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# Long-Term Trend in the Incidence of Acute Myocardial Infarction in Korea: 1997-2007

Jae Seok Hong, PhD<sup>1</sup>, Hee Chung Kang, PhD<sup>1</sup>, Sun Hee Lee, MS<sup>2</sup> and Jaiyong Kim, MD<sup>3</sup>

<sup>1</sup>Health Insurance Review & Assessment Policy Institute, <sup>2</sup>Comprehensive Review System Planning Department, Health Insurance Review & Assessment Service, Seoul, Korea

<sup>3</sup>Department of Social and Preventive Medicine, Hallym University College of Medicine, Chuncheon, Korea

## ABSTRACT

**Background and Objectives:** Information about disease incidence is indispensable for the active prevention and control of acute myocardial infarction (AMI). The purpose of this study was to provide basic information for the establishment of policy related to AMI by examining the long-term trends in incidence of AMI. **Subjects and Methods:** This study identified the trend in disease incidence during between 1997 and 2007 using the Korean National Health Insurance Database that includes AMI {the 10th International Classification of Disease (ICD-10) code: I21, I22, I23, I250, I251} as a primary or secondary disease. **Results:** The attack and incidence rates for AMI in 2007 were 118.4 and 91.8 per 100,000 persons, respectively, and the rates more than doubled for the 11 years. Both rates were higher among males than females and increased more in the older age groups. Incidence cases accounted for most of the total attack cases every year; however, in recent years the proportion of relapse cases was on the rise. The case fatality rate was highest (14.5%) in 2000, and declined rapidly to 9.8% in 2007. The case fatality rate was higher among females than males and the older age groups; in particular, female patients  $\geq 65$  years of age had the highest fatality rate. **Conclusion:** This study showed that AMI has been on the rise in Korea for 11 years. Therefore, the establishment of policy for intensive control of the incidence of AMI is necessary by building a continuous monitoring and surveillance system. (**Korean Circ J 2009;39:467-476**)

**KEY WORDS:** Myocardial infarction; Mortality; Prognosis.

## Introduction

Acute myocardial infarction (AMI) is a disease with a high case fatality rate. However, appropriate medical services have been reported to reduce mortality and disability caused by AMI. Currently, AMI is selected as a disease for evaluation and monitoring in many countries, including the United States (US), the European countries, as well as Korea.<sup>1-4)</sup>

Although the incidence of AMI in Korea is expected to increase rapidly due to westernization of diet and aging of the population, the exact prevalence and long-term trends of the disease have not been examined. A national sample survey {National Health and Nutrition Survey (NHNS)} exists, but statistical accuracy and validity of the data obtained through such a survey are weak and many studies, except NHNS, still examine subjects of small, specific areas or some medical institutions with the corresponding limitations in representation and generalization which are needed for national data.<sup>5,6)</sup>

Therefore, this study determined the long-term incidence and trends of AMI with national health insurance claims data between 1997 and 2007 to provide necessary data for establishing policies for active prevention and management.

## Subjects and Methods

### Data source and study population

This study investigated all national health insurance

**Received:** January 9, 2009

**Revision Received:** February 24, 2009

**Accepted:** March 13, 2009

**Correspondence:** Jaiyong Kim, MD, Department of Social and Preventive Medicine, Hallym University College of Medicine, 39 Hallimdaehak-gil, Chuncheon 220-702, Korea

Tel: 82-2-2182-2560, Fax: 82-2-2182-2650

E-mail: dr\_hongjs@hanmail.net

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claims due to AMI as a primary and secondary disease for the 11 years from 1997 to 2007. To evaluate all AMI patients, I21, I22, I23, I250 and I251 of the 10th International Classification of Disease (ICD-10) were designated as standards for the disease.

In 298 classifications of disease of the Korean Standard Classification of Disease and Cause of Death, AMI is the 147th disease and includes I21 and I22 of ICD-10. However, as some hospitals used I250 and I251 to request health insurance for percutaneous coronary intervention (PCI) or coronary artery bypass graft (CABG) surgery conducted for AMI patients, this study reflected maximum results of previous studies showing high treatment and examination rates of AMI patients (CABG, percutaneous transluminal coronary angioplasty (PTCA), troponin, or creatine kinase) and a high true positive

rate of AMI in I23, I250, and I251 to select diagnosis codes for analysis.<sup>5)</sup>

## Statistical analysis

### Building episode of care

In the Monitoring of Trends and Determinants in Cardiovascular Disease (MONICA) project another incident case of AMI at the same site within 28 days from the first incident case is considered an episode of AMI care.<sup>2)</sup> This study also treated a case claiming health insurance with the same disease within 28 days from the first request for AMI as an episode and recorded episodes by year from 1997 to 2007.<sup>5)</sup> When a claim was filed with health insurance for an AMI at the end of a year and then a claim was filed again within 28 days in

**Table 1.** Attack rate of acute myocardial infarction by age or gender: 1997-2007

	Year										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
<b>Total</b>											
Population*	45,953,580	46,286,503	46,616,677	47,008,111	47,357,362	47,622,179	47,859,311	48,039,415	48,138,077	48,297,184	48,456,369
Attack case	22,039	24,912	30,365	31,996	39,201	45,625	48,895	52,331	54,410	55,261	57,350
Attack rate <sup>†</sup>	48.0	53.8	65.1	68.1	82.8	95.8	102.2	108.9	113.0	114.4	118.4
<b>Gender</b>											
<b>Male</b>											
Population*	23,148,092	23,295,727	23,457,837	23,666,769	23,843,136	23,970,035	24,089,703	24,165,488	24,190,906	24,267,609	24,344,276
Attack case	13,320	14,825	17,828	18,646	23,016	26,829	29,144	31,022	32,414	33,481	34,713
Attack rate <sup>†</sup>	57.5	63.6	76.0	78.8	96.5	111.9	121.0	128.4	134.0	138.0	142.6
<b>Female</b>											
Population*	22,805,488	22,990,776	23,158,840	23,341,342	23,514,226	23,652,144	23,769,608	23,873,927	23,947,171	24,029,575	24,112,093
Attack case	8,719	10,087	12,537	13,350	16,185	18,796	19,751	21,309	21,996	21,780	22,637
Attack rate <sup>†</sup>	38.2	43.9	54.1	57.2	68.8	79.5	83.1	89.3	91.9	90.6	93.9
<b>Age</b>											
<b>0-44</b>											
Population*	34,696,864	34,676,955	34,610,580	34,502,465	34,326,287	34,047,914	33,706,685	33,273,360	32,747,120	32,254,176	31,775,248
Attack case	2,423	2,532	2,830	3,092	3,743	4,077	4,079	3,894	3,781	3,768	3,671
Attack rate <sup>†</sup>	7.0	7.3	8.2	9.0	10.9	12.0	12.1	11.7	11.5	11.7	11.6
<b>45-54</b>											
Population*	4,656,982	4,787,167	4,986,346	5,287,305	5,583,838	5,852,764	6,144,056	6,474,983	6,828,251	7,189,002	7,504,276
Attack case	3,651	3,770	4,659	4,983	6,137	7,208	7,767	8,145	8,529	8,987	9,112
Attack rate <sup>†</sup>	78.4	78.8	93.4	94.2	109.9	123.2	126.4	125.8	124.9	125.0	121.4
<b>55-64</b>											
Population*	3,670,423	3,753,328	3,796,175	3,823,445	3,868,867	3,949,426	4,040,452	4,125,098	4,196,064	4,268,304	4,366,482
Attack case	6,529	7,284	8,677	8,624	10,321	11,893	12,564	13,177	13,362	12,949	12,911
Attack rate <sup>†</sup>	177.9	194.1	228.6	225.6	266.8	301.1	311.0	319.4	318.4	303.4	295.7
<b>65-79</b>											
Population*	2,487,806	2,612,914	2,755,750	2,911,509	3,065,733	3,223,033	3,377,469	3,530,032	3,690,418	3,863,541	4,038,285
Attack case	7,910	9,384	11,720	12,384	15,425	18,048	19,607	21,630	22,784	23,221	24,678
Attack rate <sup>†</sup>	318.0	359.1	425.3	425.3	503.1	560.0	580.5	612.7	617.4	601.0	611.1
<b>80+</b>											
Population*	441,505	456,139	467,826	483,387	512,637	549,042	590,649	635,942	676,224	722,161	772,078
Attack case	1,526	1,942	2,479	2,913	3,575	4,399	4,878	5,485	5,954	6,336	6,978
Attack rate <sup>†</sup>	345.6	425.7	529.9	602.6	697.4	801.2	825.9	862.5	880.5	877.4	903.8

\*Mid-year population, <sup>†</sup>Attack rate=Attack case/Mid-year population × 100,000 (per 100,000)

the next year, the episode was included in the year of the first incident case. For example, if patient A experienced an episode on 15 December 1997 and had another episode on 5 January 1998, the latter episode was bound to the episode of 15 December 1997 and included in the incident cases of 1997.

### Measuring disease incidence

The scale of the disease incidence for 11 years was examined by separation into attack, incidence, relapse, and case fatality rates, and the scale of disease incidence according to gender and age was also investigated. Age was classified into five groups (0-44, 45-54, 55-64, 65-79, and  $\geq 80$ ) and the ages of patients in each year were also calculated.<sup>5)</sup>

The attack rate was calculated by dividing the number of total episodes (total attacks) by the population number at mid-year and the same patients could produce several attacks. The incidence and relapse rates were made by dividing the number of patients with first attacks throughout their entire lives by the population number at mid-year every year and dividing the number of total attacks less the number of first attacks of patients by the population number at mid-year, respectively. The case fatality rate was defined as the number of deaths due to the disease within 28 days after the attack according to the MONICA project.<sup>2)</sup> The attack and incidence fatality rates were calculated by dividing the number of deaths within 28 days by the number of total attacks and by the number of the first attacks of patients throughout

**Table 2.** Incidence rate of acute myocardial infarction by age or gender: 1997-2007

	Year										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
<b>Total</b>											
Population*	45,953,580	46,286,503	46,616,677	47,008,111	47,357,362	47,622,179	47,859,311	48,039,415	48,138,077	48,297,184	48,456,369
Incident case	19,986	22,156	26,645	27,762	33,539	38,061	40,106	41,361	42,702	42,411	44,460
Incidence rate <sup>†</sup>	43.5	47.9	57.2	59.1	70.8	79.9	83.8	86.1	88.7	87.8	91.8
<b>Gender</b>											
<b>Male</b>											
Population*	23,148,092	23,295,727	23,457,837	23,666,769	23,843,136	23,970,035	24,089,703	24,165,488	24,190,906	24,267,609	24,344,276
Incident case	11,948	12,996	15,392	15,918	19,308	21,934	23,317	23,912	24,917	25,225	26,365
Incidence rate <sup>†</sup>	51.6	55.8	65.6	67.3	81.0	91.5	96.8	99.0	103.0	103.9	108.3
<b>Female</b>											
Population*	22,805,488	22,990,776	23,158,840	23,341,342	23,514,226	23,652,144	23,769,608	23,873,927	23,947,171	24,029,575	24,112,093
Incident case	8,038	9,160	11,253	11,844	14,231	16,127	16,789	17,449	17,785	17,186	18,095
Incidence rate <sup>†</sup>	35.2	39.8	48.6	50.7	60.5	68.2	70.6	73.1	74.3	71.5	75.0
<b>Age</b>											
<b>0-44</b>											
Population*	34,696,864	34,676,955	34,610,580	34,502,465	34,326,287	34,047,914	33,706,685	33,273,360	32,747,120	32,254,176	31,775,248
Incident case	2,280	2,328	2,596	2,848	3,415	3,671	3,648	3,375	3,240	3,249	3,122
Incidence rate <sup>†</sup>	6.6	6.7	7.5	8.3	9.9	10.8	10.8	10.1	9.9	10.1	9.8
<b>45-54</b>											
Population*	4,656,982	4,787,167	4,986,346	5,287,305	5,583,838	5,852,764	6,144,056	6,474,983	6,828,251	7,189,002	7,504,276
Incident case	3,272	3,313	4,117	4,327	5,246	6,087	6,415	6,488	6,787	7,093	7,220
Incidence rate <sup>†</sup>	70.3	69.2	82.6	81.8	93.9	104.0	104.4	100.2	99.4	98.7	96.2
<b>55-64</b>											
Population*	3,670,423	3,753,328	3,796,175	3,823,445	3,868,867	3,949,426	4,040,452	4,125,098	4,196,064	4,268,304	4,366,482
Incident case	5,856	6,435	7,434	7,361	8,633	9,728	10,118	10,196	10,327	9,787	9,990
Incidence rate <sup>†</sup>	159.5	171.4	195.8	192.5	223.1	246.3	250.4	247.2	246.1	229.3	228.8
<b>65-79</b>											
Population*	2,487,806	2,612,914	2,755,750	2,911,509	3,065,733	3,223,033	3,377,469	3,530,032	3,690,418	3,863,541	4,038,285
Incident case	7,148	8,275	10,247	10,607	13,071	14,776	15,762	16,784	17,506	17,242	18,572
Incidence rate <sup>†</sup>	287.3	316.7	371.8	364.3	426.4	458.5	466.7	475.5	474.4	446.3	459.9
<b>80+</b>											
Population*	441,505	456,139	467,826	483,387	512,637	549,042	590,649	635,942	676,224	722,161	772,078
Incident case	1,430	1,805	2,251	2,619	3,174	3,799	4,163	4,518	4,842	5,040	5,556
Incidence rate <sup>†</sup>	323.9	395.7	481.2	541.8	619.2	691.9	704.8	710.4	716.0	697.9	719.6

\*Mid-year population, <sup>†</sup>Incidence rate=Incident case/Mid-year population  $\times$  100,000 (per 100,000)

their entire lives each year, respectively. The population number at mid-year was the total population number on 1 July each year and was obtained from the data of the Korea National Statistical Office.<sup>7)</sup>

This study evaluated the attack, incidence, and case fatality rates according to years and examined the long-term trends of the disease incidence. By considering characteristics of population structure each year, age-standardization was performed. The standardized population for age-standardization was calculated by adding the population numbers from 1997 to 2007 according to age groups (0-44, 45-54, 55-64, 65-79, and ≥80) each year.

### Results

When the number of attacks and the attack rate for AMIs were investigated according to year, there was an increase by 2.6 times from 22,039 cases in 1997 to 57,350 in 2007 and by approximately 2.5 times from 48.0 cases

per 100,000 persons in 1997 to 118.4 cases per 100,000 persons in 2007, respectively (Table 1). The incident cases (the number of first AMI attacks of patients throughout their entire lives) increased by 2.2 times from 19,986 cases in 1997 to 44,460 cases in 2007, and the incidence increased by 2.1 times from 43.5 cases per 100,000 persons in 1997 to 91.8 cases per 100,000 persons in 2007 (Table 2).

In comparing the attack rate and incidence for each year according to gender and age, males showed higher rates than females and both of the rates became higher with older ages (Tables 1 and 2).

Both the attack rate and incidence increased rapidly from 1997 to 2002 and showed a continuous increase after 2002. This tendency was similar when the rates were analyzed according to gender and age (Fig. 1). When age-standardized attack rates and incidences were compared according to year, there was also a sharp increase to 2002 and the increasing tendency slowed after 2002. This ten-

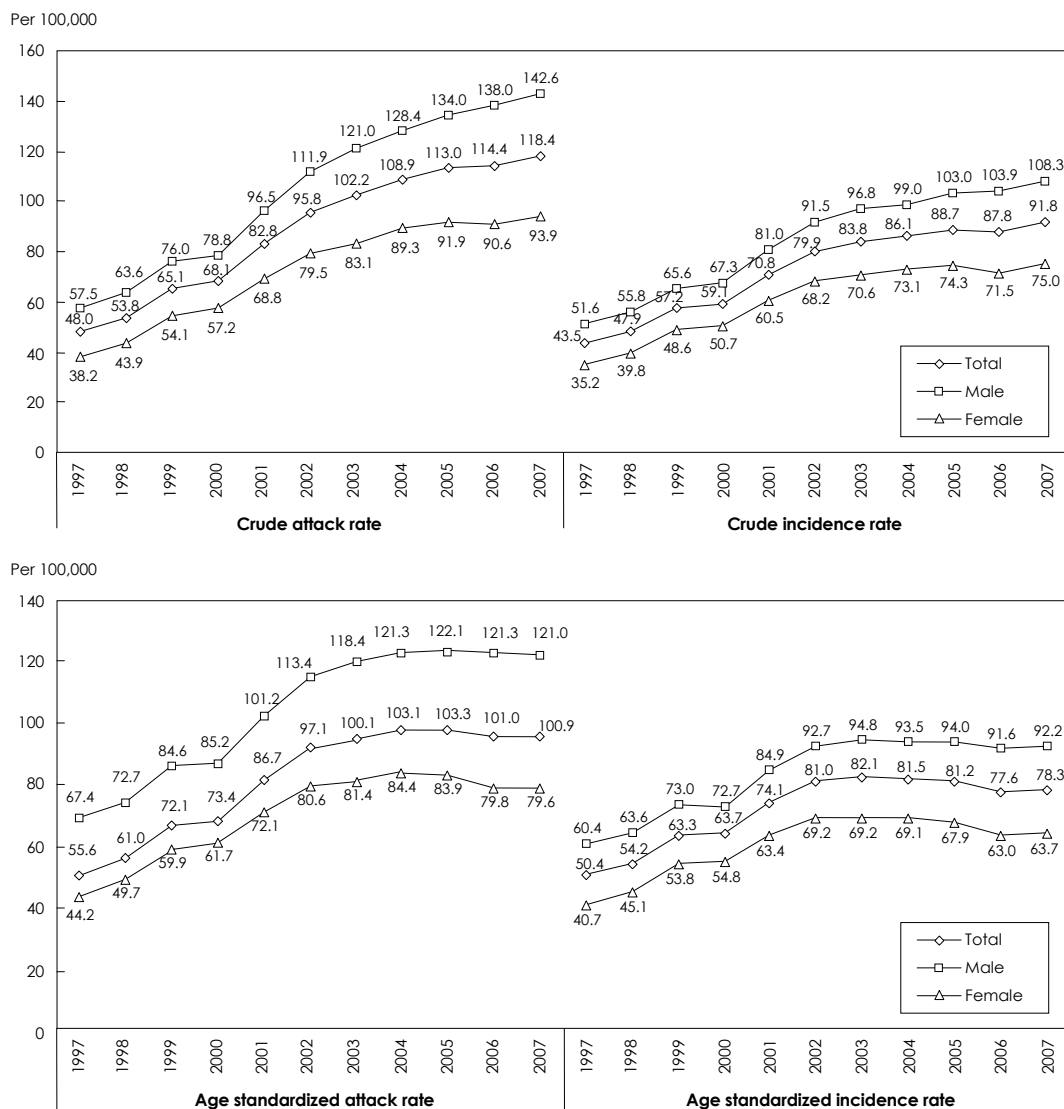


Fig. 1. Crude or age-standardized attack and incidence rates of acute myocardial infarction by gender: 1997-2007.

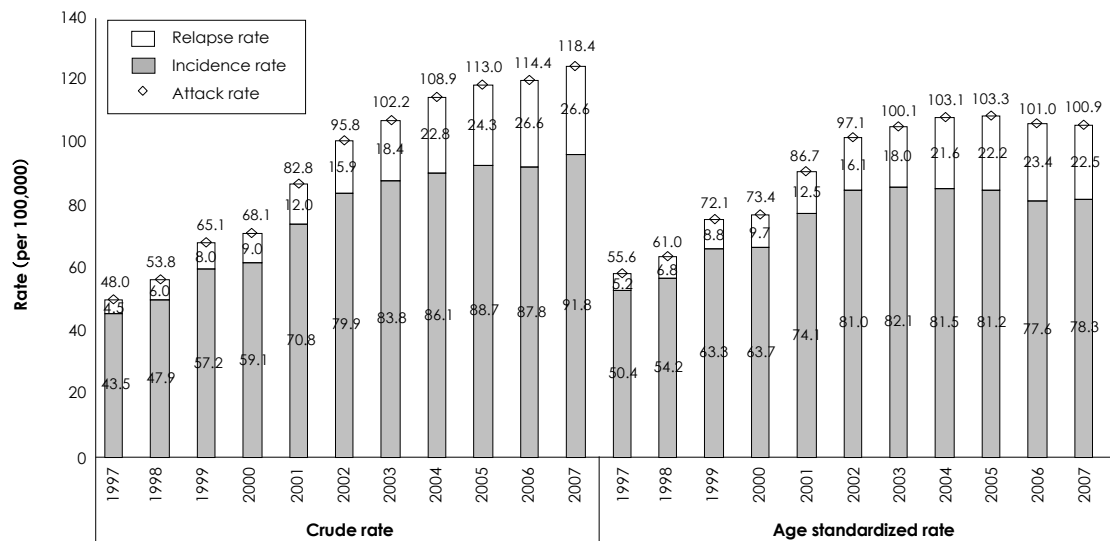


Fig. 2. Attack, incidence, and relapse rates of acute myocardial infarction: 1997-2007.

dency was the same even after males and females were separated (Fig. 1).

Although incident cases, the first attacks of AMI throughout the entire life, accounted for most of the total attacks each year, the percentage of relapse cases has currently increased. While the increase in the incidence has slowed since 2002, the relapse rates have tended to increase continuously (Fig. 2). The incidence increased from 79.9 cases per 100,000 persons in 2002 to 91.8 cases per 100,000 persons in 2007 (approximately 15%) and the relapse rates increased dramatically from 15.9 to 26.6 (approximately 67%). This tendency was similar even after age-standardization. The attack fatality rates had increased from 13.3% in 1997 to 14.5% in 2000 and then declined continuously. The attack fatality rate decreased sharply in 2007 to 9.8% (Table 3). The incidence fatality rate also increased from 14.1% in 1997 to 15.4% in 2000 and then decreased slowly. The incidence fatality rate of 2007 also decreased to 10.8% (Table 4).

When the attack and incidence fatality rates were compared according to gender and age, the rates of females were higher than males and  $\geq 80$  and the 65-79 year age groups had higher attack and incidence fatality rates (Tables 3 and 4). Currently, the case fatality rates have decreased continuously and this tendency was similar after age-standardization (Fig. 3). In comparing the incidence and incidence fatality rates of males and females according to age groups (<65 and  $\geq 65$ ) each year (Fig. 4), the incidence rates of males were higher than females in both of the groups of (<65 years and  $\geq 65$  years) for 11 years. However, while the incidence fatality rates were higher in males than in females for the <65 year age group, the rates of females were higher than males for the  $\geq 65$  year age group. This tendency was similar in comparison to the attack and attack fatality rates.

## Discussion

This study revealed that the attack and incidence rates for AMI have increased continuously in Korea for the last 11 years. The attack and incidence rates increased by around 10% each year and the increasing tendency of the two rates was the greatest from 2000 to 2002.

The increase in attack and incidence rates can be attributed to an aging population. In a country experiencing a rapidly aging population, such as Korea, the larger number of elderly is expected to lead to a natural increase in chronic diseases, such as AMI.<sup>5)</sup> The percentage of the population  $\geq 65$  years of age among the total population increased continuously from 6.4% in 1997 to 9.9% in 2007.<sup>7)</sup>

When the age-standardized attack and incidence rates for each year were examined in this study, the increase in the attack and incidence rates currently slowed. This finding supports the suggestion that the increasing tendency for AMIs in Korea follows the increase in the elderly with high attack rate and incidence rates. A previous international study also reported similar results.<sup>8)</sup>

A second reason for the increase in attack and incidence rates is the development of technologies for diagnosis. Recently, cardiac-specific troponins have been recognized as the most favorable biochemical myocardial index for evaluation of patients with acute coronary syndrome because of various properties.<sup>9)</sup> This development in new technologies for diagnosis is expected to increase the diagnosis of AMIs. In early 2002, when the troponin test was actively introduced, both the attack and incidence rates increased dramatically.

According to a 10-year survey of MONICA following up incidences, deaths, and risk factors for AMI in subjects 35-64 years of age in 21 countries, including west European countries, China, and Japan, the incidence of

**Table 3.** Attack fatality rate of acute myocardial infarction by age or gender: 1997-2007

	Year										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total											
Attack case	22,039	24,912	30,365	31,996	39,201	45,625	48,895	52,331	54,410	55,261	57,350
Case fatality	2,938	3,530	4,328	4,652	5,120	5,902	5,815	6,151	6,424	6,236	5,598
Attack fatality rate*	13.3	14.2	14.3	14.5	13.1	12.9	11.9	11.8	11.8	11.3	9.8
Gender											
Male											
Attack case	13,320	14,825	17,828	18,646	23,016	26,829	29,144	31,022	32,414	33,481	34,713
Case fatality	1,669	1,937	2,417	2,511	2,785	3,219	3,164	3,297	3,488	3,394	3,022
Attack fatality rate*	12.5	13.1	13.6	13.5	12.1	12.0	10.9	10.6	10.8	10.1	8.7
Female											
Attack case	8,719	10,087	12,537	13,350	16,185	18,796	19,751	21,309	21,996	21,780	22,637
Case fatality	1,269	1,593	1,911	2,141	2,335	2,683	2,651	2,854	2,936	2,842	2,576
Attack fatality rate*	14.6	15.8	15.2	16.0	14.4	14.3	13.4	13.4	13.3	13.0	11.4
Age											
0-44											
Attack case	2,423	2,532	2,830	3,092	3,743	4,077	4,079	3,894	3,781	3,768	3,671
Case fatality	198	250	249	280	313	350	336	297	307	294	240
Attack fatality rate*	8.2	9.9	8.8	9.1	8.4	8.6	8.2	7.6	8.1	7.8	6.5
45-54											
Attack case	3,651	3,770	4,659	4,983	6,137	7,208	7,767	8,145	8,529	8,987	9,112
Case fatality	292	298	411	435	438	497	496	547	536	518	441
Attack fatality rate*	8.0	7.9	8.8	8.7	7.1	6.9	6.4	6.7	6.3	5.8	4.8
55-64											
Attack case	6,529	7,284	8,677	8,624	10,321	11,893	12,564	13,177	13,362	12,949	12,911
Case fatality	654	742	880	861	901	1,008	927	925	916	841	701
Attack fatality rate*	10.0	10.2	10.1	10.0	8.7	8.5	7.4	7.0	6.9	6.5	5.4
65-79											
Attack case	7,910	9,384	11,720	12,384	15,425	18,048	19,607	21,630	22,784	23,221	24,678
Case fatality	1,338	1,598	2,014	2,150	2,377	2,710	2,656	2,798	2,913	2,763	2,545
Attack fatality rate*	16.9	17.0	17.2	17.4	15.4	15.0	13.5	12.9	12.8	11.9	10.3
80+											
Attack case	1,526	1,942	2,479	2,913	3,575	4,399	4,878	5,485	5,954	6,336	6,978
Case fatality	456	642	774	926	1,091	1,337	1,400	1,584	1,752	1,820	1,671
Attack fatality rate*	29.9	33.1	31.2	31.8	30.5	30.4	28.7	28.9	29.4	28.7	23.9

\*Attack fatality rate=Case fatality/Attack case  $\times$  100 (%)

males was the highest in Finland (915 per 100,000 persons) and the rate of females was the highest in England (256 per 100,000 persons).<sup>2)</sup> Although this study was conducted at a different time compared to the survey, the incidence rates of AMIs in Korea in 1997 in the current study (51.6 per 100,000 persons for males and 35.2 per 100,000 persons for females) were lower than the corresponding rates in west European countries by as much as 17 and 7 times, respectively, as well as China (76 per 100,000 persons). Lundblad et al.<sup>10)</sup> reported that the incidence rates of males and females of Sweden in 2004 were 300 and 100 per 100,000 persons, respectively, which were higher than the incidence rates in the current study (males, 99.0 per 100,000 persons; and females, 73.1 per 100,000 persons) determined in a sim-

ilar year.

However, because each country has a different system to monitor disease and because this study investigated only AMI patients visiting medical institutions, it is hard to compare the results of the countries directly. Considering that the previous study populations were west European countries and Japan with a large elderly population and that aging of the population is thought to be one of the reasons for the increasing tendency of AMIs in Korea, the risk of myocardial infarction attacks and incidence in Korea is assumed to continue to increase.

When AMI attack and incidence rates were examined according to the age groups each year, the rates grew up suddenly after 45 years of age and the increasing ten-

**Table 4.** Incidence fatality rate of acute myocardial infarction by age or gender: 1997-2007

	Year										
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Total											
Incidence case	19,986	22,156	26,645	27,762	33,539	38,061	40,106	41,361	42,702	42,411	44,460
Case fatality	2,814	3,316	4,053	4,289	4,678	5,318	5,207	5,395	5,618	5,403	4,819
Incidence fatality rate*	14.1	15.0	15.2	15.4	13.9	14.0	13.0	13.0	13.2	12.7	10.8
Gender											
Male											
Incidence case	11,948	12,996	15,392	15,918	19,308	21,934	23,317	23,912	24,917	25,225	26,365
Case fatality	1,596	1,817	2,260	2,281	2,514	2,859	2,799	2,879	3,002	2,913	2,569
Incidence fatality rate*	13.4	14.0	14.7	14.3	13.0	13.0	12.0	12.0	12.0	11.5	9.7
Female											
Incidence case	8,038	9,160	11,253	11,844	14,231	16,127	16,789	17,449	17,785	17,186	18,095
Case fatality	1,218	1,499	1,793	2,008	2,164	2,459	2,408	2,516	2,616	2,490	2,250
Incidence fatality rate*	15.2	16.4	15.9	17.0	15.2	15.2	14.3	14.4	14.7	14.5	12.4
Age											
0-44											
Incidence case	2,280	2,328	2,596	2,848	3,415	3,671	3,648	3,375	3,240	3,249	3,122
Case fatality	192	242	246	277	303	332	325	286	288	283	229
Incidence fatality rate*	8.4	10.4	9.5	9.7	8.9	9.0	8.9	8.5	8.9	8.7	7.3
45-54											
Incidence case	3,272	3,313	4,117	4,327	5,246	6,087	6,415	6,488	6,787	7,093	7,220
Case fatality	281	283	391	411	409	462	456	510	478	470	399
Incidence fatality rate*	8.6	8.5	9.5	9.5	7.8	7.6	7.1	7.9	7.0	6.6	5.5
55-64											
Incidence case	5,856	6,435	7,434	7,361	8,633	9,728	10,118	10,196	10,327	9,787	9,990
Case fatality	621	701	826	777	820	914	827	801	809	722	604
Incidence fatality rate*	10.6	10.9	11.1	10.6	9.5	9.4	8.2	7.9	7.8	7.4	6.0
65-79											
Incidence case	7,148	8,275	10,247	10,607	13,071	14,776	15,762	16,784	17,506	17,242	18,572
Case fatality	1,278	1,483	1,868	1,945	2,149	2,395	2,322	2,379	2,495	2,350	2,147
Incidence fatality rate*	17.9	17.9	18.2	18.3	16.4	16.2	14.7	14.2	14.3	13.6	11.6
80+											
Incidence case	1,430	1,805	2,251	2,619	3,174	3,799	4,163	4,518	4,842	5,040	5,556
Case fatality	442	607	722	879	997	1,215	1,277	1,419	1,548	1,578	1,440
Incidence fatality rate*	30.9	33.6	32.1	33.6	31.4	32.0	30.7	31.4	32.0	31.3	25.9

\*Incidence fatality rate=Case fatality/Incidence case × 100 (%)

dency was the highest, especially after 65 years of age. The reasons for the higher attack and incidence rates after 45 years of age were reported to be related to smoking and stress for males and with changes in hormones associated with menopause in females.<sup>8(11-15)</sup>

In this study, both the attack and incidence fatality rates have fallen considerably since 2000. The study of Lundblad et al.<sup>10)</sup> in which changes in the incidence fatality rates of AMIs in Sweden were surveyed for 20 years also revealed that the incidence fatality rate was reduced sharply from 50% in 1985 to 30% in 2004. Wellenius and Mittleman<sup>16)</sup> investigated changes in the attack fatality rate with beneficiaries of medicare in the US for 20 years and found that the attack fatality rate declin-

ed from 25.3% in 1984 to 17.2% in 2003. The decrease in the fatality rate was reported to result from the development of treatments, such as thrombolytic therapy and early visits to hospitals by patients.<sup>1(17-21)</sup>

The fatality rates of this study were lower than those of other countries. While the MONICA study reported that the attack fatality rate of males and females in 1994 were 49% and 54% respectively,<sup>2)</sup> the current study found that the rates in 1997 were 12.5% and 14.6% respectively. Although the two studies were performed at different times, the results of the current study revealed lower fatality rates. The latest study by Lundblad et al.<sup>10)</sup> also reported that the incidence fatality rate in Sweden in 2004 was 30% and the rate was higher than that of Ko-

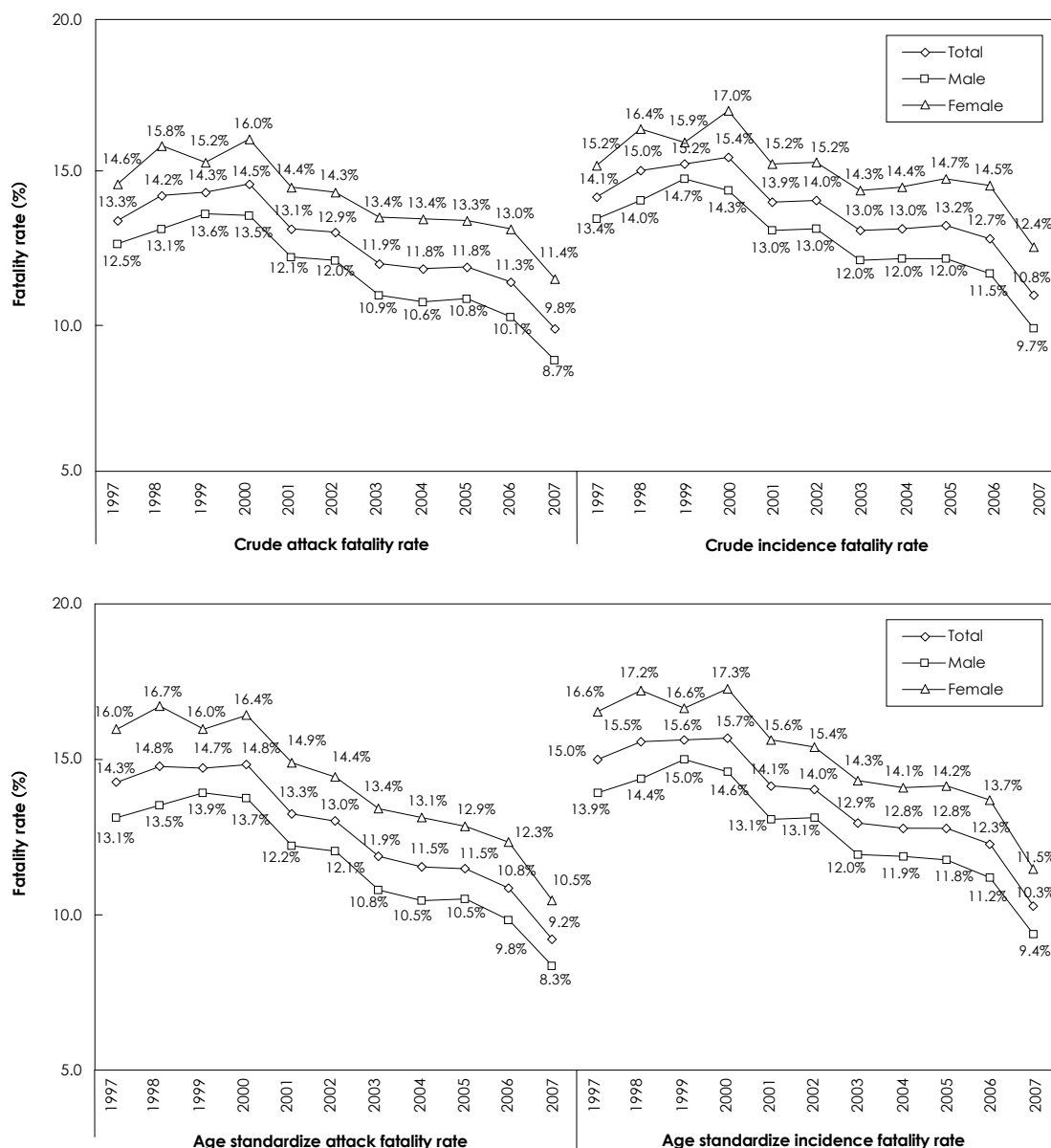


Fig. 3. Crude or age-standardized attack and incidence fatality rates of acute myocardial infarction by gender: 1997-2007.

rea in the same year (13.0%). The study performed with beneficiaries of medicare in the US reported that the attack fatality rate in 2003 was 17.2% and the rate was higher than the current study in the same year (11.9%).<sup>16)</sup>

When the fatality rates were compared according to age and gender, the rate was higher with older age and the fatality rate of females was higher than that of males. Many previous studies reported same results and suggested that the higher fatality rate of persons with older ages was led to by higher frequencies of congestive heart failure, arrhythmia, atrioventricular block, reinfarction and multivessel disease and lower frequencies of  $\beta$ -blocker, heparin, thrombolytic therapy and coronary angiography and angioplasty.<sup>1)22-24)</sup> In addition, the reasons for a higher fatality rate in females compared to the rate in males were reported to be a larger composi-

tion of the elderly among females, higher frequencies of hypertension, diabetes, and heart failure, a higher frequency of left ventricular failure during hospitalization, and lower frequencies of thrombolytic therapy, coronary angiography, and angioplasty.<sup>1)25-27)</sup> The current study also revealed a higher fatality rate in females of older ages. In comparing the fatality rates of males and females after dividing the ages into <65 and  $\geq 65$ , while males had a higher fatality rate than females in the group <65 years of age, females had a higher fatality rate in the group  $\geq 65$  years of age for 11 years. In females, the percentage of case fatalities  $\geq 65$  years of age among the total case fatalities for 11 years averaged 82.1% (range, 76.4-87.8% by year) and it was considerably higher than males (57.3%; range, 49.4-64.7%). Thus, deaths of females  $\geq 65$  years of age exceeded the deaths of males.



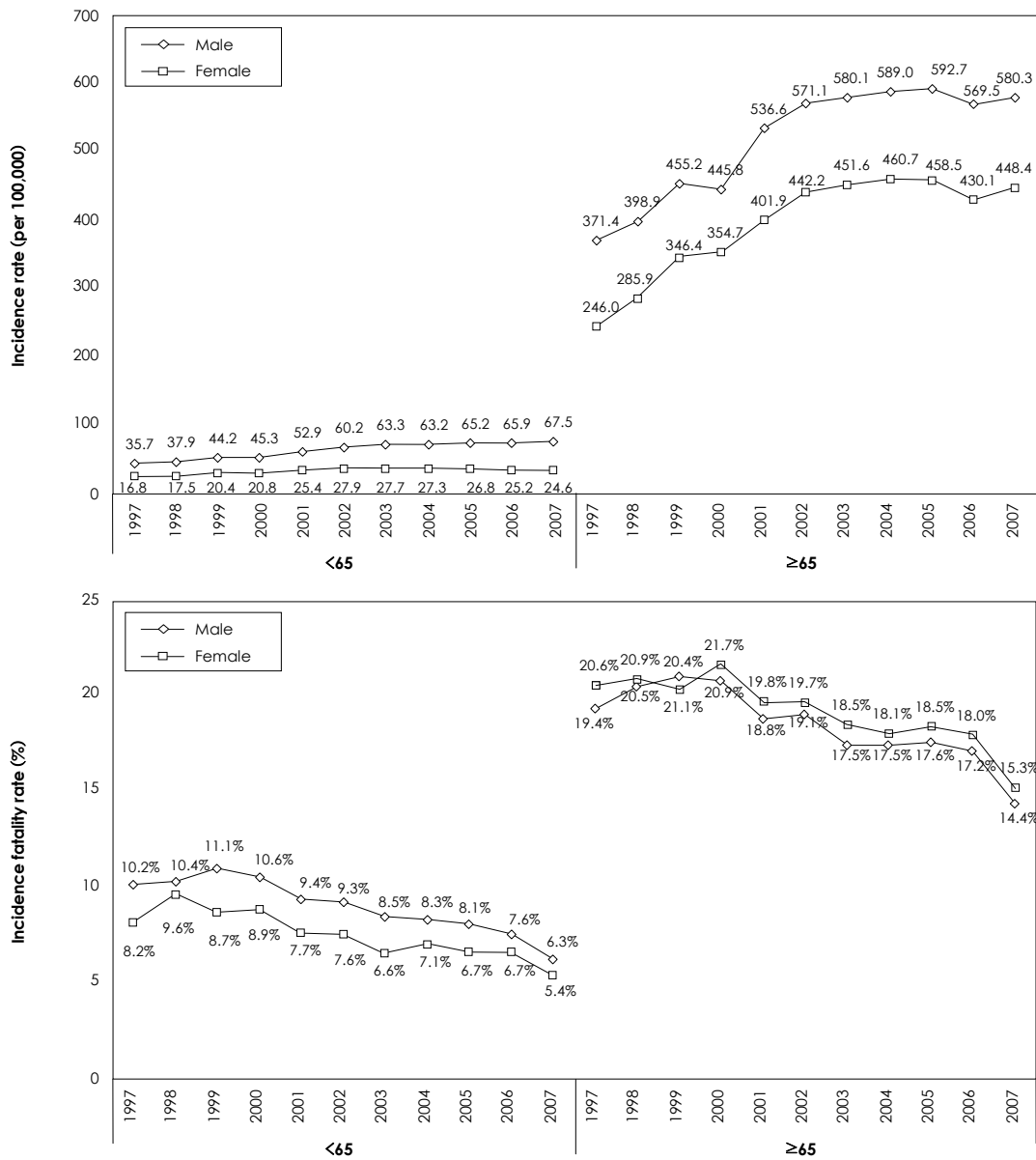


Fig. 4. Incidence and incidence fatality rates of acute myocardial infarction by age (<65 and ≥65 years) and gender: 1999-2007.

One of the reasons for this finding is a tendency that middle-aged females in Korea respond to health problems less actively by themselves compared to males.<sup>11)</sup> To verify this finding, more in-depth research will be necessary.

Based on the collective results of this study, AMI attack and incidence rates of Korea tended to increase overall for the 11 years. In particular, as the relapse rates grew sharply, policies, including continuous monitoring to prevent relapse after optimal treatments and establishment of surveillance system, are desperately needed. In addition, females showed relatively lower attack and incidence rates, but higher fatality rates than males, so more intensive management for females, especially ≥65 years of age, is necessary.

One of the limitations of this study was that it used

national health insurance claims data for 11 years to determine the scale of the incidence of AMIs. That could exclude AMI deaths not receiving medical services and inadequately investigate the incidence scale accurately because of the lack of validity of diagnosis in the data. Therefore, due to exclusion of AMI patients without symptoms and an incorrect diagnosis, the incidence scale could be underestimated or overestimated.<sup>28)29)</sup> According to the study by Kim<sup>5)</sup> determining the validity of diagnosis by investigating the medical records of patients diagnosed with an AMI with national health insurance claims data, 1,573 among the total number of subjects (2,008) were actual AMI patients for an 80% rate. To determine a more accurate incidence scale, measures to increase the validity of diagnosis with the data and development of models for diagnosis are needed.

A problem related to detecting the first attacks for calculating incidence rates also could be construed as another limitation of the current study. The national health insurance data has been computerized since 1995. Therefore, when the first attacks were investigated, the cases occurring before 1995 were not considered.

Third, the current study did not reflect changes in technologies for diagnosis. It was pointed out that the active introduction of the troponin test was a reason for the sharp increase in the attack and incidence rates in early 2000; however, it did not reflect those changes accurately. These changes in technologies could increase attack or incidence rates and reduce fatality rates regardless of changes in the actual risk of the population and of the quality of medical services.<sup>30)</sup>

Fourth, the severity of AMI was not adjusted. If mortality caused by AMIs is decreased without a change in age structure or severity, such a change can be interpreted as a cause for improvement in the quality of medical services.<sup>30)</sup>

In spite of these limitations, this study was meaningful as the only study investigating a long-term disease incidence trend over 11 years with national health insurance claims data of the entire population, and the results are expected to be used as a major source of data for developing policies for the active prevention or management of AMIs. More research to determine more accurate causes for the changes in the disease scale and to evaluate outcomes of medical services are necessary.

#### Acknowledgments

This study was funded by the Health Insurance Review and Assessment Service.

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