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RESEARCH ARTICLE (ORIGINAL)

Epidemiology of Risk Factors for St-Elevation Myocardial Infarction: An Observational Study

Epidemiologia dos Fatores de Risco no Enfarte Agudo do Miocárdio com Supra-ST: Estudo Observacional

Epidemiología de los Factores de Riesgo en el Infarto Agudo de Miocardio Con Elevación del Segmento St: Estudio Observacional

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Abstract

Background: ST-elevation myocardial infarction (STEMI) is the leading cause of premature mortality. Identifying risk factors is essential for its prevention, early diagnosis, and treatment.
Objective: To analyze the epidemiological evolution of risk factors in patients with STEMI treated at a hospital in northern Portugal between 2014 and 2024.
Methodology: Retrospective descriptive-correlational observational study.
Results: A total of 1,420 patients (mean age = 65 years) were included; mostly were male (74.3%). The most prevalent risk factors were dyslipidemia (63.4%), hypertension (57.4%), smoking (44.9%), diabetes mellitus (26.6%), and obesity (18.5%). These risk factors and a family history of acute myocardial infarction were significantly associated with age and sex ($p < 0.05$), being more prevalent with increasing age and among men.
Conclusion: Dyslipidemia and hypertension were the most prevalent risk factors and increased over time. Smoking and diabetes mellitus also increased, although less markedly.

Keywords: myocardial infarction; risk factors; epidemiology

Resumo

Enquadramento: O Enfarte Agudo do Miocárdio com elevação do segmento ST (EAMcST) é a principal causa de mortalidade prematura. A identificação dos fatores de risco é fundamental para a sua prevenção, diagnóstico prematuro e tratamento.
Objetivo: Analisar a evolução epidemiológica dos fatores de risco em doentes com EAMcST atendidos num hospital do Norte de Portugal, entre 2014 e 2024.
Metodologia: Estudo observacional retrospetivo descritivo-correlacional.
Resultados: Foram incluídos 1.420 doentes (média de idade de 65 anos), maioritariamente masculina (74,3%), com dislipidemia (63,4%), hipertensão arterial (57,4%), hábitos tabágicos (44,9%), diabetes mellitus (26,6%) e obesidade (18,5%). Estes fatores de risco e a história familiar de EAM apresentaram associações significativas com a idade e com o sexo ($p < 0,05$), aumentado com a idade e mais prevalentes nos homens.
Conclusão: A dislipidemia e a HTA foram os fatores de risco mais prevalentes no período estudado, com aumento contínuo ao longo do tempo. O tabagismo e a diabetes mellitus também evidenciaram tendência crescente, contudo, menos acentuada.

Palavras-chave: enfarte agudo do miocárdio; fatores de risco; epidemiologia

Resumen

Marco contextual: El infarto agudo de miocardio con elevación del segmento ST (IAMCST) es la principal causa de mortalidad prematura. La identificación de los factores de riesgo es fundamental para su prevención, diagnóstico precoz y tratamiento.
Objetivo: Analizar la evolución epidemiológica de los factores de riesgo en pacientes con IAMCST atendidos en un hospital del norte de Portugal entre 2014 y 2024.
Metodología: Estudio observacional retrospectivo descriptivo-correlacional.
Resultados: Se incluyeron 1420 pacientes (edad media de 65 años), en su mayoría hombres (74,3 %), con dislipidemia (63,4 %), HTA (57,4 %), tabaquismo (44,9 %), diabetes *mellitus* (26,6 %) y obesidad (18,5 %). Estos factores de riesgo y los antecedentes familiares de IAM presentaron asociaciones significativas con la edad y el sexo ($p < 0,05$), que aumentaban con la edad y eran más prevalentes en los hombres.
Conclusión: La dislipidemia y la HTA fueron los factores de riesgo más prevalentes en el período estudiado, con un aumento continuo a lo largo del tiempo. El tabaquismo y la diabetes *mellitus* también mostraron una tendencia al alza, aunque menos acusada.

Palabras clave: infarto agudo de miocardio; factores de riesgo; epidemiología

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Introduction

Acute myocardial infarction (AMI) is a medical emergency and a major public health problem, with a significant impact on mortality and healthcare costs. Understanding the epidemiological evolution of its risk factors is essential to design effective strategies for prevention, early diagnosis, and treatment. AMI incidence is higher in men, which is supported by data from the Portuguese National Health System indicating that 81% of AMI cases in 2022 occurred in males (Serviço Nacional de Saúde, 2023). In a study of women with ST-elevation myocardial infarction (STEMI) treated with percutaneous coronary intervention (PCI), women had higher mortality rates than men. However, sex-related biological frailty was not an independent predictor of mortality, suggesting that the higher mortality rate in women may be attributed to their older age, on average, and a less favorable cardiovascular risk profile (Gonçalves et al., 2023). Since the 2012 joint expert consensus document from the European Society of Cardiology, the American College of Cardiology Foundation, the American Heart Association, and the World Heart Federation, acute coronary syndromes have been classified into two main types: ST-elevation myocardial infarction (STEMI) and non-ST-elevation myocardial infarction (NSTEMI). These categories differ in terms of clinical presentation, pathology, pathogenesis, treatment, and prognosis (Ishihara et al., 2017). Vernon et al. (2019) reported a substantial increase in STEMI occurring in individuals without standard modifiable cardiovascular risk factors (SMuRFs) and highlighted persistent gaps in understanding the pathogenic mechanisms of STEMI. Moreover, a recent analysis of a population-based French registry from the Monitoring of Trends and Determinants in Cardiovascular Disease (MONICA) project found that patients with STEMI had a worse short-term prognosis than those with NSTEMI (Bouisset et al., 2021). Advances in care, particularly thrombolytic therapy, the development of coronary units, improved pharmacological support before and after procedures, and the organization of prehospital and in-hospital care, have significantly reduced hospital mortality from STEMI (Mavungu Mbuku et al., 2023). Understanding the epidemiological evolution of risk factors in patients with STEMI is essential to identify changes in exposure patterns, inform prevention strategies, and optimize therapeutic interventions for the most vulnerable populations. Therefore, this study aimed to analyze the epidemiological evolution of risk factors in patients with STEMI between 2014 and 2024.

Background

According to the World Health Organization (WHO), cardiovascular diseases remain the leading cause of death worldwide, with AMI accounting for a significant proportion of these deaths (WHO, 2023). Although it is less common in adults under 45 years of age than in older adults, it has drawn increasing clinical attention in young adults because of its potential to cause premature death and long-term disability. SMuRFs, such as diabetes mellitus, hyperlipidemia, hypertension (HTN), physical inactivity, obesity, stress, and smoking, are key components of the Framingham risk score (Andersson et al., 2021). Primary and secondary prevention programs targeting modifiable risk factors among individuals at risk for coronary disease have substantially reduced morbidity and mortality, particularly in high-income countries and some middle-income countries. Nevertheless, coronary heart disease remains one of the leading causes of death worldwide (Basit et al., 2025). Risk factors for STEMI are multifactorial and vary significantly across age and sociodemographic groups (King et al., 2024). In particular, individuals younger than 50 years present with a distinct risk factor profile than older populations (Gupta et al., 2024). The main risk factors include lifestyle, comorbidities, and sociodemographic characteristics, which together influence incidence and treatment outcomes for people with STEMI. Among younger patients, high rates of tobacco use (> 60%), alcohol intake (> 65%), and physical inactivity (> 75%) have been reported in this population (Gupta et al., 2024). Younger patients often present with obesity and severe psychiatric disorders, which are less prevalent in older patients (King et al., 2024). Among women, particularly those younger than 55 years, STEMI may be more often related to spontaneous coronary artery dissection, highlighting a distinct risk profile (Kesti et al., 2025). HTN and diabetes mellitus are the most prevalent risk factors; however, their prevalence is lower among younger patients than among older patients (Gupta et al., 2024). Although younger patients may have lower overall mortality after STEMI, they still face substantial risk due to lifestyle-related factors and emerging health problems. This reinforces the need for prevention strategies tailored to different age groups (Kesti et al., 2025). In this context, risk prediction tools are essential for accurate prognostic stratification and individualized treatment planning.

The risk prediction tool for acute coronary syndromes identifies nine variables associated with 6-month mortality: age, history of myocardial infarction, history of heart failure, increased initial heart rate, low systolic blood pressure on admission, increased initial serum creatinine, increased cardiac biomarkers, ST-segment depression on the initial electrocardiogram, and not having in-hospital PCI (Padiyara et al., 2021).

Research question

What are the most frequently identified risk factors among patients with ST-elevation myocardial infarction (STEMI)?; What are the temporal trends in the prevalence of STEMI risk factors from 2014 to 2024?

Methodology

This study was reported in accordance with the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines (von Elm et al., 2008).

Study design, inclusion criteria

A retrospective observational study with a descriptive-correlational design was conducted. The study population included all patients with STEMI treated at a Local Health Unit in the Northern region of Portugal between January 1, 2014, and December 31, 2024. Inclusion criteria were adults aged 18 years or older with a STEMI diagnosis who were admitted to the Cardiology Inpatient Unit. Exclusion criteria were as follows: patients admitted to the Cardiac Intensive Care Unit (CICU) who were not transferred to the Cardiology Inpatient Unit; patients transferred directly from the catheterization laboratory to the Cardiothoracic Surgery Unit for revascularization; interhospital transfers admitted solely for catheterization; patients who died in the catheterization laboratory; and patients admitted with suspected STEMI in whom Takotsubo syndrome and/or myocardial infarction with non-obstructive coronary arteries (MINOCA) was confirmed.

The following variables were analyzed: age (age groups: < 50 years, 51–65 years, 66–80 years, and >80 years); sex; dyslipidemia (abnormal lipid levels, such as LDL cholesterol > 100 mg/dL, HDL cholesterol < 40 mg/dL in men or < 50 mg/dL in women, triglycerides > 150 mg/dL, and total cholesterol >200 mg/dL); smoking (any daily cigarette use); HTN; diabetes mellitus; physical inactivity; obesity; stress; family history of myocardial infarction; and African-American geographic origin.

Data collection tool and methodological procedure

Data were collected through a review of medical records for patients admitted to the Cardiology Inpatient Unit between 2014 and 2024. Data extraction was conducted from late January to the second week of February 2025. The data collection instrument was developed by the research team for this study to gather information on the following variables: age, sex, dyslipidemia, smoking, HTN, diabetes mellitus, physical inactivity, obesity, stress, family history of myocardial infarction, and African-American geographic origin. Age was analyzed in categories rather than as absolute means and standard deviations to better reflect the distribution of the data, thus enabling a more descriptive and interpretative analysis. Subjective variables that are difficult to assess in retrospective studies, including physical inactivity, obesity, and stress, were extracted from clinical records, ensuring the use of systematic and standardized documentation.

Data analysis

Data were entered into Microsoft Excel© and analyzed using IBM SPSS Statistics software (Version 28.0). Descriptive statistics were used: categorical variables were presented as numerical values (%), while continuous variables were presented as means (M) and standard deviations. To analyze associations between categorical variables, inferential analyses were performed using the Chi-square test (χ^2). This test is used mainly to examine the association or independence between two categorical variables by determining whether the observed distribution differs significantly from the expected distribution (Pestana & Gageiro, 2014) under the assumption of independence. Specifically, this test was used to verify the association between STEMI risk factors and the age and sex variables. Statistical significance was set at $p < 0.05$.

Ethical considerations

The study is part of the *Nursing Care for the Person with Cardiopulmonary Disease: CP4D – Researching and Innovating to Educate and Care* project, registered at the Health Sciences Research Unit: Nursing. It received a favorable opinion from the Ethics Committee on January 17, 2025 (Reference 5601, B 09/2024). The data collected in this study were handled with strict confidentiality and protected by professional secrecy. To ensure anonymity, each record was assigned a unique code, without any personal identification. Data were stored securely and accessible only to the researcher. Data will be deleted 12 months after publication.

Results

A total of 1,420 patients with STEMI were included for the 2014-2024 period. The annual number of patients ranged from 92 in 2014 (6.5%) to 176 in 2024 (12.4%); however, the sample was relatively homogeneous across the remaining years. The most represented age group was 66–80 years (38%; *n* = 542), followed by 51–65-years (34.3%; *n* = 487). The sample was predominantly male (*n* = 1,055; 74.3%). Overall, the mean age was 65.45 ± 13.07 years, with significant variation, ranging from 25 to 100 years.

Risk factor analysis in the sample of 1,420 patients showed that dyslipidemia was the most common risk factor, affecting 900 patients (63.4%); HTN was present in 815 patients (57.4%); 637 reported smoking (44.9%); diabetes mellitus was present in 378 patients (26.6%); obesity was present in 262 patients (18.5%); physical inactivity was recorded in 10 patients (0.7%) and stress in three patients (0.2%); and 96 patients (6.8%) had a family history of AMI. Dyslipidemia, HTN, and smoking were the most prevalent risk factors in the sample, whereas other factors, such as physical inactivity, stress, family history of myocardial infarction, and African-American geographic origin, showed a much lower prevalence (Table 1).

Table 1.

Sociodemographic characterization and risk factors of the sample

Variables	Frequency	
	n **(1,420)**	**%** **(100.0)**
Year		
2014	92	6.5
2015	118	8.3
2016	125	8.8
2017	135	9.5
2018	138	9.7
2019	115	8.1
2020	127	8.9
2021	147	10.4
2022	111	7.8
2023	136	9.6
2024	176	12.4
Age	*Minimum and maximum: 25-100 years* *Mean: 65.45 ± 13.07 years*	
≤50 years	199	14.0
51-65 years	487	34.3
66-80 years	542	38.2
>80 years	192	13.5
Sex		
Male	1,055	74.3
Female	365	25.7
History		
Dyslipidemia	900	63.4
Smoking	637	44.9
HTN	815	57.4
Diabetes	378	26.6
Physical inactivity	10	0.7
Obesity	262	18.5
Stress	3	0.2
Family history of AMI	96	6.8
African-American origin	6	0.4

Note. *n* = Sample size; % = Percentage.

The results of the epidemiological data on risk factors by year (2014–2024) showed that dyslipidemia and HTN were the most prevalent risk factors during the study period, increasing significantly over time. Both dyslipidemia and HTN showed sustained growth from 2014 to 2024, indicating an increase in the number of cases or in the prevalence of these conditions over time. Smoking and diabetes mellitus also showed increasing trends, although these increases were less marled than those observed for dyslipidemia and HTN.

Figure 1.

Epidemiological data on risk factors by year (2014-2024)

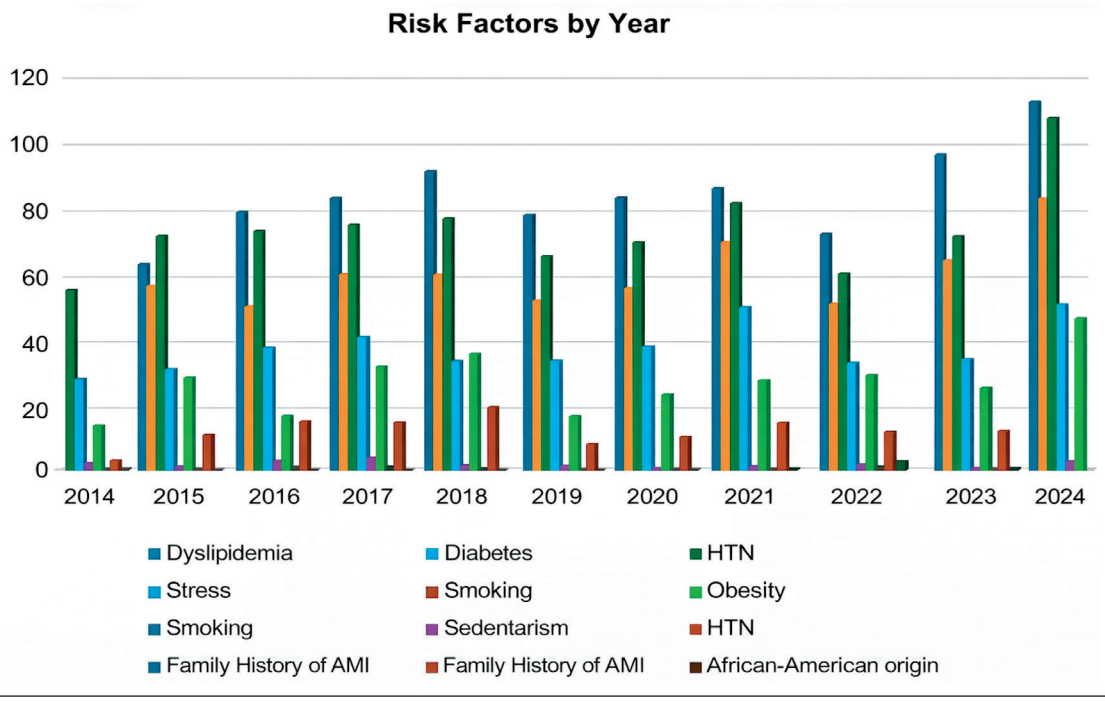

Table 2 shows the distribution of risk factors by year. In 2023, dyslipidemia was present in 71.3% of patients. It increased steadily since 2014 (53.3%), with a small variation between 2014 and 2022. Smoking reached its highest value in 2024 (47.7%), with a gradual increase since 2014 (40.2%) and remaining relatively stable, with minimal variations over the years. HTN fluctuated over time and reached its highest peak in 2024 (61.4%), representing an increase since 2014 (62.0%) and 2015 (62.7%), with a slight downward trend until 2023. Diabetes mellitus peaked in 2021 (32.0%), representing an increase when compared to previous years, particularly to 2014 (26.1%). Obesity reached its highest value in 2024 (25.6%), following an increasing trend since 2014 (13.0%), with statistically significant differences (p = 0.010). This factor shows an upward trend over the years. Family history of AMI reached its highest value in 2018 (9.4%) and then declined slightly in subsequent years, remaining within a relatively stable range throughout the study period.

Table 2.

Epidemiology of risk factors by year

Risk factors	Dyslipidemia		Smoking		HTN		Diabetes		Obesity		Family history of AMI	
	%	VR	%	VR	%	VR	%	VR	%	VR	%	VR
Year												
2014	53.3%	-2.1	40.2%	-0.9	62.0%	0.9	26.1%	-0.1	13.0%	-1.4	1.1%	-2.2
2015	54.2%	-2.2	48.3%	0.8	62.7%	1.2	22.9%	-1.0	20.3%	0.6	6.8%	0.0
2016	64.0%	0.2	40.8%	-1.0	59.2%	0.4	28.8%	0.6	10.4%	-2.4	9.6%	1.3
2017	62.2%	-0.3	45.2%	0.1	56.3%	-0.3	28.1%	0.4	21.5%	1.0	8.1%	0.7
2018	67.4%	1.0	43.5%	-0.3	56.5%	-0.2	20.3%	-1.8	22.5%	1.3	9.4%	1.3
2019	67.8%	1.0	43.5%	-0.3	56.5%	-0.2	26.1%	-0.1	11.3%	-2.1	3.5%	-1.5
2020	66.1%	0.7	44.1%	-0.2	55.9%	-0.4	27.6%	0.3	15.7%	-0.8	6.3%	-0.2
2021	57.8%	-1.5	46.9%	0.5	55.8%	-0.4	32.0%	1.6	17.0%	-0.5	8.2%	0.7
2022	65.8%	0.5	44.1%	-0.2	53.2%	-0.9	27.9%	0.3	24.3%	1.7	5.4%	-0.6
2023	71.3%	2.0	46.3%	0.4	52.2%	-1.3	23.5%	-0.9	16.9%	-0.5	7.4%	0.3
2024	64.2%	0.2	47.7%	0.8	61.4%	1.1	28.4%	0.6	25.6%	2.6	6.3%	-0.3
p	0.080		0.970		0.800		0.684		0.010*		0.342	

Note. VR = Residual Value; % = Percentage; *p* = Significance level.
Chi-square tests.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Table 3 shows the association between risk factors and age groups. No significant association was found between dyslipidemia and age group ($\chi^2 = 3.162$; $p = 0.367$), indicating a similar prevalence across age groups. A statistically significant association was found between smoking and age group ($p < 0.001$), with higher prevalence in younger patients and a marked decrease in older groups. HTN also showed a significant association with age ($p < 0.001$), with prevalence increasing with age, particularly in older age groups. Diabetes mellitus also showed a statistically significant association with age group ($p < 0.001$) and was more common in older patients, with prevalence increasing with age. Obesity was more prevalent in younger age groups ($p = 0.004$). Family history of AMI was significantly associated with the under-50 age group ($p < 0.001$).

Table 3

Association between risk factors and age

Age	≤ 50 years		51-65 years		66-80 years		➢ 80 years		X^2	*p*
	%	VR	%	VR	%	VR	%	VR		
Medical history (+)										
Dyslipidemia	13.0%	-1.4	33.9%	-0.4	39.6%	1.4	13.6%	0.0	3.162	0.367
Smoking	25.7%	11.5	47.1%	9.2	24.6%	-9.5	2.5%	-10.9	327.539	<0.001
HTN	7.6%	-8.1	27.7%	-6.0	46.0%	7.1	18.7%	6.6	148.121	<0.001
Diabetes	6.9%	-4.7	27.8%	-3.1	50.5%	5.8	14.8%	0.9	46.353	<0.001
Obesity	19.1%	2.6	37.4%	1.2	34.7%	-1.3	8.8%	-2.5	13.136	0.004
Family history of AMI	38.5%	7.2	43.8%	2.0	16.7%	-4.5	1.0%	-3.7	71.214	<0.001

Note. VR = Residual Value; % = Percentage; *p* = Significance level.

Discussion

This study analyzed the epidemiological evolution of cardiovascular risk factors in patients with STEMI between 2014 and 2024. The most prevalent risk factors were dyslipidemia, HTN, and smoking. Obesity increased in 2024, reaching statistical significance ($p < .05$). Emerging risk factors, such as stress and physical inactivity, were not adequately reported, which limits data interpretation. In a recent study, Mohseni et al. (2024) found an association between central obesity, dyslipidemia, and HTN. The interaction between obesity and dyslipidemia significantly influenced the risk of HTN. Among individuals with HTN, the prevalence of general obesity increased from 14.55% in those without dyslipidemia to 64.36% in those with dyslipidemia, while obesity increased from 13.27% to 58.88%. Therefore, Mohseni et al. (2024) reported that the co-occurrence of obesity and lipid abnormalities has many clinical implications and should be adequately monitored and assessed as part of HTN management.

The sample was predominantly male, and the most represented age group was 66-80 years, followed by 51–65 years. The mean age was 65.45 ± 13.07 years. In this sample, 14% of patients were under 50 years of age, which is consistent with a recent U.S. study in which 4–10% of STEMI events occurred in individuals aged 45 years or younger, with significant socioeconomic impact (Naz et al., 2025). The increase in the incidence of STEMI among younger people is a growing concern, with several studies highlighting unique risk factors and demographic characteristics. Although traditional risk factors such as HTN and diabetes mellitus are less prevalent in younger patients, lifestyle-related factors such as smoking and substance use contribute significantly to this increase (Naz et al., 2025; Ranjan et al., 2024). Similarly, King et al. (2024) reported that 14.6% of STEMI cases occurred in individuals under 50 years of age with these risk factors, with a predominance among male patients (68.2%).

In this study, the epidemiological results show that dyslipidemia and HTN were the most prevalent risk factors throughout the study period, with smoking and diabetes mellitus showing an increasing trend over time. This finding is consistent with the current literature, which reports that these risk factors have been widely recognized as major contributors to cardiovascular disease, with a strong association with STEMI (King et al., 2024; Naz et al., 2025; Ranjan et al., 2024). Smoking, which was highly prevalent in this sample, particularly among male patients and younger women, is widely recognized as one of the most important modifiable risk behaviors associated with increased cardiovascular mortality (King et al., 2024). These results underscore the need for public health policies focused on smoking-cessation strategies, particularly in populations at higher cardiovascular risk. Obesity was more prevalent in younger age groups and decreased in older age groups. Similarly, family history of AMI was more prevalent among patients under 50 years of age, with a substantial reduction in older age groups. Emerging risk factors, such as air pollution, acute stress, and illicit drug use, are also increasingly recognized as contributors to STEMI in this demographic group (Ranjan et al., 2024). Compared with older patients, younger individuals with STEMI tend to have lower one-year mortality rates, probably due to a greater likelihood of undergoing revascularization (King et al., 2024; Ranjan et al., 2024). Despite favorable outcomes, younger patients often present with single-vessel disease, indicating the need for targeted interventions (Kumar et al., 2023). On the other hand, although the incidence of STEMI in younger populations is increasing, overall mortality rates remain lower than in older cohorts, suggesting that early intervention and lifestyle changes may effectively reduce these risks (King et al., 2024; Kumar et al., 2023; Naz et al., 2025; Ranjan et al., 2024).

This study analyzed the epidemiological evolution of risk factors among patients with STEMI and provided relevant information for both clinical and academic practice. These findings may inform the development of preventive and therapeutic strategies that increase knowledge about population patterns over time. Understanding the epidemiological evolution of risk factors is fundamental for consolidating academic knowledge and supporting clinical decision-making, contributing to improved prognosis and patient management.

Although this study provides an overview of the epidemiological evolution of risk factors in patients with STEMI, several limitations should be acknowledged. First, data extraction revealed missing information in some medical records. Selection bias was also a concern, as the sample may not be representative of the general population, affecting the validity of the results. In addition, because the data were derived from a single hospital, the generalizability of the findings to other populations is limited. The prevalence and impact of some risk factors, such as stress and physical inactivity, are unclear because they were not reported in patients' clinical records. Another limitation is the difficulty of establishing a causal relationship, given that the data were collected retrospectively, making it difficult to prove that a specific factor caused a particular outcome. Finally, the lack of validation of the data collection instrument constitutes a relevant limitation that may affect measurement accuracy and consistency, reducing the robustness of the conclusions and requiring caution when generalizing the results. Therefore, future studies should use validated instruments or ensure prior validation. The absence of multivariable models represents an important limitation, as it prevents adjustment for potential confounders and reduces the ability to identify the independent effects of predictors.

Conclusion

In this study, the epidemiological analysis showed that dyslipidemia and HTN were the most prevalent risk factors throughout the study period, while smoking and diabetes mellitus showed an increasing trend over time. Age-related differences in risk factors suggest the need for specific approaches to STEMI treatment and prevention, particularly for younger and male patients. These findings have several implications for clinical practice, particularly

regarding STEMI management and prevention. Personalized prevention strategies should be implemented to increase adherence and enhance the effectiveness of interventions. The implementation of health education programs and prevention and screening strategies for risk factors, such as smoking, is recommended, particularly among younger populations, whereas surveillance of dyslipidemia and HTN should focus on older patients, particularly those aged 66-80 years. Given the high prevalence of dyslipidemia and HTN, it is important to increase awareness and promote adherence to screening and early monitoring programs, both in the community and during follow-up visits. Early detection and appropriate management of these risk factors can significantly reduce complications and the incidence of adverse events such as STEMI. As future lines of research, longitudinal studies should assess changes in the prevalence of risk factors over time across different populations, as well as compare historical periods or cohorts from different decades to identify emerging trends. To strengthen the robustness and validity of the conclusions, future studies should be conducted using multivariable analyses.

Author contributions

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