American Journal of Preventive Cardiology xxx (xxxx) xxx

Contents lists available at ScienceDirect

American Journal of Preventive Cardiology

journal homepage: www.journals.elsevier.com/american-journal-of-preventive-cardiology

Original Research

Prevalence and trends of risk factors and comorbidities among patients treated for acute myocardial infarction: Insights from the Hungarian Myocardial Infarction Registry, 2014–2024

András Jánosi [a], Zoltán Járai [b,c], Bettina Martus [d], Tamás Ferenci [d,e,*], Péter Andréka [a]

[a] Gottsegen György National Cardiovascular Institute, 1096, Budapest, Haller utca 29, Hungary
[b] Department of Cardiology, South Buda Centre Hospital, St. Imre University Teaching Hospital, 1115, Budapest, Tétényi út 12-16, Hungary
[c] Section of Angiology, Heart and Vascular Center, Semmelweis University, 1122, Budapest, Városmajor út 68, Hungary
[d] Department of Statistics, Corvinus University of Budapest, 1093, Budapest, Fővám tér 8, Hungary
[e] Physiological Controls Research Center, John von Neumann Faculty of Informatics, Óbuda University, 1034, Budapest, Bécsi út 96/b, Hungary

ARTICLE INFO

Keywords:
Myocardial infarction
Risk factor
Comorbidity
Obesity
Hypertension
Diabetes
Hyperlipidaemia

ABSTRACT

Background: The Hungarian Myocardial Infarction Registry is a mandatory registry that records the medical history, hospital care data, and long-term follow-up of every patient diagnosed with myocardial infarction in Hungary. The aim was to examine the age distribution, common risk factors and comorbidities among patients with acute myocardial infarction (AMI) recorded in the Registry between January 1, 2014 and December 31, 2024.

Methods: Generalised additive models were used to estimate the prevalence of risk factors and comorbidities, allowing smooth time trends and age-adjustment. UpSet plots were used to investigate frequent combinations.

Results: We analysed data from 135,865 patients (39.6% women) who received treatment for AMI (46.6% STEMI). The most prevalent comorbidity was hypertension. The prevalence of smoking, obesity and diabetes increased in both genders and both AMI types, with the odds ratios per 10 year ranging from 1.11 to 1.37 for diabetes (depending on gender and AMI type), from 1.43 to 2.08 for smoking and from 1.37 to 1.62 for obesity. In case of hyperlipidaemia, the increase was significant only among cases with STEMI. For hypertension, some changes were statistically significant, but were not clinically relevant. The prevalence of young (<40 years) patients changed significantly only among male patients with STEMI, where it decreased, while the prevalence of old (>80 years) patients decreased significantly in every group, except among male patients with NSTEMI.

Conclusion: We observed a significant increase in the prevalence of smoking, obesity and diabetes mellitus in different types of myocardial infarction in both sexes.

Introduction

Atherosclerotic vascular diseases, including acute myocardial infarction (AMI), are the leading cause of death in Europe and thus also in Hungary [1]. Major modifiable risk factors for atherosclerosis and comorbidities that worsen the prognosis include smoking, obesity, type 2 diabetes mellitus, dyslipidaemia, and hypertension [2].

In our earlier studies, we examined the prevalence of risk factors and comorbidities in patients with myocardial infarction by analysing data from national myocardial infarction registries [3,4]. These analyses showed that patients with different types of AMI had varying prevalence of risk factors and comorbidities, and that there were significant inter-country differences as well. Traditional risk factors and comorbidities were more common among patients treated for non-ST-elevation myocardial infarction (NSTEMI) than among those with ST-elevation myocardial infarction (STEMI). Among Hungarian patients with NSTEMI, hypertension and diabetes mellitus were more common compared to Sweden, Norway and Estonia [4].

In the present study, extending previous comparative analyses, we aimed to evaluate temporal changes in the prevalence of major

All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

* Corresponding author at: 1034, Budapest, Bécsi út 96/b, Hungary.
E-mail address: ferenci.tamas@nik.uni-obuda.hu (T. Ferenci).

https://doi.org/10.1016/j.ajpc.2026.101789
Received 28 May 2026; Received in revised form 6 August 2026; Accepted 8 August 2026
Available online 8 August 2026

modifiable risk factors and comorbidities – smoking, high cholesterol level, obesity, hypertension, and type 2 diabetes mellitus – along with the prevalence of low and high age among patients with AMI registered in the Hungarian Myocardial Infarction Registry (HUMIR) between 1 January, 2014 and 31 December, 2024. Investigating the impact of the risk factors and comorbidities on outcome was outside the scope of the present study, instead, we focused on documenting the patterns and trends of these factors.

Methods

Patient data

Hungary began voluntary online registration of AMI patients in 2010. It became mandatory for all healthcare providers by law (CCXLVI./2013) in 2014. The Hungarian Myocardial Infarction Registry (HUMIR) is a comprehensive, prospective, online registry managed by the Gottsegen György National Cardiovascular Institute. It systematically collects nationwide data on all hospitalised AMI patients, with or without ST-segment elevation. HUMIR joined the European Unified Registries for Heart Care Evaluation and Randomised Trials [5]. Earlier publications have thoroughly described the registry's data acquisition processes for the acute phase, in-hospital care, and follow-up periods [6]. In short, HUMIR is a comprehensive repository that collects data across 178 categories. It captures a wide range of information, from baseline demographics to hospital care, including coronary interventions and follow-up outcomes. The dataset gives an accurate picture of Hungarian healthcare and clinical practices. The Hungarian Central Ethics Committee approved the program (34858/2019/EKU). The treating physician diagnosed acute myocardial infarction based on current guidelines. This diagnosis was automatically validated by the online system software. Risk factors and comorbidities were determined by the treating physician based on medical history and hospitalisation data.

Statistical methods

Categorical variables are presented as count (proportion), while continuous variables are presented as median (interquartile range). To investigate prevalence, we used logistic regression with the predictor variables being the date of infarction (with day precision), age, and sex. We expanded continuous covariates (date and age) using thin-plate regression splines [7]. This allowed smooth modelling of the change over time without binning. For age-adjusted estimates, we generated predictions based on the fixed age distribution from the last year. To investigate overall long-term change, we also fitted a regression with time as a linear covariate. This fit a straight line on the logit scale for the whole observation period, without age adjustment. In this instance, we report the odds ratio (OR) reflecting the change for a 10-year period, with a 95% confidence interval. All calculations were carried out stratified by sex and type of infarction. Smoothed time trends are plotted with a 95% confidence interval. For low and high age groups, population-based incidence was also calculated in addition to prevalence (as in this case the counts were available for the whole population). Population counts by age and sex pertaining to January 1 were obtained from the Eurostat database 'demo_pjan' and were transferred to weekly count by linear extrapolation. Incidence was then modelled with a generalized additive model with the count as the outcome, log-population as offset, and age and (weekly) date as the predictor, with tensor-product spline expansion. The whole calculation was stratified according to sex and type of the infarction. Most prevalent combinations of risk factors are visualized with UpSet plot [8]. In case of obesity, observations in the first three months were not used as they were outliers, with anomalously high prevalence. Missing values were dropped without imputation (there were no missing values for the age and sex of the patient and the date of the infarction, for the remaining factors the proportion of missing values was less than or equal to 3%, with the exception of hyperlipidemia with 9%, and much more notably, smoking, where 43.4% had missing value). Calculations were carried out in R (version 4.5.2) using the mgcv package (version 1.9–4) [9]. Full source code of the analysis script is available at https://github.com/ferenci-tamas/infarction-risk-factor-comorbidity.

Results

From 1 January 2014 to 31 December 2024, 150,461 patients were hospitalised in Hungary with an AMI diagnosis based on the data from the single nation health insurance fund in Hungary. Linkage of the two databases allows a quantitative characterization of the completeness of registration in HUMOR, as 88.7% of these cases were registered in the HUMIR database. Changing practices or screening intensity over time might bias the results, so it is important to point out that apart from 2014 (67.0%) and 2015 (71.3%) every year had a completeness above 80%, with the most being above 85%, with no secular trend [10]. In this study, we analysed data on 135,865 hospitalised patients (39.6% women) treated for acute myocardial infarction (46.6% STEMI).

The diagnosis, gender distribution, and mean age of the patients are summarised in Table 1. As shown in this summary, NSTEMI patients were older than STEMI patients in both genders, and males were younger than females in both infarction types (Table 1).

Hypertension was the most prevalent comorbidity in both sexes and AMI types. After hypertension, the second most common comorbidity in NSTEMI was obesity in both genders. In STEMI however, the prevalence of smoking and obesity was similar after hypertension (Fig. 1).

Low and high age groups

The prevalence of young (<40 years) patients only changed significantly among males with STEMI, where it decreased (OR = 0.67 per 10 year, 95% CI: 0.56–0.80), but not for other genders and AMI types (Table 2). On the other hand, the prevalence of old (>80 years) patients decreased significantly in every groups (with ORs ranging from 0.77 to 0.86) except among male patients with NSTEMI (Table 2).

Age was an exception, because for this – in contrast to other variables – the population composition was also available (i.e., the population pyramid) allowing the calculation of population-based incidences as well in addition to the prevalence (Supplementary Figure S6). This confirms the decrease of risk in older age groups (after some elevation at the beginning of the study period in some cases). For younger age groups however the picture is more complicated with increase in some strata, and a roughly constant risk in male patients with STEMI. This does not contradict the earlier statement on increasing prevalence, as the age characteristics of the patients also changed over time: patients got slightly older on average as time went forward.

Smoking

The prevalence of smoking increased in both genders and infarction types (Fig. 1, Table 2), with the greatest increase in those aged around 70 years, regardless of gender and AMI type (Supplementary Figure S1).

Obesity

The prevalence of obesity (BMI above 30 kg/m2) increased in both

Table 1
The diagnosis, gender distribution, and age of the patients.

	Men	Women	Total	Age
STEMI	39,219	24,105	63,324	64.6 ± 13.0
NSTEMI	42,777	29,764	72,541	69.1 ± 12.3
Overall	81,996	53,869	135,865	67.0 ± 12.8

genders and infarction types (Fig. 1, Table 2) almost uniformly across all age groups (Supplementary Figure S2). In males, older age groups tend to have lower prevalence, but no such age-difference is apparent in case of females.

Diabetes mellitus

The prevalence of diabetes mellitus increased in both genders and infarction types (Fig. 1, Table 2). This increase was almost uniform for all age groups (Supplementary Figure S3).

Hyperlipidaemia

The prevalence of hyperlipidaemia increased only in STEMI patients (Fig. 1, Table 2). The age pattern was mostly consistent. For males with NSTEMI, younger age groups showed a decreasing trend, and older groups showed no trend (Supplementary Figure S4).

Hypertension

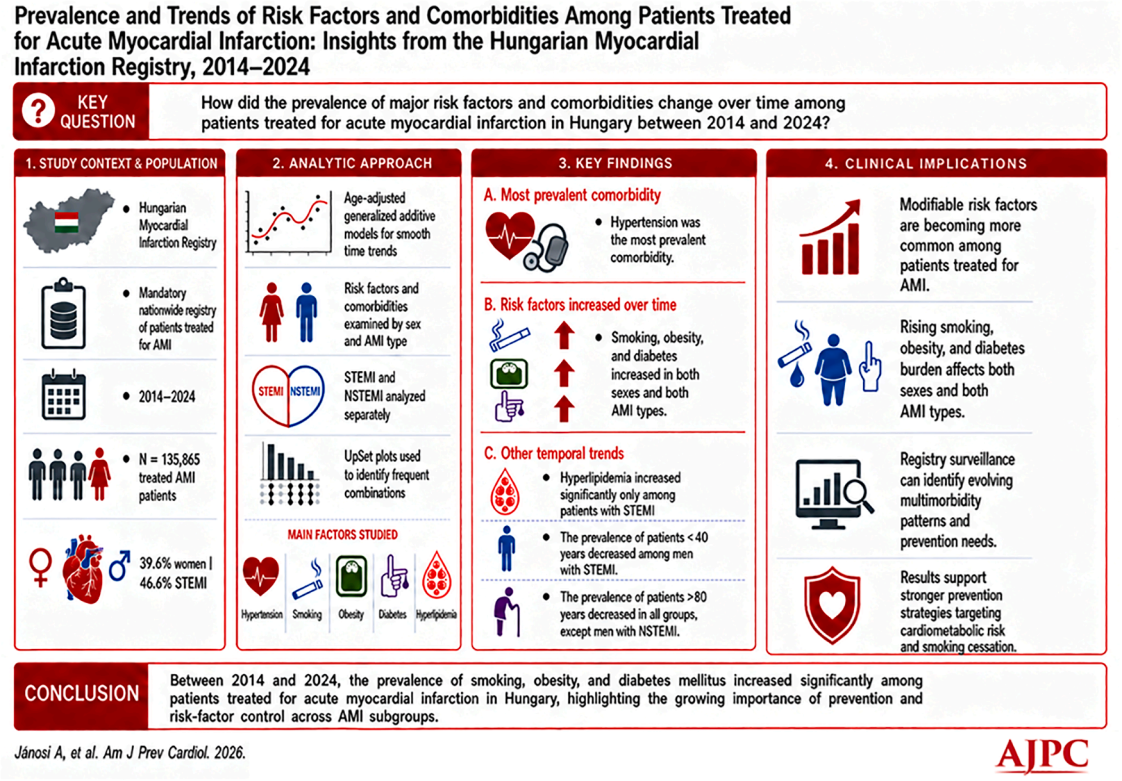
High blood pressure is by far the most prevalent risk factor in patients with AMI, regardless of gender or infarction type (Fig. 1, Table 2). There was a statistically significant increase in the prevalence among males with STEMI and a decrease in females with NSTEMI, however, these changes are small and not clinically relevant. These patterns were almost perfectly consistent across age groups (Supplementary Figure S5).

Combinations of risk factors and comorbidities

Over the observation period, the average number of modifiable risk factors increased in both AMI types, in both genders and in all age groups (Fig. 2). The highest burden of risk factors was observed for patients around 60 years of age. During the study period, the proportion of patients with 0–1 risk factors declined, while the proportion with 3 or more risk factors increased across all age groups, AMI types, and both genders (Fig. 3).

The most frequent risk factor combinations were hypertension alone, hypertension combined with smoking, hypertension combined with obesity, the combination of all three, and smoking alone. Half of the patients with smoking as their only risk factor were male STEMI cases. Patients with isolated hypertension tended to be older than the overall AMI population, while those with smoking as their sole risk factor were generally younger (Fig. 4).

Discussion



Central illustration.

This analysis elucidates evolving trends in patient demographics and cardiovascular risk factors among individuals treated for acute myocardial infarction (AMI) in Hungary from 2014 to 2024. Unfortunately, reliable prevalence estimates for the comorbidities and risk factors were not available for the whole population, precluding the calculation of the incidence of AMI according these factors (thereby limiting our ability to separate true change in risk from the change in the population's composition), the prevalences nevertheless offer valuable insights into the shifting landscape of AMI, with important implications for both clinical management and public health strategies. Given that nearly 90% of AMI cases are entered into the HUMIR register, our results can be considered representative and comprehensive of the Hungarian AMI population as a whole. The high coverage of our registry also reduces the risk of systemic bias, which is more likely in less complete registries [11].

In patients with AMI under the age of 40, men outnumbered women in both infarction types. The cause of the decline in the frequency of STEMI among younger (≤40 years) men and women, as well as among the oldest age groups (≥80 years) over the study period, needs further

Fig. 1. Age-adjusted prevalences of different risk factors and comorbidities, stratified according to gender and type of infarction.

evaluation, as during the observed decade, smoking, obesity, and diabetes prevalence increased substantially, while hypertension remained the most common comorbidity of AMI patients.

Analysis of risk factor combinations revealed an increasing burden of modifiable risks, with a decline in patients harbouring 0–1 risk factors and an increase in those with 3 or more. The most common patterns included isolated hypertension, hypertension combined with smoking or obesity, and all three factors together. Notably, younger patients tended to present with smoking as their sole risk factor, while isolated hypertension was more prevalent in older individuals.

One of the main results of our study is that our data refute the assumption that patients are having myocardial infarction at an increasingly younger age. In a US study by Tisminetzky et al., the age of patients with incident AMI decreased significantly from 2005 to 2015 [12]. On the other hand, according to the AMIS Plus study, the average age of patients with infarction did not change between 1997 and 2018 [13]. The prevalence of smoking was unchanged in men, but increased in women, while hypertension and dyslipidaemia increased in both sexes. Arora et al., analysing a nearly 20-year period, found that the incidence of young men in the infarction population decreased during the observation period, whereas an increase in incidence was reported in young women [14]. When examining the frequency of risk factors, they found a higher incidence of both hypertension and diabetes.

Based on the analysis of the SCAAR-SWEDEHEART database, Gautadottir et al. reported that while the frequency of young infarction patients did not change between 2014 and 2020, smoking and obesity

Table 2

Long-term trends of risk factors and comorbidities. Trend indicates odds ratio per 10 years assuming linear model (95% confidence interval in parenthesis; bold font indicates trends that are significant at 5%). Prevalences are predicted values according to this linear trend.

	Females					
	NSTEMI			STEMI		
	Prevalence (%)		Trend	Prevalence (%)		Trend
	2014	2024		2014	2024	
Young (age ≤ 40 years)	0.7	1.0	1.43 (0.95 - 2.16)	1.5	1.2	0.86 (0.60 - 1.21)
Elderly (age ≥ 80 years)	**31.8**	**26.1**	**0.78 (0.72 - 0.84)**	**24.1**	**21.2**	**0.86 (0.78 - 0.94)**
Hypertension	**88.4**	**85.6**	**0.79 (0.71 - 0.89)**	80.1	80.3	1.01 (0.91 - 1.12)
Diabetes mellitus	**38.4**	**41.1**	**1.11 (1.03 - 1.20)**	**29.7**	**36.9**	**1.34 (1.23 - 1.47)**
Hyperlipidemia	37.1	36.6	0.98 (0.90 - 1.07)	**26.5**	**33.8**	**1.37 (1.25 - 1.51)**
Smoking	**24.3**	**41.8**	**2.08 (1.85 - 2.33)**	**37.4**	**53.9**	**1.84 (1.65 - 2.06)**
Obesity	**48.8**	**57.4**	**1.37 (1.26 - 1.48)**	**42.1**	**49.8**	**1.39 (1.28 - 1.51)**
	Males					
	NSTEMI			STEMI		
	Prevalence (%)		Trend	Prevalence (%)		Trend
	2014	2024		2014	2024	
Young (age ≤ 40 years)	1.4	1.5	1.11 (0.86 - 1.44)	**4.1**	**2.7**	**0.67 (0.56 - 0.80)**
Elderly (age ≥ 80 years)	15.0	14.0	0.93 (0.85 - 1.02)	**8.2**	**6.3**	**0.77 (0.68 - 0.87)**
Hypertension	82.0	83.2	1.08 (0.99 - 1.17)	**69.3**	**71.5**	**1.10 (1.03 - 1.18)**
Diabetes mellitus	**35.0**	**41.1**	**1.27 (1.19 - 1.35)**	**24.8**	**31.8**	**1.37 (1.28 - 1.48)**
Hyperlipidemia	36.8	38.5	1.07 (1.00 - 1.14)	**26.8**	**32.7**	**1.30 (1.21 - 1.40)**
Smoking	**39.0**	**49.8**	**1.49 (1.37 - 1.63)**	**52.5**	**62.1**	**1.43 (1.32 - 1.55)**
Obesity	**45.6**	**58.8**	**1.62 (1.52 - 1.73)**	**41.0**	**52.8**	**1.54 (1.44 - 1.64)**

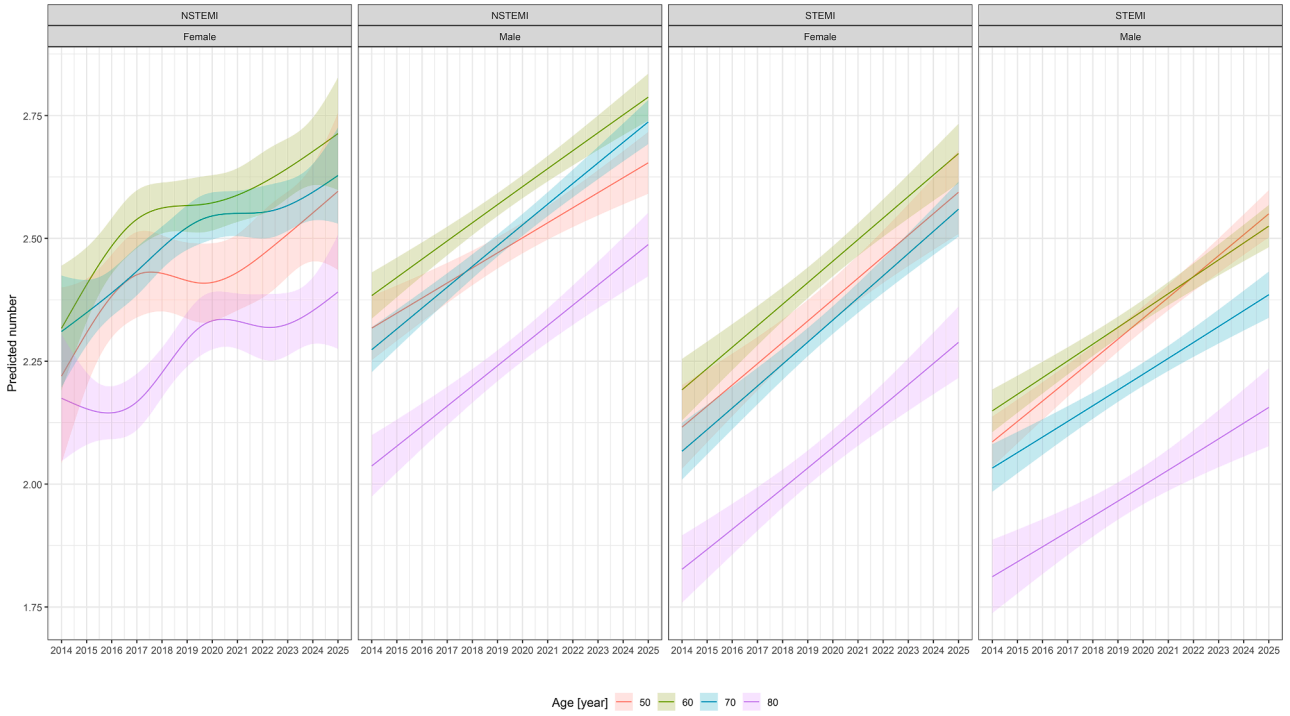


Fig. 2. Mean number of risk factors, stratified according to age, sex and type of infarction.

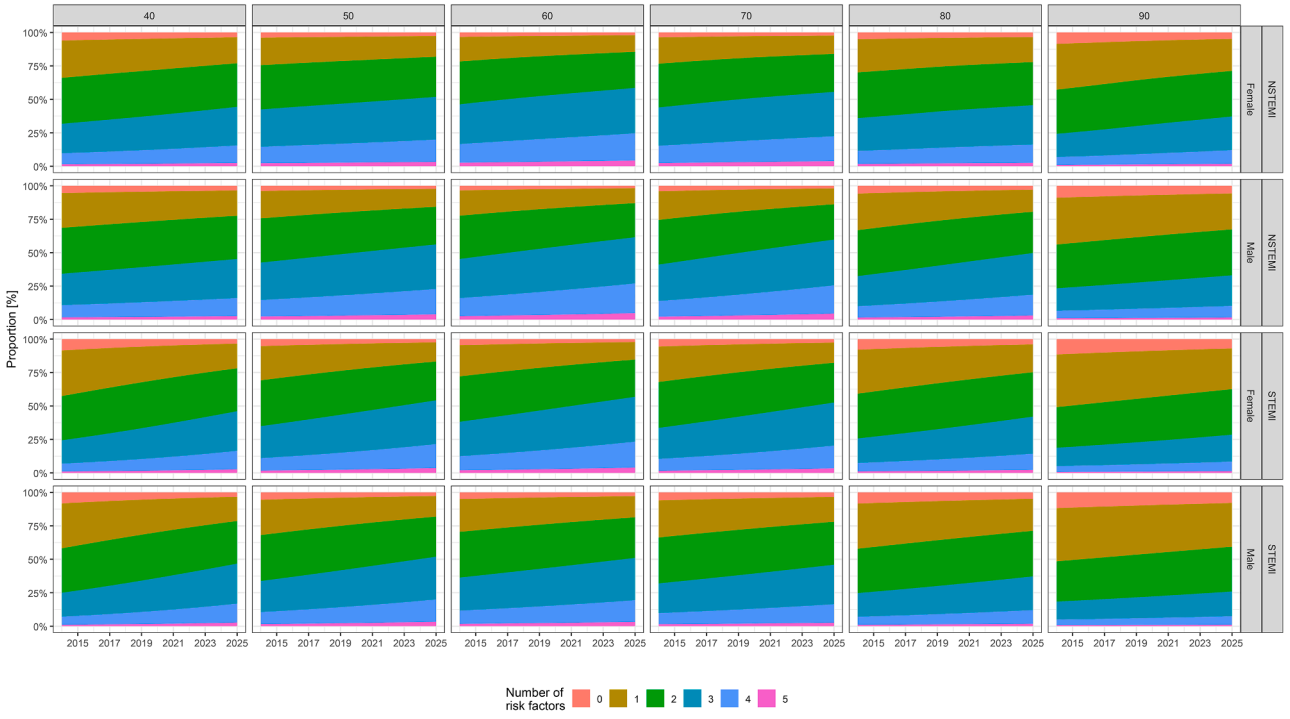


Fig. 3. Distribution of the number of risk factors, stratified according to age, sex and type of infarction.

were more common among young infarction patients than in the older age group [15]. In another cohort of patients from the US, Gandhi et al. showed increasing prevalence of diabetes in the infarction population, which negatively affected the prognosis [16]. A recent review by Wu et al. concluded that, while the incidence of AMI is generally decreasing in the US, this favourable trend did not apply to young men or women [17]. They explained this phenomenon by the fact that major risk factors were more common among young people.

Agarwal et al. analysed the data of patients hospitalised for acute myocardial infarction and acute stroke during the period 2003–2013 [18]. They found that the average age of patients decreased during the observation period, in both cases, while the frequency of important risk factors for atherosclerosis increased. This phenomenon was associated with patients' socioeconomic status [18].

Satish et al. found that the occurrence and patterns of both traditional and non-traditional risk factors were more common in young

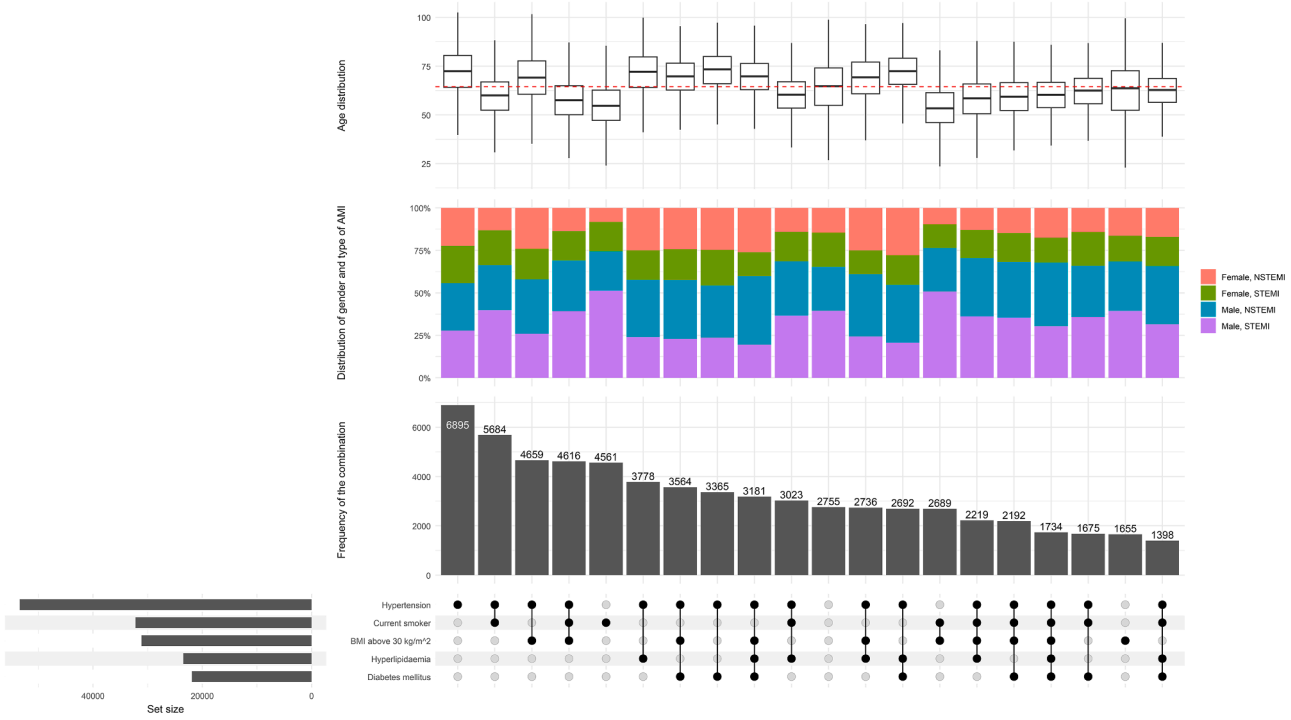


Fig. 4. Most prevalent combinations of risk factors, and the age, sex and type of infarction distribution for each combination visualized with UpSet plot.

patients with AMI than in older counterparts [19].

Tierney et al. examined data from Australian STEMI patients treated at a tertiary cardiology centre between 2010 and 2019 and found no change in the frequency of traditional risk factors [20]. On the other hand, in another Australian study, Kazi et al. examined the frequency of risk factors in STEMI patients [21]. They found that diabetes increased over 13 years, hypertension did not change, and the frequency of hypercholesterolemia and smoking decreased [21].

In conclusion, while our study primarily provides a regional confirmation of observations previously reported from other national registries, there are some notable differences too. These can be explained by variations in AMI populations, national CV prevention strategies, the effectiveness of primary prevention, and the completeness of the registries. Different risk factor patterns and prevalence can also account for these differences. An analysis, using the Global Burden of Disease 2023 data, revealed the fact that the structure of health losses in Hungary is substantially different from those of Austria, the Czech Republic, Poland, and Slovakia (e.g. premature mortality was substantially higher in Hungary compared to the other countries, specially Hungarian men due to high prevalence of smoking, unhealthy diet, and hypertension) [22].

The development of risk factors in post-infarction patients in recent years confirms that in this special patient group, too, an unfavourable change in lifestyle-related risk factors (obesity, diabetes mellitus, smoking) can be observed. A desirable change in lifestyle can be ensured primarily through population-level prevention practices.

The rise in smoking, obesity, and diabetes among AMI patients highlights critical gaps in Hungary's current primary cardiovascular prevention strategies. These escalating trends suggest that existing public health initiatives, particularly tobacco control and lifestyle-based metabolic management, are insufficient for reaching high-risk populations before event onset. These findings also emphasize the need to shift future cardiovascular prevention initiatives toward targeted, multidisciplinary interventions, including early-onset metabolic risk screening and integrated smoking cessation programs. Ultimately, the allocation of national health resources should take these findings into account to decrease the burden of avoidable acute coronary events.

Study limitations

This study has several limitations that should be acknowledged. Firstly, as the data are derived from the Hungarian Myocardial Infarction Registry (HUMIR), the findings are dependent on the accuracy and completeness of registry entries, which may be subject to reporting biases or missing data. Additionally, although the registry captures consecutive cases of myocardial infarction across Hungary, regional variations in data quality or clinical practice may not be fully accounted for. Additionally, we do not have data on the temporal evolution of risk factor frequency in the healthy population; therefore, given the lack of background population data, we could not calculate incidence rates.

The study is observational, which means causality between identified risk factors and outcomes cannot be established. Furthermore, certain confounding factors, such as socioeconomic status, lifestyle factors, or medication adherence, may not be fully captured in the registry, limiting the scope of analysis. The prevalence of these factors was not available in the population, precluding a statistical adjustment for them. Finally, while the risk factors, comorbidities and their basic diagnostic criteria remained uniform throughout the study period, the effect of changing diagnostic practices, awareness and screening intensity cannot be excluded over the past ten years which could influence trends in risk factor prevalence and comorbidity rates.

Conclusion

Our population-based study demonstrated that the incidence of myocardial infarction decreased among young and old patients in Hungary over the past decade. On the other hand, our data also confirmed the increasing prevalence of risk factors in patients treated for myocardial infarction; in this regard, the increasing prevalence of diabetes and obesity is particularly noteworthy. The high frequency of obesity in younger male STEMI patients is particularly concerning, suggesting early onset of metabolic risk and potential for future disease burden and warranting intensified efforts in lifestyle modification and risk factor management. The persistence and escalation of smoking rates suggest that current tobacco control measures may be insufficient for

high-risk populations and reinforce the necessity for targeted cessation programmes integrated into cardiovascular care. From a clinical perspective, identifying prevalent risk factor clusters should inform tailored intervention strategies and support multidisciplinary approaches to prevention and management.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work the author(s) used ChatGPT in order to create the graphical abstract. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

CRediT authorship contribution statement

András Jánosi: Writing – original draft, Investigation, Data curation, Conceptualization. **Zoltán Járai:** Writing – original draft, Investigation, Conceptualization. **Bettina Martus:** Methodology. **Tamás Ferenci:** Writing – original draft, Visualization, Validation, Software, Methodology. **Péter Andréka:** Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgement

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ajpc.2026.101789.

References

[1] Timmis A, Aboyans V, Vardas P, Townsend N, Torbica A, Kavousi M, Boriani G, Huculeci R, Kazakiewicz D, Scherr D, Karagiannidis E, Cvijic M, Kapłon-Cieślicka A, Ignatiuk B, Raatikainen P, De Smedt D, Wood A, Dudek D, Van Belle E, Weidinger F. ESC National Cardiac Societies. European Society of Cardiology: the 2023 Atlas of Cardiovascular Disease Statistics. Eur Heart J 2024;45(38):4019–62. https://doi.org/10.1093/eurheartj/ehae466. PMID: 39189413.

[2] Visseren FLJ, Mach F, Smulders YM, Carballo D, Koskinas KC, Bäck M, Benetos A, Biffi A, Boavida JM, Capodanno D, Cosyns B, Crawford C, Davos CH, Desormais I, Angelantonio ED, Franco OH, Halvorsen S, Richard Hobbs FD, Hollander M, Jankowska EA, Michal M, Sacco S, Sattar N, Tokgozoglu L, Tonstad S, Tsioufis KP, van Dis I, van Gelder IC, Wanner C, Williams B, ESC Scientific Document Group. 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice: developed by the Task Force for cardiovascular disease prevention in clinical practice with representatives of the European Society of Cardiology and 12 medical societies, with the special contribution of the European Association of Preventive Cardiology (EAPC). Rev Esp Cardiol 2022;75(5):429. https://doi.org/10.1016/j.rec.2022.04.003 (Engl Ed)PMID: 35525570.

[3] Blöndal M, Ainla T, Eha J, Lõiveke P, Marandi T, Saar A, Veldre G, Edfors R, Lewinter C, Jernberg T, Jortveit J, Halvorsen S, Becker D, Csanádi Z, Ferenci T, Andréka P, Jánosi A. Comparison of management and outcomes of ST-segment elevation myocardial infarction patients in Estonia, Hungary, Norway, and Sweden according to national ongoing registries. Eur Heart J Qual Care Clin Outcomes 2022;8(3):307–14. https://doi.org/10.1093/ehjqcco/qcaa098. PMID: 33710273.

[4] Edfors R, Jernberg T, Lewinter C, Blöndal M, Eha J, Lõiveke P, Marandi T, Ainla T, Saar A, Veldre G, Ferenci T, Andréka P, Jánosi A, Jortveit J, Halvorsen S. Differences in characteristics, treatments and outcomes in patients with non-ST-elevation myocardial infarction: novel insights from four national European continuous real-world registries. Eur Heart J Qual Care Clin Outcomes 2022;8(4):429–36. https://doi.org/10.1093/ehjqcco/qcab013. PMID: 33605415.

[5] Wallentin L, Gale CP, Maggioni A, Bardinet I, Casadei B. EuroHeart: European unified registries on heart care evaluation and randomised trials. Eur Heart J 2019;40(33):2745–9. https://doi.org/10.1093/eurheartj/ehz599. PMID: 31505603.

[6] Jánosi A, Ferenci T, Ofner P, Lupkovics G, Becker D, Faluközy J, Polgár P, Kőszegi Z, Horváth I, Jambrik Z, Szentes V, Merkely B, Dézsi CA. Does gender have prognostic value among patients with myocardial infarction? Analysis of the data from the Hungarian Myocardial infarction registry. J Womens Health (Larchmt) 2018;27(12):1491–8. https://doi.org/10.1089/jwh. 2017.6763. Epub 2018 Oct 10. PMID: 30307791.

[7] Wood SN. Generalised additive models: an introduction with r. 2nd edition. Chapman and Hall/CRC; 2017.

[8] Lex A, Gehlenborg N, Strobelt H, Vuillemot R, Pfister H. UpSet: visualization of intersecting sets. IEEE Trans Vis Comput Graph 2014;20(12):1983–92. https://doi.org/10.1109/TVCG.2014.2346248.

[9] R Core Team. R: a language and environment for statistical computing. R foundation for statistical computing. Vienna, Austria; 2025.

[10] Jánosi A, Ofner P, Andréka P. Clinical and scientific value of the Hungarian Myocardial Infarction Registry. Orv Hetil 2024;165(24–25):944–9.

[11] Ferreira-González I, Marsal JR, Mitjavila F, Parada A, Ribera A, Cascant P, Soriano N, Sánchez PL, Arós F, Heras M, Bueno H, Marrugat J, Cuñat J, Civeira E, Permanyer-Miralda G. Patient registries of acute coronary syndrome: assessing or biasing the clinical real-world data? Circ Cardiovasc Qual Outcomes 2009;2(6):540–7. https://doi.org/10.1161/CIRCOUTCOMES.108.844399. Epub 2009 Sep 22. PMID: 20031891.

[12] Tisminetzky M, Miozzo R, Gore JM, Gurwitz JH, Lessard D, Yarzebski J, Granillo E, Abu HO, Goldberg RJ. Trends in the magnitude of chronic conditions in patients hospitalised with a first acute myocardial infarction. J Multimorb Comorb 2021;11:2633556521999570. https://doi.org/10.1177/2633556521999570. PMID: 33738263; PMCID: PMC7934031.

[13] Cimci M, Witassek F, Radovanovic D, Rickli H, Pedrazzini GB, Erne P, Müller O, Eberli FR, Roffi M. Temporal trends in cardiovascular risk factors' prevalence in patients with myocardial infarction. Eur J Clin Invest 2021;51(4):e13466. https://doi.org/10.1111/eci.13466. Epub 2021 Feb 15. PMID: 33258133.

[14] Arora S, Stouffer GA, Kucharska-Newton AM, Qamar A, Vaduganathan M, Pandey A, Porterfield D, Blankstein R, Rosamond WD, Bhatt DL, Caughey MC. Twenty-year trends and sex differences in young adults hospitalised with acute myocardial infarction. Circulation 2019;139(8):1047–56. https://doi.org/10.1161/CIRCULATIONAHA.118.037137. PMID: 30586725; PMCID: PMC6380926.

[15] Gautadottir K, Gudmundsdottir IJ, Sigurdsson MI, Andersen K. Acute myocardial infarction in young adults: incidence, risk factors and prognosis]. Laeknabladid 2022;108(10):439–45. https://doi.org/10.17992/lbl.2022.10.709. PMID: 36149639.

[16] Gandhi GY, Roger VL, Bailey KR, Palumbo PJ, Ransom JE, Leibson CL. Temporal trends in prevalence of diabetes mellitus in a population-based cohort of incident myocardial infarction and impact of diabetes on survival. Mayo Clin Proc 2006;81(8):1034–40. https://doi.org/10.4065/81.8.1034. PMID: 16901026.

[17] Wu WY, Berman AN, Biery DW, Blankstein R. Recent trends in acute myocardial infarction among the young. Curr Opin Cardiol 2020;35(5):524–30. https://doi.org/10.1097/HCO.0000000000000781. PMID: 32694263; PMCID: PMC8454219.

[18] Agarwal S, Sud K, Thakkar B, Menon V, Jaber WA, Kapadia SR. Changing trends of atherosclerotic risk factors among patients with acute myocardial infarction and acute ischemic stroke. Am J Cardiol 2017;119(10):1532–41. https://doi.org/10.1016/j.amjcard.2017.02.027. Epub 2017 Mar 31. PMID: 28372804.

[19] Satish M, Walters RW, Safford M, Kini V. Trends in risk factor prevalence and incidence of acute myocardial infarction in young adults. JACC Adv 2025;4(9):102082. https://doi.org/10.1016/j.jacadv.2025.102082. Epub 2025 Aug 20. PMID: 40839905; PMCID: PMC12539488.

[20] Tierney M, Norman S, Al Ahmad J, Hansen T, Lee A, Shetty P. A 10-year review of presentation, management and outcomes of STEMI in a high-volume regional tertiary Australian centre. Int J Cardiol 2024;410:132224. https://doi.org/10.1016/j.ijcard.2024.132224. Epub 2024 May 28. PMID: 38815671.

[21] Kazi SN, von Huben A, Marschner S, Chong JJH, Denniss AR, Ong ATL, Chow CK. Trends in modifiable risk factors amongst first presentation ST elevation myocardial infarction patients in a large longitudinal registry. Heart Lung Circ 2023;32(4):480–6. https://doi.org/10.1016/j.hlc.2022.12.012. Epub 2023 Feb 16. PMID: 36801127.

[22] Vitrai J, Horváth V. What diseases and risks cause health losses in Hungary? (Milyen betegségek és kockázatok okozzák a magyarországi egészségveszteségeket? Orv Hetil 2026;167(6):232–42. https://doi.org/10.1556/650.2026.33481. PMID: 41655154.