Original article

doi:10.5633/amm.2026.0414

Frailty Assessment in Elderly Patients With Acute Coronary Syndrome: Prognostic Value of the Rockwood and Hopkins Scores

Jelena Perišić[1], Svetlana Apostolović[1,2], Boris Djindjić[1,2], Bojan Maričić[1], Sonja Dakić[1,2], Dragana Stanojević[1,2], Danica Milošević[1], Stefan Ilić[2], Tamara Filipović[1], Bane Spasović[1], Jelena Milošević[1]

[1]University Clinical Centre Niš, Cardiovascular Diseases Clinic, Niš, Serbia

[2]University of Niš, Faculty of Medicine, Niš, Serbia

Contact: Stefan Ilić

81 Dr Zorana Djindjića, 18000 Niš, Serbia

E-mail: stefanilic105@gmail.com

Frailty is an important prognostic factor in elderly patients with acute coronary syndrome (ACS), reflecting reduced physiological reserve and increased vulnerability. Nurses play a crucial role in early frailty identification through continuous patient monitoring, functional assessment, and coordination of multidisciplinary care. The aim of this study was to evaluate the significance of frailty in elderly ACS patients and to compare the prognostic value of the Rockwood Clinical Frailty Scale and Hopkins Frailty Score in predicting intrahospital mortality and complications. This observational study included 117 patients aged ≥75 years hospitalized for ACS at the Cardiology Clinic, University Clinical Center Niš. Frailty was assessed using Rockwood and Hopkins scores. Demographic, clinical, laboratory, echocardiographic parameters, and intrahospital outcomes were analyzed. Intrahospital complications occurred in 28.21% of patients, while mortality was 10.26%. The Rockwood score was significantly associated with mortality ($p = 0.002$) and complications ($p < 0.001$), whereas the Hopkins score showed no significant association. The Rockwood Clinical Frailty Scale is a reliable prognostic tool in elderly ACS patients, and systematic frailty assessment with active nurse involvement may improve risk stratification and quality of care.

Keywords: frailty, acute coronary syndrome, nursing care, Rockwood Clinical Frailty Scale, Hopkins Frailty Score, elderly patients

Originalni rad

doi:10.5633/amm.2026.0414

Procena krhkosti kod starijih pacijenata sa akutnim koronarnim sindromom: prognostička vrednost Rockwood i Hopkins skorova

Jelena Perišić[1], Svetlana Apostolović[1,2], Boris Đinđić[1,2], Bojan Maričić[1], Sonja Dakić[1,2], Dragana Stanojević[1,2], Danica Milošević[1], Stefan Ilić[2], Tamara Filipović[1], Bane Spasović[1], Jelena Milošević[1]

[1]Univerzitetski Klinički Centar Niš, Klinika za kardiologiju, Niš, Srbija

[2]Univerzitet u Nišu, Medicinski fakultet, Niš, Srbija

Kontakt: Stefan Ilić

Bulevar Dr Zorana Đinđića 81, Niš, Srbija

E-mail: stefanilic105@gmail.com

Frailty sindrom predstavlja važan prognostički faktor kod starijih pacijenata sa akutnim koronarnim sindromom (ACS), jer odražava smanjenu fiziološku rezervu i povećanu vulnerabilnost organizma. Medicinske sestre imaju ključnu ulogu u ranom prepoznavanju frailty sindroma kroz kontinuirano praćenje pacijenata, procenu funkcionalnog statusa i koordinaciju multidisciplinarne nege. Cilj istraživanja bio je da se proceni značaj frailty sindroma kod starijih pacijenata sa ACS i uporedi prognostička vrednost Rockwood Clinical Frailty Scale i Hopkins Frailty Score u predikciji intrahospitalnog mortaliteta i komplikacija. Opservaciona studija obuhvatila je 117 pacijenata starijih od 75 godina hospitalizovanih zbog ACS u Klinici za Kardiologiju UKC Niš. Frailty je procenjen Rockwood i Hopkins skorom. Analizirani su demografski, klinički, laboratorijski i ehokardiografski parametri i intrahospitalni ishodi. Intrahospitalne komplikacije zabeležene su kod 28,21% pacijenata, a mortalitet kod 10,26%. Rockwood skor bio je značajno povezan sa mortalitetom ($p = 0,002$) i komplikacijama ($p < 0,001$), dok Hopkins skor nije pokazao značajnu povezanost. Rockwood skala predstavlja pouzdan prognostički alat kod starijih ACS pacijenata, a sistematska procena frailty sindroma uz aktivno učešće medicinskih sestara može unaprediti stratifikaciju rizika i kvalitet zdravstvene nege.

Ključne reči: frailty sindrom, akutni koronarni sindrom, sestrinska nega, Rockwood skor, Hopkins skor, stariji pacijenti

Introduction

Cardiovascular diseases remain the leading cause of mortality worldwide, with acute coronary syndrome (ACS) representing one of the most significant clinical challenges, particularly in elderly patients (1,2). The growing proportion of older adults with ACS necessitates a multidisciplinary and patient-centered approach, in which nurses play a crucial role in early assessment, continuous monitoring, and coordination of care for vulnerable patients (3,4).

With increasing life expectancy, the number of elderly patients presenting with ACS is steadily rising, resulting in greater clinical complexity and a higher burden of comorbidities (2). Chronological age alone does not adequately reflect biological vulnerability in this population, which has led to increased recognition of frailty as a key determinant of outcomes (1,4). Frailty is defined as a multidimensional geriatric syndrome characterized by decreased physiological reserve, increased susceptibility to stressors, and impaired recovery capacity following acute illness (1,4). Frailty is commonly assessed using validated clinical tools, among which the Rockwood Clinical Frailty Scale (CFS) and the Hopkins Frailty Score are among the most frequently used in clinical practice. Importantly, frailty has been consistently associated with higher rates of in-hospital mortality, prolonged hospitalization, and adverse clinical outcomes in patients with ACS (1,2,5).

From a nursing perspective, frailty assessment represents a fundamental component of comprehensive and patient-centered care in ACS (3). Nurses are uniquely positioned to identify early signs of frailty through continuous bedside presence and systematic evaluation of functional status, mobility, nutritional condition, and cognitive function (3,4). Early recognition of these changes enables timely interventions and contributes to the prevention of complications such as falls, delirium, and functional decline during hospitalization (3,4).

Furthermore, nursing interventions—including continuous monitoring, patient education, support for medication adherence, and coordination within the multidisciplinary team—play a central role in improving clinical outcomes in frail elderly patients (1,3). Recent evidence suggests that structured frailty assessment enhances risk stratification and supports individualized treatment planning, allowing for more tailored and safer clinical decision-making in older patients with cardiovascular disease (1,2).

Frailty has also been associated with reduced utilization of invasive procedures, increased risk of complications, and higher mortality rates, further emphasizing the importance of early

identification and targeted management (2,5). In this context, nurses contribute significantly to early mobilization, prevention of adverse events, discharge planning, and ensuring continuity of care beyond hospitalization (3).

Given the high prevalence and strong prognostic significance of frailty in elderly patients with ACS, systematic assessment using validated tools should be considered an integral part of routine clinical practice (1,2,4). Understanding frailty from a nursing perspective is essential for optimizing patient-centered care, improving risk stratification, and ultimately enhancing in-hospital outcomes in this high-risk population (1–4).

Aim

The aim of this study was to evaluate the significance of frailty in elderly patients with ACS and to compare the predictive value of the Rockwood Clinical Frailty Scale and the Hopkins Frailty Score in relation to intrahospital mortality and complications.

Materials and Methods

This observational study included 117 patients aged ≥75 years hospitalized due to acute coronary syndrome (ACS) at the Cardiology Clinic of the University Clinical Center Niš. Patients were classified according to the clinical presentation as ST-elevation myocardial infarction (STEMI), non–ST-elevation myocardial infarction (NSTEMI), or unstable angina. Demographic data, clinical presentation, comorbidities, laboratory findings, echocardiographic parameters, and intrahospital outcomes were retrospectively collected from electronic medical records.

Frailty Assessment

Frailty was assessed using two validated instruments.

The Rockwood Clinical Frailty Scale was used to classify patients into three categories:

- non-frail (1–3 points)
- vulnerable (4–6 points)
- frail (7–9 points)

Additionally, frailty was assessed using the Hopkins Frailty Score, with patients categorized into three groups:

- robust (0 points)
- pre-frail (1–2 points)
- frail (3–5 points)

The primary outcomes were intrahospital mortality and intrahospital complications during hospitalization.

Statistical Analysis

Continuous variables are presented as mean ± standard deviation (SD) with 95% confidence intervals (CI), while categorical variables are expressed as counts and percentages.

Differences between categorical variables were analyzed using the χ^2 test or Fisher's exact test, where appropriate.

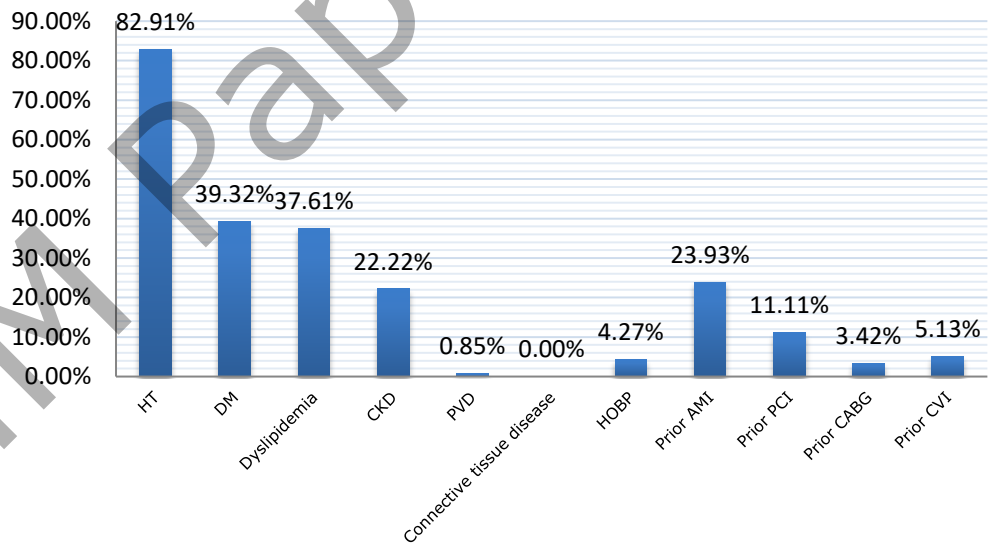
Comparisons of continuous variables between Rockwood frailty groups were performed using one-way analysis of variance (ANOVA). Due to significant variability and non-normal distribution, C-reactive protein (CRP) levels were analyzed using the Kruskal–Wallis test.

The impact of frailty scores on clinical outcomes was evaluated using univariate logistic regression analysis, with results expressed as odds ratios (OR) and 95% confidence intervals.

A p-value < 0.05 was considered statistically significant.

Results

The study included 117 patients, of whom 56.4% were male. The mean age of the population was 79.82 ± 4.13 years, and the average length of hospitalization was 6.24 ± 4.10 days. Mean left ventricular ejection fraction was 47.24 ± 13.11%. Comorbidities and risk factors are presented in Figure 1.



*HT: Hypertension; DM: Diabetes Mellitus; CKD: Chronic Kidney Disease; HOBP: Chronic Obstructive Pulmonary Disease; AMI: Acute Myocardial Infarction; PCI: Percutaneous Coronary Intervention; CABG: Coronary Artery Bypass Grafting; CVI: Cerebrovascular Insult

Figure 1. Distribution of comorbidities and cardiovascular risk factors

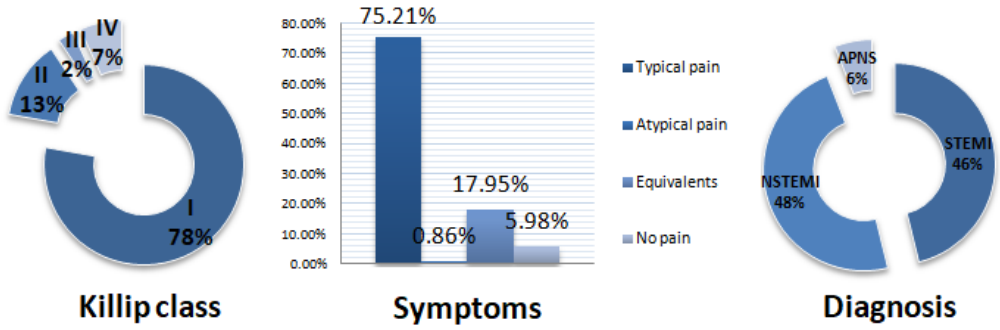


Figure 2. Clinical presentation

In the study population, NSTEMI was the most frequent clinical diagnosis, typical chest pain was the predominant symptom, and most patients were classified as Killip class I (Figure 2).

During hospitalization, intrahospital complications occurred in 28.21% (exitus, GIT/urinary/genital bleeding, psyhoorganic sindrom, heart decompensation, worsening of kidney function) of patients, while intrahospital mortality occurred in 10.26%.

Association Between Rockwood Frailty Score and Clinical Outcomes

A significant association was observed between the Rockwood frailty score and intrahospital mortality ($p = 0.002$). Mortality increased markedly across frailty categories, reaching 30.8% among patients with severe frailty (scores 7–9).

Similarly, the incidence of intrahospital complications increased significantly with increasing frailty ($p < 0.001$), occurring in 61.5% of patients in the severe frailty group.

Higher frailty scores were also associated with chronic kidney disease ($p = 0.030$) and lower prevalence of dyslipidemia ($p = 0.031$). In addition, heart failure decompensation was more frequent among patients with higher frailty scores ($p = 0.026$).

A borderline association was observed between frailty and the presence of psycho-organic syndrome ($p = 0.053$) (Table 1).

Table 1. Association Between Rockwood Frailty Score and Clinical Parameters

		Rockwood score			p-value
		1-3	4-6	7-9	
Exitus	no (%)	96.9	94.9	69.2	0.002
	yes (%)	3.1	5.1	30.8	
Intrahospital complications	no (%)	90.6	76.3	38.5	<0.001
	yes (%)	9.4	23.7	61.5	
Dyslipidemia	no (%)	46.9	62.7	80.8	0.031
	yes (%)	53.1	37.3	19.2	
CKD	no (%)	93.8	71.2	73.1	0.030
	yes (%)	6.3	28.8	26.9	
Psycho-organic syndrome	no (%)	96.8	94.9	80.8	0.053
	yes (%)	3.2	5.1	19.2	
Heart failure decompensation	no (%)	100	96.6	84.6	0.026
	yes (%)	0	3.4	15.4	

*CKD: Chronic Kidney Disease

Laboratory and Echocardiographic Differences Across Frailty Groups

Increasing frailty was associated with worsening cardiac and renal function. Left ventricular ejection fraction decreased significantly across Rockwood frailty groups, from 50.73 ± 10.57% in patients with mild frailty to 38.42 ± 11.25% in patients with severe frailty (p = 0.001).

Similarly, renal dysfunction was more pronounced in frailer patients, with progressively higher urea levels (p = 0.016) and lower eGFR values (p = 0.043).

Serum calcium levels were significantly lower in patients with higher frailty scores (p = 0.031). Inflammatory activity, reflected by CRP levels, increased markedly across frailty categories (p = 0.039) (Table 2).

Table 2. Laboratory and Echocardiographic Differences Across Frailty Groups

	Rockwood score	Mean ± SD	95% CI	p-value
EF	1-3	50.73 ± 10.57	46.46-55.00	0.001 (ANOVA)
	4-6	49.39 ± 13.42	45.80-52.99	
	7-9	38.42 ± 11.25	33.67-43.17	
Urea	1-3	8.68 ± 1.89	7.98-9.39	0.016 (ANOVA)
	4-6	10.86 ± 6.50	9.17-12.56	
	7-9	13.42 ± 7.81	10.26-16.57	
eGFR	1-3	56.74 ± 12.23	52.14-61.31	0.043 (ANOVA)
	4-6	49.60 ± 21.42	44.01-55.18	
	7-9	44.29 ± 17.26	37.32-51.26	
Ca	1-3	2.37 ± 0.10	2.32-2.42	0.031 (ANOVA)
	4-6	2.37 ± 0.12	2.32-2.41	
	7-9	2.26 ± 0.10	2.19-2.33	
CRP	1-3	13.27 ± 21.93	4.93-21.62	0.039 (Kruskal Wallis)
	4-6	25.92 ± 37.21	15.96-35.89	
	7-9	62.86 ± 87.66	99.04	

*EF: Ejection fraction

No significant differences between Hopkins frailty groups were observed for most clinical outcomes. However, a significant association was found between the Hopkins score and diabetes

mellitus (p = 0.006). Interestingly, the prevalence of diabetes mellitus decreased with increasing Hopkins frailty score.

Although not statistically significant, a trend toward higher intrahospital mortality with increasing Hopkins scores was observed (p = 0.220; linear trend p = 0.062). A trend was observed for dyslipidemia also, but the prevalence of dyslipidemia decreased with increasing Hopkins frailty score (p = 0.081; linear trend p = 0.043) (Table 3).

Table 3. Association Between Hopkins Frailty Score and Clinical Parameters

		Hopkins score			p-value	Linear by linear association
		0	1-2	3-5		
DM	no (%)	0	57.8	70.8	0.006	0.011
	yes (%)	100	42.2	29.2		
Exitus	no (%)	100	93.8	83.3	0.220	0.062
	yes (%)	0	6.2	16.7		
Dyslipidemia	no (%)	40.0	56.2	72.9	0.081	0.043
	yes (%)	60.0	43.8	27.1		
Intrahospital complications	no (%)	80.0	75.0	66.7	0.629	0.364
	yes (%)	20.0	25.0	33.3		

*DM: Diabetes Mellitus

Significant differences between Hopkins groups were observed for length of hospital stay (p = 0.027), hemoglobin levels (p = 0.049), and serum protein levels (p = 0.049) (Table 4).

Table 4. Differences between Hopkins frailty groups in hospital stay duration, hemoglobin, and serum protein levels

	Hopkins score	Mean ± SD	95% CI	p-value
Hospital stay	0	7.60 ± 4.51	2.01-13.19	0.027
	1-2	7.06 ± 4.62	5.89-8.24	
	3-5	5.04 ± 2.98	4.18-5.91	
HGB	0	97.8 ± 42.13	45.48-150.12	0.049
	1-2	126.4 ± 22.26	120.79-132.00	
	3-5	125.87 ± 26.43	117.93-133.81	
Protein	0	59.63 ± 4.15	49.33-69.94	0.049
	1-2	68.68 ± 6.34	66.96-70.42	
	3-5	67.38 ± 6.36	65.26-69.50	

In univariate logistic regression analysis, the Rockwood frailty score was significantly associated with adverse in-hospital outcomes. Compared with the reference group (Rockwood 1–3), patients with severe frailty (scores 7–9) had a markedly higher risk of intrahospital mortality (OR = 13.778, 95% CI: 1.591–119.286, p = 0.017) and intrahospital complications (OR = 15.467, 95% CI: 3.711–64.456, p < 0.001). However, the confidence intervals were wide due to the relatively small number of events, indicating limited precision of risk estimates.

In contrast, the Hopkins frailty score was not significantly associated with intrahospital complications (p = 0.305). Patients with Hopkins scores of 3–5 demonstrated approximately threefold higher odds of intrahospital mortality, although this result did not reach statistical significance (OR = 3.250, 95% CI: 0.919–11.494, p = 0.067).

Discussion

Frailty serves as a critical prognostic factor in older patients with acute coronary syndrome (ACS), reflecting the cumulative impact of comorbidities, physiological decline, and increased vulnerability. This study evaluates frailty in patients over 75 years of age hospitalized for ACS, comparing the prognostic value of the Rockwood Clinical Frailty Scale and the Hopkins Frailty Score. The findings indicate that the Rockwood scale reliably predicts in-hospital mortality and complications. Severe frailty (CFS 7–9) is associated with a pronounced cardio-renal-inflammatory burden. In contrast, while the Hopkins score correlates with certain hematological parameters (e.g., hemoglobin and protein levels), it did not independently predict mortality or complications.

The CFS demonstrated strong predictive value for in-hospital mortality and complications, with statistically significant associations (mortality, p = 0.002; complications, p < 0.001). Logistic regression analysis confirmed its independent prognostic significance (OR for mortality = 13.778, p = 0.017; OR for complications = 15.467, p < 0.001). These results align with a growing body of evidence from recent high-quality studies and meta-analyses. For instance, a 2024 systematic review and meta-analysis found that multidimensional frailty, assessed using tools such as the CFS, significantly predicts mortality in older adults (HR = 5.48, 95% CI: 3.91–7.67) (6). Similarly, a large multicenter cohort study reported that patients with ACS and advanced frailty have a 1.5–3-fold higher risk of adverse cardiovascular events and all-cause mortality compared to non-frail patients. A recent European Heart Journal study further demonstrated that the CFS is independently associated with both short- and long-term mortality in ACS patients, even after adjustment for age, comorbidities, and GRACE risk score (OR: 1.6, 95% CI: 1.34–1.91; HR: 1.37, 95% CI: 1.18–1.58) (2,7).

The Hopkins Frailty Score, representing the frailty phenotype model, did not independently predict mortality or complications in this cohort, though a non-significant trend toward higher mortality

was observed (p = 0.220; linear trend p = 0.062; OR = 3.250, p = 0.067). Notably, higher Hopkins scores were associated with shorter hospital stays and higher levels of hemoglobin and serum protein. The higher hemoglobin and protein levels, although within lower normal limits, suggest that patients classified as less frail by this score may still harbor significant physiological deficits not adequately captured by the tool. These findings may appear counterintuitive; however, they likely reflect the limitations of the Hopkins score and phenotype-based tools in capturing the multidimensional nature of frailty in acutely ill cardiac patients compared to multidimensional instruments like the CFS. Recent comparative studies further support these findings. For example, a 2024 multicenter study found that the CFS had higher sensitivity and specificity for predicting mortality and complications in ACS than the Hospital Frailty Risk Score (HFRS) or phenotype-based tools, particularly when using optimized cut-offs (8).

The observed associations between severe frailty (CFS 7–9) and lower left ventricular ejection fraction (LVEF), elevated urea, reduced estimated glomerular filtration rate (eGFR), and higher CRP are consistent with this pathophysiological framework. Frail ACS patients are more likely to have underlying heart failure, chronic kidney disease (CKD), and systemic inflammation, all of which synergistically increase the risk of complications, mortality, and functional decline. Elevated CRP levels in patients with higher Rockwood scores suggest a heightened inflammatory state, consistent with the concept of “inflammaging” described in contemporary geriatric cardiology. Chronic low-grade inflammation has been implicated in the pathogenesis of both frailty and cardiovascular disease, potentially exacerbating vulnerability to acute stressors (9).

Recognition of the cardio-renal-inflammatory axis in frail older ACS patients has important clinical implications, highlighting the need for an integrated, multidisciplinary approach to management that targets not only cardiovascular risk but also renal function, inflammation, and nutritional and functional status. These findings support the use of comprehensive geriatric assessment and multidimensional frailty tools such as the CFS (10–12).

A paradoxical finding in this study is the lower prevalence of dyslipidemia and lower serum calcium in severely frail patients (CFR and Hopkins scale). This “lipid paradox” has been reported in multiple recent studies of ACS and other inflammatory conditions. Several large-scale cohorts have observed that lower LDL-C levels at admission for ACS are associated with higher mortality, particularly in patients with elevated inflammatory markers. One possible explanation is that inflammation accelerates cholesterol catabolism, increases LDL receptor expression, and

promotes LDL oxidation, resulting in lower measured LDL-C in the setting of acute illness and frailty (13,14). Additionally, poor nutritional status in frail patients contributes to hypocholesterolemia and hypocalcemia. These mechanisms may lead to an underestimation of dyslipidemia prevalence in frail patients, particularly when based on lipid levels assessed during acute illness.These findings caution against interpreting low cholesterol or calcium levels as indicators of lower cardiovascular risk in older frail patients; rather, they may reflect advanced disease, malnutrition, and heightened inflammatory burden (10,13,14).

The study also showed that higher Rockwood scores were associated with heart failure decompensation, CKD, and a trend toward more psycho-organic syndrome ($p = 0.053$). These associations are well-supported by recent literature. Frailty is highly prevalent in heart failure populations, with rates up to 50%, and is independently associated with increased mortality, hospital readmission, and prolonged recovery. The interplay between frailty and heart failure is bidirectional: heart failure accelerates frailty progression through neurohormonal, metabolic, and inflammatory pathways, while frailty reduces tolerance to therapy and increases the risk of decompensation (10,15).

Similarly, the association between frailty and CKD is well-established. Frail individuals have a higher prevalence of CKD, faster decline in eGFR, and increased risk of adverse outcomes, including anemia, mineral bone disorders, and cognitive impairment (11,12).

The observed trend toward more psycho-organic syndrome in frailer patients reflects the close relationship between frailty and cognitive impairment in hospitalized elderly populations. Cognitive impairment and psycho-organic syndromes are common in frail elderly ACS patients and are associated with worse outcomes, including prolonged hospital stay, increased complications, and higher mortality (16).

The study's logistic regression analyses confirmed the Rockwood score as a significant predictor of mortality and complications, with high odds ratios (ORs) but wide confidence intervals (CIs). This statistical pattern is common in studies with small sample sizes or rare events, where the effect size appears large, but the precision is limited due to wide confidence intervals. Wide CIs reflect greater uncertainty about the true magnitude of the association and may be influenced by sample size, event rates, and data variability. Nevertheless, the statistically significant p-values indicate that the observed associations are unlikely to be due to chance. Larger, multicenter studies are needed to validate these results and refine the precision of prognostic estimates.

Recent guidelines and consensus statements from the European Society of Cardiology (ESC) and other professional societies emphasize the importance of frailty assessment in the management of elderly ACS patients and recommend a holistic, individualized approach that incorporates geriatric syndromes, including frailty, into care plans for older adults (17,18). The observed discrepancies between the CFS and the Hopkins Frailty Score reflect fundamental differences in their conceptual models. The CFS, based on the cumulative deficit model, captures a multidimensional spectrum of vulnerability, including comorbidities, functional status, cognition, and psychosocial factors. The Hopkins score, derived from the frailty phenotype, focuses on physical performance and may be less sensitive to cognitive, psychological, and social deficits. Recent comparative studies have shown that multidimensional tools like the CFS or Multidimensional Prognostic Index have superior predictive validity for mortality and adverse outcomes in older adults, particularly in acute and complex clinical settings (8).

Conclusion

Our findings highlight the critical role of frailty assessment in the management of elderly patients with acute coronary syndrome. This study demonstrates that the Rockwood Clinical Frailty Scale is an independent predictor of mortality and complications in elderly patients hospitalized for acute coronary syndrome, outperforming the Hopkins Frailty Score. Severe frailty, as measured by the CFS, was associated with a distinct cardio-renal-inflammatory profile, reflecting the complex interplay of multisystem dysfunction in this population.

These findings support the use of multidimensional frailty assessment for improved risk stratification and clinical decision-making in elderly ACS patients. Larger multicenter studies are warranted to validate these results and further refine prognostic models.

Acknowledgment

This work was supported by the project *"Clinical characteristics and frailty assessment as predictors of mortality and six-month prognosis in patients aged ≥75 years with acute coronary syndrome (Senior MI Registry)"*, approved by the Ethical Committee under act number 29757 (October 6, 2025).

Conflict of interest statement

The authors stated that they have no conflicts of interest regarding the publication of this article.

References:

1. Fishman B, Segev A, Ashri S, Lerman TT, Sultani S, Beigel R, et al. Frailty Modifies the Prognostic Effect of Age Among Older Adults With Acute Coronary Syndrome. Journal of the American Heart Association. 2026 Jan 6;15(1):e040688. doi:10.1161/JAHA.124.040688

2. Völschow B, Goßling A, Kellner C, Neumann JT. Frailty prevalence, invasive treatment frequency, and in-hospital outcome in patients hospitalized for acute coronary syndrome in Germany (2005–2022): a nationwide registry study. The Lancet Regional Health – Europe. 2025 Feb 1;49. doi:10.1016/j.lanepe.2024.101168 PubMed PMID: 39737370.

3. Zhang J, Zhang L, Zhou J, Tao M, Luo M, Li X, et al. Latent Profile Analysis of Preoperative Frailty in Cardiac Surgery Patients: Implications for Individualised Nursing Care. Journal of Clinical Nursing. n/a(n/a). doi:10.1111/jocn.70210

4. Dimitriadou I, Fradelos EC, Skoularigis J, Toska A, Saridi M. Frailty in acute coronary syndrome: From risk stratification to clinical decision-making. World J Cardiol. 2026 Jan 26;18(1):113258. doi:10.4330/wjc.v18.i1.113258 PubMed PMID: 41607613; PubMed Central PMCID: PMC12836078.

5. Graham MM, Galbraith PD, O'Neill D, Rolfson DB, Dando C, Norris CM. Frailty and Outcome in Elderly Patients With Acute Coronary Syndrome. Canadian Journal of Cardiology. 2013 Dec 1;29(12):1610–5. doi:10.1016/j.cjca.2013.08.016

6. Liu W, Qin R, Qiu Y, Luan T, Qiu B, Yan K, et al. Multidimensional frailty as a predictor of mortality among older adults: a systematic review and meta-analysis. BMC Geriatr. 2024 Sep 28;24(1):793. doi:10.1186/s12877-024-05377-4

7. Impact of clinical frailty scale on short and long term outcome in patients with acute coronary syndrome | European Heart Journal. Acute Cardiovascular Care | Oxford Academic [Internet]. [cited 2026 Mar 20]. Available from: https://academic.oup.com/ehjacc/article/13/Supplement_1/zuae036.129/7666307?guestAccessKey

8. Van Nguyen T, Tran HM, Ngo TKT. Comparative clinical frailty scale and hospital frailty risk score in identifying frailty and predicting mid-term outcomes in older patients with acute coronary syndrome: a multicenter cohort study in Vietnam. BMC Geriatr. 2025 Feb 24;25(1):125. doi:10.1186/s12877-025-05690-6 PubMed PMID: 39994542; PubMed Central PMCID: PMC11849291.

9. Singh A, Schurman SH, Bektas A, Kaileh M, Roy R, Wilson DM, et al. Aging and Inflammation. Cold Spring Harb Perspect Med. 2024 Jun 3;14(6):a041197. doi:10.1101/cshperspect.a041197 PubMed PMID: 38052484; PubMed Central PMCID: PMC11146314.

10. Giallauria F, Lorenzo AD, Venturini E, Pacileo M, D'Andrea A, Garofalo U, et al. Frailty in Acute and Chronic Coronary Syndrome Patients Entering Cardiac Rehabilitation. Journal of Clinical Medicine. 2021 Apr 15;10(8). doi:10.3390/jcm10081696

11. Shi X, Wang S, Hu J, Chen F, Zhang H, Yang Y, et al. Relationship of Frailty with Kidney Function in Adults More Than 60-Years-Old: Effect of Using Different Formulas to Estimate Glomerular Filtration Rate. CIA. 2023 Jun 27;18:999–1007. doi:10.2147/CIA.S409140

12. Nair D, Liu CK, Raslan R, McAdams-DeMarco M, Hall RK. Frailty in Kidney Disease: A Comprehensive Review to Advance Its Clinical and Research Applications. American Journal of Kidney Diseases. 2025 Jan 1;85(1):89–103. doi:10.1053/j.ajkd.2024.04.018 PubMed PMID: 38906506.

13. Sato R, Matsuzawa Y, Yoshii T, Akiyama E, Konishi M, Nakahashi H, et al. Impact of Low-Density Lipoprotein Cholesterol Levels at Acute Coronary Syndrome Admission on Long-Term Clinical Outcomes. Journal of Atherosclerosis and Thrombosis. 2024;31(4):444–60. doi:10.5551/jat.64368

14. Zeng G, Zhang C, Song Y, Zhang Z, Xu J, Liu Z, et al. The potential impact of inflammation on the lipid paradox in patients with acute myocardial infarction: a multicenter study. BMC Med. 2024 Dec 23;22(1):599. doi:10.1186/s12916-024-03823-z

15. Vitale C, Jankowska E, Hill L, Piepoli M, Doehner W, Anker SD, et al. Heart Failure Association of the European Society of Cardiology Position Paper on Frailty in Patients with Heart Failure. European Journal of Heart Failure. 2019 Nov 1;21(11):1299–305. doi:10.1002/ejhf.1611

16. Wontor R, Lisiak M, Łoboz-Rudnicka M, Ołpińska B, Wyderka R, Dudek K, et al. The Impact of the Coexistence of Frailty Syndrome and Cognitive Impairment on Early and Midterm Complications in Older Patients with Acute Coronary Syndromes. Journal of Clinical Medicine. 2024 Dec 5;13(23). doi:10.3390/jcm13237408

17. ESC Clinical Guidelines for Cardiovascular Care [Internet]. [cited 2026 Mar 20]. Available from: https://www.escardio.org/Guidelines/Clinical-Practice-Guidelines

18. Jiménez-Salva M, Carmona-Segovia A, Molina-Ramos AI, García-Rodríguez L, Puyol-Ruiz F, Doncel-Abad V, et al. Older adults with acute coronary syndrome: the impact of frailty and nutritional status on in-hospital complications. European Journal of Cardiovascular Nursing. 2025 May 28;24(4):595–605. doi:10.1093/eurjcn/zvaf006