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# Epidemiological pattern of myocardial infarction and modelling risk factors relevant to in-hospital mortality: the first results from the Iranian Myocardial Infarction Registry

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## Abstract

**Background:** Myocardial infarction (MI) care and treatment contribute greatly to the patients' fatality and mortality. Assessing and monitoring mortalities and the effective factors are necessary in MI care and treatment programs. No comprehensive and population-based study has yet been conducted in Iran to determine the epidemiological pattern of MI, and particularly in-hospital mortality rate and the effective factors.

**Aim:** To determine the epidemiological pattern of MI based on person-, time-, place-, and mortality-associated risk factors.

**Methods:** This was a prospective, population-based cohort study, which analysed the data of 20,750 MI patients in Iran in 2012. MI was diagnosed based on ICD-10: codes I21 and I22. The cohort of the patients was defined in terms of the date at diagnosis, hospitalisation, and the date at discharge (recovery or death due to MI). The in-hospital mortality rate was calculated by Cox regression. Univariate analysis and multiple logistic regression were used to determine the effective factors on the patients' mortality. The odds ratio (95% confidence interval [CI]) was reported using Stata software.

**Results:** The relative frequency of in-hospital mortality was 12.1%. The in-hospital mortality rate was higher in women than in men, and 6.74 (95% CI 6.4–7.0) per 100 person-years were at risk of death. The highest relative mortality (13.2%) was obtained in January (11 Dey to 11 Bahman in the Persian calendar) and the lowest (5.9%) in May (11 Ordibehest to 10 Khordad in the Persian calendar). Age of over 84 years, female gender, educational level, smoking, lack of thrombolytic therapy, type 2 diabetes, chest pain prior to arriving in hospital, right bundle branch block**,** ventricular tachycardia, percutaneous coronary intervention, lateral MIs, and ST segment elevation myocardial infarction (STEMI) were determinants of in-hospital mortality in the patients. The relative frequency of mortality was higher from STEMI (83.7% of deaths in registry) vs. non-STEMI (16.3% of deaths in registry).

**Conclusions:** STEMI, lack of thrombolytic therapy, age of over 84 years, and ventricular tachycardia have the greatest effect on in-hospital mortality in MI patients. The results of this study are helpful in planning for monitoring and promotion of healthcare of the patients.

**Key words:** myocardial infarction, ischaemic heart disease, in-hospital mortality, risk factor

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## INTRODUCTION

Cardiovascular disease (CVD) is considered as one of the important priorities in the health systems of all countries, including Iran. The burden of these diseases is increasing in low-, moderate-, and high-income countries [1, 2]. Worldwide, Finland and Japan have the highest and lowest myocardial infarction (MI) incidence rate, respectively [3–5]. More than

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1/3 of the mortalities in Iran are due to CVD, so it is a serious challenge facing the country's healthcare system [6–9].

Few studies have investigated the factors relevant to in-hospital mortality [10]. The decrease in mortalities due to MI is mainly related to the decreased fatality of the disease, the enhanced healthcare of the disease, and appropriate treatment. The healthcare and treatment of MI have a pivotal role in patient fatality and mortality. The epidemiological pattern of MI varies between different communities [2, 10]. Reports on population-based MI incidence rates are rare in developing countries. So far, no comprehensive and population-based work has been conducted in Iran to determine the epidemiological pattern of MI, particularly the effective factors on patient mortality [11]. Most MIs and the mortalities due to them seem to be preventable. The first step is to determine and explain their epidemiology in order to plan for and improve the process of healthcare and treatment. This study was conducted to determine the epidemiological pattern of MI based on person-, time-, place-, and mortality-associated risk factors in the patients in Iran in 2012.

## METHODS

In this prospective, population-based cohort study the data of 20,750 MI patients in 540 hospitals in Iran in 2012 were analysed. The cohort of the study consisted of patients registered in the Iranian Myocardial Infarction Registry of the Iran Health and Medical Education Ministry (Department of Cardiovascular Disease Prevention) in hospitals with a cardiology ward across 31 provinces of Iran using the date at arrival to and discharge from the hospital. Data collection is mandatory in all hospitals although some private and military hospitals do not participate. The coverage of the MI registry was 87% [11, 12]. Inclusion criteria were defined based on International Classification of Diseases (ICD; codes I21, I22). Patients with no definite diagnosis of MI by the cardiologist were excluded from the study. MIs are generally classified into ST segment elevation myocardial infarction (STEMI) and non-STEMI (NSTEMI). Echocardiography (ECG) is used to differentiate between the two types of MIs based on the shape of the tracing. An ST section of the trace higher than the baseline is called STEMI, which usually requires more invasive treatment. For a person to qualify as having STEMI the ECG must show new ST elevation in two or more adjacent ECG leads [13].

The demographic data of the patients, including age, gender, educational level, place of residence, and individual, clinical, and laboratory risk factors — such as the date at MI incidence, duration of hospitalisation, type 2 diabetes, hypertension, smoking, hyperlipidaemia, type of diagnosis, treatment, place of MI, and pain pattern, were considered as the independent variables (predictor), and in-hospital mortality as a dependent variable. The above variables were measured based on national protocol and World Health Organisation (WHO) standards and recorded by the cardiologist and matron of the cardiology ward in electronic medical files.

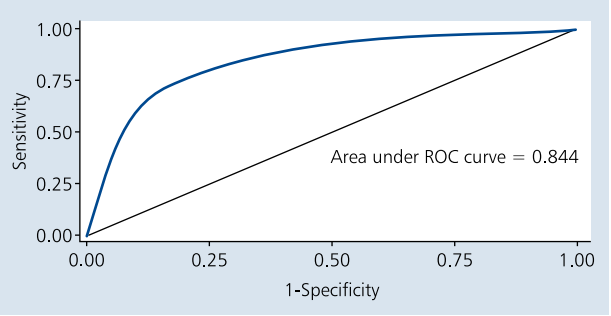


Figure 1. The area under receiver operating characteristic (ROC) curve for final logistic model

Educational level was classified as zero (illiteracy), 1–5 years (primary), 6–9 years (guidance), 10–12 years (high school), and more than 12 years (university). The cohort of the patients was defined in terms of the date at diagnosis, hospitalisation, and the date at discharge (recovery or death due to MI).

Multiple logistic regression was used for modelling and simultaneous examination of the variables' effect as well as controlling confounding variables. Variables with a significance value of less than 0.2 were entered into the multivariate model. The presuppositions were checked and confirmed. Goodness-of-fit was assessed by Hosmer-Lemeshow test and obtained as acceptable ($p = 0.415$). For the final model the area under receiver operating characteristic (ROC) curve was obtained 0.844 (Fig. 1). The in-hospital mortality rate was calculated by Cox regression. The crude incidence rate was calculated per 100,000 individuals in different age groups. For calculation of actual incidence rates in the denominator, the data from a population census by the Statistical Centre of Iran in 2011 were used. Quantitative variables were reported by mean ± standard deviation (SD) and the grouped variables by frequency and percentage. The rates, odds ratio (OR), and 95% confidence interval (CI) were calculated using Stata software (Stata Corp. 2011. Stata Statistical Software: Release 12. College Station, TX: Stata Corp LP). $P < 0.05$ was considered as significant.

## RESULTS

In total 15,033 (72.4%) patients were male. The mean ± SD age of the patients was 61.2 ± 13.4 years. The mean age at MI incidence was significantly lower in men (59.6 ± 13.3 years) than in women — 65 ± 12.6 years ($p = 0.001$). The mean age at MI incidence was significantly different by the province of residence ($p = 0.001$). The demographic characteristics and the risk factors under investigation are shown in Table 1. Except for coronary artery bypass grafting (CABG), right bundle branch block (RBBB), and ventricular fibrillation, all of the studied variables were significantly different between men

Table 1. Demographic characteristics and clinical and lifestyle risk factors in the study population

| Characteristics | Total | Men | Women | P |
|---|---|---|---|---|
| Age groups [year]: | | | | 0.001 |
| < 30 | 129 (0.62%) | 113 (0.75%) | 16 (0.28%) | |
| 30–64 | 12375 (59.6%) | 9701 (64.5%) | 2674 (46.7%) | |
| 65–84 | 7477 (36%) | 4743 (31.5%) | 2734 (47.8%) | |
| ≥ 85 | 769 (3.7%) | 476 (3.2%) | 293 (5.2%) | |
| Gender | 20750 (100%) | 15033 (72.45%) | 5717 (27.55%) | 0.001 |
| Education: | | | | 0.001 |
| Illiterate | 9611 (46.3%) | 5488 (36.5%) | 4123 (72.12%) | |
| Primary | 4941 (23.8%) | 3906 (25.9%) | 1035 (18.1%) | |
| Guidance | 1940 (9.3%) | 1684 (11.2%) | 256 (4.48%) | |
| High-school | 2992 (14.4%) | 2742 (18.2%) | 250 (4.37%) | |
| University | 1266 (6.1%) | 1213 (8.1%) | 53 (0.93%) | |
| Smoking | 5443 (26.2%) | 4291 (28.5%) | 1152 (20.1%) | 0.001 |
| Hypertension | 7376 (35.5%) | 4303 (28.6%) | 3073 (53.7%) | 0.001 |
| Type 2 diabetes | 4612 (22.2%) | 2701 (18%) | 1911 (33.4%) | 0.001 |
| Dyslipidaemia | 3710 (17.8%) | 2265 (15%) | 1445 (25.3%) | 0.001 |
| CABG | 539 (2.6%) | 383 (2.5%) | 156 (2.7%) | 0.464 |
| PCI | 1431 (7%) | 1101 (7.3%) | 330 (5.8%) | 0.001 |
| Chest pain | 2229 (10.7%) | 1551 (10.3%) | 678 (11.9%) | 0.001 |
| Lack thrombolytic | 9222 (44.5%) | 6966 (46.3%) | 2256 (39.4%) | 0.001 |
| RBBB | 383 (1.8%) | 229 (1.5%) | 154 (2.7%) | 0.001 |
| VF | 511 (2.5%) | 389 (2.6%) | 122 (2.2%) | 0.537 |
| VT | 1198 (5.7%) | 916 (6%) | 282 (4.9%) | 0.001 |
| STEMI | 15729 (75.8%) | 11681 (77.7%) | 4048 (70.81%) | 0.001 |
| NSTEMI | 5021 (24.2%) | 3352 (22.3%) | 1669 (29.19%) | 0.001 |

CABG — coronary artery bypass grafting; NSTEMI — non ST-segment elevation myocardial infarction; PCI — percutaneous coronary intervention; RBBB — right bundle branch block; STEMI — ST-segment elevation myocardial infarction; VF — ventricular fibrillation; VT — ventricular tachycardia

and women. In final regression model, except for CABG all variables were significant (Table 2). In univariate analysis, hypertension history and body mass index were yielded as significant risk factors. However, they were not significant in multivariate analysis. The highest relative frequency (13.2%) was obtained in January (11 Dey to 11 Bahman in the Persian calendar) and the lowest (5.89%) in May (11 Ordibehest to 10 Khordad in the Persian calendar). Details of the relative frequencies of MI incidence for each month and the Iranian calendar are shown in Table 3. In univariate analysis the death OR in July (10 Tir to 10 Mordad in the Persian calendar) was 1.33 times (95% CI 1.05–1.6) higher than that in March (the first month in the Persian calendar), with a significant difference. The lowest death OR (0.82) was obtained for October (95% CI 0.7–0.99), which was significant. In multivariate analysis, the OR in the year's months was not significant. The relative frequency of disease incidence for each month is shown in Figure 2 for men and women. The relative frequency of in-hospital mortality was 12.1% (2,511 cases). The relative frequency of mortality from STEMI and NSTEMI was 83.7% and 16.25%, respectively (2,103 vs. 408).

Based on Cox regression model, the in-hospital mortality rate was 6.74 (95% CI 6.4–7) per 100 person-years. This rate was 6.12 (95% CI 5.83–6.43) and 8.36 (95% CI 7.81–9.94) in men and women, respectively. The men/women ratio of mortality rate was 1.36 (95% CI 1.2–1.4).

In the final model of determinants of MI-associated in-hospital mortality, age over 84 years, female gender, educational level, smoking, lack of thrombolytic therapy, type 2 diabetes, chest pain prior to arriving in hospital, RBBB, ventricular tachycardia (VT), percutaneous coronary intervention (PCI), lateral MIs, and STEMI were present. The OR (95% CI) of the studied risk factors is shown in Table 2 as crude and standardised.

## DISCUSSION

In this study, the epidemiologic status of MI incidence, its associated mortality, and related factors were reported for the first

Table 2. Unadjusted and adjusted odds ratio for the effect of characteristics on mortality

| Characteristics | Unadjusted OR | | | Adjusted OR | | | 95% CI |
|---|---|---|---|---|---|---|---|
| | OR | SE | P | OR | SE | P | |
| Age groups [year]: | | | | | | | |
| < 30 | Ref. | – | – | – | – | – | – |
| 30–64 | 1.13 | 0.3 | 0.683 | 0.91 | 0.31 | 0.804 | 0.46–1.81 |
| 65–84 | 1.68 | 0.5 | 0.099 | 1.44 | 0.5 | 0.293 | 0.72–2.87 |
| ≥ 85 | 6.75 | 2.1 | 0.001 | 7.84 | 2.8 | 0.001 | 3.85–15.9 |
| Women | 1.42 | 0.06 | 0.001 | 1.23 | 0.06 | 0.001 | 1.11–1.37 |
| Education: | | | | | | | |
| Illiterate | 1.36 | 0.12 | 0.001 | 0.93 | 0.1 | 0.555 | 0.76–1.15 |
| Primary | 0.97 | 0.09 | 0.77 | 0.81 | 0.08 | 0.068 | 0.65–1.01 |
| Guidance | 0.68 | 0.08 | 0.002 | 0.64 | 0.08 | 0.001 | 0.5–0.83 |
| High-school | 0.75 | 0.08 | 0.01 | 0.69 | 0.08 | 0.002 | 0.55–0.87 |
| University | Ref. | – | – | – | – | – | – |
| Smoking | 1.3 | 0.06 | 0.001 | 1.24 | 0.06 | 0.001 | 1.12–1.38 |
| Type 2 diabetes | 1.14 | 0.05 | 0.008 | 1.18 | 0.06 | 0.002 | 1.06–1.32 |
| Chest pain | 6.63 | 0.3 | 0.001 | 3.95 | 0.24 | 0.001 | 3.49–4.46 |
| Lack of TT | 2.07 | 0.08 | 0.001 | 3.06 | 0.16 | 0.001 | 2.75–3.42 |
| RBBB | 2.54 | 0.2 | 0.001 | 2.05 | 0.33 | 0.001 | 1.48–2.83 |
| VT | 2.17 | 0.15 | 0.001 | 2.23 | 0.2 | 0.001 | 1.86–2.65 |
| STEMI | 3.76 | 0.16 | 0.001 | 3.85 | 0.21 | 0.001 | 3.45–4.3 |
| PCI | 0.39 | 0.04 | 0.001 | 0.69 | 0.08 | 0.005 | 0.54–0.89 |
| CABG | 1.08 | 0.14 | 0.523 | 1.15 | 0.16 | 0.304 | 0.87–1.53 |
| Lateral MI | 1.57 | 0.13 | 0.001 | 1.93 | 0.19 | 0.001 | 1.58–2.34 |

CABG — coronary artery bypass; CI — confidence interval; OR — odds ratio; MI — myocardial infarction; SE — standard error; PCI — percutaneous coronary intervention; RBBB — right bundle branch block; STEMI — ST-segment elevation myocardial infarction; VT — ventricular tachycardia; TT — thrombolytic therapy

Table 3. Details of relative frequency of myocardial infarction incidence per month

| Period (in Persian/Gregorian calendar) | Frequency (%) |
|---|---|
| 11 Day to 11 Bahman/January | 2739 (13.2%) |
| 12 Bahman to 9 Esfand/February | 2045 (9.85%) |
| 10 Esfand to 10 Farvardin/March | 1547 (7.45%) |
| 11 Farvardin to 10 Ordibehest/April | 1450 (6.98%) |
| 11 Ordibehest to 10 Khordad/May | 1224 (5.89%) |
| 11 Khordad to 9 Tir/June | 1463 (7.05%) |
| 10 Tir to 10 Mordad/July | 1497 (7.21%) |
| 11 Mordad to 9 Shahrivar/August | 1334 (6.42%) |
| 10 Shahrivar to 8 Mehr/September | 1613 (7.77%) |
| 9 Mehr to 10 Aban/October | 1798 (8.66%) |
| 11 Aban to 9 Azar/November | 1960 (9.44%) |
| 10 Azar to 10 Day/December | 2080 (10.02%) |

time in Iran. Age over 84 years, female gender, educational level, smoking, lack of thrombolytic therapy, type 2 diabetes, chest pain prior to arriving in hospital, RBBB, VT, PCI, lateral MIs, and STEMI increased the mortality rate due to MI in Iran. The results of our study offer an appropriate opportunity for managing, evidence-based decision making, and planning for the prevention and control of MI and its related mortalities in Iran. Although CVDs have been decreasing in developed and high-income countries, this trend, by several reports, is on rise in developing and moderate- and low-income countries, such as Iran [3, 13–15].

According to the Iranian Mortality Registry, the mortality rate due to CVD and MI was reported, respectively, as 171 and 85 per 100,000. In our study, the MI mortality incidence rate was obtained at 6.74 (per 100 person year). The mortality rate in Iran is lower compared to that in the world and the Eastern Mediterranean region [11].

The main reason for this difference seems to be the ways of accessing and receiving healthcare, several and various risk factors worldwide, and Iran's young population. To compare the determinants of in-hospital mortality risk with those investigated in other studies, no similar study in Iran's neighbouring countries was found as far as we searched. In

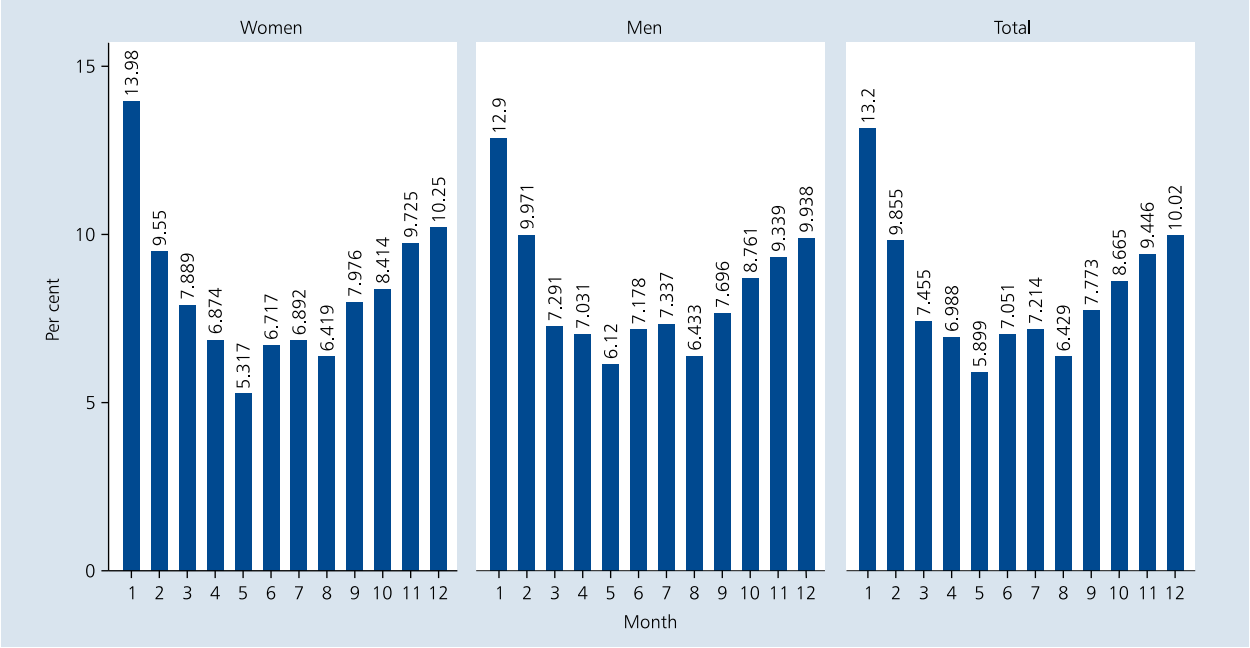


Figure 2. Frequency of myocardial infarction per month in 2012

our study, a difference in the age at MI incidence was noted between men and women, which is consistent with other studies. Age over 84 years was yielded as a risk factor for death, in agreement with works in other countries such as Japan and Korea [4, 16–18].

The incidence rate in our study was higher compared to Japan and Korea and lower compared to Finland and Australia. The in-hospital mortality rate was higher in women compared to men in Japan. Also, the in-hospital mortality rate was lower in the patients in Iran compared to Japan [3, 4]. In Korea, 19.2% of MI patients had diabetes, 67.3% were smokers, and 61.2% had STEMI. In our study, the prevalence of diabetes was 22.2%, which is higher compared to Japan. In our study, hypertension association with in-hospital mortality was significant ($p = 0.011$, OR = 1.11) in univariate analysis, but it was not significant in multivariate analysis. In Japan, hypertension was significantly associated with the patients' mortality [18].

In a study, age, female gender, lack of thrombolytic therapy, and STEMI were the most important determinants of survival and mortality in the MI patients, which is similar to our study. Hypertension, type 2 diabetes, and smoking were obtained as, respectively, 49%, 53%, and 30% in multiple regression and were not significant as risk factors for death [19]. In a similar study, 73% of the patients were male and their mean age was 61.8 years, which is similar to our study. History of CABG, PCI, and diabetes were reported respectively 4.4%, 12.5%, and 25.3% in the patients; these rates were obtained, respectively, as 2.6%, 3.2%, and 22.2% in our study, which are lower compared to that study [20]. In our study, in-hospital mortality rate due to MI was 12%, which is lower compared to 23.3% reported by another study [21]. In a study in India, the mean age of the patients was reported as 57.5 years, which is lower compared to Iran. In India, 30.4% of the patients had type 2 diabetes, 37.7% had hypertension, and 40% were smokers; the corresponding figures in our study are, respectively, 22.2%, 35.5%, and 26.2%. In India, despite the high prevalence of risk factors, the death percentage was 6.7%, which is lower compared to our study. In our study, 83% of the patients were hospitalised for less than six days. In India, this figure was 57.3%. The difference in mortality percentage between our study and the study in India could be due to the different pattern of, and access to, treatment as well as different approaches to providing healthcare services [22]. In-hospital mortality due to MI in the United States (10–70%) was higher in blacks compared to whites and higher in individuals over 70 years of age compared to other age groups [23]. The difference in incidence rate, mortality, the factors relevant to in-hospital mortality, and the mean age could be due to the old populations in some countries, e.g. the United States and Japan, the difference in life expectancy and lifestyle, the difference in distribution of and coping with CVD risk factors, as well as approaches to providing healthcare [24, 25]. Failure to follow up the patients for 28 days, failure to include MI death cases outside hospital and in the home, and failure to calculate the patients' survival time were some of the limitations of the present study, which are recommended to be eliminated in future studies. Being population-based, recruiting a large sample size, measuring the variables by the same method and per WHO standards, and being the first report on MI incidence in Iran could be considered as strengths of our work.

## CONCLUSIONS

In view of the results obtained in the present study, STEMI and age over 84 years are likely to contribute most to in-hospital mortality in patients with MI. The findings of the present study could be helpful for planning in health systems as well as monitoring and improving the patients' care and treatment.


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***Conflict of interest:*** *none declared*


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# Epidemiologia zawału serca i modelowanie czynników ryzyka wpływających na śmiertelność wewnątrzszpitalną: pierwsze wyniki Irańskiego Rejestru Zawałów Serca

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## Streszczenie

**Wstęp:** Opieka zdrowotna i sposób leczenia mają ogromny wpływ na śmiertelność i umieralność chorych z zawałem serca (MI). Programy opieki zdrowotnej i leczenia MI muszą uwzględniać ocenę i monitorowanie śmiertelności oraz determinujących ją czynników. W Iranie nie przeprowadzono dotychczas kompleksowego badania populacyjnego w celu określenia epidemiologii MI, a w szczególności śmiertelności wewnątrzszpitalnej i wpływających na nią czynników.

**Cel:** Badanie przeprowadzono w celu określenia epidemiologii MI na podstawie danych dotyczących pacjentów, czasu, miejsca i czynników ryzyka związanych ze śmiertelnością.

**Metody:** Było to prospektywne populacyjne badanie kohortowe, w którym analizowano dane 20 750 chorych, którzy przebyli MI w Iranie w 2012 r. Zawał serca diagnozowano zgodnie z klasyfikacją ICD-10, kody I21 i I22. Określono grupę pacjentów pod względem daty ustalenia rozpoznania, hospitalizacji i daty wypisania ze szpitala (powrót do zdrowia lub zgon z powodu MI). Wskaźnik śmiertelności wewnątrzszpitalnej obliczono metodą regresji Coxa. W celu określenia czynników wpływających na śmiertelność wewnątrzszpitalną zastosowano analizę jednozmiennową i analizę wielokrotnej regresji logistycznej. Iloraz szans [95-procentowy przedział ufności (CI)] określono, stosując oprogramowanie Stata.

**Wyniki:** Śmiertelność wewnątrzszpitalna wynosiła 12,1%. Wskaźnik śmiertelności wewnątrzszpitalnej był wyższy u mężczyzn niż u kobiet; ryzyko zgonu oszacowano na 6,74 (95% CI 6,4–7,0) na 100 osobo-lat leczenia. Największą śmiertelność (13,2%) odnotowano w styczniu (w perskim kalendarzu od 11 Dey do 11 Bahman), a najmniejszą (5,9%) — w maju (w perskim kalendarzu od 11 Ordibehest do 10 Khordad). Wiek powyżej 84 lat, płeć żeńska, poziom wykształcenia, palenie tytoniu, niestosowanie leczenia trombolitycznego, cukrzyca typu 2, ból w klatce piersiowej przed przybyciem do szpitala, blok prawej odnogi pęczka Hisa, częstoskurcz komorowy, przezskórna interwencja wieńcowa, MI ściany bocznej i MI z uniesieniem odcinka ST (STEMI) były czynnikami determinującymi śmiertelność wewnątrzszpitalną. Częstość względna zgonów była wyższa w grupie STEMI niż w non-STEMI (odpowiednio 83,7% *vs.* 16,3% zgonów w rejestrze z tych dwóch grup).

**Wnioski:** STEMI, niestosowanie leczenia trombolitycznego, wiek powyżej 84 lat i częstoskurcz komorowy najsilniej wpływały na śmiertelność wewnątrzszpitalną wśród chorych z MI. Wyniki niniejszego badania są pomocne w planowaniu monitorowania pacjentów i zapewnieniu im właściwej opieki zdrowotnej.

**Słowa kluczowe:** zawał serca, choroba niedokrwienna serca, śmiertelność wewnątrzszpitalna, czynnik ryzyka

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