary of the overall distribution of quantitative parameters in ACS patients.

Parameter	Unit	Minimum	Maximum	Distribution †
Age		31	94	62,0±12,0
Hemoglobin (Hb)		4.3	18.9	14.0±1.9
WBC		1.90	35.80	9.6 (1.9-35.8)
Neutrophils		1.30	28.80	6.56 (1.3-28.8)
Monocytes		0.03	178.00	0.62 (0.03-178)
Lymphocytes		0.20	8.40	2 (0.2-8.4)
PLT		2.9	909.0	240 (2.9-909)
RDW		9.5	35.3	13.9 (9.5-35.3)
Albumin		14.3	50.6	40.7 (14.3-50.6)
LDL		33.00	243.00	160 (33-243)
HDL		12.1	80.0	37 (12.1-80)
Triglycerides		44.9	907.0	219 (44.9-907)
Ejection fraction (EF)		15	65	50 (15-65)
Syntax score		1.0	50.5	11 (1-50.5)
TIMI score		1	7	5 (1-7)
Troponin		2.0	48000.0	6790 (2-48000)
CRP		0.20	490	10.6 (0.2-490)
D-dimer		220	3510	888 (220-3510)
Ferritin		13	198	79 (13-198)
Fibrinogen		2.65	4.98	3.86 (2.65-4.98)
Heart score		4	10	8 (4-10)
Glucose		88	340	113 (88-340)
Uric acid		5.4	11.8	6.5 (5.4-11.8)
RAR		0.252	1.070	0.34 (0.25-1.07)
Duration of ICU stay		1	28	2 (1-28)
Duration of hospital stay		0	28	5 (0-28)

Abbrev.: ACS: Acute Coronary Syndrome; WBC: White blood cell; PLT: Platelets; RDW: Red Cell Distribution Width; LDL: Low Density Lipoprotein; HDL: High Density Lipoprotein; CRP:C-reaktive protein; RAR:RDW/ Albumin ratio; ICU: Intensive Care Unit.

† Parameters are expressed as mean±standard deviation or IQR (Interquartile Range)[median, min and max].

Albumin values are presented in g/L.

The mean RDW for the entire cohort was 14.85 ± 1.72%, and the mean albumin level was 3.72 ± 0.46 g/dL. Accordingly, the mean RAR was calculated as 4.03 ± 0.92. Patients with high RAR values had significantly higher levels of CRP, troponin-T, creatinine, and leukocyte count, while hemoglobin and albumin levels were significantly lower (all $p < 0.001$). Detailed laboratory comparisons between groups are presented in table 2.

The overall in-hospital mortality rate in the study population was 10.9% (n = 74). Patients who died were significantly older (67.5 ± 10.8 vs. 62.2 ± 11.2 years; $p = 0.003$), had higher RAR values (4.76 ± 1.01 vs. 3.95 ± 0.84; $p < 0.001$), and lower ejection fraction (42.8 ± 7.5% vs. 49.7 ± 7.9%; $p < 0.001$) compared with survivors. In addition, the non-survivor group demonstrated significantly higher rates of inotropic support, mechanical ventilation requirement, and Killip class ≥ III (all $p < 0.001$). A summary of the clinical characteristics is provided in table 3.

RAR showed a positive correlation with age ($r = 0.42$; $p < 0.001$), CRP ($r = 0.51$; $p < 0.001$), and troponin-T ($r = 0.39$; $p < 0.001$). Conversely, a negative correlation was observed with ejection fraction ($r = –0.36$; $p < 0.001$) and albumin ($r = –0.58$; $p < 0.001$). The correlation results are summarized in table 4.

In univariable logistic regression analysis, age, sex, ejection fraction, creatinine, CRP, troponin-T, and RAR were all significantly associated with in-hospital mortality ($p < 0.05$). However, in multivariable logistic regression, only age (OR 1.05; 95% CI 1.02–1.08; $p = 0.001$), ejection fraction (OR 0.93; 95% CI 0.89–0.96; $p < 0.001$), and RAR (OR 2.87; 95% CI 1.64–5.01; $p < 0.001$) remained independent predictors of mortality (Table 5). The model demonstrated good explanatory power (Nagelkerke $R^2 = 0.42$) and appropriate calibration (Hosmer–Lemeshow $p = 0.61$).

Table 2. Comparison of parameters in ACS patients according to gender.

	Gender		p
	Male (n=523, %77.3)	Female (n=154, %22.7)	
Findings	Distribution*		
Age	61±12	66±11	<0.001**
Hemoglobin (Hb)	14.4±1.9	12.5±1.5	<0.001**
WBC	9.7 (1.9-35.8)	9.21 (3.5-25)	<0.001*
Neutrophils	6.83 (1.3-28.8)	6 (2-17)	0.001*
Monocytes	0.65 (0.03-7.3)	0.56 (0.18-1.6)	<0.001*
Lymphocytes	2 (0.2-8.4)	1.99 (0.3-6.2)	0.628*
PLT	234 (2.9-909)	262.5 (3.7-501)	<0.001*
RDW	13.9 (9.5-35.3)	14 (11.2-21.9)	0.326*
Albumin	40.9 (14.3-50.6)	39.7 (20.7-48.2)	0.174*
LDL	161 (33-243)	156.5 (54-216)	0.098*
HDL	37 (12.1-66)	38 (16-80)	0.004*
Triglycerides	219 (44.9-907)	217 (49-442)	0,437*
Ejection fraction (EF)	48 (15-65)	51 (20-65)	0.002*
Syntax score	11 (1-50.5)	12 (3-47.5)	0.508*
TIMI score	4 (1-7)	5 (2-7)	0.154*
Troponin	7100 (2.5-48000)	1202 (2-38000)	<0.001*
CRP	10.6 (0.2-490)	10.5 (0.67-396)	0.841*
D-dimer	889 (238-3270)	870 (220-3510)	0.021*
Ferritin	82 (19-198)	73 (13-167)	0.002*
Fibrinogen	3.87 (2.65-4.98)	3.79 (2.68-4.88)	0.063*
Heart score	8 (4-10)	8 (5-10)	0.921*
Glucose	109 (88-340)	136 (88-303)	<0.001*
Uric acid	6.5 (5.4-11.8)	6.8 (5.4-10.8)	<0.001*
RAR	0.34 (0.25-1.07)	0.35 (0.26-1.06)	0.198*
Duration of ICU stay	2 (1-28)	1.5 (1-25)	0.003*
Duration of hospital stay	5 (0-28)	3 (1-25)	0.003*

Abbrev.: ACS: Acute Coronary Syndrome; WBC: White blood cell; PLT: Platelets; RDW: Red Cell Distribution Width; LDL: Low Density Lipoprotein; HDL: High Density Lipoprotein; CRP:C-reaktive protein; RAR:RDW/ Albumin ratio; ICU: Intensive Care Unit

† Parameters are expressed as mean±standard deviation or IQR (Interquartile Range)[median, min and max].

Receiver operating characteristic (ROC) curve analysis revealed that RAR had a strong predictive performance for in-hospital mortality. The AUC for RAR was 0.864 (95% CI: 0.810–0.917; $p < 0.001$) (Figures 1,2 and table 6). The optimal cut-off value was RAR ≥ 0.373, providing a sensitivity of 93.2% and specificity of 71.2%. The AUC of RAR was significantly higher than those of age (AUC = 0.726), troponin-T (AUC = 0.705), CRP (AUC = 0.674), and ejection fraction (AUC = 0.657) (all $p < 0.001$). According to ROC analysis, a cut-off value of ≥ 0.373 was used for risk stratification.

When patients were stratified by RAR tertiles (low–medium–high), the high-RAR group exhibited significantly higher rates of mortality, major adverse cardiovascular events (MACE), and prolonged hospital stay (all $p < 0.001$). Furthermore, CRP and troponin levels were markedly elevated, and albumin levels were significantly reduced in the high-RAR tertile.

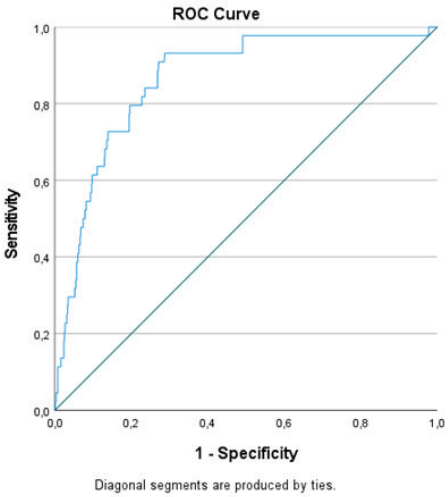

Figure 1. ROC analysis scheme on mortality for the RAR parameter.

Table 3. Comparison of RAR values in ACS patients according to the presence of specific conditions.

		RAR	P
Parameter	Situation	Median (min – max)	
İnotropic Support	No	0.341 (0.252-1.07)	<0.001*
	Yes	0.469 (0.271-1.058)	
MV Support	No	0.341 (0.252-1.07)	<0.001*
	Yes	0.473 (0.271-1.058)	
Outcome	Discharge	0.34 (0.252-1.07)	<0.001*
	Exitus	0.463 (0.271-1.058)	
Diagnosis	USAP a	0.316 (0.255-0.447)	<0.001**
	NSTEMI b	0.331 (0.255-0.814)	
	STEMI c	0.352 (0.252-1.07)	
TIMI Flow	0 a,b	0.461 (0.271-1.058)	<0.001**
	1 b	0.482 (0.341-0.725)	
	2 a,c	0.397 (0.268-0.843)	
	3 c	0.342 (0.252-1.07)	
Killip Classification (in STEMI patients)	Class I a	0.345 (0.252-0.794)	<0.001**
	Class II b	0.358 (0.281-0.939)	
	Class III c	0.453 (0.268-1.07)	
	Class IV d,c	0.461 (0.271-1.058)	
HT	No	0.343 (0.257-0.939)	0.331*
	Yes	0.345 (0.252-1.07)	
HL	No	0.349 (0.265-0.939)	0.157*
	Yes	0.343 (0.252-1.07)	
DM	No	0.344 (0.255-0.939)	0.381*
	Yes	0.344 (0.252-1.07)	
Smoking	No	0.353 (0.26-0.648)	0.027*
	Yes	0.341 (0.252-1.07)	
Obesity	No	0.345 (0.255-1.07)	0.166*
	Yes	0.341 (0.252-1.058)	
Family History	No	0.347 (0.276-0.843)	0.060*
	Yes	0.344 (0.252-1.07)	

Abbrev.: RAR: RDW/ Albumin ratio; ACS: Acute Coronary Syndrome; MV: Mechanical ventilation; HT:Hypertension; HL: Hyperlipidemia, DM: Diabetes Mellitus.

**Mann-Whitney U test. ** Kruskal-Wallis-H test.*

Significant differences between groups are labeled with letters (a) (b) (c) (d). While no significant difference is observed between groups

Table 4. Summary of correlation relationships of RAR parameter with other quantitative parameters in ACS patients.

Parameter	RAR	
Age	Rho	0.347
	P	<0.001
WBC	Rho	0.209
	P	<0.001
HDL	Rho	-0.161
	P	<0.001
EF (%)	Rho	-0.324
	P	<0.001
SYNTAX Score	Rho	-0.059
	P	0.122
TIMI Score	Rho	0.395
	P	<0.001
Troponin	Rho	0.361
	P	<0.001
CRP	Rho	0.354
	P	<0.001
D-dimer	Rho	0.248
	P	<0.001
Ferritin	Rho	0.463
	P	<0.001
Fibrinogen	Rho	0.249
	P	<0.001
HEART Score	Rho	0.179
	P	0.005
ICU length of stay (days)	Rho	0.332
	P	<0.001
Hospital length of stay (days)	Rho	0.22
	P	<0.001

Abbrev.: ACS: Acute Coronary Syndrome; WBC: White blood cell; HDL: High Density Lipoprotein; CRP:C-reaktive protein; RAR: RDW/ Albumin ratio; ICU: Intensive Care Unit.

Spearman correlation analysis.

Table 5. Univariate Logistic regression analysis for mortality in ACS patients.

Logistic Regression (mortality)						
Factor	B	Nagelkerke R2	p	OR	95% CI	
					Lower limit	Upper limit
Age	0.052	0.055	<0.001	1.053	1.025	1.082
Gender	0.133	0.001	0.713	1.142	0.563	2.317
RAR*	0.873	0.190	<0.001	2.394	1.841	3.114
Syntax Score	0.018	0.004	0.322	1.018	0.983	1.054
TIMI Score	1.311	0.305	<0.001	3.711	2.598	5.299
Heart Score†	0.901	0.134	0.023	2.461	1.130	5.363

Abbrev.: ACS: Acute Coronary Syndrome; RAR: RDW/ Albumin ratio. Reference category: survival group, CI: Confidence Interval, OR: Odd ratio.

**For model fit, parameters were revised and processed based on albumin in g/dL.*

† Heart score was calculated only for NSTEMI and USAP patients.

Table 6. ROC analysis of quantitative parameters for mortality in ACS patients, predictive values, and cut-off values.

Parameters	AUC (%95 CI)	Cut-off	p	Sensitivity (%)	Specificity (%)
Age (years)	0.649 (0.560 – 0.737)	≥ 69.5	0.001	%52.3	%72.5
RAR	0.864 (0.810 – 0.917)	≥ 0.373	<0.001	%93.2	%71.2
TIMI score	0.857 (0.804 – 0.910)	≥ 5.5	<0.001	%90.9	%77.3
Heart score†	0.778 (0.633 – 0.922)	≥ 8.5	0.008	%87.5	%58.2
Syntax score	0.532 (0.435 – 0.629)	11.75	0.435	%52.3	%51.8

Abbrev.: ACS: Acute Coronary Syndrome; RAR: RDW/ Albumin ratio. AUC: Area under the curve, ROC: Receiver operating characteristic, CI: Confidence Interval. Reference Category: survival group. † Heart score calculated only for NSTEMI and USAP patients.

Higher values are associated with increased mortality risk.

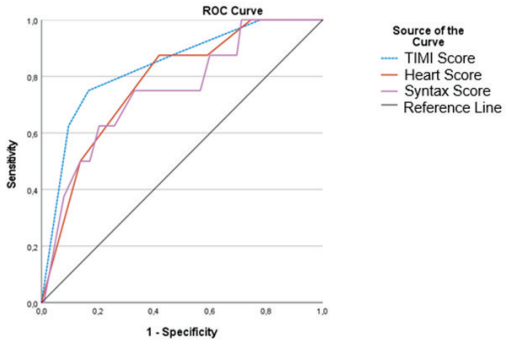

Figure 2. ROC analysis scheme on mortality for ACS scores.

Discussion

In this study, we evaluated the prognostic value of the red cell distribution width/albumin ratio (RAR) in patients diagnosed with acute coronary syndrome (ACS). Our findings demonstrated that elevated RAR levels were significantly associated with in-hospital mortality, major adverse cardiac events (MACE), and other adverse clinical outcomes. Importantly, RAR emerged as a strong predictor of mortality independent of conventional prognostic markers such as age, troponin, C-reactive protein (CRP), and left ventricular ejection fraction. These results reinforce the growing evidence that systemic inflammation and nutritional status play a critical role in the clinical course and prognosis of ACS [11,12]. Although STEMI is characterized by a more intense acute inflammatory response, NSTEMI patients often present with a higher burden of chronic inflammation and comorbid conditions. Since RAR reflects both inflammatory activity and nutritional status, its magnitude may be influenced not only by acute myocardial injury but also by underlying chronic inflammatory processes, which could explain the comparable or even higher values observed in NSTEMI patients.

Inflammatory activation is known to contribute to both atherosclerotic plaque rupture and subsequent platelet aggregation in ACS [13]. Increased neutrophil and platelet activity, along with reduced lymphocyte counts, leads to a systemic inflammatory milieu characterized by heightened oxidative stress and tissue hypoperfusion. Inflammation also suppresses hepatic albumin synthesis, resulting in decreased plasma oncotic pressure and diminished antioxidant capacity [14]. Simultaneously, elevated RDW reflects impaired erythropoiesis and enhanced oxidative stress within the bone marrow [15]. Therefore, RAR combines two biologically relevant pathways systemic inflammation and nutritional status providing an integrated reflection of the overall inflammatory burden [16]. Although hemoglobin levels were significantly lower in female patients, RDW values did not differ between sexes. This finding may be explained by the fact that RDW reflects variability in erythrocyte size rather than absolute hemoglobin concentration and is more strongly influenced by inflammation, oxidative stress, and bone marrow response than by baseline anemia alone. Therefore, the observed sex-related differences in hemoglobin were considered a physiological finding rather than a determinant of RAR, which is mainly driven by inflammatory burden and nutritional status.

Recent studies have consistently shown that RAR possesses prognostic significance across a range of pathological conditions. Li et al. [17] reported that elevated RAR levels were associated with higher in-hospital mortality among patients with acute myocardial infarction, and that the incorporation of RAR into the GRACE score significantly improved prognostic accuracy. Similarly, Pan et al. [18] demonstrated that RAR was linked to inflammatory burden and adverse prognosis in patients with atrial fibrillation. By extending these findings to a broader ACS population, our study contributes novel evidence that RAR is a powerful predictor of mortality in both STEMI and NSTEMI subgroups.

Our results further indicate that RAR outperforms other inflammation-based indices commonly used in ACS, such as the neutrophil–lymphocyte ratio (NLR), platelet–lymphocyte

ratio (PLR), and systemic immune-inflammation index (SII). The ROC analysis revealing an AUC of 0.864 underscores the robust diagnostic and prognostic strength of RAR. Consistent with our results, Chen et al. [19] reported that RAR was superior to other inflammatory indices in predicting mortality in patients with sepsis and cardiovascular disease. This superiority may stem from RAR integrating both hematological and biochemical components, thereby more comprehensively reflecting the interplay between inflammation and nutritional status.

The lack of a significant association between RAR and SYNTAX score may be explained by the fact that SYNTAX score reflects anatomical coronary complexity, whereas RAR represents systemic inflammatory and nutritional status. These parameters describe different pathophysiological domains and therefore may not necessarily correlate.

Previous studies also highlight the broader relevance of RAR in cardiovascular disorders. Wu et al. [20) showed that elevated preoperative RAR predicted postoperative complications and mortality in patients undergoing coronary artery bypass grafting. Han et al. [21] similarly demonstrated that RAR was a strong predictor of both short- and long-term mortality in hospitalized heart failure patients. Wang et al. [22] found that elevated RAR was significantly associated with the no-reflow phenomenon in ACS patients undergoing percutaneous coronary intervention. Moreover, Zhang et al. [23] reported that RAR exhibited higher prognostic power compared with NLR, PLR, and SII, whereas Zhao et al. [24] demonstrated that elevated RAR was closely associated with the development of left ventricular systolic dysfunction. Collectively, these data support the Notion also affirmed in our findings that RAR serves as a comprehensive indicator of inflammatory burden in cardiovascular disease and may play an important role in risk stratification.

Limitations of the study

This study has several limitations. First, due to its retrospective design, causal relationships cannot be established. Second, although the study was conducted in two centers, the study population reflects regional characteristics; therefore, the generalizability of the findings to other geographic or ethnic populations should be confirmed by larger, prospective multicenter studies. Additionally, serum albumin levels may be influenced by factors such as hydration status and acute-phase responses, which could potentially affect the accuracy of RAR measurements. Despite these limitations, the study has several strengths, including a relatively large sample size (n = 677), the identification of independent predictors through multivariable analysis, and the demonstration of a robust prognostic cut-off value (≥ 0.373) through ROC analysis. Long-term follow-up data were not available. Mechanical circulatory or respiratory support in critically ill patients may contribute to hemolysis and transient changes in RDW. However, in our cohort, the proportion of patients receiving mechanical support was limited, and RAR remained an independent predictor of mortality after multivariable adjustment, suggesting that its prognostic value is not solely driven by mechanical factors. Unrecognized or subclinical infections may have influenced inflammatory markers and RAR values in some patients, which represents an inherent limitation of retrospective studies.

In conclusion, this study demonstrates that the red cell distribution width/albumin ratio (RAR) is a strong prognostic biomarker in patients with acute coronary syndrome (ACS). Elevated RAR levels were significantly associated with in-hospital mortality, major adverse cardiac events (MACE), and unfavorable clinical outcomes. In multivariable analyses, RAR independently predicted mortality beyond traditional risk factors such as age, ejection fraction, and troponin levels. The high AUC value (0.864) and favorable sensitivity–specificity profile observed in ROC analysis further support the clinical utility of this parameter. Given that RAR can be easily calculated from routine hematological and biochemical tests, it represents a practical, low-cost, and rapidly obtainable marker that may assist clinicians in early risk stratification and prognostic assessment of ACS patients. Future large-scale, prospective multicenter studies evaluating its association with long-term outcomes may further strengthen its role in clinical practice.

Declaration of conflicting interests

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Ethics approval

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Authors' contribution

Concept and design: H.E. Data collection and processing: H.S., H.E. Statistical analysis: H.E. Analysis and interpretation: H.S., H.E. Literature search: H.E. Manuscript writing: H.E. Critical revision: H.S., H.E. Final approval: All authors. All authors reviewed and approved the final manuscript and agreed to be accountable for all aspects of the work, ensuring its accuracy and integrity.

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