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Original Article

Eleven-year trends of acute myocardial infarction incidence, mortality and case-fatality rate in Shanghai: a 1.09 million population based surveillance study

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Abstract: The objective of this study was to estimate trends in the incidence, mortality rate and 28-day case-fatality rate of acute myocardial infarction (AMI) between 2004 and 2014 based on 11- community population in Shanghai. We appraised the risk factors for the short- and long-term mortality. Age-adjusted rates were computed. Chi-square test was used to test the rate differences between men and women. Annual percentage changes (APC) were obtained by Joinpoint regression. Logistic regression and Cox regression were used to analyze the risk factors of short-term and long-term mortality, respectively. A total of 5651 AMI events occurred. For the first 5 years, the rates increased significantly, and then kept stable or decreased sharply from 2008 to 2014. The elder patients had extremely higher rates. For the case-fatality, no transition point was observed. Female patients had a significant higher fatality rate, comparing with male patients. Old age, history of coronary heart disease and hyperlipidemia are the risk factors for short- and long-term mortality. The level of hospital and history of hypertension are the protective factors. Conclusively, successful measures of public health and clinical efforts reversed the increasing trends from 2008 to 2014. Further research on risk factors is required.

Keywords: Acute myocardial infarction, incidence, mortality, case-fatality, risk factors

Background

In general, the prevalence of cardiovascular diseases (CVDs) in China continues to show an upward tendency. It is estimated that the number of CVD patients is 290 million in 2012, of whom 2.5 million suffered a myocardial infarction (MI). CVD is the leading cause of death in China, which accounts for 40% of deaths from any cause [1].

Given the burden of CVDs and AMI, it is essential to monitor the incidence, mortality rate, fatality rate and risk factors for AMI in China. From 1984 to 1993, Zhao *et al.*, supported by MONICA project, had estimated the trend of incidence of acute coronary events in the population aged 35-74 years in Beijing area [2]. However, with the development in economy and prevention measurements as well as the change in lifestyle, the incidence, mortality rate, case-fatality rate and risk factors for AMI may also have changed. For instance, the incidence of acute coronary events was rising in the population of Beijing area from 1984 to 1997 [3]. Meanwhile, Rosamond *et al.* found significant downward trends in MI incidence between 1997 and 2008 in 4 US Communities [4]. The Framingham Study cohort also reported the decline in coronary heart disease (CHD) mortality [5]. Although available studies have offered valuable insights into the trends in MI incidence and CHD mortality, additional data from recent years and other geographically diverse environments are needed to provide new and valuable insights into disease trends in the population [4, 6].

Some risk factors have been well studied and sufficiently discussed in several studies. In the

Table 1. The main characteristics of the AMI attacked patients and deaths

	AMI attack	All death	28-day death
All	5651	1685	1549
Sex			
Men	3451 (61.07)	851 (50.50)	784 (50.61)
Women	2200 (38.93)	834 (49.50)	765 (49.39)
Age (years)*	74.27±12.23	81.04±8.60	81.04±8.63
Survival days#	--	7 (2, 15)	6 (2, 12)
Level of hospital			
Level I	10 (0.18)	7 (0.42)	7 (0.45)
Level II	2309 (40.86)	925 (54.90)	859 (55.46)
Level III	3321 (58.77)	749 (44.45)	679 (43.83)
Missing	10 (0.28)	4 (0.24)	4 (0.26)
Comorbidities			
Hypertension			
Yes	3205 (56.72)	966 (57.33)	892 (57.59)
No	1422 (25.16)	463 (27.48)	430 (27.76)
Missing	1024 (18.12)	256 (15.19)	227 (14.65)
History of CHD			
Yes	1998 (35.36)	633 (37.57)	584 (37.70)
No	2151 (38.06)	532 (31.57)	492 (31.76)
Missing	1502 (26.58)	520 (30.86)	473 (30.54)
Diabetes			
Yes	1445 (25.57)	455 (27.00)	419 (27.05)
No	3160 (55.92)	967 (57.39)	897 (57.91)
Missing	1046 (18.51)	263 (15.61)	233 (15.04)
Hyperlipidemia			
Yes	1190 (21.06)	295 (17.51)	267 (17.24)
No	2877 (50.91)	837 (49.67)	777 (50.16)
Missing	1584 (28.03)	553 (32.82)	505 (32.60)
Smoking			
Yes	1092 (19.32)	217 (12.88)	206 (13.30)
No	3392 (60.02)	1122 (66.59)	1033 (66.69)
Missing	1167 (20.65)	346 (20.53)	310 (20.01)
Alcohol			
Yes	398 (7.04)	66 (3.92)	62 (4.00)
No	4086 (72.31)	1273 (75.55)	1177 (75.98)
Missing	1167 (20.65)	346 (20.53)	310 (20.01)

Note: *Age (years) was denoted by Mean ± SD, #Survival days were denoted by Median (Q1, Q3). All other variables are denoted by *n (%)*.

WHO-MONICA Study, it was estimated that trends in major risk factors, such as systolic blood pressure, smoking and cholesterol, explained 40% and 15% of the variability in men and women with coronary events, respectively [7]. However, the risk factors for short-term case-fatality after AMI and long-term survival have not been well studied, such as gender and hypertension [8-12].

In order to estimate the trends in AMI incidence, mortality rates and 28-day case-fatality rates in urban population of China during the last decade and appraise the risk factors for the short-term death and long-term survival, we conducted a surveillance study in Yangpu District in Shanghai (Shanghai Yangpu Acute Myocardial Infarction Surveillance program, SHAIMS). This study also compared trends in gender and age.

Materials and Methods

Data sources

Since 2004, the program has conducted a continuous surveillance of AMI patients discharged from hospital and deaths due to AMI occurring in or out of the hospital among the residents of all 11 communities in Yangpu District, Shanghai, China (Dinghai Street, Daqiao Street, Pingliang Street, Jiangpu Street, Siping Street, Kongjiang Street, Yanji Street, Changbai Street, Wujiaochang Street, Yinhang Street and the Town of Wujiaochang), with a combined study population of 1.09 million in 2014. The main characteristics of AMI patients were collected from hospitals in Yangpu district, including age, gender, level of the hospital, and history of hypertension, coronary heart disease, diabetes, hyperlipidemia, smoking and alcohol consumption. The community health care centers are responsible for the patients' follow-up after discharge.

Identification of AMI events

Criteria for AMI diagnoses: Symptoms (including chest congestion and chest pain), ECGs (including ST segment elevation and non-ST segment elevation), cardiac biomarkers (including total creatinine phosphokinase (CPK), CK-MB, lactate dehydrogenase, and troponin) and necropsy findings (if required). An event was considered as new if its duration of onset was more than 28 days after

Table 2. the sex-specific AMI incidence and death rate from 2004~2014

Year	AMI (1/100000)		χ^2	*p*-value	Mortality (1/100000)		χ^2	*p*-value	Fatality (%)		χ^2	*p*-value
	Man	Woman			Man	Woman			Man	Woman		
2004	11.98	9.55	1.4797	0.238	3.76	3.44	0.0756	0.7833	31.34	30.00	0.0243	0.8762
2005	22.77	16.20	5.9737	0.0145	4.66	5.34	0.2454	0.6203	21.26	31.76	2.9600	0.0853
2006	39.84	22.87	24.5928	<0.0001	8.65	7.24	0.6741	0.4116	19.46	30.00	4.8565	0.0275
2007	49.25	38.86	6.5808	0.0103	11.59	12.00	0.0388	0.8439	18.38	29.41	7.9806	0.0047
2008	65.11	49.06	12.1405	0.0005	14.87	17.43	1.0920	0.2960	21.45	30.89	7.0743	0.0078
2009	68.63	50.40	15.101	0.0001	16.66	18.05	0.3030	0.5820	23.75	35.07	9.8987	0.0017
2010	83.71	56.55	28.5519	<0.0001	20.79	22.40	0.3250	0.5686	23.97	38.61	18.7761	<0.0001
2011	75.84	48.76	32.0678	<0.0001	23.17	19.65	1.5754	0.2094	28.64	39.54	8.7101	0.0032
2012	71.80	46.97	27.4804	<0.0001	23.93	23.20	0.0601	0.8063	28.65	40.49	9.4898	0.0021
2013	87.21	42.43	84.2348	<0.0001	17.3	15.87	0.3362	0.5621	18.79	32.17	15.6564	<0.0001
2014	51.37	31.18	26.8568	<0.0001	9.51	11.99	1.5679	0.2105	16.01	34.32	20.0351	<0.0001
All	56.91	37.62	233.4814	<0.0001	14.03	14.27	0.1219	0.7270	22.72	34.80	98.5591	<0.0001

any previous CHD event. AMI total events include non-fatal and fatal AMI.

Identification of fatal AMI events and non-fatal AMI deaths

AMI fatal events were determined if the death occurred within 28 days from the onset of the first symptom. Non-fatal AMI deaths were considered if the patients suffered a sudden death after 28 days from the onset of acute symptoms. The death cases included both out-of hospital and in-hospital deaths. Trends in AMI mortality included deaths due to either definite fatal AMI or non-fatal AMI. However, due to lacking of information about out-hospital deaths, we didn't carry out the analysis stratified by out-hospital and in-hospital case-fatality in this study.

All the data in this study were double checked by physicians and investigators from Centers for Disease Control of Yangpu District. All the AMI cases were reported without missing. Replicated case reports were removed from the system by checking the patients' ID, events and events time that overlapped.

Data analysis

Age-adjusted rates (incidence, mortality) for the population were computed by direct methods using the 2010 China Standard Population as the standardizing population [13]. Chi-square test was used to test the differences between men and women. For trend analysis, the assumption of linearity of rates on the logarithmic scale may be not appropriate over the entire time period. When the trend is not constant, the nonlinearity of the trend can be characterized using annual percent change (APC) from segmented analysis. This approach assumes that the change in age-adjusted rates is constant over each time partition defined by the transition points, but varies among different time partitions [14]. Therefore, trends in incidence, mortality and 28-day case fatality were estimated using joinpoint regression, which involves fitting a series of joined straight lines on a logarithmic scale in each segment to the trends in the annual age-adjusted rates [15, 16]. The terms "increase" or "decrease" were used when the APC of the trend was statistically significant; otherwise, the terms "stable" were used. All-population and sex-specific rate trends were presented with smoothed curves obtained by nonparametric regression using the LOESS function in R. To ascertain an age-specific trend in incidence and mortality rate, we divided the age at AMI onset into 6 categories: ≤44 years, 45-54 years, 55-64 years, 65-74 years, 75-84 years, and ≥85 years. In order to compare the trends between old and young/middle aged patients, we also stratified patients into 2 categories: ≤64 years and >64 years. For the purposes of examining risk factors that associated with the 28-day case fatality, logistic regression was performed. In order to evaluate the risk factors for the long-term survival, multivariate Cox regression was used.

Joinpoint regression was carried out by Join point Regression Program (National Cancer Institute Bethesda, Maryland, USA, Version 4.2.0.2) [15, 17]. All other statistical analyses

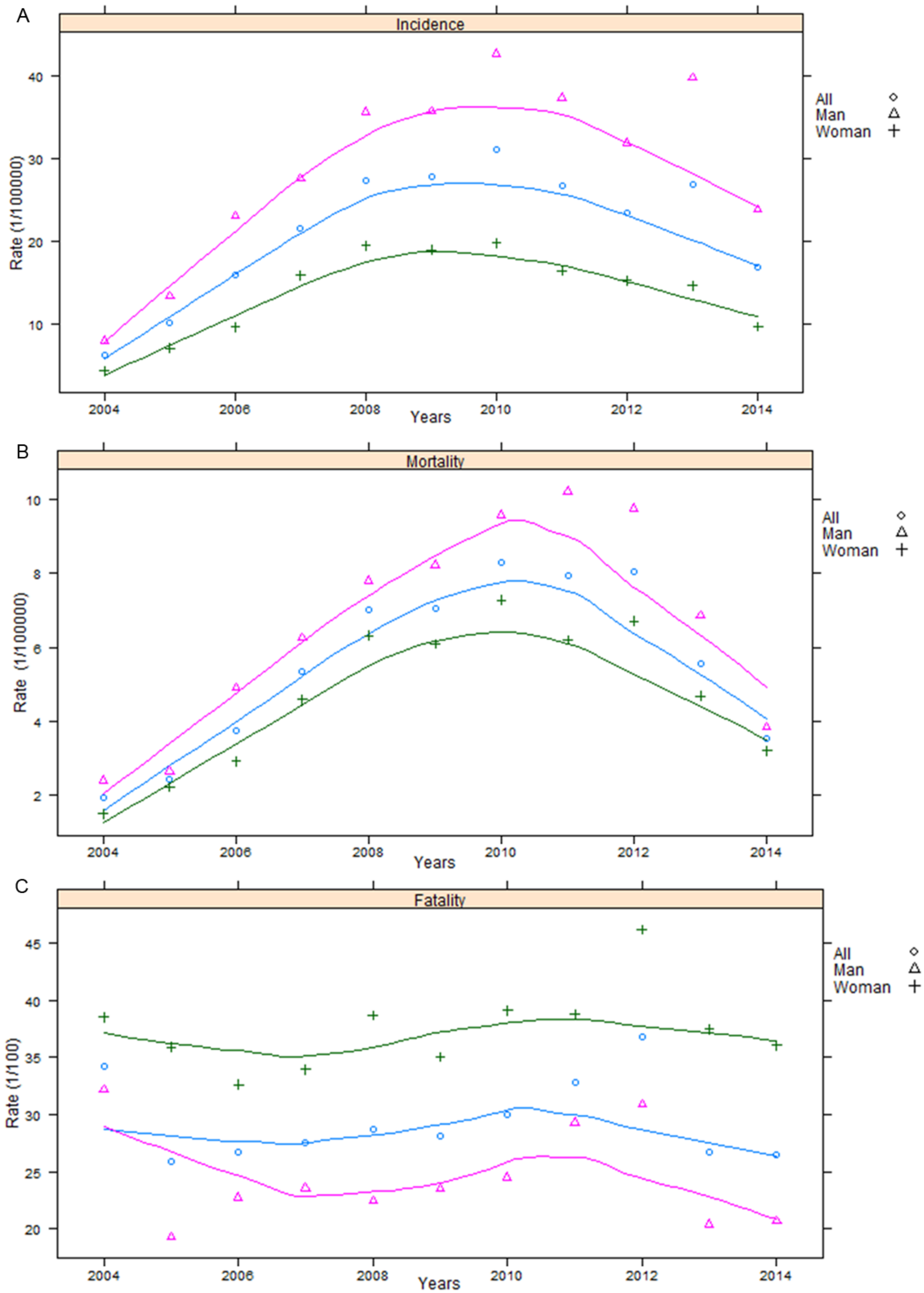

Figure 1. Trends in AMI incidence, mortality rate and fatality rate in 11-community population during in Yangpu District of Shanghai from Year 2004 to Year 2014. A: AMI incidence. B: AMI mortality rate. C: AMI fatality rate.

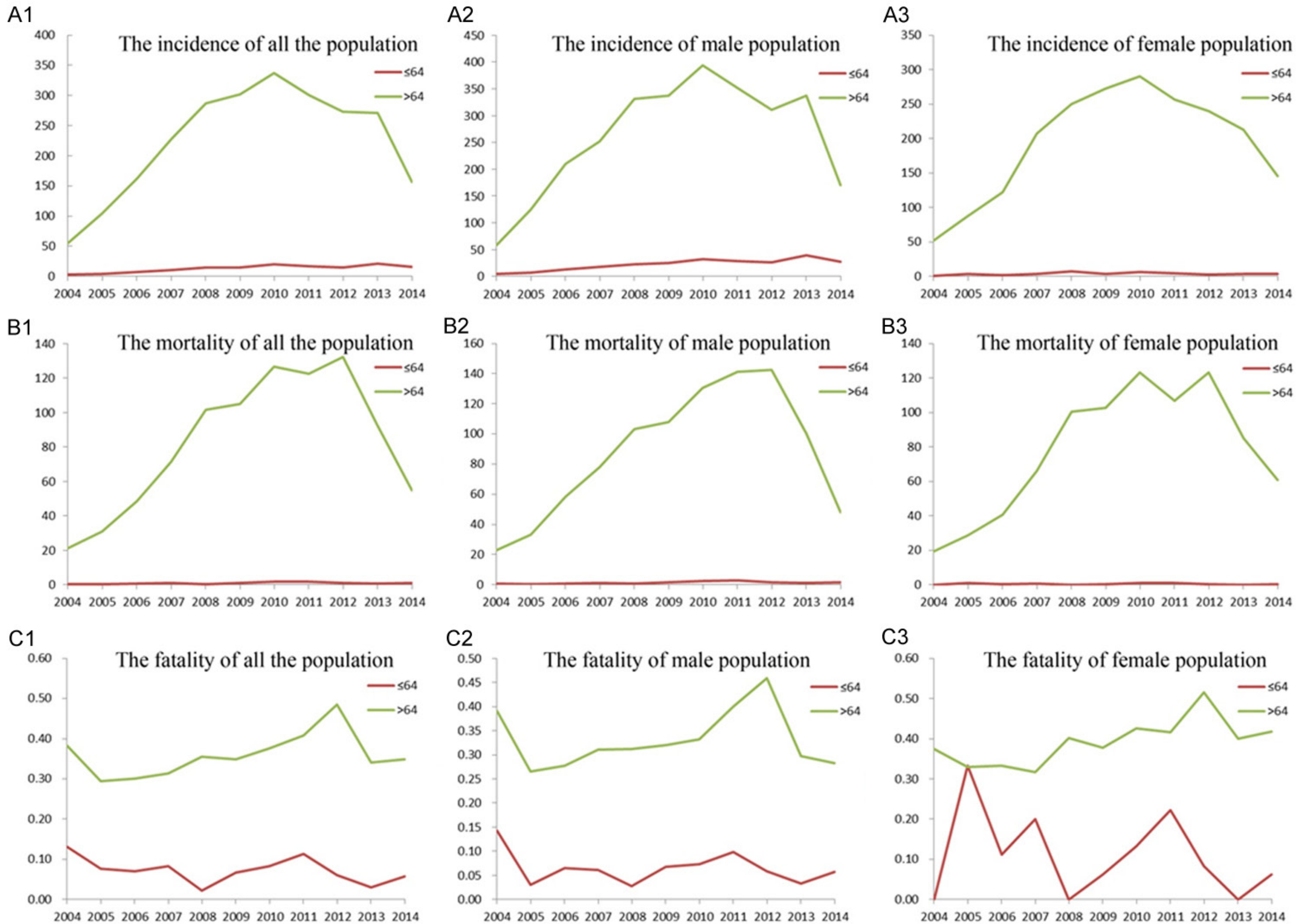

Figure 2. Trends in age-specific AMI incidence, mortality and 28-day case fatality rates. A1-A3: the age-specific AMI incidence of different sex groups; B1-B3: the age-specific AMI mortality of different sex groups; C1-C3: the age-specific AMI 28-day case fatality rate of different sex groups.

Table 3. Joinpoint regression of all-populations trends on AMI incidence, mortality and fatality rate in 2004-2014

	Period	APC (95% CI)	Period	APC (95% CI)	Period	APC (95% CI)
All						
Incidence	2004-2008	44.6 (19.2, 75.3)*	2008-2014	-5.4 (-12.0, 1.8)		
≤64	2004-2008	56.1 (31.1, 85.8)*	2008-2014	1.1 (-7.9, 11.0)		
>64	2004-2008	54.6 (29.5, 84.6)*	2008-2014	-8.3 (-16.6, 0.8)		
Mortality	2004-2008	39.7 (20.5, 61.9)*	2008-2012	3.6 (-8.7, 17.7)	2012-2014	-34.0 (-51.9, -9.6)*
≤64	2004-2014	11.9 (0.3, 24.9)*				
>64	2004-2008	48.6 (37.3, 60.8)*	2008-2012	7.0 (-5.6, 21.2)	2012-2014	-35.5 (-49.7, -17.2)*
Fatality	2004-2014	0.19 (-2.4, 2.9)				
≤64	2004-2014	-5.5 (-15.3, 5.5)				
>64	2004-2014	2.0 (-1.0, 5.0)				
Men						
Incidence	2004-2008	42.5 (10.2, 84.2)*	2008-2014	-3.3 (-11.9, 6.2)		
≤64	2004-2008	53.0 (28.6, 82.1)*	2008-2014	3.5 (-5.7, 13.6)		
>64	2004-2006	89.7 (-27.3, 395.1)	2006-2010	17.7 (-27.2, 90.1)	2010-2014	-15.6 (-37.7, 14.3)
Mortality	2004-2008	35.8 (13.8, 62.1)*	2008-2012	6.1 (-8.3, 22.8)	2012-2014	-37.1 (-57.0, -8.1)*
≤64	2004-2014	16.6 (3.5, 31.3)*				
>64	2004-2007	55.8 (37.0, 77.2)*	2007-2012	13.1 (4.3, 22.7)*	2012-2014	-43.3 (-56.1, -26.6)*
Fatality	2004-2014	-0.49 (-4.3, 3.4)				
≤64	2004-2014	-2.3 (-12.5, 9.1)				
>64	2004-2014	0.8 (-3.0, 4.8)				
Women						
Incidence	2004-2008	47.8 (27.5, 71.4)*	2008-2014	-9.6 (-14.7, -4.1)*		
≤64	2004-2014	11.1 (-3.7, 28.2)				
>64	2004-2007	58.3 (25.5, 99.8)*	2007-2010	14.1 (-28.3, 81.6)	2010-2014	-14.9 (-26.5, -1.4)*
Mortality	2004-2008	43.5 (16.7, 76.5)*	2008-2012	1.4 (-17.1, 24.0)	2012-2014	-30.9 (-58.1, 13.9)
≤64	2004-2014	20.2 (-69.8, 379)				
>64	2004-2008	51.5 (34.2, 71.0)*	2008-2012	5.2 (-13.2, 27.4)	2012-2014	-29.4 (-51.9, 3.6)
Fatality	2004-2014	1.07 (-0.9, 3.0)				
≤64	2004-2014	15.1 (-67.0, 301.7)				
>64	2004-2014	3.0 (0.7, 5.3)*				

*The Annual Percent Change (APC) is statistically significant different, the *P*-value is less than 0.05.

were performed with R Statistical Package [18]. P<0.05 were considered as statistically significant.

Results

During 2004 to 2014, a total of 5651 AMI events occurred among residents of 11communities in Yangpu District. There were 1685 deaths due to AMI within or more than 28 days, in which 1549 deaths were fatal AMI events. The main characteristics of all AMI attacked patients and deaths are shown in **Table 1**. The sex-specific AMI incidence and death rates were listed in **Table 2**. The age-specific rates were presented in **Figure 2**.

Trends in incidence

A nonlinear incidence trend was observed when all patients were analyzed together (**Figure 1A** and **Table 3**). The significant transition point is year 2008. For the first 5 years (2004-2008), the incidence of AMI increased significantly, with an estimated APC of 44.6%/year (95% CI: 19.2 to 75.3). As shown in **Table 3**, the age-stratified incidence had the similar trends.

Regarding the incidence trends in men, it also had the same tendency as the results from all patients together. However, the rising trend was not statistically significant in the male patients over 64 years old. It's worth noting that the inci-

Table 4. The factors that associated with short-term death (within 28 days) of AMI

Parameters	Coefficients estimation	Wald X^2	*P*-value	OR (95% CI)
Age*	0.810	383.910	<.001	2.25 (2.07, 2.44)
History of CHD	0.102	24.878	<.001	1.11 (1.06, 1.15)
Hypertension	-0.325	16.004	<.001	0.72 (0.62, 0.85)
Hyperlipidemia	0.053	8.142	0.004	1.05 (1.02, 1.09)
Hospital level	-0.773	91.960	<.001	0.46 (0.39, 0.54)

*The patients age were divided into 6 categories: 44 years, 45-54 years, 55-64 years, 65-74 years, 75-84 years, and 85 years.

Table 5. The factors that associated with long-term survival of AMI

Parameters	Coefficients estimation	Wald X^2	*P*-value	RR (95% CI)
Age*	0.668	436.582	<.001	1.95 (1.83, 2.08)
History of CHD	0.070	25.300	<.001	1. 07 (1.04, 1.10)
Hospital level	-0.540	83.219	<.001	0.58 (0.52, 0.65)
Hypertension	-0. 254	18.821	<.001	0.78 (0.69, 0.87)
Hyperlipidemia	0.034	6.812	0.009	1.03 (1.01, 1.06)

4484 patients that have the full information were included in the Cox regression. 3143 patients were censored at the end of follow-up. *The age of patients was divided into 6 categories: 44 years, 45-54 years, 55-64 years, 65-74 years, 75-84 years, and 85 years.

dence in female patients decreased significantly (APC: -9.6, 95% CI: -14.7 to -4.1). The incidence in elder female patients was steeper than that in younger female patients (APC: 58.3, 95% CI: 25.5 to 99.8). From 2010 to 2014, the incidence in elder female patients had a significant decrease (APC: -14.9, 95% CI: -26.5 to -1.4). The difference between men and women was statistically significant (χ^2= 233.481, P<0.0001). As shown in **Figure 2**, the elder patients had extremely high incidence than the younger ones.

Trends in mortality rate

There was also a nonlinear trend in the mortality when all patients were analyzed together (**Figure 1B** and **Table 3**). Compared to the incidence trends, the mortality trends had two transition points: year 2008 and 2012. The mortality rate first increased significantly from 2004 to 2008 (APC: 58.3, 95% CI: 25.5 to 99.8), and then kept stable from 2008-2012, and finally deceased dramatically from 2012 to 2014 (APC: -34.0, 95% CI: -51.9 to -9.6). For the younger patients, the mortality trend was linear, and the increase trend was mild (APC: 11.9, 95% CI: 0.3 to 24.9). For the elder patients, the trend was steeper than that of younger from 2004 to 2008 (APC: 48.6, 95% CI: 37.3 to 60.8).

The mortality of men had the similar trend as that of all patients. First, increased sharply from 2004 to 2008, and then kept stable from 2008 to 2012, then decreased dramatically from 2012 to 2014. However, in the elder male patients, the first transition point was 2007, and the increase trend was significant from 2007 to 2012 (APC: 13.1, 95% CI: 4.3 to 22.7). Among the overall female patients and elder female patients, the decline rate from 2012 to 2014 were not statistically significant (APC: -30.9, 95% CI: -58.1 to 13.9 and APC: -29.4, 95% CI: -51.9 to 3.6, respectively). There were no differences in the rates between men and women (χ^2=0.122, P=0.727). As shown by **Figure 2**, the elder patients had extremely high mortality than the younger ones.

Trends in fatality rate

No transition point was observed in 28-day case-fatality trends of all patients, male and female patients (**Figure 1C** and **Table 3**). The trends were stable from 2004 to 2014 (APC: 0.19, 95% CI: -2.4 to 2.9, APC: -0.49, 95% CI: -4.3 to 3.4 and APC: 1.07, 95% CI: -0.9 to 3.0 for all patients, male and female patients, respectively). However, in the elder female patients, the fatality rate increased mildly from 2004 to 2014 APC: 3.0, 95% CI: 0.7 to 5.3). Significant differences in the rates between men and women were detected (χ^2=98.559, P<0.0001). Female patient had higher fatality rate than that of men.

Risks factors associated with short-term death and long-term survival

For the short-term death, 4484 patients with full clinical information were included in the logistic regression, including 3245 survivor and 1239 deaths. All the included deaths died within 28 days from the onset of the first symptom. The results in **Table 4** shows that the fatality rates increased dramatically when the patients get elder (OR: 2.25, 95% CI: 2.07 to 2.44). History of CHD (OR: 1.11, 95% CI: 1.06 to 1.15) and hyperlipidemia (OR: 1.05, 95% CI: 1.02 to 1.09) were also the risk factors for the short-term death. As expected, the level of hospital was a protective factor (OR: 0.46, 95% CI: 0.39 to 0.54). It's worth noting that the patients with hypertension had lower risk of death (OR: 0.72, 95% CI: 0.62 to 0.85).

For the long-term survival, 4484 patients were included in the Cox regression, in which 3143 patients were censored at the end of follow-up (January 1st, 2015). As shown in **Table 5**, similar with short-term death, old age (RR: 1.95, 95% CI: 1.83 to 2.08), history of CHD (RR: 1. 07, 95% CI: 1.04 to 1.10) and hyperlipidemia (RR: 1.03, 95% CI: 1.01 to 1.06) were the risk factors. The level of hospital (RR: 0.58, 95% CI: 0.52 to 0.65) and hypertension (RR: 0.78, 95% CI: 0.69 to 0.87) were the protective factors.

Discussion

Incidence

Within a large community-based population, an inverted V-shaped trend was observed in the age-adjusted AMI incidence from 2004 to 2014. After a rapid increase from 2004 to 2008, an encouraging decline was presented from 2008 to 2014, especially in female population. This trend was similar with the result of Worcester Heart Attack Study that conducted in 80's of last century in US [19]. The transition point in 2008 may result from the successful control of hypertension, hypercholesterolaemia and smoking in recent decade. History of hypertension is common among patients with AMI and is widely considered as a risk factor for AMI [20]. With the improvement of the community health care system, much effort had been devoted to hypertension control by modifiable risk factors management and drug intervention in Shanghai [21-23]. In the INTERHEART study, smoking is one of the most important risk factors for AMI, which accounts for about 36% of the population suffering AMI [20]. In the recent decade, public bans on smoking has been emphasized both on the individual and community levels in Shanghai.

Compared with the incidence in western countries, averagely, the incidence in our study was rather low [4, 24, 25]. A study conducted in another metropolis in China, Beijing, locating in northern China, reported that about two-fold higher incidence both in men and women as compared with the incidence of this study [26]. Northern Chinese usually have higher rates of smoking, more salty foods, and therefore, had higher rate of CVDs than those in southern China [2, 21]. Numerous studies have shown the incidence of AMI is greater among men than women [19, 27]. The results of the present study are in agreement with these findings, showing a higher incidence of age-adjusted rates of AMI in men compared with women. This difference mainly caused by the different level of exposure to the risk factors, for example smoking [28].

Mortality

As to mortality rates, plateaus were observed both in men and women from 2008 to 2012. Before 2008, the mortality rates increased dramatically. However, after 2012, the mortality rates decreased significantly. The observed increase in mortality rates from 2004 to 2008 is consistent with the national report on cardiovascular diseases of China [29]. Compared with the national level, mortality rates in Shanghai urban area were relatively low. For example, the national mortality rate of urban residents in 2008 was 34.12/100,000, comparing with 7.00/100,000 in Shanghai. It's worth noting that the mortality rates did not increase any more from 2008 in this study. However, at national level, the mortality rate increased steadily. Up to 2013, the national level increased to 51.46/100,000, but the Shanghai local level decreased to 5.57/100,000 [29]. The decrease trend was especially obvious in elders.

Several efforts have been made to reduce the AMI mortality. The most important measure is the health insurance policy. Before 2009, coronary artery stents were not covered by any public health insurance in China. From December 2009, the Shanghai Medical Insurance Bureau decided to cover stents under public health insurance, and the reimbursement rate was set at 80% for stents made in China and 70% for imported stents [30]. Besides, family physician system was initiated from 2011 in Shanghai. The main goal of family physicians is to reduce the incidence and mortality of chronic diseases among elders.

Special attention should be paid to younger male patients. Unlike the elders, the mortality rate of younger male patients increased significantly throughout the study period.

Fatality

Regarding 28-day case fatality, the trends were stable in all subgroups, except in the elder women patients. Consistent with previous findings [31-33], we found that women, but not men, had higher rate of death within 28 days after AMI occurred. There was no evidence showing that this difference between women and men diminished over the last decade in China [34]. This may be caused by under-diagnosis of AMI due to the unobvious or unrepresentative early symptoms, signs, and pathophysiology of coronary heart disease in women [35, 36]. Additionally, under-treatment in female patients in the early course of AMI appeared more common [37]. What's more, female patients usually have older age, more comorbidity and less frequent use of invasive procedures [38-40]. Vaccarino *et al.* suggested that women with AMI had higher short-term mortality as compared with men, and should be considered as a heterogeneous group [36].

Risk factors

One of the notable findings in this study is that, as a well-known risk factor for the development of AMI, hypertension, however, is a protective factor for the survival after AMI attack, no matter for short- or long-term survival. The prognostic role of hypertension in post-infarction patients is controversial [8, 41-45]. However, the possible biological and clinical mechanisms of this protective effect are reasonable. First, higher DBP may improve collateral circulation and coronary perfusion and therefore may promote reperfusion success and reduce infarct size positively. In addition, a thicker left ventricle (LV) may positively affect LV remodeling, with a reduction in LV dilatation [44]. Second, from the perspective of clinical intervention, patients with a history of hypertension took more cardiovascular drugs [46], and underwent more intensive physical examination. From the results of the study conducted by Shanghai Secondary Prevention of Acute Myocardial Infarction Study Group, long-term treatment with captopril exerts a beneficial effect on the prognosis of AMI patients [47]. However, the mechanisms and clinical implications of this protective effect deserve further evaluation.

The higher level hospitals usually have lower mortality and fatality rate. In China, high level hospitals, for example tertiary hospitals in Shanghai, usually have "green channel" for the AMI patients and have higher use of PCI and aspirin in the following years. This phenomenon is also found in the higher-volume hospitals in US and Taiwan [48, 49].

Advantages and limitations

Advantages of our study include its population-based design (inclusion of all the communities in Yangpu District), and strict quality control process. However, several limitations need to be considered. First, no separate information about ST-segment elevation (STEMI) and non-ST-segment elevation (NSTEMI) in myocardial infarction were obtained in this study. Hospital fatality rate was significantly different between patients with STEMI and NSTEMI [50]. Regrettably, we cannot estimate the proportion of the subtypes of AMI from the current system. Second, no information about intervention was available. Intervention plays a pivotal role in the prognosis. For example, the time interval from AMI onset to reperfusion is crucial. However, we haven't collected this kind of variables. Third, generalization of the trends to all population in Shanghai or in China must be cautious. We analyzed the population from 11 communities in one district of Shanghai, meaning that the reported trends might be not representative of the whole population in Shanghai, especially for the rural area. Meanwhile, Shanghai, as a metropolis in eastern China, has more high level hospitals and outstanding community health systems which can help to decrease the incidence, mortality and fatality rate.

Conclusions

In summary, successful measures of public health and clinical efforts have been devoted to reduce the risk factors for incidence and mortality rate of AMI, and the increasing trends was reversed from 2008 to 2014. However, not all population showed decreased AMI trend in the last decade. In addition, case fatality in women was higher than that in men. Future studies should aim to understand which factor affect men and women differently to identify a better treatment for female patients. What's more, novel strategies for managing the risk factors in women are needed, both at the time of symptoms presentation and hospitalization.

Disclosure of conflict of interest

None.

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