

## FAKTORI RIZIKA ZA NASTANAK AKUTNOG INFARKTA MIOKARDA U REPUBLICI SRBIJI

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### SAŽETAK

**Uvod/cilj:** Akutni infarkt miokarda (AIM) jedan je od vodećih uzroka obolevanja i umiranja od kardiovaskularnih bolesti (KVB) globalno, pri čemu je razvoj bolesti snažno povezan sa prisustvom i interakcijom više faktora rizika – nemodifikabilnih (pol, starost, porodična anamneza) i modifikabilnih (hipertenzija, dislipidemija, pušenje, gojaznost, fizička neaktivnost, dijabetes mellitus, stres). Cilj rada je da se analizira prevalencija ključnih faktora rizika za AIM među pacijentima sa akutnim koronarnim sindromom (AKS) lečenim u koronarnim jedinicama u Republici Srbiji (2006–2011), kao i u opštoj populaciji Srbije (2012–2022), uz poređenje sa evropskim i globalnim prosekom radi boljeg sagledavanja opterećenja faktorima rizika i dodatnog uvida u potrebu za unapređenjem preventivnih intervencija na nacionalnom nivou.

**Metode:** Sprovedena je deskriptivna epidemiološka studija. Podaci o prevalenciji faktora rizika kod hospitalizovanih pacijenata sa akutnim koronarnim sindromom (AKS) za period 2006–2011. godine preuzeti su iz godišnjih publikacija Instituta za javno zdravlje Srbije „Dr Milan Jovanović Batut” – Registra za akutni koronarni sindrom. Prevalencija istih faktora rizika u opštoj populaciji Republike Srbije za period 2012–2022. godine analizirana je korišćenjem nacionalnih i međunarodnih sekundarnih izvora podataka, uključujući izveštaje Svetske zdravstvene organizacije (World Health Organization – WHO), Globalnog istraživanja o upotrebi duvana kod odraslih (Global Adult Tobacco Survey – GATS), Studije globalnog opterećenja bolestima (Global Burden of Disease Study – GBD), nacionalna zdravstvena istraživanja iz 2013. i 2019. godine, kao i Evropskog zdravstvenog istraživanja (European Health Interview Survey – EHIS). Faktori rizika definisani su u skladu sa metodologijom korišćenih izvora podataka i važećim međunarodnim smernicama.

**Rezultati:** Kod pacijenata sa AKS hospitalizovanih u koronarnim jedinicama u Republici Srbiji zabeležena je visoka prevalencija svih analiziranih faktora rizika. U 2011. godini, približno 35% pacijenata bilo je evidentirano kao pušači u trenutku hospitalizacije (aktivni pušači), oko 73% je imalo arterijsku hipertenziju, oko 28% dijabetes melitus, oko 20% gojaznost (BMI  $\geq 30$  kg/m<sup>2</sup>), oko 37% je bilo fizički neaktivno, više od polovine imalo je dislipidemiju i pozitivnu porodičnu anamnezu, dok je oko 31% prijavilo povišen psihosocijalni stres. Analiza trendova za period 2012–2022. godine ukazuje na perzistentno visoke vrednosti navedenih modifikabilnih faktora rizika u opštoj populaciji, koje prate ili premašuju nivoe zabeležene kod hospitalizovanih pacijenata sa AKS u prethodnom periodu.

**Zaključak:** Rezultati studije ukazuju na perzistentno visoku prevalenciju modifikabilnih faktora rizika u Republici Srbiji, koja se iz populacije pacijenata sa AKS (2006–2011.) preslikala i na opštu populaciju u narednoj deceniji (2012–2022.). Ovakvi trendovi, koji su nepovoljni u odnosu na evropski prosek, ukazuju na potrebu za integrisanim preventivnim strategijama usmerenim na modifikabilne faktore rizika sa ciljem smanjenja ukupnog kardiovaskularnog opterećenja u Republici Srbiji.

**Ključne reči:** akutni infarkt miokarda, akutni koronarni sindrom, faktori rizika, prevalencija, prevencija, pušenje, hipertenzija, gojaznost

### Uvod

Kardiovaskularne bolesti (KVB) predstavljaju vodeći uzrok umiranja na globalnom nivou i odgovorne su za oko 19,8 miliona smrtnih ishoda godišnje, što čini približno trećinu ukupne smrtnosti u svetu. Najveći deo ovog opterećenja beleži se u zemljama sa niskim i srednjim prihodima, gde se registruje oko tri četvrtine svih smrtnih ishoda od KVB. Među uzrocima smrti od KVB, akutni infarkt miokarda i moždani udar imaju dominantan

udeo i predstavljaju vodeće pojedinačne uzroke smrtnosti (1).

„Ishemijska bolest srca (IBS) predstavlja najčešći entitet unutar spektra KVB i nastaje kao posledica aterosklerotskih promena u koronarnim arterijama, koje dovode do smanjenog snabdevanja srčanog mišića krvlju (ishemije), a u težim slučajevima i do nekroze miokarda (2). Klinički oblici IBS obuhvataju anginu pektoris, akutni infarkt miokarda (AIM), iznenadnu srčanu smrt i ishemijsku kar-

## RISK FACTORS FOR ACUTE MYOCARDIAL INFARCTION IN THE REPUBLIC OF SERBIA

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### SUMMARY

**Background/Aim:** Acute myocardial infarction (AMI) is a leading cause of morbidity and mortality from cardiovascular diseases (CVD) globally. The development of the disease is strongly associated with the presence and interaction of multiple risk factors – non-modifiable (sex, age, family history) and modifiable (hypertension, dyslipidemia, smoking, obesity, physical inactivity, diabetes mellitus, stress). The aim of this study is to analyze the prevalence of key risk factors for AMI among patients with acute coronary syndrome (ACS) treated in coronary care units in the Republic of Serbia (2006–2011), as well as in the general population of Serbia (2012–2022). Furthermore, these findings are compared with European and global averages to better understand the burden of risk factors and provide additional insight into the need for improved national preventive interventions.

**Methods:** A descriptive epidemiological study was conducted. Data on the prevalence of risk factors in hospitalized patients with acute coronary syndrome (ACS) for the period 2006–2011 were retrieved from the annual publications of the “Dr Milan Jovanović Batut” Institute of Public Health of Serbia – the National Registry for Acute Coronary Syndrome. The prevalence of the same risk factors in the general population of the Republic of Serbia for the period 2012–2022 was analyzed using national and international secondary data sources, including reports from the World Health Organization (WHO), the Global Adult Tobacco Survey (GATS), the Global Burden of Disease Study (GBD), the National Health Surveys from 2013 and 2019, and the European Health Interview Survey (EHIS). Risk factors were defined in accordance with the methodology of the data sources used and current international guidelines.

**Results:** A high prevalence of all analyzed risk factors was recorded among patients with ACS hospitalized in coronary care units in the Republic of Serbia. In 2011, approximately 35% of patients were recorded as smokers at the time of hospitalization (active smokers), about 73% had arterial hypertension, approximately 28% had diabetes mellitus, about 20% had obesity (BMI  $\geq 30$  kg/m<sup>2</sup>), and roughly 37% were physically inactive. More than half had dyslipidemia and a positive family history, while approximately 31% reported elevated psychosocial stress. Trend analysis for the 2012–2022 period indicates persistently high values of these modifiable risk factors in the general population, which match or exceed the levels recorded among hospitalized ACS patients in the preceding period.

**Conclusion:** The findings of this study indicate a persistently high prevalence of modifiable risk factors in the Republic of Serbia, which transitioned from the ACS patient population (2006–2011) to the general population over the following decade (2012–2022). These trends, which are more unfavorable than the European average, highlight the urgent need for integrated preventive strategies targeting modifiable risk factors to reduce the overall cardiovascular burden in the Republic of Serbia.

**Keywords:** Acute myocardial infarction, acute coronary syndrome, risk factors, prevalence, prevention, smoking, hypertension, obesity

### Introduction

Cardiovascular diseases (CVDs) are the leading cause of mortality globally and they are responsible for about 19.8 million deaths annually, accounting for approximately one-third of all global deaths. The largest part of this burden is recorded in low- and middle-income countries, where about three-quarters of all deaths caused by CVDs are registered. Among the causes of death attributed to CVDs, acute myocardial infarction and stroke have a dom-

inant share and represent the leading individual causes of mortality (1).

“Ischemic heart disease (IHD) represents the most common entity within the spectrum of CVDs and it occurs as a consequence of atherosclerotic changes in coronary arteries, which lead to the reduced blood supply to the heart muscle (ischemia), and in severe cases to myocardial necrosis” (2). “Clinical forms of IHD include angina pectoris, acute myocardial infarction (AMI), sudden cardiac death

diomiopatiju" (2). Nestabilna angina pectoris, infarkt miokarda bez elevacije ST segmenta, infarkt miokarda sa elevacijom ST segmenta i iznenadna srčana smrt grupišu se pod zajedničkim nazivom akutni koronarni sindrom (AKS) (3,4).

AIM predstavlja jedan od najznačajnijih kliničkih i javnozdravstvenih problema unutar AKS, sa visokim udelom u ukupnom morbiditetu i mortalitetu od KVB, kako u razvijenim zemljama, tako i u zemljama u razvoju (1). Uprkos značajnom napretku u dijagnostici, terapiji i organizaciji zdravstvene zaštite, AIM i dalje ima izražen epidemiološki i socioekonomski značaj, kako zbog visokog mortaliteta, tako i zbog dugoročnih posledica po funkcionalni status i kvalitet života obolelih (5).

Faktori rizika za nastanak KVB tradicionalno se dele na nepromenljive i promenljive. Nepromenljivi faktori rizika uključuju starost, pol, genetsku predispoziciju i pripadnost određenim etničkim grupama, iako se na njih ne može direktno uticati, oni značajno doprinose ukupnom kardiovaskularnom riziku. Rizik od nastanka AIM raste sa godinama života, viši je kod muškaraca u ranijim životnim dekadama, dok se kod žena značajno povećava nakon menopauze (6). Pozitivna porodična anamneza, naročito rana pojava KVB kod srodnika prvog stepena, dodatno povećava verovatnoću obolevanja (7).

Promenljivi faktori rizika obuhvataju ponašajne i metaboličke determinante, uključujući pušenje duvana, nezdravu ishranu, fizičku neaktivnost, prekomernu konzumaciju alkohola, hronični psihosocijalni stres i poremećaje mentalnog zdravlja (6). Metabolički faktori rizika uključuju arterijsku hipertenziju, dislipidemiju, poremećaje metabolizma glukoze (uključujući dijabetes melitus), gojaznost, naročito abdominalnog tipa, kao i hroničnu bubrežnu bolest. Upravo ovi promenljivi faktori rizika predstavljaju osnovu savremenih strategija prevencije KVB na globalnom i regionalnom nivou (1,8,9).

Prema dostupnim epidemiološkim podacima, Republika Srbija se ubraja među zemlje sa nepovoljnim kardiometaboličkim profilom (10,11). U populaciji se beleži visoka prevalencija ključnih faktora rizika za nastanak akutnog infarkta miokarda, uključujući pušenje (oko 35%), arterijsku hipertenziju (približno 40%), dijabetes mellitus (oko 10%), gojaznost (tj. indeks telesne mase  $\geq 30$  kg/m<sup>2</sup> je bio oko 25%) i fizičku neaktivnost (oko 40%), uz značajan uticaj psihosocijalnih i socioekonomskih faktora, procenjenih na približno 30% (10-15). U

poređenju sa prosekom većine evropskih zemalja, u Srbiji se registruje viši udeo pušača i osoba sa povišenim krvnim pritiskom, kao i izraženija fizička neaktivnost, dok su globalno prevalencije pušenja i gojaznosti niže (14,15).

Ovakav nepovoljan profil rizika doprinosi visokom opterećenju AIM u populaciji i ukazuje na potrebu za kontinuiranim praćenjem trendova i ciljanim preventivnim intervencijama.

Uprkos napretku u dijagnostici, terapiji i organizaciji zdravstvene zaštite, visok nivo izloženosti navedenim faktorima rizika održava značajan teret AIM i drugih KVB (1,5,9). Analiza prevalencije i raspodele faktora rizika, kako u opštoj populaciji, tako i među hospitalizovanim pacijentima sa AKS lečenim u koronarnim jedinicama, od ključnog je značaja za planiranje, evaluaciju i optimizaciju nacionalnih preventivnih strategija (5,8).

Cilj rada je da se analizira prevalencija ključnih faktora rizika za AIM među pacijentima sa AKS lečenim u koronarnim jedinicama u Republici Srbiji (2006–2011), kao i u opštoj populaciji Srbije (2012–2022), uz poređenje sa evropskim i globalnim prosekom radi boljeg sagledavanja opterećenja faktorima rizika i dodatnog uvida u potrebu za unapređenjem preventivnih intervencija na nacionalnom nivou.

## Metode

U okviru ove studije sprovedena je deskriptivna epidemiološka analiza sekundarnih podataka o prevalenciji faktora rizika povezanih sa AIM. S obzirom na to da u posmatranom periodu nisu postojali jedinstveni, kontinuirani podaci koji na istovetan način prate faktore rizika specifične za AIM u opštoj populaciji, primenjen je pristup analize podataka kroz dva komplementarna izvora: kliničku populaciju pacijenata sa AKS i opštu populaciju Republike Srbije.

Podaci o prevalenciji faktora rizika kod pacijenata hospitalizovanih zbog AKS u koronarnim jedinicama preuzeti su iz godišnjih publikacija Instituta za javno zdravlje Srbije „Dr Milan Jovanović Batut“ - Registra za akutni koronarni sindrom za period 2006-2011. godine (16). AKS je u ovom kontekstu klasifikovan na infarkt miokarda (IM) sa elevacijom ST segmenta (STEMI), IM bez elevacije ST segmenta (NSTEMI) i nestabilnu anginu pectoris, na osnovu elektrokardiografskih nalaza i laboratorijskih parametara (srčanih markera) (3,4,17).

Analiza trendova faktora rizika u opštoj populaciji Republike Srbije sprovedena je korišćen-

and ischemic cardiomyopathy” (2). “Unstable angina pectoris, non-ST-segment elevation myocardial infarction, ST-segment elevation myocardial infarction and sudden cardiac death are grouped under the common name acute coronary syndrome (ACS)” (3,4).

AMI represents one of the most significant clinical and public health problems within ACS, with a high share in the total morbidity and mortality attributed to CVDs, both in developed and in developing countries (1). Despite significant advances in the diagnosis, treatment and organization of health care, AMI still has a pronounced epidemiological and socio-economic significance, due to its high mortality, as well as long-term effects on the patients’ functional status and quality of life (5).

Risk factors for the occurrence of CVDs are traditionally classified into modifiable and non-modifiable. Non-modifiable risk factors include sex, age, genetic predisposition, and ethnicity. Although they cannot be influenced directly, they significantly contribute to the overall cardiovascular risk. The risk of AMI increases with age, and it is higher in men in the earlier decades of life, while in women it significantly increases after menopause (6). The positive family history, especially the early onset of CVDs in first-degree relatives additionally increases the probability of developing this disease (7).

Modifiable risk factors include behavioral and metabolic determinants, including tobacco smoking, unhealthy diet, physical inactivity, excessive alcohol consumption, chronic psychosocial stress and mental health disorders (6). Metabolic risk factors include arterial hypertension, dyslipidemia, disorders of glucose metabolism (including diabetes mellitus), obesity, especially abdominal, as well as chronic kidney disease. Precisely these modifiable risk factors represent the basis of contemporary strategies for the prevention of CVDs at the global and regional level (1,8,9).

According to the available epidemiological data, the Republic of Serbia is among the countries with the unfavorable cardio-metabolic profile (10,11). The high prevalence of key risk factors for the development of acute myocardial infarction is recorded in the population, including smoking (around 35%), arterial hypertension (approximately 40%), diabetes mellitus (about 10%), obesity (that is, body mass index  $\geq 30$  kg/m<sup>2</sup> was about 25%) and physical inactivity (around 40%), with the significant influence of psychosocial and socioeconomic factors, estimated at about 30% (10-15). In comparison to the aver-

age numbers in most European countries, a higher share of smokers and persons with hypertension is registered in Serbia, as well as pronounced physical inactivity, while globally the prevalence of smoking and obesity is lower (14,15).

Such an unfavorable profile of risks contributes to the high burden of AMI in the population and it points to the need for the continuous monitoring of trends and targeted preventive interventions.

Despite advances in the diagnosis, treatment and organization of health care, the high level of exposure to these risk factors maintains a significant burden of AMI and other CVDs (1,5,9). The analysis of prevalence and distribution of risk factors in the general population and among hospitalized patients with ACS treated in coronary care units, is crucial for the planning, evaluation and optimization of national preventive strategies (5,8).

The aim of this study is to analyze the prevalence of key risk factors for AMI among patients with acute coronary syndrome (ACS) treated in coronary care units in the Republic of Serbia (2006–2011), as well as in the general population of Serbia (2012–2022). Furthermore, these findings are compared with European and global averages to better understand the burden of risk factors and provide additional insight into the need for improved national preventive interventions.

## Methods

A descriptive epidemiological analysis of secondary data on the prevalence of risk factors associated with AMI was conducted within this study. Given that in the observed period, there were no unique, continuous data that tracked in the same way risk factors specific to AMI in the general population, the approach to data analysis was applied through two complementary sources: the clinical population of patients with ACS and the general population of the Republic of Serbia.

Data on the prevalence of risk factors in hospitalized patients with acute coronary syndrome (ACS) were retrieved from the annual publications of the Institute of Public Health of Serbia “Dr Milan Jovanović Batut” – the National Registry for Acute Coronary Syndrome for the period 2006-2011 (16). ACS was in this context classified into myocardial infarction (MI), ST-segment elevation myocardial infarction (STEMI), non-ST-segment elevation myocardial infarction (NSTEMI), unstable angina pectoris, based on the electrocardiographic findings and laboratory parameters (cardiac markers) (3,4,17).

jem nacionalnih zdravstvenih istraživanja iz 2013. i 2019. godine (18,19), kao i međunarodnih baza podataka za period 2012–2022: Svetske zdravstvene organizacije (WHO) (8), *Global Adult Tobacco Survey (GATS)* (14), *Global Burden of Disease Study (GBD)* (20) i *European Health Interview Survey (EHIS)* (21).

Faktori rizika definisani su u skladu sa metodologijom korišćenih izvora, pri čemu je primenjena kombinacija objektivnih podataka (medicinska dokumentacija za pacijente sa AKS) i subjektivnih indikatora (samoprijavljena dijagnoza, primena terapije ili anketni podaci za opštu populaciju).

Pušenje je definisano kao trenutno korišćenje duvanskih proizvoda (svakodnevno ili povremeno) u momentu ispitivanja (14,21). Arterijska hipertenzija, dijabetes melitus i dislipidemija su kod pacijenata sa AKS verifikovani uvidom u medicinsku dokumentaciju, dok su za opštu populaciju definisani kao samoprijavljena prethodna dijagnoza postavljena od strane lekara i/ili kontinuirana upotreba propisane terapije (10,18,19,21). Gojaznost i prekomerna telesna težina procenjuju se su izračunavanjem indeksa telesne mase (BMI, iskazan u  $\text{kg/m}^2$ ). Zbog razlika u dostupnosti godišnjih izveštaja, za opštu populaciju korišćena je zbirna kategorija  $\text{BMI} \geq 25 \text{ kg/m}^2$  (prekomerna telesna težina i gojaznost), dok se podaci za pacijente sa AKS interpretiraju uz oprez zbog nedosledne kvantifikacije ovog parametra u Registru u periodu 2006–2011. (16,21–23). Fizička neaktivnost je definisana prema EHIS kriterijumima kao neostvarivanje najman-

je 150 minuta umerene ili 75 minuta intenzivne fizičke aktivnosti nedeljno (21). Psihosocijalni stres analiziran je kao samoprijavljeni osećaj stresa evidentiran u godišnjim izveštajima Registra za AKS. Rezultati su prikazani kao sirove prevalencije. U nedostatku kontinuiranih godišnjih podataka za pojedine indikatore, korišćene su referentne procene iz najbližih dostupnih istraživačkih perioda. Za 2006. godinu, usled nedostatka podataka u primarnom izvoru (Registar za akutni koronarni sindrom), faktori poput psihosocijalnog stresa, gojaznosti i fizičke neaktivnosti nisu analizirani (16).

Poređenje prevalencija vršeno je deskriptivno, uz razmatranje metodološke heterogenosti izvora podataka.

## Rezultati

U Tabeli 1 prikazana je prevalencija ključnih faktora rizika kod pacijenata sa AKS lečenih u koronarnim jedinicama u Srbiji za period 2006–2011. godine. Uočava se visoka učestalost gotovo svih faktora rizika kod osoba sa AKS u trenutku postavljanja ove dijagnoze. U 2011. godini, približno 35% hospitalizovanih pacijenata sa AKS bili su aktivni pušači, oko 73% je imalo hipertenziju, oko 28% dijabetes melitus, oko 20% gojaznost ( $\text{BMI} \geq 30 \text{ kg/m}^2$ ), gotovo 37% je bilo fizički neaktivno, a svaka druga osoba ( $\approx 52\%$ ) je imala dislipidemiju i pozitivnu porodičnu anamnezu za AKS, dok je oko 31% prijavilo povišen nivo stresa. Visoka učestalost ovih faktora je bila prisutna tokom celog posmatranog perioda 2006–2011.

**Tabela 1.** Prevalencija ključnih faktora rizika kod pacijenata sa AKS lečenih u koronarnim jedinicama u Srbiji za period 2006 – 2011. (16)

Godina	Pušenje (%)	Hipertenzija (%)	Dijabetes (%)	Gojaznost (%)	Fizička neaktivnost (%)	Dislipidemija (%)	Nasleđe (%)	Stres (%)
2006	46,1	64,5	25,0	–	–	46,2	–	–
2007	32,5	70,9	26,1	17,5	32,8	48,5	48,5	26,1
2008	48,9	71,4	26,3	65,4	36,7	46,6	48,2	27,4
2009	33,2	75,3	29,5	67,8	43,9	61,3	61,8	37,0
2010	32,1	73,4	28,1	19,5	37,6	50,7	53,7	31,7
2011	35,3	73,0	27,6	20,5	36,7	52,3	52,9	30,6

U Tabeli 2 prikazana je prevalencija ključnih faktora rizika u opštoj populaciji Republike Srbije, zasnovane na dostupnim nacionalnim i međunarodnim izvorima podataka za period 2012–2022. godine. U opštoj populaciji, prevalencija pušenja iznosila je približno 35% do 37%, dok se prevalencija arterijske hipertenzije kretala u rasponu od oko 30%

do 33%. Dijabetes melitus je bio prisutan kod približno 8–10% stanovništva. Prevalencija gojaznosti i prekomerne telesne težine ( $\text{BMI} \geq 25 \text{ kg/m}^2$ ) iznosila je oko 57–60%, dok je fizička neaktivnost bila prisutna kod približno 35–40% ispitanika. Samoprocenjena učestalost dislipidemije je zabeležena kod približno 12–15% stanovništva.

The analysis of trends in risk factors in the general population of the Republic of Serbia was conducted using the National Health Surveys from 2013 and 2019 (18,19), as well as international secondary data sources for the period 2012–2022, including reports from the World Health Organization (WHO) (8), the Global Adult Tobacco Survey (GATS) (14), the Global Burden of Disease Study (GBD) (20), and the European Health Interview Survey (EHIS) (21).

Risk factors were defined in accordance with the methodology of used sources, where a combination of objective data (medical records for patients with ACS) and subjective indicators (self-reported diagnosis, use of therapy or survey data for the general population) was applied.

Smoking was defined as the current use of tobacco products (daily or occasionally) at the time of examination (14,21). Arterial hypertension, diabetes mellitus and dyslipidemia in patients with ACS were verified by reviewing medical records, while for the general population, they were defined as the self-reported previous diagnosis made by a doctor and/or continuous use of prescribed therapy (10,18,19,21). Obesity and overweight were defined by calculating the body mass index (BMI, expressed in kg/m<sup>2</sup>). Due to differences in the availability of annual reports, the combined category of BMI  $\geq$  25 kg/m<sup>2</sup> (overweight and obesity) was used for the general population, while data for patients with ACS were interpreted with caution because of the inconsistent quantification of this parameter in the Registry in the period 2006–2011 (16,21–23). Physical inactivity was defined according to EHIS

criteria as not undertaking at least 150 minutes of moderate-intensity or 75 minutes of vigorous physical activity per week (21). Psychosocial stress was analyzed as a self-reported feeling of stress recorded in the annual reports of the Registry for ACS. The results were presented as crude prevalence. In the absence of continuous annual data for specific indicators, reference estimates from the closest available research periods was used. For the year 2006, due to the lack of data in the primary source (Registry for acute coronary syndrome), factors such as psychosocial stress, obesity and physical inactivity were not analyzed (16).

The comparison of prevalence was conducted descriptively, taking into consideration the methodological heterogeneity of data sources.

## Results

The prevalence of key risk factors in patients with ACS treated in coronary care units in Serbia for the period 2006–2011 was presented in Table 1. The high prevalence of almost all risk factors was observed in patients with ACS at the moment when diagnosis was made. In 2011, approximately 35% of hospitalized patients with ACS were active smokers, about 73% had arterial hypertension, approximately 28% had diabetes mellitus, about 20% had obesity (BMI  $\geq$ 30 kg/m<sup>2</sup>), and roughly 37% were physically inactive, more than half had dyslipidemia and a positive family history for ACS, while approximately 31% reported elevated psychosocial stress. The high prevalence of these factors was present during the whole observed period 2006–2011.

**Table 1.** Prevalence of key risk factors in patients with acute coronary syndrome (ACS) treated in coronary care units in Serbia for the period 2006–2011.

Year	Smoking (%)	Hypertension (%)	Diabetes (%)	Obesity (%)	Physical inactivity (%)	Dyslipidemia (%)	Family history (%)	Stress (%)
2006	46.1	64.5	25.0	–	–	46.2	–	–
2007	32.5	70.9	26.1	17.5	32.8	48.5	48.5	26.1
2008	48.9	71.4	26.3	65.4	36.7	46.6	48.2	27.4
2009	33.2	75.3	29.5	67.8	43.9	61.3	61.8	37.0
2010	32.1	73.4	28.1	19.5	37.6	50.7	53.7	31.7
2011	35.3	73.0	27.6	20.5	36.7	52.3	52.9	30.6

The prevalence of key risk factors in the general population of the Republic of Serbia was shown in Table 2, based on available national and international sources of data for the period 2012–2022. In the general population, the prevalence of smoking amounted to around 35% to 37%, while the prevalence of arterial hypertension ranged from 30%

to 33%. Diabetes mellitus was present in approximately 8–10% of the population. The prevalence of obesity and overweight (BMI  $\geq$  25 kg/m<sup>2</sup>) was about 57–60%, while physical inactivity was present in approximately 35–40% of respondents. The self-reported prevalence of dyslipidemia was recorded in approximately 12–15% of the population.

**Tabela 2.** Referentne prevalencije ključnih faktora rizika u opštoj populaciji Republike Srbije za period 2012 – 2022. (10,11,14,20,21)

Faktor rizika	Prevalencija (%)	Izvor podataka
Pušenje	≈35–37	(10,14,18,19)
Arterijska hipertenzija	≈30–33	(10,18,19,21)
Dijabetes melitus	≈8–10	(10,18,19,)
BMI ≥25 kg/m <sup>2</sup>	≈57–60	(10,18,19,22)
Fizička neaktivnost	≈35–40	(10,18,19,21)
Dislipidemija	≈12–15	(10,18,19)

Podaci predstavljaju približne referentne procene prevalencije zasnovane pretežno na samoprijavljenim (anketnim) podacima nacionalnih zdravstvenih istraživanja, uz metodološke okvire GATS i EHIS. Zbog razlika u definicijama indikatora i dizajnu izvora podataka, vrednosti se tumače kao referentni okvir i nisu direktno uporedive između svih izvora. Godišnji podaci nisu dostupni za sve faktore rizika, te tabela ne prikazuje vremenske trendove.

## Diskusija

Rezultati ove studije potvrđuju da Republika Srbija održava nepovoljan kardiometabolički profil, koji se decenijama preslikava iz opšte populacije u koronarne jedinice. Kod pacijenata sa AKS dominiraju arterijska hipertenzija, dislipidemija i pušenje, što je u potpunosti u skladu sa globalnim podacima koji identifikuju ove faktore kao nosioce najvećeg dela preventabilnog kardiovaskularnog opterećenja (24,25).

Posebno je zabrinjavajući nalaz o perzistentnosti faktora rizika u opštoj populaciji tokom posmatranog desetogodišnjeg perioda (2012–2022). Dok razvijene evropske zemlje beleže pad prevalencije pušenja i bolju kontrolu arterijske hipertenzije, podaci za Srbiju ukazuju na stagnaciju ili čak porast ovih parametara. Činjenica da je prevalencija pušenja u opštoj populaciji (oko 37%) viša nego kod pacijenata koji su već doživeli AKS (oko 35%) sugeriše na ozbiljne propuste u primarnoj prevenciji i kontroli upotrebe duvana. Ovakav obrazac zahteva radikalnu promenu javnozdravstvenih politika, uz uvođenje strožih fiskalnih mera (porezi na duvan i šećer)

i stvaranje okruženja koje aktivno podstiče fizičku aktivnost (26,27).

Komparativna analiza sa evropskim prosekom pozicionira Srbiju u sam vrh zemalja sa visokim rizikom. Viša stopa gojaznosti (BMI ≥ 25kg/m<sup>2</sup> kod oko 60% populacije) i fizičke neaktivnosti (oko 40%) u odnosu na proseke EU stvara “rezervoar” budućih pacijenata za koronarne jedinice. Ovi nalazi direktno podržavaju potrebu za uvođenjem SCORE2 modela procene rizika, koji je specifično prilagođen populacijama sa veoma visokim kardiovaskularnim rizikom poput naše (37).

Procena rizika u kliničkoj praksi ne sme biti svedena na posmatranje izolovanih faktora. Naša analiza naglašava da se sinergistički efekat pušenja, hipertenzije i dijabetesa ne sabira, već multiplikuje, što je osnovni princip Framingham i SCORE modela stratifikacije rizika (32,39). Tabela 3 prikazuje da integrisani pristup proceni kardiovaskularnog rizika omogućava efikasniju i racionalniju upotrebu zdravstvenih resursa, kroz pravovremeno prepoznavanje i ciljanje osoba u kategoriji visokog i veoma visokog rizika, pre nastanka ireverzibilnog oštećenja miokarda.

**Tabela 3.** Ilustrativni prikaz kategorizacije faktora rizika prema SCORE i Framingham modelima (prilagođeno prema Conroy i sar., 2003; Wilson i sar., 1998) (32,37,39)

Faktor rizika	Nizak rizik	Srednji rizik	Visok rizik
Starost	<45 godina	45–60 godina	>60 godina
Pušački status	Nepušač	Povremeni pušač	Aktivni pušač
Sistolni krvni pritisak	<130 mmHg	130–139 mmHg	≥140 mmHg
Holesterol (ukupni)	<130 mg/dL	130–159 mg/dL	≥160 mg/dL
Dijabetes mellitus (modifikator rizika; van SCORE)	Ne	Predijabetes	Da

Kategorija dijabetesa je prikazana u ilustrativne svrhe kao modifikator rizika. Dijabetes melitus nije deo originalnog SCORE algoritma, dok je uključen u Framingham modele procene rizika, uključujući opšti kardiovaskularni profil rizika (D’Agostino i sar., 2008) (32).

**Table 2.** Reference prevalence of key cardiovascular risk factors in the general population of the Republic of Serbia 2012–2022 (10,11,14,20,21)

Risk factor	Prevalence (%)	Data source
Smoking	≈35–37	(10,14,18,19)
Arterial hypertension	≈30–33	(10,18,19,21)
Diabetes mellitus	≈8–10	(10,18,19)
BMI ≥25 kg/m <sup>2</sup>	≈57–60	(10,18,19,22)
Physical inactivity	≈35–40	(10,18,19,21)
Dyslipidaemia	≈12–15	(10,18,19)

The data represent approximate reference prevalence estimates, derived primarily from self-reported (survey-based) data from national health surveys, using the methodological frameworks of GATS and EHIS. Due to differences in indicator definitions and source design, the values should be interpreted as a reference framework and are not directly comparable across all sources. Annual data are not available for all risk factors; therefore, the table does not present time trends.

## Discussion

The results of this study confirm that the Republic of Serbia maintains an unfavorable cardiometabolic profile, which has transitioned from the general population to coronary care units for decades. Arterial hypertension, dyslipidemia and smoking are dominant in patients with ACS, which is completely in accordance with the global data that identify these factors as the carriers of the largest part of the preventable cardiovascular burden (24,25).

Findings concerning the persistence of risk factors in the general population during the observed ten-year period (2012–2022) are particularly worrying. While developed European countries record a decline in the prevalence of smoking and better control of arterial hypertension, data for Serbia indicate stagnation or even an increase in these parameters. The fact that the prevalence of smoking in the general population (about 37%) is higher than in patients who have already experienced ACS (about 35%) suggests serious omissions in the primary prevention and control of tobacco use. This pattern requires a radical change in public health policies, with the introduction of stricter fiscal measures (tobacco and sugar taxes) and the

creation of environment that actively encourages physical activity (26,27).

The comparative analysis of the European average places Serbia at the very top of countries with a high risk. A higher rate of obesity (BMI ≥ 25 kg/m<sup>2</sup> in about 60% of the population) and physical inactivity (about 40%) compared to the EU average numbers creates a “reservoir” of future patients in coronary care units. These findings directly support the need to introduce the SCORE2 risk assessment model, which is specifically adjusted to populations with a very high cardiovascular risk such as ours (37).

Risk assessment in clinical practice must not be reduced to the observation of isolated factors. It is emphasized in our analysis that the synergistic effect of smoking, hypertension and diabetes is not merely additive, but multiplicative, which is the basic principle of Framingham’s and SCORE model of risk stratification (32,39). Table 3 shows that the integrated approach to cardiovascular risk assessment enables a more efficient and rational use of health resources, through timely recognition and targeting of persons belonging to the category of high and very high risk, before the onset of irreversible myocardial damage.

**Table 3.** Illustrative presentation of risk factor categorization according to the SCORE and Framingham models (*adapted from Conroy et al., 2003; Wilson et al., 1998*) (32,37,39)

Risk factor	Low risk	Moderate risk	High risk
Age	<45 years	45–60 years	>60 years
Smoking status	Non-smoker	Occasional smoker	Active smoker
Systolic blood pressure	<130 mmHg	130–139 mmHg	≥140 mmHg
Cholesterol (total)	<130 mg/dL	130–159 mg/dL	≥160 mg/dL
Diabetes mellitus(risk modifier; outside SCORE)	No	Prediabetes	Yes

The diabetes category is provided for illustrative purposes as a risk modifier. Diabetes mellitus is not part of the original SCORE algorithm, whereas it is incorporated in Framingham-based models, including the general cardiovascular risk profile (D’Agostino et al., 2008) (32).

Konačno, visoka prevalencija psihosocijalnog stresa (oko 31%) kod pacijenata sa AKS ukazuje na to da savremeni preventivni protokoli u Srbiji moraju uključiti i aspekte mentalnog zdravlja i socioekonomskog statusa, koji se u našoj sredini često zanemaruju u korist isključivo metaboličkih parametara (12,38).

Sveobuhvatni pristup kontroli kardiovaskularnog opterećenja u Srbiji zahteva precizno definisane nivoe intervencija. Primarna prevencija mora ostati prioritet javnog zdravlja, s fokusom na modifikaciju životnog stila. Prestanak pušenja, prelazak na mediteranski tip ishrane i redovna fizička aktivnost, uz ranu identifikaciju dijabetesa i adekvatnu kontrolu arterijskog krvnog pritiska, čine temelj smanjenja incidencije AIM (6,28,40). Podatak o visokom BMI u opštoj populaciji Srbije (60%) dodatno naglašava potrebu za intervencijama koje prevazilaze samo savetovanje i prelaze u domen nacionalnih politika kontrole hrane i fizičkog okruženja (29,30).

Za pacijente koji su već razvili koronarnu bolest, sekundarna prevencija predstavlja imperativ u sprečavanju fatalnih ishoda. Ona se oslanja na "zlatni standard" farmakoterapije (antitrombocitna terapija, beta-blokatori, ACE inhibitori i statini) i rano uključivanje u programe kardiološke reha-

bilitacije. Ovi programi nisu samo medicinska podrška, već strukturirani procesi koji dokazano redukuju ukupni mortalitet i rizik od recidiva infarkta (28,41,42).

Iako se u praksi često poistovećuje sa sekundarnom, tercijarna prevencija (dugoročno postinfarktno zbrinjavanje) ima specifičan cilj: očuvanje preostalog funkcionalnog kapaciteta miokarda i prevenciju razvoja hronične srčane insuficijencije. Ona podrazumeva kontinuiranu edukaciju i reintegraciju pacijenta, uz stalnu optimizaciju terapije kako bi se izbegle teške aritmije i druge kasne komplikacije AIM (28,43).

Uporedna analiza efekata ovih mera (Tabela 4) jasno pokazuje da nepušački status i fizička aktivnost ostvaruju najveću relativnu redukciju rizika, često nadmašujući efekte pojedinačnih farmakoloških agenasa. Međutim, ključni zaključak kliničkih i epidemioloških studija jeste da preventivne intervencije deluju sinergijski. Kombinovana primena nefarmakoloških mera i savremene terapije (statina i antihipertenziva) pruža zaštitu koja je značajno veća od zbira njihovih pojedinačnih efekata (6,28,44). Ovakav integrisani pristup, usklađen sa evropskim smernicama, jedini je održiv model za smanjenje visokog kardiovaskularnog mortaliteta u Republici Srbiji.

**Tabela 4.** Ilustrativni prikaz relativnog smanjenja kardiovaskularnog rizika povezanog sa odabranim preventivnim intervencijama kod akutnog infarkta miokarda

Intervencija	Relativno smanjenje rizika	Ciljna populacija
Prestanak pušenja	Smanjenje kardiovaskularnog rizika za 36%	Opšta populacija, pacijenti posle AIM (28,29)
Smanjenje krvnog pritiska (za 10 mmHg sistolnog)	Smanjenje rizika od nastanka AIM za 20–25%	Osobe sa hipertenzijom (24,34)
Statini (na 1 mmol/L smanjenja LDL)	Smanjenje velikih kardiovaskularnih događaja za 20–25%	Primarna i sekundarna prevencija (9,36)
ACE inhibitori (posle AIM)	Smanjenje mortaliteta za 20–22%	Sekundarna prevencija (41)
Kardiološka rehabilitacija	Smanjenje ukupnog rizika i rizika reinfarkta za 13–26%	Pacijenti posle AIM (28,42)
Fizička aktivnost $\geq 150$ min/ nedeljno	Smanjenje kardiovaskularnog rizika za 20–30%	Opšta populacija (27,28)

*Napomena: Prikazane vrednosti predstavljaju približne procene relativnog smanjenja kardiovaskularnog rizika zasnovane na različitim kliničkim i epidemiološkim studijama i odnose se na specifične ciljne populacije. Prikazani efekti nisu direktno uporedivi između intervencija, već služe za ilustraciju potencijalnog doprinosa pojedinačnih preventivnih mera u smanjenju rizika od akutnog infarkta miokarda.*

Prednosti ove studije ogledaju se pre svega u dugoročnom vremenskom obuhvatu od šesnaest godina, što je omogućilo detaljno praćenje trendova faktora rizika kako u opštoj populaciji tako i među osobama sa AKS lečenim u koronarnim jedinicama. Iako se deo podataka odnosi na širi spek-

tar AKS, oni pružaju pouzdanu sliku o opterećenju faktorima rizika koji su direktno povezani sa patogeneom AIM. Sa druge strane, studija ima određena ograničenja, prvenstveno zbog heterogenosti izvora podataka. Dok su podaci za pacijente sa AKS bazirani na objektivnim kliničkim nalazima,

Finally, the high prevalence of psychosocial stress (about 31%) in patients with ACS indicates that modern prevention protocols in Serbia must also include aspects of mental health and socioeconomic status, which are often neglected in our environment in favor of solely metabolic parameters (12,38).

A comprehensive approach to the control of cardiovascular burden in Serbia requires precisely defined levels of interventions. Primary prevention must remain the priority of public health with a focus on lifestyle modification. Quitting smoking, switching to the Mediterranean diet, and regular physical activity, along with the early identification of diabetes and adequate control of arterial blood pressure, make the basis for reducing the incidence of AMI (6,28,40). The data on the high BMI in the general population in Serbia (60%) additionally emphasizes the need for interventions that go beyond counseling and go into the domain of national policies relating to the control of food and physical environment (29,30).

For patients who have already developed coronary disease, secondary prevention is imperative in preventing fatal outcomes. It relies on the “gold standard” of pharmacotherapy (antiplatelet therapy, beta-blockers, ACE inhibitors and statins) and the early inclusion in cardiac rehabilitation programs. These programs do not imply only medical support,

but structured processes that have been proven to reduce overall mortality and the risk of recurrent myocardial infarction (28,41,42).

Although it is often equated with secondary prevention in practice, tertiary prevention (long-term post-infarction care) has a specific goal: preserving the remaining functional capacity of the myocardium and preventing the development of chronic heart failure. It implies the continuous integration and reintegration of the patient, with the constant optimization of therapy in order to avoid severe arrhythmias and other late complications of AMI (28,43).

The comparative analysis of effects of these measures (Table 4) clearly shows that non-smoking status and physical activity achieve the greatest relative risk reduction, often surpassing the effects of individual pharmacological agents. However, a key conclusion of clinical and epidemiological studies is that preventive interventions act synergistically. The combined application of non-pharmacological measures and modern therapy (statins and antihypertensives) provides the protection which is significantly greater than the sum of their individual effects (6,28,44). This integrated approach, which is aligned with the European guidelines, is the only sustainable model for reducing high cardiovascular mortality in the Republic of Serbia.

**Table 4.** Illustrative overview of relative risk reduction associated with selected preventive interventions for acute myocardial infarction

Intervention	Relative risk reduction	Target population
Smoking cessation	36% reduction in cardiovascular risk	General population, post-AMI (28,29)
Blood pressure reduction (10 mmHg systolic)	20–25% reduction in incident AMI	Hypertensive patients (24,34)
Statins (per 1 mmol/L LDL reduction)	20–25% reduction in major cardiovascular events	Primary and secondary prevention (9,36)
ACE inhibitors (post-AMI)	20–22% reduction in mortality	Secondary prevention (41)
Cardiac rehabilitation	13–26% reduction in overall and reinfarction risk	Post-AMI patients (28,42)
Physical activity $\geq 150$ min/week	20–30% reduction in cardiovascular risk	General population (27,28)

*Note: The presented values represent approximate estimates of relative cardiovascular risk reduction derived from different clinical and epidemiological studies and refer to specific target populations. The effects are not directly comparable across interventions and are intended to illustrate the potential contribution of individual preventive measures to reducing the risk of acute myocardial infarction.*

The advantages of this study are reflected, first of all, in the long-term time span of 16 years, which enabled a detailed monitoring of trends in risk factors, both in the general population and in persons with ACS treated in coronary care units. Although some of the data refer to the wider spectrum of

ACS, they provide a reliable picture of the burden related to risk factors that are directly associated with the pathogenesis of AMI. On the other hand, the study has certain limitations, primarily due to the heterogeneity of data sources. Although data relating to patients with ACS are based on objec-

podaci za opštu populaciju se velikim delom oslanjaju na ankete i samoprocenu, što nosi rizik od potcenjivanja prevalencije određenih stanja, naročito dislipidemije. Takođe, oslanjanje na sekundarne izvore podataka onemogućilo je dublju analizu specifičnih laboratorijskih biomarkera u opštoj populaciji, dok deskriptivna studija omogućava da se uoči korelacija i prate trendovi, ali ne i dokazivanje uzročno-posledičnih veza.

## Zaključak

Rezultati studije ukazuju na perzistentno visoku prevalenciju modifikabilnih faktora rizika u Republici Srbiji, koja se iz populacije pacijenata sa AKS u periodu 2006–2011. godine preslikala i na opštu populaciju u narednoj deceniji, od 2012. do 2022. godine. Ovakvi trendovi, nepovoljniji u odnosu na evropski prosek, ukazuju na potrebu za integrisanim preventivnim strategijama usmerenim na modifikabilne faktore rizika, sa ciljem smanjenja ukupnog kardiovaskularnog opterećenja u Republici Srbiji.

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tive clinical findings, data for the general population are, to a large extent, based on questionnaires and self-assessment, which carries the risk of underestimating the prevalence of certain conditions, especially dyslipidemia. Also, relying on secondary data sources did not allow a deeper analysis of specific laboratory biomarkers in the general population, while a descriptive study allows one to observe correlations and follow trends, but not to prove the causal connection.

## Conclusion

The findings of this study indicate a persistently high prevalence of modifiable risk factors in the Republic of Serbia, which transitioned from the ACS patient population (2006–2011) to the general population over the following decade (2012–2022). These trends, which are more unfavorable than the European average, highlight the need for integrated preventive strategies targeting modifiable risk factors to reduce the overall cardiovascular burden in the Republic of Serbia.

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