SERUM URIC ACID LEVELS IN PATIENTS WITH ACUTE CORONARY SYNDROME ACCORDING TO RENAL FUNCTION

Ivan Zeljko[1,2], Kornelija Jurčić Bulić[1], Ivana Ljubić Zeljko[3],
Ivan Mustapić[1], Domagoj Tomić[1], Ivan Tomić[1,2]
[1]Department of Internal Medicine, University Clinical Hospital Mostar,
Bijeli brijeg bb, 88 000 Mostar, Bosnia & Herzegovina
[2]Faculty of Medicine, University of Mostar, Zrinskog Frankopana 34, 88 000 Mostar, Bosnia & Herzegovina
[3]Department of Ophthalmology, University Clinical Hospital Mostar,
Bijeli brijeg bb, 88 000 Mostar, Bosnia & Herzegovina
Received on 25 February 2025. Revised on 27 March 2026. Accepted on 13 April 2026.

ABSTRACT

Introduction: Elevated serum uric acid has been associated with adverse cardiovascular outcomes and impaired renal function. Its role in patients with acute coronary syndrome (ACS) remains insufficiently clarified, particularly in relation to estimated glomerular filtration rate (eGFR). The aim of our study was to analyze serum uric acid levels in patients with ACS according to renal function assessed by eGFR.

Subjects and Methods: This retrospective study included 149 patients hospitalized with ACS at the University Clinical Hospital Mostar between October 2024 and March 2025. Patients were divided according to serum uric acid levels and renal function status (normal vs. reduced eGFR). Data were collected from medical records and analyzed using appropriate descriptive and inferential statistical methods.

Results: Reduced eGFR was observed in a significantly higher proportion of patients with ACS compared to normal renal function ($p < 0.001$). Patients with reduced eGFR had significantly higher serum uric acid levels than those with preserved renal function ($p < 0.001$). A strong negative correlation between uric acid levels and eGFR was identified ($r = -0.648$, $p < 0.001$).

Conclusion: Elevated serum uric acid levels are significantly associated with reduced renal function in patients with ACS. Uric acid may represent a useful marker for identifying patients at higher risk of renal impairment and adverse outcomes in the setting of ACS.

Keywords: acute coronary syndrome, uric acid, eGFR, renal function, cardiovascular risk

Corresponding author: Ivan Zeljko, MD; ivan.zeljko@mef.sum.ba

INTRODUCTION

Acute coronary syndrome (ACS) encompasses a spectrum of clinical conditions resulting from acute myocardial ischemia due to a sudden reduction in coronary blood flow, most commonly caused by atherosclerotic plaque rupture and subsequent thrombosis (1,2). Despite significant advances in reperfusion strategies and pharmacological therapy, ACS remains a leading cause of morbidity and mortality worldwide, particularly among elderly patients and those with multiple comorbidities (3).

Renal dysfunction has been consistently identified as an independent predictor of adverse outcomes in patients with ACS. Reduced estimated glomerular filtration rate (eGFR) is associated with increased in-hospital mortality, recurrent ischemic events, bleeding complications, and long-term cardiovascular mortality (4–6). Even mild impairment of renal function has been shown to negatively affect prognosis, emphasizing the importance of kidney function assessment in acute cardiovascular settings (7).

Uric acid, the final product of purine metabolism in humans, has gained increasing attention as a potential biomarker and pathophysiological mediator in cardiovascular disease. Hyperuricemia has been associated with hypertension, metabolic syndrome, diabetes mellitus, chronic kidney disease, and cardiovascular events (8–10). Elevated serum uric acid levels contribute to oxidative stress, endothelial dysfunction, inflammation, and vascular smooth muscle cell proliferation, all of which play a key role in atherosclerosis progression and plaque instability (11–13).

In the context of ACS, ischemia-induced activation of xanthine oxidase leads to increased production of uric acid and reactive oxygen species, further exacerbating myocardial injury and endothelial dysfunction (14). Several studies have demonstrated that elevated uric acid levels are associated with increased infarct size, worse left ventricular function, and higher short- and long-term mortality in patients with ACS (15–17). However, it remains unclear whether uric acid is a causal factor or merely a marker of increased oxidative stress and impaired renal excretion.

Renal function plays a crucial role in uric acid homeostasis, as approximately 70% of uric acid is excreted via the kidneys. Reduced eGFR leads to decreased urate clearance and subsequent hyperuricemia, creating a bidirectional relationship between kidney dysfunction and elevated uric acid levels (18,19). In patients with ACS, this interaction may represent a vicious cycle in which renal impairment and hyperuricemia mutually exacerbate cardiovascular risk.

Given the prognostic significance of both uric acid levels and renal dysfunction, understanding their relationship in patients with ACS may provide valuable insights for risk stratification and clinical management.

The aim of this study was to analyze serum uric acid levels in patients with acute coronary syndrome according to renal function assessed by estimated glomerular filtration rate and to explore their association with demographic characteristics.

SUBJECTS AND METHODS

This retrospective study was conducted at the Clinical Department of Internal Medicine with Dialysis Center, University Clinical Hospital Mostar. Medical records of patients hospitalized with acute coronary syndrome between October 1, 2024 and March 1, 2025 were reviewed.

A total of 149 patients were included. Patients were categorized according to serum uric acid levels (normal vs. elevated) and renal function

status (normal eGFR vs. reduced eGFR). Renal function was assessed using eGFR calculated from routine laboratory parameters.
Data on age, sex, serum uric acid levels, and eGFR were collected from the hospital information system. The study was conducted in accordance with ethical standards and patient data were anonymized.

Statistical Analysis

Statistical analysis was performed using SPSS version 20.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean ± standard deviation or median with interquartile range, depending on distribution. Categorical variables were expressed as frequencies and percentages. Group comparisons were performed using Student's t-test or chi-square test, as appropriate. Correlations were assessed using Pearson's correlation coefficient. A p-value < 0.05 was considered statistically significant.

RESULTS

A total of 149 patients with acute coronary syndrome were included in the study. Of these, 53.7% were male (n = 80) and 46.3% were female (n = 69). There was no statistically significant difference in sex distribution ($\chi^2 = 0.812$, $p = 0.368$).
The youngest patient was 44 years old, while the oldest was 97 years old. The median age of the entire cohort was 71 years (interquartile range 15). Female patients were significantly older than male patients (74.4 ± 10.9 vs. 67.8 ± 10.0 years; $t = -3.826$, $p < 0.001$).
Serum uric acid levels did not differ significantly between male and female patients ($t = -1.304$, $p = 0.194$). However, male patients had significantly higher estimated glomerular filtration rate (eGFR) values compared to female patients (77.3 ± 24.0 vs. 65.0 ± 30.7 mL/min/1.73 m²; $t = 2.726$, $p = 0.007$).

Table 1. *Basic descriptive parameters of urate and eGFR values*

Parameter	Sex	Min	Max	Mean ± SD
Uric acid (μmol/L)	Total	159	896	391.3 ± 129.0
	Male (n = 80)	159	605	378.5 ± 102.4
	Female (n = 69)	206	896	406.1 ± 153.7
eGFR (mL/min/1.73 m²)	Total	6.9	177.8	71.6 ± 27.9
	Male (n = 80)	24.6	122.1	77.3 ± 24.0
	Female (n = 69)	6.9	177.8	65.0 ± 30.7

A significantly higher proportion of patients had reduced renal function (eGFR < 90 mL/min/1.73 m²) compared to those with preserved renal function ($\chi^2 = 33.108$, $p < 0.001$). Most patients belonged to CKD stage G2 (60–89 mL/min/1.73 m²), accounting for 38.3% of the study population.

Figure 1. *Distribution of patients with acute coronary syndrome according to renal function status*

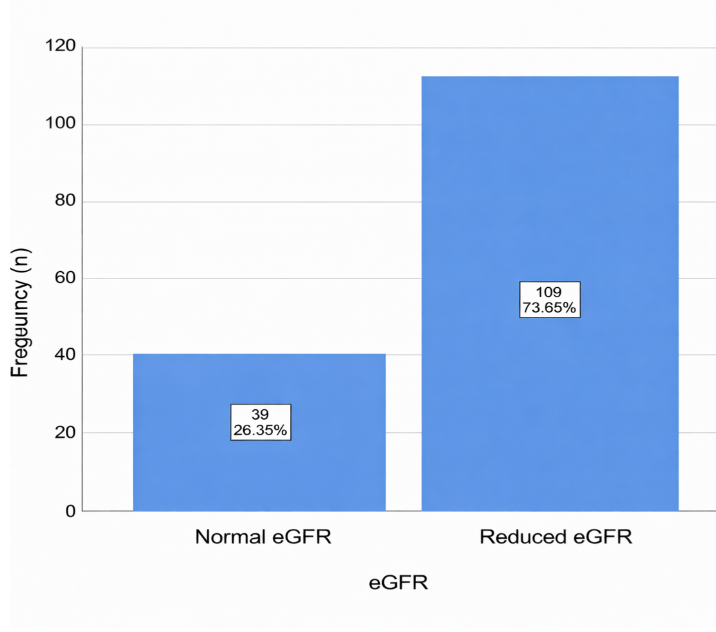
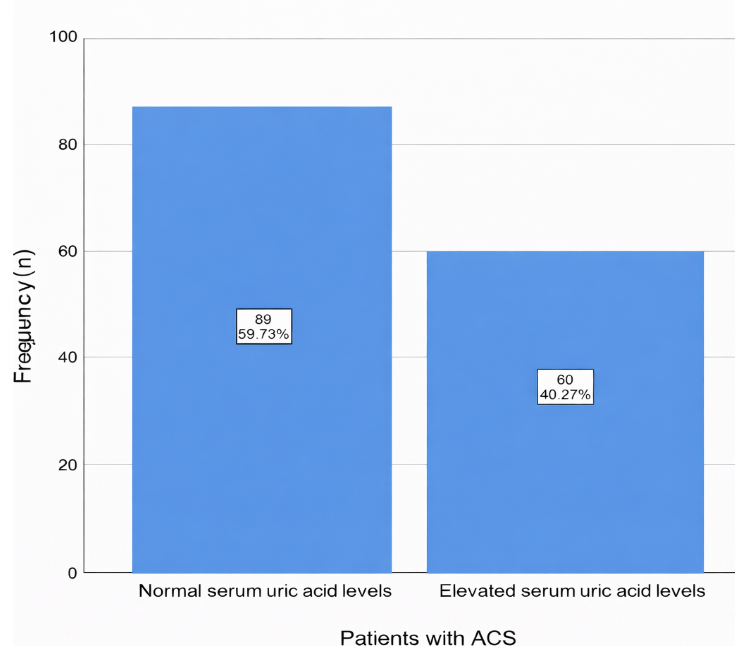


Table 2. *Distribution of patients according to CKD stage based on eGFR*

CKD stage	eGFR (mL/min/1.73 m²)	n (%)
G1	≥ 90	39 (26.2)
G2	60–89	57 (38.3)
G3a	45–59	23 (15.4)
G3b	30–44	14 (9.4)
G4	15–29	8 (5.4)
G5	< 15	2 (1.3)

Regarding serum uric acid levels, 89 patients (59.7%) had normal values, whereas 60 patients (40.3%) had elevated uric acid levels ($\chi^2 = 5.644$, $p = 0.018$).

Figure 2. *Distribution of patients with acute coronary syndrome according to serum uric acid levels*



Categorical analysis revealed a statistically significant association between uric acid concentration (normal vs. elevated) and renal function status (normal vs. reduced eGFR) ($\varphi = 0.456$, $p < 0.001$). Patients with preserved renal function more frequently had normal uric acid levels, whereas patients with reduced eGFR predominantly exhibited elevated uric acid concentrations.

Correlation analysis showed a strong negative association between serum uric acid levels and eGFR ($r = -0.648$, $p < 0.001$), indicating that higher uric acid levels were associated with reduced renal function.

Figure 3. *Serum uric acid levels according to renal function status in patients with acute coronary syndrome*

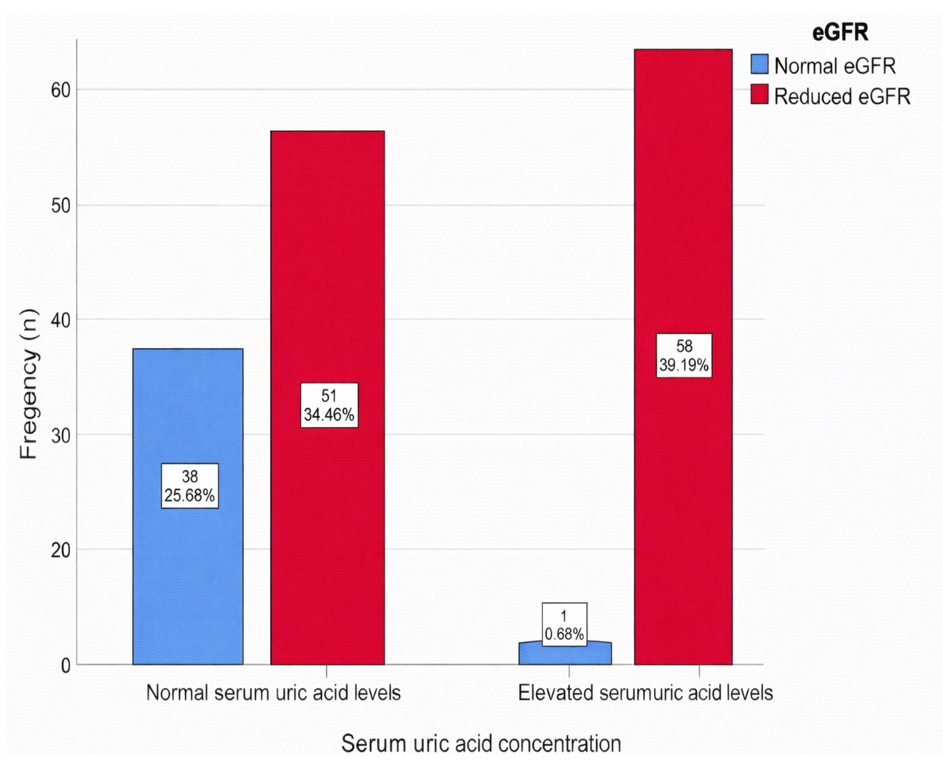


Table 3. *Comparison of serum uric acid levels according to renal function status*

eGFR group	Min	Max	Mean ± SD (μmol/L)	t	p
Normal eGFR (≥ 90)	159	561	297.1 ± 74.5		
Reduced eGFR (< 90)	236	896	424.5 ± 128.4	−7.431	<0.001

DISCUSSION

The present study demonstrates a strong and statistically significant association between elevated serum uric acid levels and reduced renal function in patients with acute coronary syndrome. Patients with lower eGFR values had significantly higher uric acid concentrations, and correlation analysis revealed a robust negative relationship between these parameters. These findings support the growing body of evidence linking hyperuricemia with renal impairment and adverse cardiovascular outcomes.

Renal dysfunction is a well-established prognostic marker in ACS. Previous studies have shown that reduced eGFR is associated

with increased mortality, higher rates of heart failure, and recurrent ischemic events (4,5,20). In our cohort, a substantial proportion of patients exhibited reduced eGFR, underscoring the clinical relevance of renal assessment in ACS populations, particularly in elderly patients.

Hyperuricemia has been increasingly recognized as a cardiovascular risk factor. Experimental and clinical studies suggest that uric acid promotes endothelial dysfunction by reducing nitric oxide bioavailability, increasing oxidative stress, and inducing inflammatory pathways (11,12). These mechanisms may contribute to plaque instability and thrombogenesis, which are central to the pathophysiology of ACS.

Our findings are consistent with previous studies demonstrating an inverse relationship between uric acid levels and renal function. Han et al. reported that elevated uric acid levels were associated with coronary artery calcification in patients with early-stage chronic kidney disease (21). Similarly, Yang et al. found that higher serum uric acid levels correlated with greater severity of coronary artery disease in patients with impaired renal function (22). Unlike these studies, our analysis specifically focused on patients presenting with ACS, highlighting the relevance of this association in an acute clinical setting.

The observed lack of significant sex-related differences in uric acid levels is in line with prior reports suggesting that sex differences may diminish in older populations and in the presence of renal impairment (23). However, male patients exhibited higher eGFR values, likely reflecting age-related differences and greater baseline muscle mass, which influence creatinine-based estimates of renal function.

Whether uric acid is a causal factor in cardiovascular disease or simply a marker of increased oxidative stress and renal dysfunction remains a subject of debate. Large randomized trials evaluating urate-lowering therapy have yielded mixed results regarding cardiovascular benefit. The ALL-HEART trial did not demonstrate a significant reduction in cardiovascular events with allopurinol therapy in patients with ischemic heart disease (24). These findings suggest that while uric acid is a valuable prognostic marker, its role as a therapeutic target in ACS remains uncertain.

From a clinical perspective, the assessment of serum uric acid in patients with ACS may aid in identifying individuals at higher risk of renal impairment and adverse outcomes. Given its low cost and widespread availability, uric acid measurement could be incorporated into routine risk stratification, particularly in patients with known or suspected renal dysfunction.

Limitations: This study is limited by its retrospective design and single-center setting, which may limit generalizability. Additionally, causality cannot be inferred, and potential confounding factors such as medication use and dietary influences were not fully assessed. Prospective, multicenter studies are warranted to further elucidate the prognostic and therapeutic implications of hyperuricemia in ACS.

CONCLUSIONS

Elevated serum uric acid levels are significantly associated with reduced eGFR in patients with acute coronary syndrome.

A strong negative correlation exists between uric acid levels and renal function.

Assessment of serum uric acid may aid in identifying ACS patients at increased risk of renal impairment and adverse outcomes.

Further prospective studies are required to clarify the clinical role of uric acid in risk

stratification and management of ACS patients.

GENERATIVE AI STATEMENT

In the preparation of this manuscript, artificial intelligence (AI) tools were used in the following manner: ChatGPT (GPT-5.2 version) was used exclusively for translating the original manuscript text into English, as well as for linguistic and stylistic editing of the text, while all outputs were reviewed and edited by the authors. The authors remain responsible for the integrity and originality of the content.

REFERENCES

1. Thygesen K, Alpert JS, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, et al. Fourth universal definition of myocardial infarction (2018). J Am Coll Cardiol. 2018;72(18):2231-2264.
2. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, 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.
3. Timmis A, Townsend N, Gale CP, Torbica A, Lettino M, Petersen SE, et al. European Society of Cardiology: cardiovascular disease statistics 2019. Eur Heart J. 2020;41(1):12–85.
4. Fox CS, Matsushita K, Woodward M, Bilo HJ, Chalmers J, Heerspink HJ, et al.Associations of kidney disease measures with mortality and end-stage renal disease. Circulation. 2012;125(23):2799–2807.
5. Anavekar NS, McMurray JJ, Velazquez EJ, Solomon SD, Kober L, Rouleau JL. Relation between renal dysfunction and cardiovascular outcomes after myocardial infarction. N Engl J Med. 2004;351(13):1285–1295.
6. Go AS, Chertow GM, Fan D, McCulloch CE, Hsu CY. Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization. N Engl J Med. 2004;351(13):1296–1305.
7. Damman K, Valente MA, Voors AA, O'Connor CM, Van Veldhuisen DJ, Hillege HL. Renal impairment, worsening renal function, and outcome in patients with acute coronary syndrome. Eur Heart J. 2014;35(7):455–469.
8. Feig DI, Kang DH, Johnson RJ. Uric acid and cardiovascular risk. N Engl J Med. 2008;359(17):1811–1821.
9. Johnson RJ, Nakagawa T, Jalal D, Sanchez-Lozada LG, Kang DH, Ritz E. Uric acid and chronic kidney disease: which is chasing which? Hypertension. 2013;61(5):948–955.
10. Borghi C, Rodriguez-Artalejo F, De Backer G, Dallongeville J, Medina J, Guallar E. Serum uric acid levels are associated with cardiovascular risk. Eur J Intern Med. 2020;80:1–11.
11. Kang DH, Park SK, Lee IK, Johnson RJ. Uric acid-induced C-reactive protein expression: implication on cell proliferation and nitric oxide production. Am J Nephrol. 2005;25(5):430–439.
12. Sautin YY, Johnson RJ. Uric acid: the oxidant–antioxidant paradox. Nucleosides Nucleotides Nucleic Acids. 2008;27(6):608–619.
13. Ndrepepa G. Uric acid and cardiovascular disease. Clin Chim Acta. 2018;484:150–163.
14. George J, Struthers AD, MacDonald TM. Xanthine oxidase activity in patients with myocardial ischemia. Circulation. 1999;99(24):3020–3025.
15. Kojima S, Sakamoto T, Ishihara M, Kimura K, Miyazaki S, Yamagishi M, et al. Prognostic usefulness of serum uric acid

after acute myocardial infarction. Circ J. 2005;69(7):783–789.

16. Lazzeri C, Valente S, Chiostri M, Gensini GF. Uric acid in the acute phase of ST-elevation myocardial infarction. Int J Cardiol. 2010;138(2):206–209.
17. Ndrepepa G, Braun S, Haase HU, Schulz S, Hadamitzky M, Mehilli J, et al. Prognostic value of uric acid in patients with acute coronary syndromes. Am J Cardiol. 2012;109(9):1260–1265.
18. Richette P, Bardin T. Gout. Lancet. 2010;375(9711):318–328.
19. Johnson RJ, Bakris GL, Borghi C, Chonchol M, Feldman D, Lanaspa MA, et al. Hyperuricemia, acute and chronic kidney disease, hypertension, and cardiovascular disease. Kidney Int. 2018;93(2):238–251.
20. Damman K, Tang WH, Testani JM, McMurray JJ. Cardiorenal syndrome in acute heart failure. Eur J Heart Fail. 2015;17(9):884–895.
21. Han MY, Lee SY, Kim YJ, Kim HJ, Lee YH, Kim MK. Serum uric acid and coronary artery calcification in chronic kidney disease. Atherosclerosis. 2015;238(1):204–210.
22. Yang Y, Zhou J, Liu X, Zhang W, Wang J, Liu Y. Association between serum uric acid and severity of coronary artery disease. BMC Cardiovasc Disord. 2019;19:26.
23. Stack AG, Johnson ME, Blakely K, Decker E, Magee C, Harrington JM. Gender differences in the association between serum uric acid and kidney disease. Am J Kidney Dis. 2013;61(6):987–996.
24. Mackenzie IS, Ford I, Walker A, Hawkey C, Begg A, Avery A, et al. Allopurinol and cardiovascular outcomes in patients with ischemic heart disease (ALL-HEART). N Engl J Med. 2022;386(17):1616–1625.

SERUMSKA RAZINA MOKRAĆNE KISELINE U BOLESNIKA S AKUTNIM KORONARNIM SINDROMOM PREMA BUBREŽNOJ FUNKCIJI

Ivan Zeljko[1,2], Kornelija Jurčić Bulić[1], Ivana Ljubić Zeljko[3],
Ivan Mustapić[1], Domagoj Tomić[1], Ivan Tomić[1,2]
[1]Odjel za internu medicinu, Sveučilišna klinička bolnica Mostar, Bijeli brijeg bb, 88 000 Mostar, Bosna i Hercegovina
[2]Medicinski fakultet, Sveučilište u Mostaru, Zrinskog Frankopana 34, 88 000 Mostar, Bosna i Hercegovina
[3]Odjel za oftalmologiju, Sveučilišna klinička bolnica Mostar, Bijeli brijeg bb, 88 000 Mostar, Bosna i Hercegovina

CC BY

SAŽETAK

Uvod: Povišene serumske vrijednosti mokraćne kiseline povezane su s nepovoljnim kardiovaskularnim ishodima i oštećenjem bubrežne funkcije. Njihova uloga u bolesnika s akutnim koronarnim sindromom (AKS) još uvijek nije u potpunosti razjašnjena, osobito u odnosu na procijenjenu brzinu glomerularne filtracije (eGFR).

Cilj: Analizirati serumske vrijednosti mokraćne kiseline u bolesnika s AKS-om u odnosu na bubrežnu funkciju procijenjenu pomoću eGFR-a.

Ispitanici i metode: Retrospektivno istraživanje obuhvatilo je 149 bolesnika hospitaliziranih zbog AKS-a u SKB Mostar u razdoblju od listopada 2024. do ožujka 2025. godine. Bolesnici su podijeljeni prema razini mokraćne kiseline i statusu bubrežne funkcije. Podaci su analizirani odgovarajućim statističkim metodama.

Rezultati: Veći broj bolesnika s AKS imao je smanjenu bubrežnu funkciju mjerenu preko eGFR ($p < 0,001$). Bolesnici sa smanjenim eGFR-om imali su značajno više vrijednosti mokraćne kiseline u odnosu na bolesnike s urednom bubrežnom funkcijom ($p < 0,001$). Utvrđena je snažna negativna korelacija između razine mokraćne kiseline i eGFR-a ($r = -0,648$, $p < 0,001$).

Zaključak: Povišene serumske vrijednosti mokraćne kiseline značajno su povezane sa smanjenom bubrežnom funkcijom u bolesnika s AKS-om. Mokraćna kiselina može predstavljati koristan marker za identifikaciju bolesnika s povećanim rizikom od bubrežnog oštećenja i lošijih ishoda.

Ključne riječi: akutni koronarni sindrom, mokraćna kiselina, eGFR, bubrežna funkcija, kardiovaskularni rizik.

Osoba za korespondenciju: Ivan Zeljko, dr. med.; ivan.zeljko@mef.sum.ba