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Mortality in patients with myocardial infarction and potential risk factors: A five-year data analysis

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Original Article

Abstract

BACKGROUND: Coronary artery disease (CAD) is among the most common causes of death in almost all countries across the world. Awareness of risk factors for the management and prevention of the disease can reduce complications and mortality rates. This study was conducted with the aim to investigate the mortality and potential risk factors of myocardial infarction (MI) as well as their relationships in patients who were admitted to one university hospital in the North of Iran from 2014 to 2018.

METHODS: This study had retrospective descriptive design. Using a checklist, all necessary information was extracted from 5-year medical records data of MI patients in the university hospital from 2014 to 2018 (n = 564). The data analysis was performed in SPSS software using descriptive statistics and two binary logistic regression analyses.

RESULTS: The results showed that the mean age of the patients was 62.78 ± 13.38 years, and most of them were men (66.3%). The patients' mortality was 18.6% in a 5-year analysis. However, the number of mortalities was higher in the women (P = 0.001). Descriptive analysis showed that the most common risk factors of the disease in both genders were hypertension (46.6%), diabetes mellitus (DM) (38.5%), hyperlipidemia (24.1%), smoking (20%), and family history of CVDs (18.8%), respectively. However, the results of the adjusted regression model showed that the odds ratio (OR) of the patients' mortality increased in diabetic MI patients (OR: 2.33; 95%CI: 1.42-3.81; P = 0.001), but this ratio decreased in MI patients with a history of hyperlipidemia (OR: 0.23; 95%CI: 0.11-0.44; P < 0.001).

CONCLUSION: Based on the results, individual- and population-based prevention strategies by focusing on hypertension and diabetes are recommended in our health programs. Surprisingly, the mortality rate of MI patients was lower among those with a history of hyperlipidemia. There are different hypotheses for the cause of this. Therefore, laboratory studies with animal models and prospective cohorts are suggested for future studies.

Keywords: Cardiovascular Disease; Coronary Artery Disease; Myocardial Infarction; Risk Factor; Mortality

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Introduction

Cardiovascular diseases (CVDs) are the number one cause of death worldwide. They are a group of disorders of the heart and blood vessels.[1] Among the conditions under this umbrella name, myocardial infarction (MI), from the group of coronary artery diseases (CADs), is the most common cause of mortality in different populations.

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CAD and MI are the fourth major cause of the burden of diseases in the world.[2] They lead to almost a third of the deaths worldwide.[3] They can also bring about numerous complications and severe disabilities, and represent a major economic burden on the health care systems of different countries.[4] Despite significant developments in cardiology, CVDs are still one of the world's greatest silent killers.[5]

The first half of the 20th century witnessed a rapid growth in the prevalence of CVDs due to industrialization, urbanization, and increase in social development and welfare in developed countries. However, there was a significant decline in the mortality rates of CVDs in the second half of the 20th century. As a result of aging and population growth, the mortality rates of CVDs have increased by 29.5% worldwide. The highest mortality rates are related to developing countries.[6] Evidence shows that 50% and 25% of the mortality rates of CVDs at the beginning of the 21st century are, respectively, related to developing and developed countries. This epidemiological difference has become more prevalent in different societies, because of the severity of risk factors and some changes in socioeconomic and demographic conditions; thus, they need to be accurately investigated.[7] In 50% of cases, CAD patients had one or more non-modifiable risk factor, such as old age, male gender, and family history of CVDs. The 4 modifiable risk factors of hypertension, diabetes mellitus (DM), smoking history, and hyperlipidemia have been reported as the major risk factors for the development of CAD and its complications.[8]

The present study was conducted with the aim to investigate the mortality of MI patients, potential risk factors, and the relationships between patients' mortality and risk factors in our context using the medical records of MI patients in 1 university hospital during a 5-year period. The results of this study can be useful in identifying the individuals and populations at higher risk of MI and can contribute to planning for early detection and control of the disease.

Materials and Methods

The present study had a retrospective descriptive design. The code of ethics was obtained from the Research Ethics Committee of Shahid Beheshti University of Medical Sciences in Tehran, Iran (code: IR. SBMU.PHNM.1396.786). Data collection was started in the study setting after obtaining a permission letter from the hospital authorities. The ethical principles were followed in all the phases of the study.

The data of the patients diagnosed with MI and admitted to Ayatollah Rouhani Hospital affiliated to Babol University of Medical Sciences in Babol, Iran, were collected through their medical records from 2014 to 2018. The inclusion criteria for the selection of the records were medical records with MI diagnosis for the patient during 2014 to 2018. The exclusion criteria included records with incomplete medical history and/or registrations of vague diagnosis. Of the 614 medical records, 50 records were excluded from data extraction due to obscure information or obscure. Hence, the necessary data were extracted from only 564 records at the hospital by the last author. The data collection tool used was a 2-part checklist. The first part included a demographic characteristics form, containing questions on age, gender, place of residence, and the final condition of the patient at the hospital (deceased or discharged). The second part consisted of a checklist of the major risk factors, and extra space for writing necessary information about the risk factors, if there was any.

In this study, MI was described based on the International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM), diagnosis code 410, and with reference to the clinical criteria developed by the World Health Organization (WHO) and the American Heart Association (AHA).[9] Accordingly, MI was considered based on at least 2 out of the 3 conditions described as follows: ischemic chest pain for at least 20 minutes, elevated serum levels of myocardial enzymes (viz. troponin, creatine kinase MB, creatine kinase isoenzymes, or other enzymes) at a rate of 2 to 3 times higher than the normal range within 48 hours after a heart attack, and electrocardiographic changes which confirmed MI.

The common risk factors (i.e., hypertension, hyperlipidemia, DM, smoking history, and family history of CVDs) were also described based on the American College of Cardiology (ACC)/AHA guidelines.[10] Thus, hypertension was described through the history of high blood pressure in the patients as registered in their medical records, their self-reports, and blood pressure ≥ 140/90 mm/Hg with or without medication intake upon admission. Moreover, hyperlipidemia was defined as a documented history of medication use to control cholesterol levels or total cholesterol levels of > 200 mg/dl or triglyceride levels of > 150 mg/dl or both. The individuals with DM were those with fasting blood sugar levels of > 126 mg/dl, or those

undergoing DM treatments and/or with a history of DM in the past or at present, with or without medication intake upon admission. Family history of CVDs in one of the first-degree relatives and smoking history were recorded in the patient's medical record during admission through obtaining the patient's medical history.

Statistical analysis: The data analysis was performed in SPSS software for windows (version 20; IBM Corp., Armonk, NY, USA) using descriptive statistics and binary logistic regression analyses. In this study, the continuous variables were presented as mean and standard deviation (Mean ± SD), and qualitative variables as number and percentage (n, %). Chi-square test was used to examine the differences between categorical variables in the same sample. Furthermore, t-test was used to examine mean differences in continuous variables. Binary logistic regression analyses were carried out to predict the association between MI risk factors (independent variables) and patients' mortality (dependent variable; deceased or discharged patients). All independent variables were dichotomized, except for age which was treated as a continuous variable in the regression models. Odds ratio (OR) was presented with 95% confidence intervals (CI). All assumptions of the logistic regression analysis were fulfilled (the appropriate structure of outcome variable or binary dependent variable, independent observations, absence of multicollinearity between independent variables, linear relation of independent variables with log-odds, and adequate sample size).[11]

To perform logistic regression analysis, a minimum of 5 to 6 samples per each variable are conventionally required.[12] Given the number of independent variables examined in this study (n = 7) and the number of reviewed medical records (n = 564), the sample size is adequate. A P-value of less than 0.05 was considered statistically significant for all analyses.

Results

The results of the descriptive statistics revealed that the mean age of the patients was 62.78 ± 13.38 years. The mean age of the men and the women were, respectively, 60.45 ± 13.54 and 67.37 ± 11.81 year. The ratio of the men (66.3%) was higher, compared with the women (33.7%). About 15% (n = 29) of the female patients and 38% (n = 141) of the male patients were younger than 55 years of age (not shown in the table). The patients' mortality based on the demographic variables and MI risk factors are presented in table 1.

Table 1 shows that the most prevalent risk factors of CVDs in our context are, respectively, hypertension (46.6%), DM (38.5%), hyperlipidemia (24.1%), smoking history (20%), and family history of CVDs (18.8%).

Table 2 shows that the differences between the gender groups were significant in terms of patients' mortality (P = 0.001) and all risk factors (hypertension, DM, hyperlipidemia, and smoking history) (P = 0.001), except for family history of CVDs (P = 0.05). In addition, the differences between the two groups of < 55 and ≥ 55 years of age were significant in terms of patients' mortality (P = 0.001) and all risk factors (family history of CVDs, hypertension, DM, and smoking history) (P < 0.05), except for hyperlipidemia (P = 0.08).

Table 1. Mortality of patients with myocardial infarction based on demographic variables and risk factors

Variables		Total of patients (n = 564)	Deceased (n = 105)	Discharged (n = 459)	P
		n (%)	n (%)	n (%)	
Age (Mean ± SD)		62.78 ± 13.38	69.53 ± 10.97	61.24 ± 13.41	0.001*
Age (year)	< 55	170 (30.1)	12 (7.1)	158 (92.9)	0.001
	≥ 55	394 (69.9)	93 (23.6)	301 (76.4)	
Gender	Male	374 (66.3)	51 (13.6)	323 (86.4)	0.001
	Female	190 (33.7)	54 (28.4)	136 (71.4)	
Hypertension	Yes	263 (46.6)	58 (21.1)	205 (77.9)	0.050
	No	301 (53.4)	47 (15.6)	254 (84.4)	
Diabetes mellitus	Yes	217 (38.5)	56 (25.8)	161 (74.2)	0.001
	No	347 (61.5)	49 (14.1)	298 (85.9)	
Hyperlipidemia	Yes	136 (24.1)	14 (10.3)	122 (89.7)	0.004
	No	428 (75.9)	91 (21.3)	337 (78.7)	
Smoking history	Yes	113 (20.0)	11 (9.7)	102 (90.3)	0.004
	No	451 (80.0)	94 (20.8)	357 (79.2)	
Family history of CVDs	Yes	106 (18.8)	15 (14.2)	91 (85.8)	0.200
	No	458 (81.2)	90 (19.7)	368 (80.7)	

*Independent t-test, and the rest chi-square test; CVDs: cardiovascular diseases

Table 2. Frequency of risk factors and mortality in patients with myocardial infarction based on age and gender groups (n = 564)

Variables		Gender		P*	Age (year)		P*
		Male [n (%)]	Female [n (%)]		< 55 [n (%)]	≥ 55 [n (%)]	
	Total	374 (66.3)	190 (33.7)		170 (30.1)	394 (69.9)	
Family history of CVDs	Yes	79 (21.1)	27 (14.02)	0.050	54 (31.8)	52 (13.2)	0.001
	No	295 (78.9)	163 (85.8)		116 (68.2)	342 (86.8)	
Hypertension	Yes	142 (38.0)	121 (63.7)	0.001	51 (30.0)	212 (53.8)	0.001
	No	232 (62.0)	69 (36.3)		119 (70.0)	182 (46.2)	
Diabetes mellitus	Yes	107 (28.6)	110 (57.9)	0.001	53 (31.2)	164 (41.6)	0.020
	No	267 (71.4)	80 (42.1)		117 (68.8)	230 (58.4)	
Hyperlipidemia	Yes	70 (18.7)	66 (34.7)	0.001	33 (19.4)	103 (26.1)	0.080
	No	304 (81.0)	124 (65.3)		137 (80.6)	291 (73.9)	
Smoking history	Yes	105 (28.1)	8 (4.2)	0.001	48 (28.2)	65 (16.5)	0.002
	No	269 (71.9)	182 (95.8)		122 (71.8)	329 (83.5)	
Patients' mortality	Yes	51 (13.6)	54 (28.4)	0.001	12 (7.1)	93 (23.6)	0.001
	No	323 (86.4)	136 (71.6)		158 (99.9)	301 (76.4)	

*Chi-square test in all analyses

The obtained data show that the most prevalent risk factors of CAD in women were, respectively, hypertension (63.7%), DM (57.9%), and a history of hyperlipidemia (34.7%). The women experienced a larger percentage of the above-mentioned risk factors compared with the men in our society. However, smoking history was more important in the men (28.1%) than the women (4.2%). Moreover, the prevalence of the risk factors of hypertension (53.8%) and DM (41.6%) was higher in the age group of ≥ 55 years compared with the age group of < 55 years.

In total, 18.8% (n = 105) of all MI patients who were admitted to the hospital were deceased before discharge (not shown in the table). Approximately, 28.4% of the deceased patients were women and 13.9% were men. The comparison of the groups showed that 88.7% (n = 93) of the deceased patients were in the age group of ≥ 55 years. There was a significant relationship between increasing age and higher mortality in the patients (P = 0.001).

Table 3 shows the results of binary logistic regression analyses regarding the prediction of the association between MI risk factors and patients' mortality. The results of the crude model revealed that the ORs of the patients' mortality were higher in the patients aged ≥ 55 years (OR: 4.07; 95% CI: 2.16-7.64), in the women (OR: 2.51; 95% CI: 1.63-3.87), and those with hypertension (OR: 1.53; 95%CI: 0.99-2.34), DM (OR: 2.11; 95% CI: 1.37-3.24), hyperlipidemia (OR: 0.42; 95% CI: 0.23-0.77), and smoking history (OR: 0.41; 95% CI: 0.21-0.79). However, after applying the full model, the result of logistic regression showed that the ORs of mortality in the patients with DM (OR: 2.33; 95%CI: 1.42-3.81) increased; however, this rate was decreased in the patients with a history of hyperlipidemia (OR: 0.23; 95%CI: 0.11-0.44).

Table 3. The results of logistic regression analysis for risk factors of mortality in patient with myocardial infarction (n = 546)

Variables	Categories	Crude Model		Full Model	
		OR (95% CI)	P	OR (95% CI)	P
Age (year)	< 55	-	-	-	-
	≥ 55	4.07 (2.16-7.64)	0.001	3.45 (1.78-6.67)	< 0.001
Sex	Men	-	-	-	-
	Women	2.51 (1.63-3.87)	0.001	1.82 (1.11-2.99)	0.017
Hypertension	No	-	-	-	-
	Yes	1.53 (0.99-2.34)	0.050	1.25 (0.77-2.03)	0.350
Diabetes mellitus	No	-	-	-	-
	Yes	2.11 (1.37-3.24)	0.001	2.33 (1.42-3.81)	0.001
Hyperlipidemia	No	-	-	-	-
	Yes	0.42 (0.23-0.77)	0.005	0.23 (0.11-0.44)	< 0.001
Smoking history	No	-	-	-	-
	Yes	0.41 (0.21-0.79)	0.008	0.68 (0.33-1.39)	0.290
Family history of CVDs	No	-	-	-	-
	Yes	0.67 (0.37-1.21)	0.190	1.10 (0.57-2.10)	0.770

OR: Odds ratio; CI: Confidence interval; CVDs: Cardiovascular diseases

Discussion

The objective of this retrospective descriptive study was to investigate mortality among MI patients, the importance of its risk factors, and the relationships between patients' mortality and risk factors in our context through data analysis of 5-year medical records of the patients in one university hospital in the north of Iran. The risk factors of the disease in our context in order of prevalence are, respectively, hypertension (46.6%), DM (38.5%), hyperlipidemia (24.1%), smoking history (20%), and family history of CVDs (18.8%). The study results showed that, except for smoking history and family history of CVDs, the rest of the risk factors, including hypertension, DM, and hyperlipidemia, showed higher in women compared with men. It should be noted that the effects of estrogen in women could justify the gender-specific biological differences in CAD patients.[13] Notably, the prevalence of hypertension and mortality was higher in the patients in the age group of ≥ 55 years compared with those in the age group of < 55 years.

The results of this study also confirmed the findings reported by Yamamoto et al., in which hypertension was reported as the most common risk factor in Japanese patients with acute coronary syndrome, accounting for 70% of the case in men and 79% of the cases in women.[14] Furthermore, hyperlipidemia and DM were also reported as important risk factors in the patients in their study.[14] In addition, other studies showed that DM, hypertension, and hyperlipidemia were the risk factors in order of priority, but smoking history was not very significant.[15,16] Another study reported the prevalence of hypertension in women and men as 46.7% and 33.7%, respectively. However, the number of male smokers (46.9%) was higher compared with their female counterparts (26.9%). Therefore, it seems that the risk factors for CAD were different in men, possibly depending on several factors.[17]

In our study, the mean age of the men and women was, respectively, 60.45 ± 13.54 and 67.37 ± 11.81 years. Moreover, the number of men was higher (66.3%). Our findings are comparable with that of other studies. Asgari et al. reported that most patients diagnosed with MI were men (66.3%) in their study.[18] With respect to the variables of age and gender in the present study, most of the hospitalized women (85%) were in the age group of ≥ 55 years, while only 62% of men were in this age group. In addition, the risk of atherosclerosis increased with an increase in age; thus, in men aged < 45 years and in women aged < 55 years, CAD could typically occur due to the protective effect of estrogen.[19]

Our mortality results showed that in total, 18.8% of the patients admitted with MI diagnosis died in the hospital. Gender results revealed that around 28% and 14% of the MI patients who had died at the hospital were women and men, respectively. The preliminary findings of our study demonstrated that 23.6% of the deceased patients were ≥ 55 years of age. Moreover, a significant relationship was found between the deaths of the patients in the age group of ≥ 55 years, and hypertension and DM. The higher number of deceased women compared with men can be justified by the higher prevalence of the risk factors in them, and the positive relationship between the risk factors and their mortality. Based on the presence of typical symptoms in the men and atypical symptoms in women,[20] which could be sometimes confusing in the early diagnosis and treatment of the disease, the higher number of mortalities of the women compared with the men is acceptable. It should be noted that individuals, particularly men at a younger age, have typical symptoms, which can be the main cause of early detection and prevention as well as lower morbidity and mortality rates in this gender. Numerous studies have reported higher mortality in women. They have argued that the higher mortality in women with MI might be related to the higher mean age of the women,[21-23] higher prevalence of risk factors, as well as worse prognosis in women compared with men.[24,25] However, in the present study, after adjustment of age and gender in the regression model, there was still a direct relationship between DM and patients' mortality. Nevertheless, a reverse relationship was found between the history of hyperlipidemia and patients' mortality.

Even though smoking history is a quite well-known risk factor for CVDs, as cited in the Framingham Risk Score,[26-28] a reverse relationship was observed between mortality and this risk factor in the present study. However, this result was not statistically significant after adjustment of the regression model for variables of age and gender. This type of contradiction has been reported in several survey studies.[29-32] In total, the results of the present study were consistent with the findings of large-scale studies with long-term follow-ups.[33,34]

Interestingly, in our study following the controlling of the variables of age and gender in the regression model, DM was an important risk factor for the mortality of the patients. Thus, a rising trend in DM could lead to an increase in the number of deaths in

MI patients. This finding was in line with the results reported by Alabas et al.[35] In their study, DM was associated with long-term mortality, accompanying it more than other risk factors for CVDs.[35]

Nevertheless, there was a reverse significant relationship between patients' mortality and their history of hyperlipidemia in our study. This finding is supported by the findings of Korhonen et al., perhaps attributable to the prescription of statins before the occurrence of MI.[36] Remarkably, Yeramaneni et al. also observed a lower mortality rate in patients who had hyperlipidemia even in patients who had not used statins.[37] Therefore, there are several hypotheses that may explain this relationship. It can be discussed that hyperlipidemia itself has a neuroprotective property like statins. Thus, they can neutralize free radicals, and lessen the rate of ischemic damage following interruption in antioxidant function. Another hypothesis is that MI patients can be detected earlier due to their complaints and hyperlipidemia induced by DM, and then, undergo treatments. Nevertheless, there is still a contradiction in numerous studies with regard to the effect of risk factors such as hyperlipidemia on mortality rates. Accordingly, lipids are central to the development of atherosclerosis. With reference to the studies in this field, hyperlipidemia, particularly cholesterol levels, is one of the main risk factors in the development of atherosclerosis and CVDs.[38] In contrast, some surveys have suggested that the presence of hyperlipidemia can have a protective effect against mortality rates in patients.[39] In this regard, one study has reported that lower death rates are the result of higher serum lipoprotein levels.[40] However, some studies reflected on the impact of prescribing statins for hyperlipidemia on lower mortality rates among patients with MI.[41] Some studies also rejected these results and pointed out that there was a lower death rate even in patients with a history of hyperlipidemia and no prescription of statins for their treatment.[37] In this regard, one survey showed that obesity led to a reduction in MI and mortality of patients undergoing non-cardiac surgery.[42] Therefore, laboratory studies with animal models and prospective cohorts are suggested for future studies. Moreover, based on the results, individual- and population-based prevention strategies by focusing on hypertension and diabetes are recommended in the health programs in our society.[43]

The strength of this study was its novelty. It was the first time that the relationship between patients' mortality and risk factors of MI was investigated through a 5-year data analysis in our context. Furthermore, we found a contradictory result that mortality was lower in MI patients with a history of hyperlipidemia. In this case, our study created the grounds for new studies in the future to investigate these contradictory results. Selection of one hospital as the research setting was one of the limitations of the study. In addition, sometimes it was not possible to extract all the necessary data from the medical records due to some shortages or inadequate information in the records. Therefore, some of the medical records were removed at the beginning of the study. It is suggested more data on MI risk factors be gathered through cohort studies and longitudinal follow-ups in our context.

Conclusion

A 5-year analysis showed that the risk factors of MI in our context are, respectively, hypertension (46.6%), DM (38.5%), hyperlipidemia (24.1%), smoking (20%), and family history of CVDs (18.8%). Hypertension in MI patients aged ≥ 55 years was higher than the MI patients aged < 55 years. The mortality results showed that 18.8% of the patients hospitalized with MI diagnosis had died. Gender results revealed that around 28% of the deceased MI patients were women and 14% of them were men. Moreover, hypertension and DM in the women, and smoking history in the men were the most important MI risk factors. After adjustment of the regression model based on age and gender, the patients' mortality increased in diabetic MI patients, but it decreased in MI patients with a history of hyperlipidemia. Different hypotheses are proposed in this area; therefore, further laboratory studies with animal models and prospective cohorts are suggested. Furthermore, in the development of the CAD health programs, individual and population-based prevention strategies are recommended by focusing on hypertension and DM in our context.

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Conflict of Interests

Authors have no conflict of interests.

Authors' Contribution

CR and HJ performed the conception and designing of the study. Data analysis was performed by HJ, CR, and HG. The first draft of the manuscript was written by HJ. CR, HJ, YM, and BE did the critical revisions of the manuscript and had a significant contribution to the text. All authors read and approved the final version of the manuscript.

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