



# **Singapore Myocardial Infarction Registry Annual Report 2016**

**National Registry of Diseases Office  
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## Acknowledgement

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## 1. GLOSSARY

<b>AMI</b>	Acute myocardial infarction
<b>ASIR</b>	Age standardized incidence rate
<b>ASMR</b>	Age standardized mortality rate
<b>BMI</b>	Body mass index
<b>CFR</b>	Case fatality rate
<b>CI</b>	Confidence interval
<b>CIR</b>	Crude incidence rate
<b>CMR</b>	Crude mortality rate
<b>DTB</b>	Door-to-balloon
<b>ECG</b>	Electrocardiogram
<b>HPB</b>	Health Promotion Board
<b>ICD</b>	International Classification of Diseases
<b>IQR</b>	Interquartile range
<b>MHA</b>	Ministry of Home Affairs
<b>MOH</b>	Ministry of Health
<b>MONICA</b>	Monitoring Trends and Determinants in Cardiovascular Disease
<b>NRDO</b>	National Registry of Diseases Office
<b>NRIC</b>	National Registration Identity Card
<b>NSTEMI</b>	Non-ST-segment elevation myocardial infarction
<b>PCI</b>	Percutaneous coronary intervention
<b>SMIR</b>	Singapore Myocardial Infarction Registry
<b>STEMI</b>	ST-segment elevation myocardial infarction

## 2. EXECUTIVE SUMMARY

The number of acute myocardial infarction (AMI) episodes increased from 6,817 episodes in 2007 to 10,728 episodes in 2016. The age-standardized incidence rate (ASIR) also increased from 208.9 per 100,000 population in 2007 to 220.8 per 100,000 population in 2016. However, the rise in ASIR was not significant.

The number of AMI deaths was 885 in 2016, a drop compared to 1,109 in 2007. The age-standardized mortality rate (ASMR) declined significantly from 33.5 per 100,000 population in 2007 to 17.0 per 100,000 population in 2016. The number of AMI deaths within 30 days from onset fell from 1,076 in 2007 to 832 in 2016. Similarly, the 30-day case fatality rate (CFR) decreased significantly from 16.7% in 2007 to 8.3% in 2016.

The common presenting symptoms of AMI were chest pain, breathlessness and diaphoresis. While about half of the patients had chest pain (53.2%) and breathlessness (51.0%) accompanying the onset of AMI in 2016, about a quarter of them (26.8%) had diaphoresis.

Hypertension and hyperlipidemia were consistently the two most common risk factors among the AMI patients across the years. In 2016, 75.0% of the patients had hypertension and 71.6% of them had hyperlipidemia.

The median door-to-balloon (DTB) time improved from 95 minutes in 2007 to 55 minutes in 2016. The proportion of ST-segment elevation myocardial infarction (STEMI) with DTB time of 90 minutes or less improved from 45.5% in 2007 to 94.3% in 2016.

### 3. INTRODUCTION

Ischaemic heart disease was the third most common cause of hospitalization in 2015, accounting for 3.1% of all discharges in Singapore<sup>1</sup>. It was also the third most common cause of death in 2016, accounting for 17.0% of all deaths in Singapore<sup>2</sup>. AMI, commonly known as heart attack, is a type of ischaemic heart disease.

The most common cause of AMI is atherosclerosis - narrowing of arteries due to the build-up of cholesterol deposits. AMI occurs when blood flow to the heart is restricted, resulting in a poor supply of oxygen to the heart. Restoring blood flow to the heart through revascularization of the blocked arteries, coupled with medications, are the recommended treatment for AMI. As delayed treatment can lead to irreversible heart damage, early intervention plays a crucial role in the prognosis of AMI.

Singapore's population is rapidly ageing. The proportion of residents aged 65 years or above has increased from 8.5% in 2007 to 13.0% in 2017<sup>3</sup>. Like many other diseases, old age is a risk factor of AMI. Other common risk factors for AMI are hypertension, hyperlipidaemia and diabetes. However, these risk factors are preventable with a healthy lifestyle.

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<sup>1</sup> Top 10 Conditions of Hospitalisation. Ministry of Health, Singapore.

<sup>2</sup> Principal Causes of Death. Ministry of Health, Singapore.

<sup>3</sup> SingStat Population Trends. Department of Statistics, Singapore.

## 4. METHODOLOGY

The National Registry of Diseases Office (NRDO) collects and analyses epidemiological data to support national disease management plans, policy formulation and programme planning.

The Acute Myocardial Infarction Registry was established in 1988 and managed by the Ministry of Health (MOH). It was subsequently transferred to the Singapore Cardiac Databank in 2002. In April 2007, the NRDO, under the purview of Health Promotion Board (HPB), took over the management of the Registry, which was re-named to Singapore Myocardial Infarction Registry (SMIR). The SMIR collects epidemiological data on AMI cases diagnosed in all public hospitals, private hospitals and a small number of AMI deaths that occurred at home, which had been certified by the general practitioners in Singapore. Legislation mandated notification from all hospitals from September 2012 onwards.

### Data sources

The SMIR receives AMI case notifications from:

1. All hospitals via the Hospital In-patient Discharge Summary and the cardiac biomarkers (such as Troponins T and Troponin I) list.
2. The MOH via the Mediclaims list and the Casemix & Subvention list.
3. The Death Registry from the Ministry of Home Affairs (MHA) via the death list.

The International Classification of Diseases 9<sup>th</sup> Revision (ICD-9) Clinical Modification code 410 was used to identify AMI cases in the data sources from 2007 to 2011, while the ICD-10 American Modification codes I21 and I22 are used for AMI cases diagnosed from 2012 onwards. A master patient list is created by merging data from these sources using the patients' National Registration Identification Card (NRIC) numbers as identifiers.

The registry coordinators confirm the diagnosis of AMI by viewing the patients' case notes and electronic medical records, before extracting relevant detailed clinical information from the case notes and electronic medical records at the hospitals. All cases collected by the SMIR must be diagnosed as an AMI by a certified doctor, accompanied by symptoms of AMI, raised cardiac enzymes or abnormal electrocardiogram (ECG).

The MONICA (Monitoring Trends and Determinants in Cardiovascular Disease) criterion is used for episode management, whereby a recurring AMI after 28 days of a preceding episode will be counted as another episode<sup>4</sup>. AMI are broadly classified into STEMI, NSTEMI and others (neither STEMI nor NSTEMI) in the SMIR. From 2011 onwards, besides STEMI and NSTEMI, type 1, 2, 3, 4A, 4B and 5 are also used to classify the cases based on the clinical classification recommended by the American

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<sup>4</sup> Tunstall-Pedoe H et al. Myocardial infarction and coronary deaths in the World Health Organisation MONICA project. *Circulation* 1994; 90: 583-612.



Heart Association<sup>5</sup>. In particular, type 2 AMI episodes were eventually combined with NSTEMI episodes in this report as their clinical characteristics are similar<sup>6</sup>.

The vital status of all patients registered in the SMIR were updated till 31 July 2017 by matching the patients' NRIC with the death information imported from the MHA.

### Population estimates

The Singapore population estimates used to calculate the incidence rate and mortality rate in this report were obtained from the Singapore Department of Statistics, which releases mid-year population estimates of Singapore residents (i.e. Singapore citizens and permanent residents) annually<sup>7</sup>. The Segi World population estimates used for age standardization are available on the World Health Organization website<sup>8</sup>.

### Incidence rate

The incidence rate in each year was computed by taking the number of AMI episodes that occurred in a year, divided by the number of Singapore residents in the same year. The count was based on the onset date of each AMI episode. Patients were categorized into 5-year age groups and age standardization was done using the direct method with the Segi World population as the standardization weights.

### Mortality rate

The mortality rate in each year was computed by taking the number of deaths with AMI as the primary cause of death occurring in a year, divided by the number of Singapore residents in the same year. The count was based on the death date of each AMI patient. Patients were categorized into 5-year age groups and age standardization was done using the direct method with the Segi World population as the standardization weights.

### Case fatality rate

The case fatality rate in each year was computed by taking the number of deaths with AMI as the primary cause of death that occurred within 30 days from AMI onset, regardless of whether the death occurred within or outside the hospital in a year, divided by the number of AMI patients in the same year. The count was based on the onset date of each AMI patient. This indicator reflects the severity of AMI, the timeliness of healthcare delivery and the effectiveness of AMI treatment.

This report focuses on only Singapore residents, aged 15 years and above, diagnosed with AMI episodes from 2007 to 2016 as they stood on 1 November 2017. All findings in this report except mortality and case fatality, were based on episodes.

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<sup>5</sup> American College of Cardiology Foundation. Universal definition of myocardial infarction. *Journal of the American College of Cardiology* 2007; 50(22): 2173-2195.

<sup>6</sup> Stein YG et al. Type-II myocardial infarction – patient characteristics, management and outcomes. *PLoS One* 2014; 9(1): e84285.

<sup>7</sup> SingStat Table Builder, Population and Population Structure, Annual Population, Singapore Residents by age group, ethnic group and sex. Department of Statistics, Singapore.

<sup>8</sup> Omar BA et al. Age standardization of rates: a new WHO standard. GPE discussion paper series: no. 31. EIP.GPE/EBD World Health Organization 2001.

## 5. FINDINGS

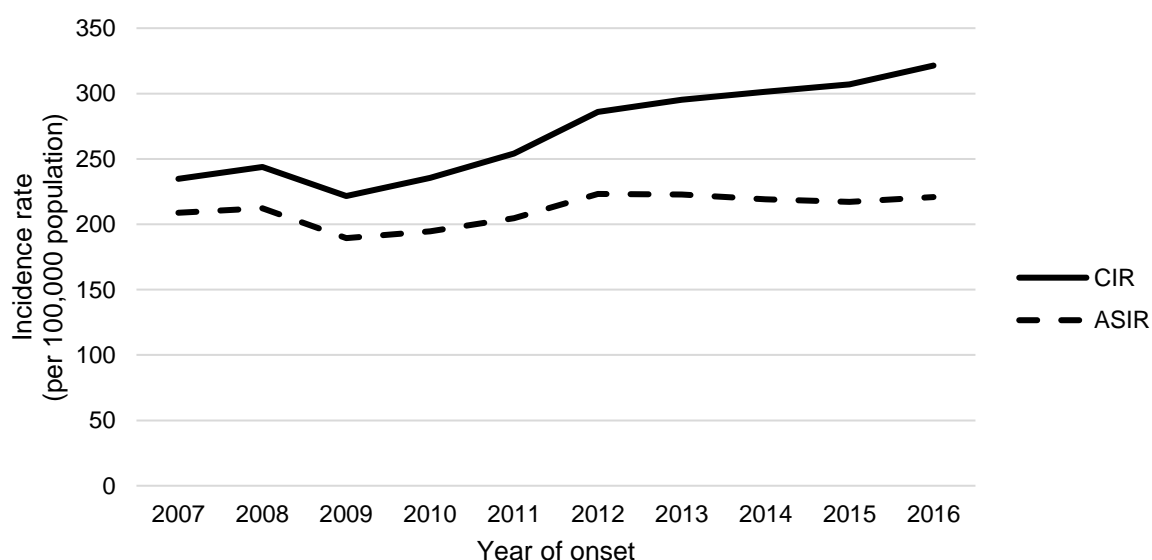
### 5.1 Incidence of AMI

The number of AMI episodes increased from 6,817 episodes in 2007 to 10,728 episodes in 2016 (Table 5.1.1). Similarly, the crude incidence rate (CIR) increased significantly from 234.7 per 100,000 population in 2007 to 321.4 per 100,000 population in 2016 ( $p < 0.001$ ) (Figure 5.1.1). Taking into account of Singapore's ageing population, the ASIR also increased over the years, from 208.9 per 100,000 population in 2007 to 220.8 per 100,000 population in 2016. However, the rise in ASIR was not significant ( $p = 0.066$ ), and hence the rise in number and CIR is likely due to Singapore's ageing population.

**Table 5.1.1: Incidence number and rate (per 100,000 population)**

Year of onset	Number	CIR	95% CI	ASIR	95% CI
2007	6817	234.7	229.2-240.3	208.9	203.9-214.0
2008	7247	243.9	238.3-249.5	212.2	207.3-217.2
2009	6795	221.6	216.3-226.9	189.4	184.8-194.0
2010	7345	235.6	230.2-241.0	194.6	190.0-199.1
2011	8013	254.2	248.6-259.8	204.7	200.1-209.2
2012	9123	285.9	280.0-291.7	223.2	218.6-227.9
2013	9531	295.2	289.2-301.1	222.8	218.2-227.3
2014	9832	301.3	295.4-307.3	219.2	214.8-223.6
2015	10131	307.0	301.0-313.0	217.2	212.8-221.5
2016	10728	321.4	315.4-327.5	220.8	216.6-225.1
P for trend	-	<0.001	-	0.066	-

**Figure 5.1.1: Incidence rate (per 100,000 population)**



The average age at onset ranged from 67 to 70 years and it increased gradually over the years (Table 5.1.2 and Figure 5.1.2). About 7 in 10 of the patients were aged 60 years or above.

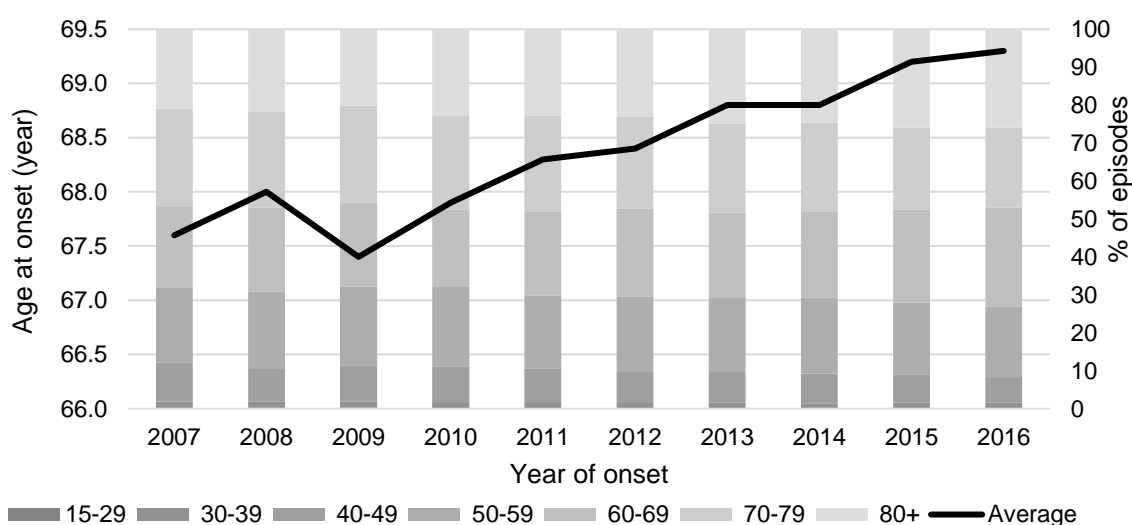
**Table 5.1.2: Average age at onset (year) and age distribution (%)**

Year of onset	Average age	Age 15-29		Age 30-39		Age 40-49	
		Number	%	Number	%	Number	%
2007	67.6	10	0.1	117	1.7	704	10.3
2008	68.0	10	0.1	121	1.7	642	8.9
2009	67.4	13	0.2	112	1.6	649	9.6
2010	67.9	12	0.2	118	1.6	676	9.2
2011	68.3	13	0.2	126	1.6	709	8.8
2012	68.4	15	0.2	139	1.5	725	7.9
2013	68.8	13	0.1	139	1.5	765	8.0
2014	68.8	11	0.1	126	1.3	768	7.8
2015	69.2	13	0.1	148	1.5	742	7.3
2016	69.3	16	0.1	154	1.4	724	6.7

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	1352	19.8	1456	21.4	1751	25.7	1427	20.9
2008	1461	20.2	1608	22.2	1824	25.2	1581	21.8
2009	1410	20.8	1507	22.2	1735	25.5	1369	20.1
2010	1563	21.3	1484	20.2	1826	24.9	1666	22.7
2011	1536	19.2	1784	22.3	2016	25.2	1829	22.8
2012	1818	19.9	2107	23.1	2213	24.3	2106	23.1
2013	1859	19.5	2145	22.5	2241	23.5	2369	24.9
2014	1972	20.1	2239	22.8	2297	23.4	2419	24.6
2015	1922	19.0	2489	24.6	2189	21.6	2628	25.9
2016	1994	18.6	2795	26.1	2262	21.1	2783	25.9

**Figure 5.1.2: Average age at onset (year) and age distribution (%)**

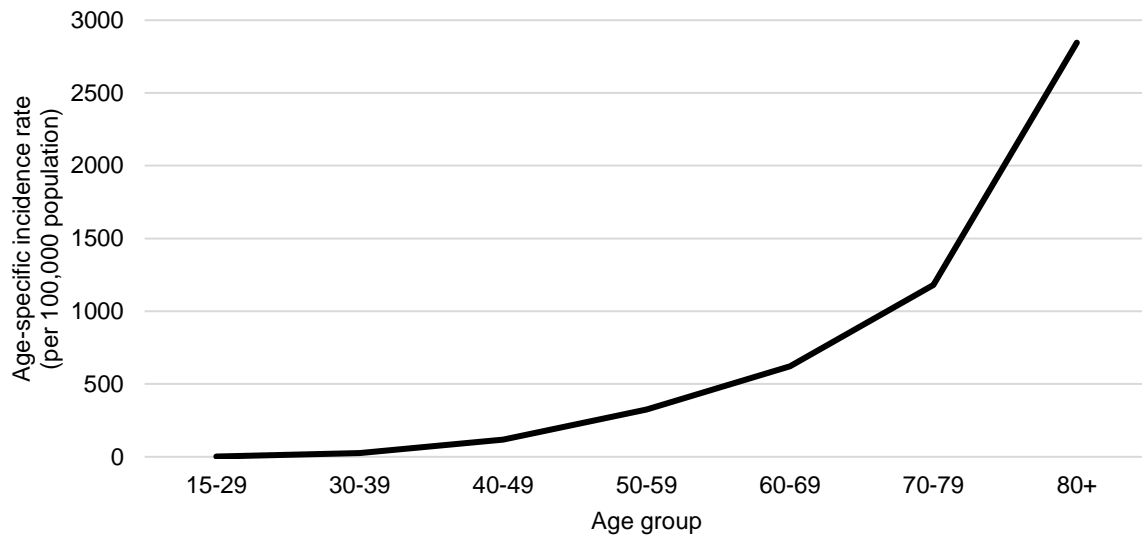


The age-specific incidence rate increased with age (Table 5.1.3) and the oldest age group had the highest incidence rate (Figure 5.1.3a). There was a rise in incidence rate from 2009 to 2013 among the oldest age group, but it plateaued from 2013 onwards (Figure 5.1.3b).

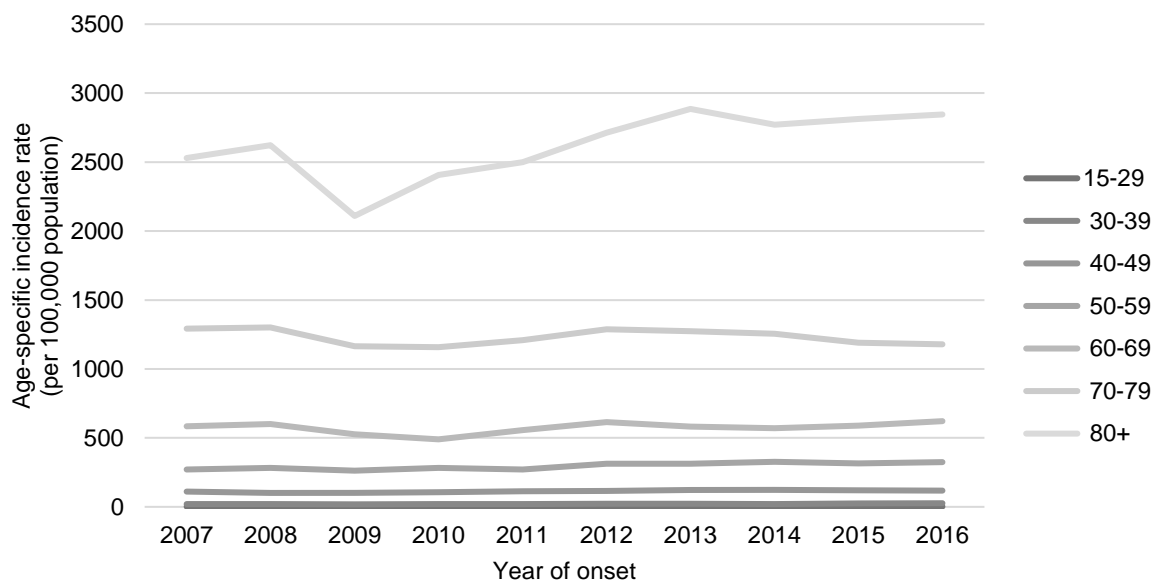
**Table 5.1.3: Age-specific incidence rate (per 100,000 population)**

Year of onset	Overall		Age 15-29		Age 30-39		Age 40-49	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2007	234.7	229.2-240.3	1.4	0.5-2.2	19.6	16.1-23.2	110.6	102.5-118.8
2008	243.9	238.3-249.5	1.3	0.5-2.2	20.3	16.7-23.9	101.1	93.2-108.9
2009	221.6	216.3-226.9	1.7	0.8-2.6	18.2	14.8-21.6	102.1	94.3-110.0
2010	235.6	230.2-241.0	1.5	0.7-2.4	19.1	15.6-22.5	106.8	98.7-114.8
2011	254.2	248.6-259.8	1.7	0.8-2.6	20.5	16.9-24.1	112.4	104.2-120.7
2012	285.9	280.0-291.7	1.9	1.0-2.9	22.8	19.0-26.6	115.1	106.8-123.5
2013	295.2	289.2-301.1	1.7	0.8-2.6	23.1	19.2-26.9	121.7	113.0-130.3
2014	301.3	295.4-307.3	1.4	0.6-2.3	21.2	17.5-24.9	123.0	114.3-131.7
2015	307.0	301.0-313.0	1.7	0.8-2.6	25.0	21.0-29.0	119.6	111.0-128.3
2016	321.4	315.4-327.5	2.0	1.0-3.1	26.2	22.1-30.4	117.8	109.2-126.4
P for trend	<0.001	-	0.064	-	0.002	-	0.005	-
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2007	270.4	256.0-284.8	584.0	554.0-614.0	1293.2	1232.6-1353.8	2530.1	2398.9-2661.4
2008	281.7	267.3-296.2	599.3	570.0-628.6	1301.0	1241.3-1360.7	2621.9	2492.6-2751.1
2009	262.4	248.7-276.1	527.1	500.5-553.7	1164.4	1109.6-1219.2	2109.4	1997.7-2221.1
2010	283.3	269.2-297.3	489.4	464.5-514.3	1157.9	1104.8-1211.0	2407.5	2291.9-2523.1
2011	270.1	256.6-283.6	556.6	530.8-582.5	1207.9	1155.2-1260.6	2498.6	2384.1-2613.1
2012	312.3	297.9-326.6	614.6	588.4-640.9	1286.6	1233.0-1340.2	2713.9	2598.0-2829.8
2013	313.0	298.8-327.2	582.7	558.1-607.4	1272.6	1219.9-1325.3	2885.5	2769.3-3001.7
2014	326.5	312.1-341.0	570.2	546.5-593.8	1254.4	1203.1-1305.7	2771.1	2660.7-2881.5
2015	315.0	300.9-329.1	588.5	565.4-611.7	1190.7	1140.8-1240.6	2812.3	2704.7-2919.8
2016	324.1	309.9-338.4	621.3	598.3-644.3	1179.7	1131.0-1228.3	2845.6	2739.9-2951.4
P for trend	0.001	-	0.300	-	0.415	-	0.032	-

**Figure 5.1.3a: Age-specific incidence rate (per 100,000 population) across age groups**



**Figure 5.1.3b: Age-specific incidence rate (per 100,000 population) across years**



Although gender distribution was almost equal among the general population, there were more men suffering from AMI than women (Table 5.1.4). The rise in ASIR over the years was significant for men ( $p=0.025$ ) but not for women ( $p=0.502$ ) (Figure 5.1.4). The ASIR for men was consistently higher than that for women across the years. Men had an ASIR of 321.9 per 100,000 population, while women had an ASIR of 127.6 per 100,000 population in 2016.

Male gender is a well-known predictor of heart disease. The underlying causes are multifactorial and related to the pathophysiological gender differences in AMI<sup>9</sup>. Furthermore, the prevalence of hypertension, total cholesterol and diabetes were higher among men than women in the general population as shown by the National Health Survey 2010<sup>10</sup>. In contrast, oestrogen has a protective effect on pre-menopausal women's hearts by causing women to have, relative to men, a lower systolic blood pressure, a lower level of low-density lipoprotein (bad) cholesterol, and a higher level of high-density lipoprotein (good) cholesterol. Consequently, less cholesterol deposits build up in the arteries of pre-menopausal women. Hence, pre-menopausal women have a lower risk of developing cardiovascular diseases than post-menopausal women<sup>11</sup>.

**Table 5.1.4: Incidence number and rate (per 100,000 population) by gender**

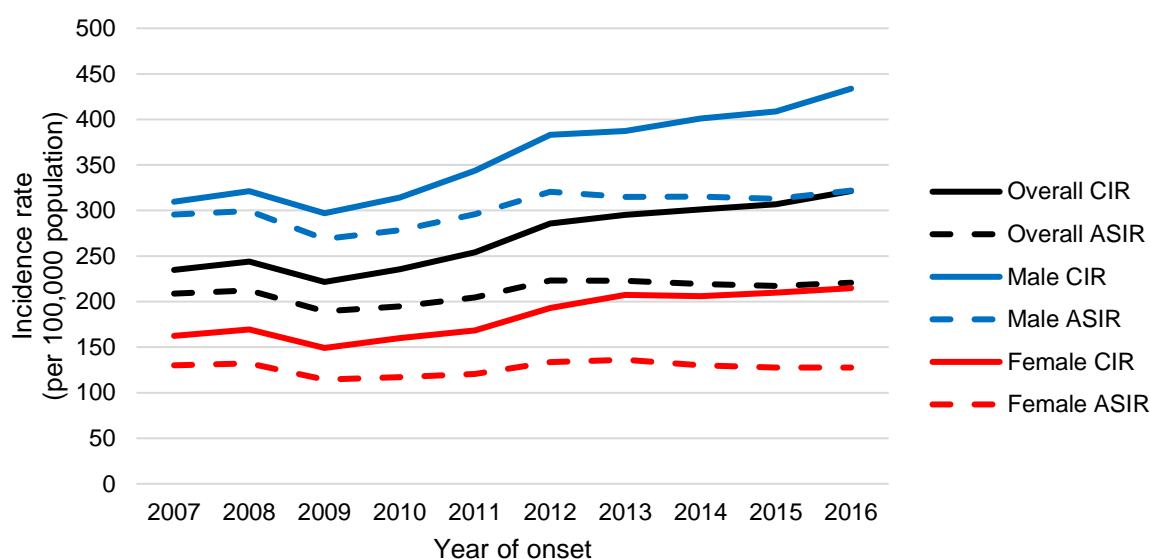
Male						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
2007	4420	64.8	309.8	300.7-318.9	295.5	286.6-304.3
2008	4683	64.6	321.1	311.9-330.3	299.4	290.7-308.1
2009	4463	65.7	297.0	288.3-305.7	268.8	260.8-276.8
2010	4799	65.3	314.3	305.4-323.2	278.3	270.3-286.3
2011	5305	66.2	343.9	334.6-353.1	295.8	287.7-303.9
2012	5975	65.5	383.0	373.3-392.7	320.7	312.5-328.9
2013	6106	64.1	387.2	377.5-396.9	314.9	306.9-322.8
2014	6388	65.0	401.2	391.3-411.0	315.3	307.5-323.0
2015	6580	64.9	408.8	398.9-418.7	312.7	305.0-320.3
2016	7052	65.7	433.7	423.6-443.9	321.9	314.3-329.5
P for trend	-	-	<0.001	-	0.025	-
Female						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
2007	2397	35.2	162.3	155.8-168.8	130.2	124.8-135.5
2008	2564	35.4	169.5	162.9-176.0	132.3	127.0-137.6
2009	2332	34.3	149.2	143.1-155.2	114.5	109.7-119.3
2010	2546	34.7	160.1	153.8-166.3	117.3	112.5-122.0
2011	2708	33.8	168.2	161.9-174.6	120.7	116.0-125.5
2012	3148	34.5	193.0	186.2-199.7	133.7	128.8-138.5
2013	3425	35.9	207.3	200.4-214.3	136.2	131.5-140.9
2014	3444	35.0	206.2	199.3-213.1	130.1	125.6-134.6
2015	3551	35.1	210.0	203.1-216.9	127.7	123.3-132.1
2016	3676	34.3	214.8	207.8-221.7	127.6	123.2-131.9
P for trend	-	-	0.001	-	0.502	-

<sup>9</sup> Mehta LS et al. Acute myocardial infarction in women. *Circulation* 2016; 133.

<sup>10</sup> National Health Survey 2010. Ministry of Health, Singapore.

<sup>11</sup> Risk Factors, Gender. Singapore Heart Foundation.

**Figure 5.1.4: Incidence rate (per 100,000 population) by gender**

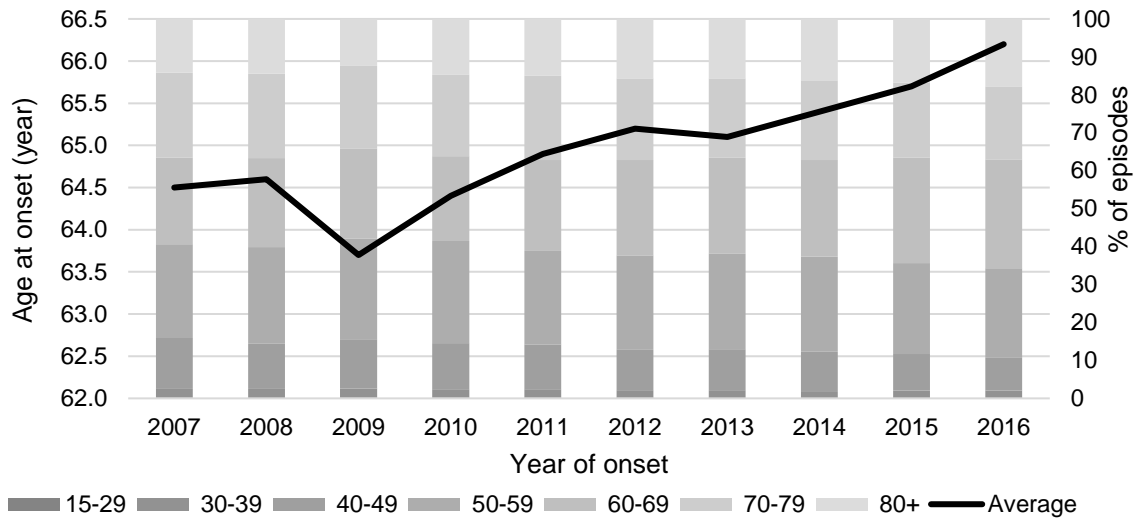


The average age at onset ranged from 63 to 67 years among men and it increased gradually over the years (Table 5.1.5a and Figure 5.1.5a). The majority of the male patients were aged 50 to 69 years (23.7% and 28.7% in the 50-59 and 60-69 age groups respectively in 2016).

**Table 5.1.5a: Average age at onset (year) and age distribution (%) among men**

Year of onset	Average age	Age 15-29		Age 30-39		Age 40-49		
		Number	%	Number	%	Number	%	
2007	64.5	8	0.2	103	2.3	591	13.4	
2008	64.6	8	0.2	107	2.3	559	11.9	
2009	63.7	10	0.2	105	2.4	573	12.8	
2010	64.4	9	0.2	105	2.2	584	12.2	
2011	64.9	12	0.2	116	2.2	627	11.8	
2012	65.2	11	0.2	120	2.0	632	10.6	
2013	65.1	10	0.2	121	2.0	661	10.8	
2014	65.4	10	0.2	110	1.7	664	10.4	
2015	65.7	8	0.1	126	1.9	637	9.7	
2016	66.2	11	0.2	133	1.9	609	8.6	
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	1093	24.7	1011	22.9	988	22.4	626	14.2
2008	1194	25.5	1096	23.4	1045	22.3	674	14.4
2009	1188	26.6	1059	23.7	976	21.9	552	12.4
2010	1293	26.9	1074	22.4	1025	21.4	709	14.8
2011	1306	24.6	1273	24.0	1174	22.1	797	15.0
2012	1490	24.9	1500	25.1	1286	21.5	936	15.7
2013	1534	25.1	1547	25.3	1277	20.9	956	15.7
2014	1599	25.0	1630	25.5	1342	21.0	1033	16.2
2015	1575	23.9	1834	27.9	1298	19.7	1102	16.7
2016	1668	23.7	2022	28.7	1353	19.2	1256	17.8

**Figure 5.1.5a: Average age at onset (year) and age distribution (%) among men**



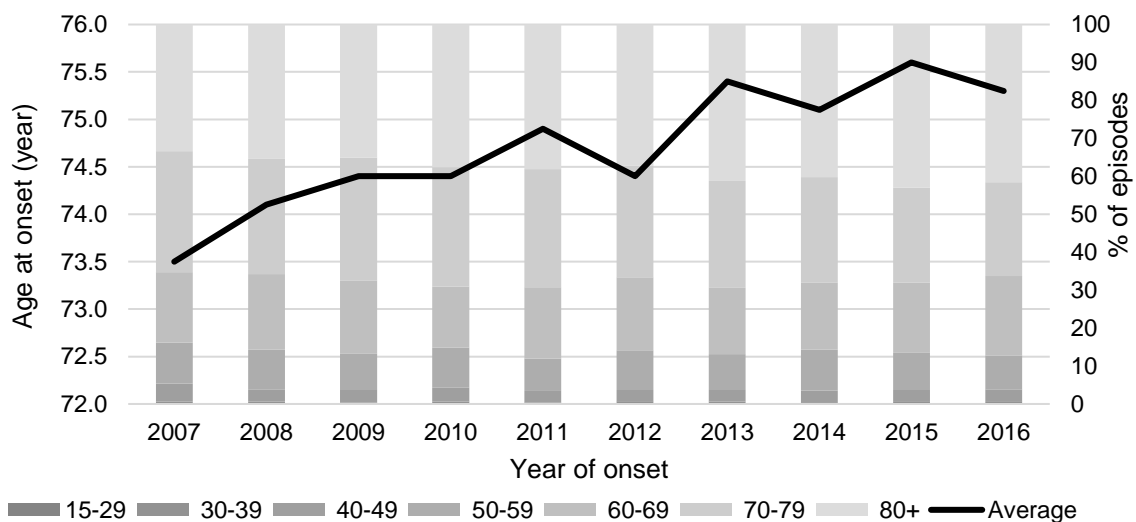
The average age at onset ranged from 73 to 76 years among women, almost a decade older than the average age at onset among men (Table 5.1.5b and Figure 5.1.5b). The majority of the female patients were aged 80 years or above, with 41.5% in this age group in 2016.



**Table 5.1.5b: Average age at onset (year) and age distribution (%) among women**

Year of onset	Average age	Age 15-29		Age 30-39		Age 40-49		
		Number	%	Number	%	Number	%	
2007	73.5	2	0.1	14	0.6	113	4.7	
2008	74.1	2	0.1	14	0.5	83	3.2	
2009	74.4	3	0.1	7	0.3	76	3.3	
2010	74.4	3	0.1	13	0.5	92	3.6	
2011	74.9	1	0.0	10	0.4	82	3.0	
2012	74.4	4	0.1	19	0.6	93	3.0	
2013	75.4	3	0.1	18	0.5	104	3.0	
2014	75.1	1	0.0	16	0.5	104	3.0	
2015	75.6	5	0.1	22	0.6	105	3.0	
2016	75.3	5	0.1	21	0.6	115	3.1	
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	259	10.8	445	18.6	763	31.8	801	33.4
2008	267	10.4	512	20.0	779	30.4	907	35.4
2009	222	9.5	448	19.2	759	32.5	817	35.0
2010	270	10.6	410	16.1	801	31.5	957	37.6
2011	230	8.5	511	18.9	842	31.1	1032	38.1
2012	328	10.4	607	19.3	927	29.4	1170	37.2
2013	325	9.5	598	17.5	964	28.1	1413	41.3
2014	373	10.8	609	17.7	955	27.7	1386	40.2
2015	347	9.8	655	18.4	891	25.1	1526	43.0
2016	326	8.9	773	21.0	909	24.7	1527	41.5

**Figure 5.1.5b: Average age at onset (year) and age distribution (%) among women**



Similar to the general population's ethnic distribution, most of the AMI episodes occurred among the Chinese, followed by the Malays, then the Indians (Table 5.1.6). The rise in ASIR over the years was significant among the Malays only ( $p=0.006$ ) (Figure 5.1.6). The Chinese consistently had a lower ASIR than the Malays and Indians across the years. In 2016, the ASIR was 174.4, 445.6 and 429.9 per 100,000 population for the Chinese, Malays and Indians respectively.

The prevalence of hypertension, high total cholesterol and diabetes were higher among the Malays, relative to the Chinese and Indians in the general population as shown by the National Health Survey 2010<sup>12</sup>. Although the prevalence of hypertension and high total cholesterol among the Indians were lower than the Chinese, the prevalence of diabetes among the Indians was higher the Chinese. Furthermore, the Indians have ethnic-specific risk for coronary artery disease<sup>13,14</sup>.

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<sup>12</sup> National Health Survey 2010. Ministry of Health, Singapore.

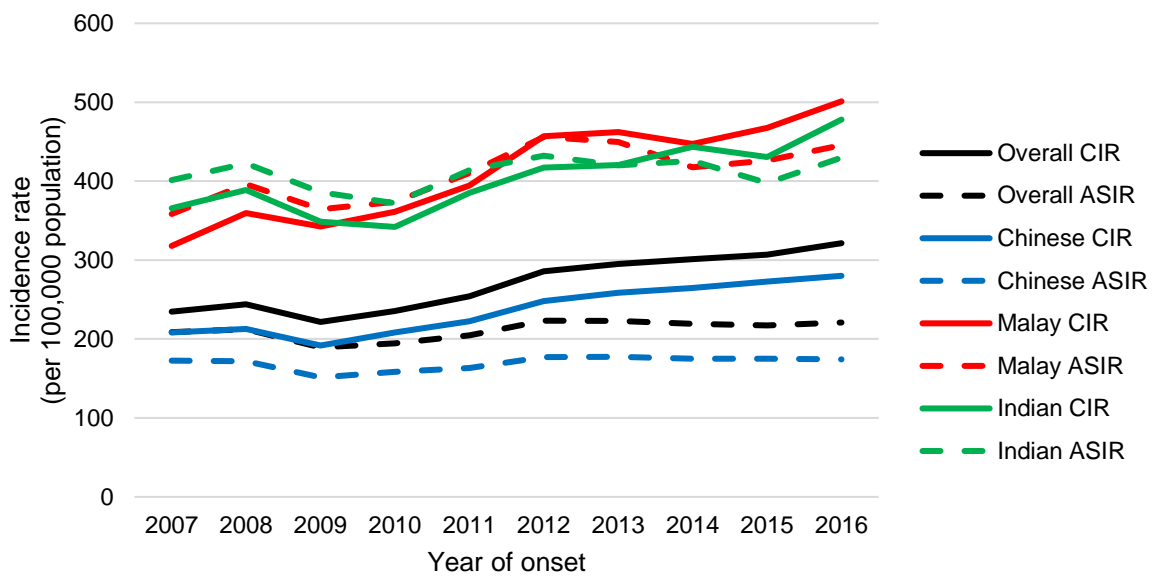
<sup>13</sup> Mak KH et al. Ethnic differences in acute myocardial infarction in Singapore. *European Heart Journal* 2003; 24: 151-160.

<sup>14</sup> Heng CK et al. Variations in the promoter region of the apolipoprotein A-1 gene influence plasma lipoprotein(a) levels in Asian Indian neonates from Singapore. *Pediatric Research* 2001; 49: 514-518.

**Table 5.1.6: Incidence number and rate (per 100,000 population) by ethnicity**

<b>Chinese</b>						
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CIR</b>	<b>95% CI</b>	<b>ASIR</b>	<b>95% CI</b>
2007	4630	67.9	208.1	202.1-214.1	172.6	167.6-177.7
2008	4821	66.5	212.7	206.7-218.7	171.7	166.8-176.7
2009	4452	65.5	191.8	186.1-197.4	151.5	146.9-156.0
2010	4907	66.8	208.3	202.5-214.1	158.3	153.7-162.8
2011	5296	66.1	222.4	216.4-228.4	163.4	158.9-167.9
2012	5982	65.6	248.1	241.8-254.4	176.9	172.4-181.5
2013	6307	66.2	258.5	252.2-264.9	177.4	173.0-181.9
2014	6520	66.3	264.6	258.2-271.0	175.0	170.7-179.3
2015	6801	67.1	272.8	266.3-279.3	175.0	170.8-179.3
2016	7059	65.8	280.1	273.5-286.6	174.4	170.2-178.5
<b>P for trend</b>	-	-	<0.001	-	0.172	-
<b>Malay</b>						
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CIR</b>	<b>95% CI</b>	<b>ASIR</b>	<b>95% CI</b>
2007	1170	17.2	317.9	299.7-336.2	358.4	337.2-379.7
2008	1352	18.7	359.6	340.4-378.7	396.1	374.4-417.9
2009	1316	19.4	342.6	324.1-361.1	364.6	344.2-384.9
2010	1414	19.3	361.4	342.5-380.2	373.6	353.4-393.8
2011	1567	19.6	394.6	375.1-414.1	410.1	389.0-431.3
2012	1841	20.2	456.8	436.0-477.7	456.0	434.6-477.4
2013	1890	19.8	462.3	441.5-483.2	449.6	428.9-470.3
2014	1853	18.8	447.0	426.7-467.4	417.5	398.1-436.9
2015	1964	19.4	467.5	446.8-488.2	426.2	407.0-445.5
2016	2134	19.9	501.1	479.9-522.4	445.6	426.2-464.9
<b>P for trend</b>	-	-	<0.001	-	0.006	-
<b>Indian</b>						
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CIR</b>	<b>95% CI</b>	<b>ASIR</b>	<b>95% CI</b>
2007	883	13.0	365.5	341.4-389.6	401.3	373.9-428.7
2008	975	13.5	388.6	364.2-413.0	422.5	395.1-449.9
2009	935	13.8	348.8	326.4-371.1	386.0	360.4-411.5
2010	934	12.7	342.0	320.1-363.9	372.1	347.5-396.7
2011	1062	13.3	385.1	361.9-408.2	414.0	388.2-439.7
2012	1163	12.7	417.0	393.0-441.0	432.3	406.8-457.7
2013	1182	12.4	420.3	396.4-444.3	420.1	395.6-444.5
2014	1259	12.8	443.6	419.1-468.1	425.8	401.9-449.7
2015	1232	12.2	430.7	406.6-454.7	397.6	375.1-420.2
2016	1379	12.9	478.0	452.8-503.3	429.9	406.8-453.0
<b>P for trend</b>	-	-	0.002	-	0.251	-

**Figure 5.1.6: Incidence rate (per 100,000 population) by ethnicity**

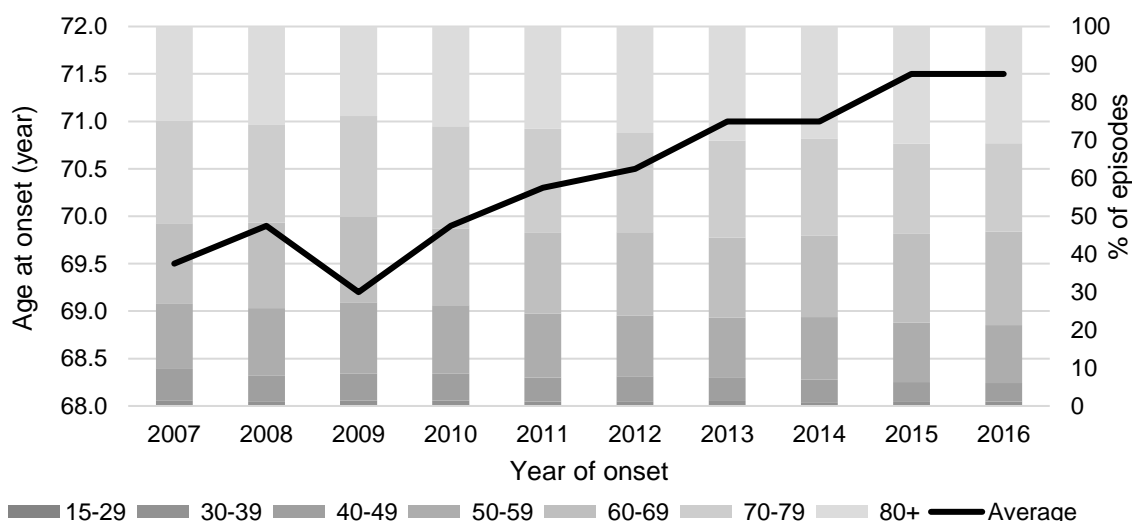


The average age at onset ranged from 69 to 72 years among the Chinese and it increased gradually over the years (Table 5.1.7a and Figure 5.1.7a). The majority of the Chinese patients were aged 80 years or above, with 30.7% in this age group in 2016.

**Table 5.1.7a: Average age at onset (year) and age distribution (%) among Chinese**

Year of onset	Average age	Age 15-29		Age 30-39		Age 40-49		
		Number	%	Number	%	Number	%	
2007	69.5	2	0.0	69	1.5	380	8.2	
2008	69.9	4	0.1	54	1.1	332	6.9	
2009	69.2	8	0.2	53	1.2	320	7.2	
2010	69.9	3	0.1	67	1.4	346	7.1	
2011	70.3	5	0.1	55	1.0	337	6.4	
2012	70.5	10	0.2	66	1.1	392	6.6	
2013	71.0	8	0.1	75	1.2	381	6.0	
2014	71.0	6	0.1	59	0.9	389	6.0	
2015	71.5	9	0.1	66	1.0	353	5.2	
2016	71.5	4	0.1	80	1.1	343	4.9	
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	803	17.3	976	21.1	1248	27.0	1152	24.9
2008	855	17.7	1086	22.5	1245	25.8	1245	25.8
2009	833	18.7	1004	22.6	1184	26.6	1050	23.6
2010	887	18.1	994	20.3	1319	26.9	1291	26.3
2011	894	16.9	1124	21.2	1454	27.5	1427	26.9
2012	961	16.1	1308	21.9	1568	26.2	1677	28.0
2013	1002	15.9	1333	21.1	1610	25.5	1898	30.1
2014	1072	16.4	1398	21.4	1674	25.7	1922	29.5
2015	1066	15.7	1590	23.4	1619	23.8	2098	30.8
2016	1078	15.3	1738	24.6	1646	23.3	2170	30.7

**Figure 5.1.7a: Average age at onset (year) and age distribution (%) among Chinese**

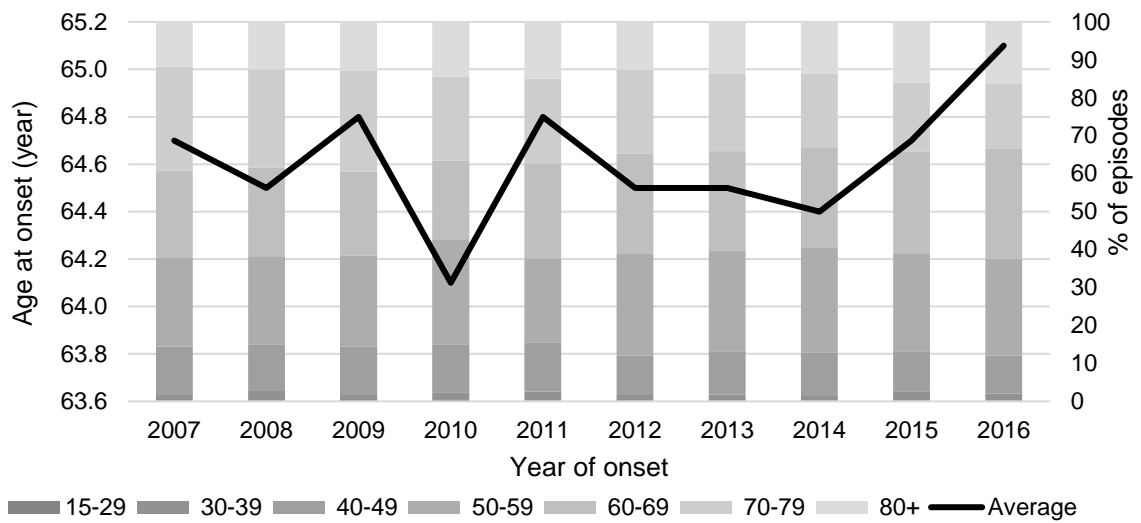


The average age at onset ranged from 64 to 66 years among the Malays, a few years younger than the average age at onset among the Chinese (Table 5.1.7b and Figure 5.1.7b). The majority of the Malay patients were aged 50 to 69 years (25.5% and 29.0% in the 50-59 and 60-69 age groups respectively in 2016).

**Table 5.1.7b: Average age at onset (year) and age distribution (%) among Malays**

Year of onset	Average age		Age 15-29		Age 30-39		Age 40-49	
			Number	%	Number	%	Number	%
2007	64.7		3	0.3	19	1.6	147	12.6
2008	64.5		2	0.1	35	2.6	165	12.2
2009	64.8		1	0.1	24	1.8	164	12.5
2010	64.1		6	0.4	26	1.8	179	12.7
2011	64.8		4	0.3	37	2.4	200	12.8
2012	64.5		3	0.2	32	1.7	187	10.2
2013	64.5		3	0.2	32	1.7	214	11.3
2014	64.4		3	0.2	28	1.5	206	11.1
2015	64.7		4	0.2	48	2.4	208	10.6
2016	65.1		7	0.3	37	1.7	214	10.0
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	273	23.3	270	23.1	320	27.4	138	11.8
2008	315	23.3	315	23.3	350	25.9	170	12.6
2009	316	24.0	292	22.2	351	26.7	168	12.8
2010	393	27.8	294	20.8	311	22.0	205	14.5
2011	350	22.3	392	25.0	349	22.3	235	15.0
2012	494	26.8	486	26.4	407	22.1	232	12.6
2013	503	26.6	494	26.1	387	20.5	257	13.6
2014	516	27.8	485	26.2	362	19.5	253	13.7
2015	507	25.8	524	26.7	359	18.3	314	16.0
2016	544	25.5	618	29.0	368	17.2	346	16.2

**Figure 5.1.7b: Average age at onset (year) and age distribution (%) among Malays**

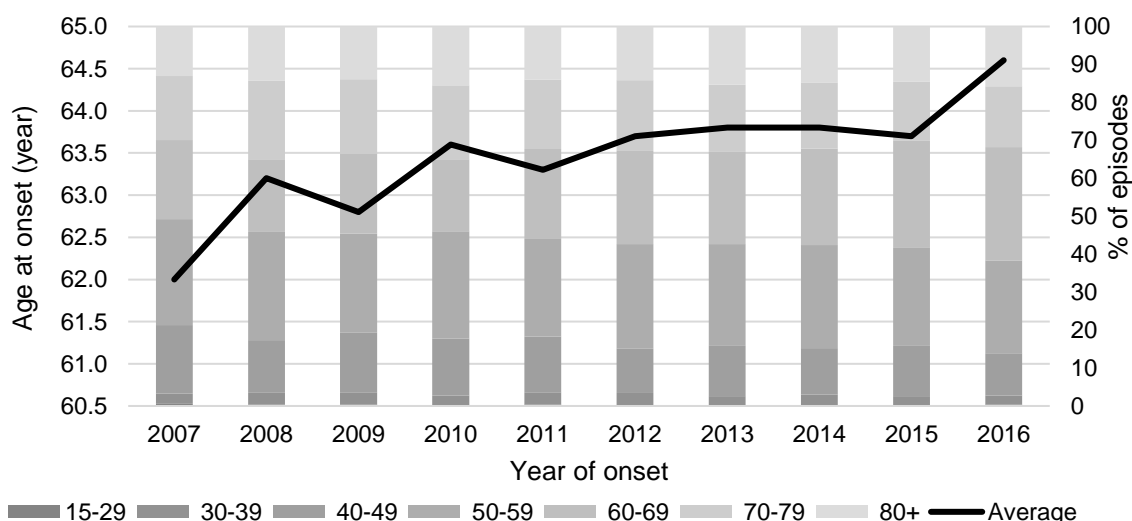


The average age at onset ranged from 62 to 65 years among the Indians. The average age at onset among the Indians was the youngest across the three main ethnic groups and it increased gradually over the years (Table 5.1.7c and Figure 5.1.7c). The majority of the Indian patients were aged 50 to 69 years (24.4% and 29.9% in the 50-59 and 60-69 age groups respectively in 2016).

**Table 5.1.7c: Average age at onset (year) and age distribution (%) among Indians**

Year of onset	Average age	Age 15-29		Age 30-39		Age 40-49		
		Number	%	Number	%	Number	%	
2007	62.0	5	0.6	24	2.7	159	18.0	
2008	63.2	4	0.4	31	3.2	134	13.7	
2009	62.8	4	0.4	30	3.2	146	15.6	
2010	63.6	2	0.2	24	2.6	140	15.0	
2011	63.3	4	0.4	34	3.2	156	14.7	
2012	63.7	2	0.2	38	3.3	135	11.6	
2013	63.8	2	0.2	29	2.5	156	13.2	
2014	63.8	2	0.2	36	2.9	154	12.2	
2015	63.7	0	0.0	32	2.6	163	13.2	
2016	64.6	5	0.4	33	2.4	154	11.2	
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	247	28.0	184	20.8	149	16.9	115	13.0
2008	278	28.5	187	19.2	202	20.7	139	14.3
2009	245	26.2	197	21.1	183	19.6	130	13.9
2010	264	28.3	177	19.0	182	19.5	145	15.5
2011	273	25.7	252	23.7	195	18.4	148	13.9
2012	321	27.6	286	24.6	216	18.6	165	14.2
2013	317	26.8	287	24.3	210	17.8	181	15.3
2014	342	27.2	320	25.4	219	17.4	186	14.8
2015	318	25.8	349	28.3	192	15.6	178	14.4
2016	337	24.4	412	29.9	221	16.0	217	15.7

**Figure 5.1.7c: Average age at onset (year) and age distribution (%) among Indians**



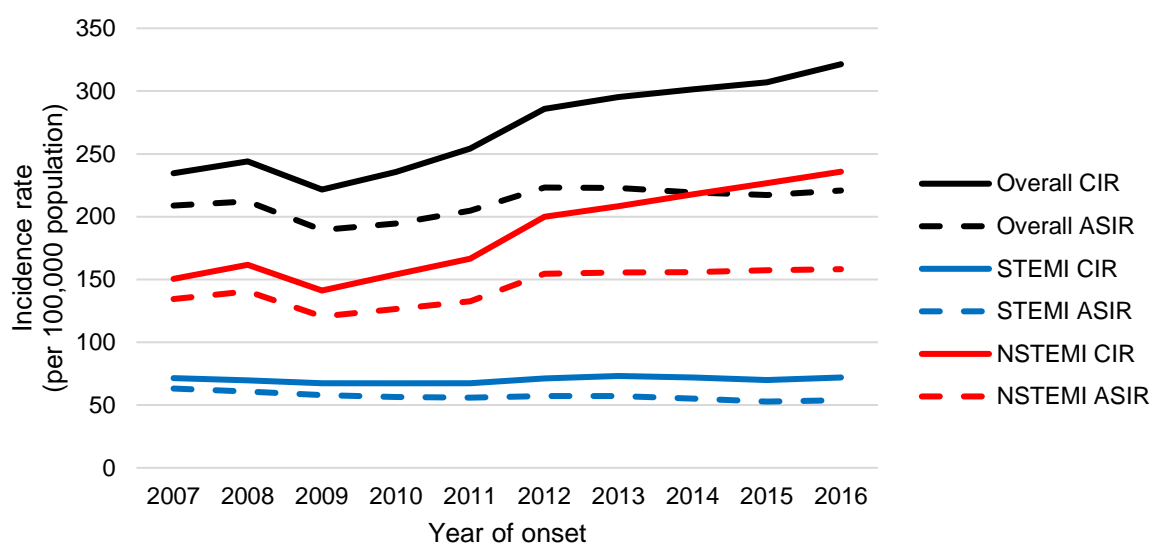


NSTEMI episodes were more common than STEMI episodes (Table 5.1.8). The ASIR of STEMI decreased significantly from 63.1 per 100,000 population in 2007 to 53.8 per 100,000 population in 2016 ( $p<0.001$ ), while the ASIR of NSTEMI increased significantly from 134.5 per 100,000 population in 2007 to 158.2 per 100,000 population in 2016 ( $p=0.008$ ) (Figure 5.1.8). The ASIR of NSTEMI was consistently higher than that of STEMI across the years. As NSTEMI may be precipitated by other underlying co-morbidities in elderly patients, Singapore's ageing population is likely a contributory factor to the higher incidence of NSTEMI than STEMI.

**Table 5.1.8: Incidence number and rate (per 100,000 population) by AMI subtype**

STEMI						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
2007	2077	30.5	71.5	68.4-74.6	63.1	60.4-65.9
2008	2068	28.5	69.6	66.6-72.6	60.7	58.0-63.4
2009	2069	30.4	67.5	64.6-70.4	57.9	55.4-60.4
2010	2099	28.6	67.3	64.5-70.2	56.5	54.0-59.0
2011	2127	26.5	67.5	64.6-70.3	55.9	53.5-58.3
2012	2275	24.9	71.3	68.4-74.2	57.3	54.9-59.7
2013	2362	24.8	73.1	70.2-76.1	57.2	54.9-59.6
2014	2344	23.8	71.8	68.9-74.7	55.1	52.8-57.4
2015	2308	22.8	69.9	67.1-72.8	52.8	50.6-55.0
2016	2403	22.4	72.0	69.1-74.9	53.8	51.6-56.0
P for trend	-	-	0.220	-	<0.001	-
NSTEMI						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
2007	4371	64.1	150.5	146.1-155.0	134.5	130.5-138.6
2008	4801	66.2	161.6	157.0-166.1	140.5	136.5-144.6
2009	4329	63.7	141.2	137.0-145.4	120.6	116.9-124.2
2010	4799	65.3	153.9	149.6-158.3	126.4	122.8-130.1
2011	5250	65.5	166.5	162.0-171.1	132.7	129.0-136.4
2012	6379	69.9	199.9	195.0-204.8	154.6	150.8-158.5
2013	6729	70.6	208.4	203.4-213.4	155.5	151.8-159.3
2014	7108	72.3	217.9	212.8-222.9	155.9	152.3-159.6
2015	7481	73.8	226.7	221.5-231.8	157.3	153.6-160.9
2016	7870	73.4	235.8	230.6-241.0	158.2	154.6-161.8
P for trend	-	-	<0.001	-	0.008	-

**Figure 5.1.8: Incidence rate (per 100,000 population) by AMI subtype**

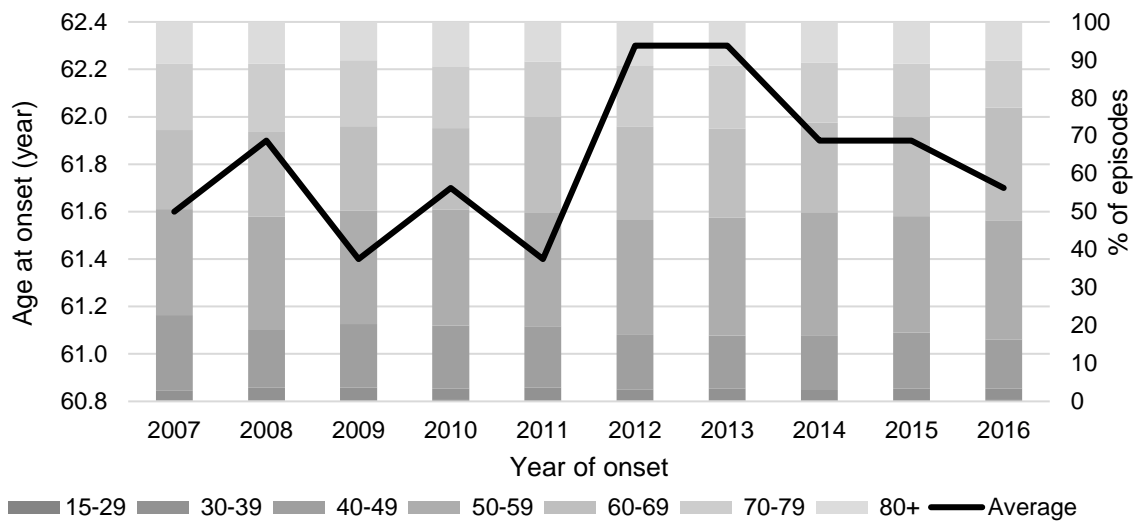


The average age at onset ranged from 61 to 63 years among STEMI (Table 5.1.9a and Figure 5.1.9a). The majority of the STEMI patients were aged 50 to 69 years (31.4% and 29.7% in the 50-59 and 60-69 age groups respectively in 2016).

**Table 5.1.9a: Average age at onset (year) and age distribution (%) among STEMI**

Year of onset	Average age	Age 15-29		Age 30-39		Age 40-49		
		Number	%	Number	%	Number	%	
2007	61.6	4	0.2	57	2.7	412	19.8	
2008	61.9	4	0.2	70	3.4	320	15.5	
2009	61.4	7	0.3	69	3.3	346	16.7	
2010	61.7	9	0.4	62	3.0	348	16.6	
2011	61.4	7	0.3	72	3.4	342	16.1	
2012	62.3	5	0.2	67	2.9	326	14.3	
2013	62.3	5	0.2	76	3.2	329	13.9	
2014	61.9	8	0.3	62	2.6	338	14.4	
2015	61.9	3	0.1	74	3.2	340	14.7	
2016	61.7	9	0.4	71	3.0	312	13.0	
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	580	27.9	432	20.8	364	17.5	228	11.0
2008	613	29.6	461	22.3	372	18.0	228	11.0
2009	617	29.8	461	22.3	360	17.4	209	10.1
2010	643	30.6	449	21.4	342	16.3	246	11.7
2011	635	29.9	538	25.3	311	14.6	222	10.4
2012	689	30.3	559	24.6	365	16.0	264	11.6
2013	735	31.1	554	23.5	391	16.6	272	11.5
2014	760	32.4	553	23.6	372	15.9	251	10.7
2015	710	30.8	606	26.3	321	13.9	254	11.0
2016	755	31.4	714	29.7	298	12.4	244	10.2

**Figure 5.1.9a: Average age at onset (year) and age distribution (%) among STEMI**

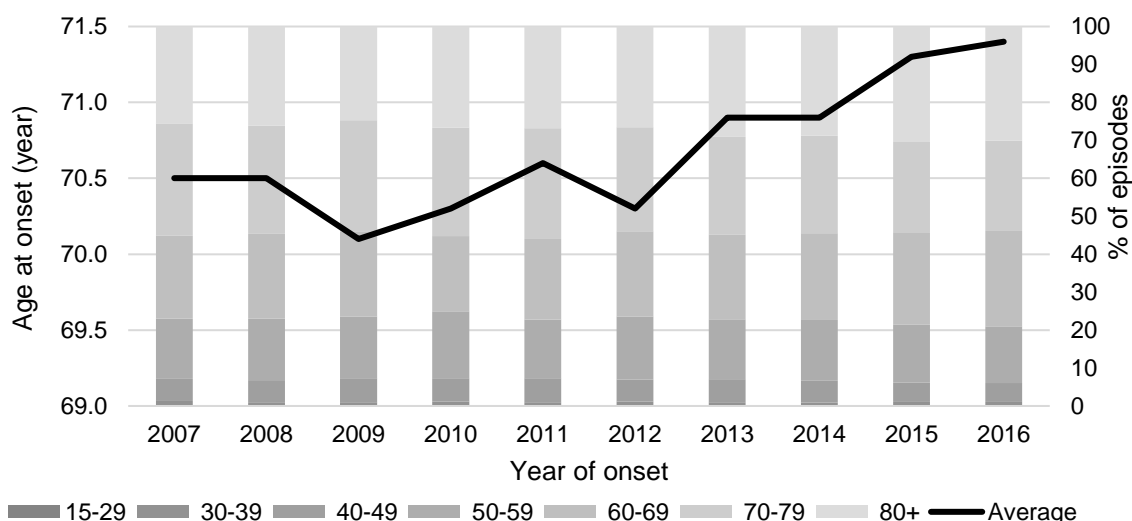


The average age at onset ranged from 70 to 72 years among NSTEMI, almost a decade older than the average age at onset among STEMI and it increased gradually over the years (Table 5.1.9b and Figure 5.1.9b). The majority of the NSTEMI patients were aged 80 years or above, with 30.1% in this age group in 2016.

**Table 5.1.9b: Average age at onset (year) and age distribution (%) among NSTEMI**

Year of onset	Average age	Age 15-29		Age 30-39		Age 40-49		
		Number	%	Number	%	Number	%	
2007	70.5	5	0.1	53	1.2	255	5.8	
2008	70.5	4	0.1	42	0.9	280	5.8	
2009	70.1	5	0.1	39	0.9	273	6.3	
2010	70.3	1	0.0	53	1.1	295	6.1	
2011	70.6	5	0.1	46	0.9	331	6.3	
2012	70.3	9	0.1	62	1.0	373	5.8	
2013	70.9	8	0.1	60	0.9	407	6.0	
2014	70.9	3	0.0	59	0.8	411	5.8	
2015	71.3	10	0.1	67	0.9	381	5.1	
2016	71.4	7	0.1	79	1.0	390	5.0	
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	693	15.9	953	21.8	1295	29.6	1117	25.6
2008	780	16.2	1070	22.3	1372	28.6	1253	26.1
2009	704	16.3	965	22.3	1275	29.5	1068	24.7
2010	847	17.6	953	19.9	1371	28.6	1279	26.7
2011	812	15.5	1115	21.2	1535	29.2	1406	26.8
2012	1060	16.6	1431	22.4	1749	27.4	1695	26.6
2013	1061	15.8	1501	22.3	1738	25.8	1954	29.0
2014	1141	16.1	1620	22.8	1834	25.8	2040	28.7
2015	1148	15.3	1820	24.3	1790	23.9	2265	30.3
2016	1177	15.0	1977	25.1	1869	23.7	2371	30.1

**Figure 5.1.9b: Average age at onset (year) and age distribution (%) among NSTEMI**



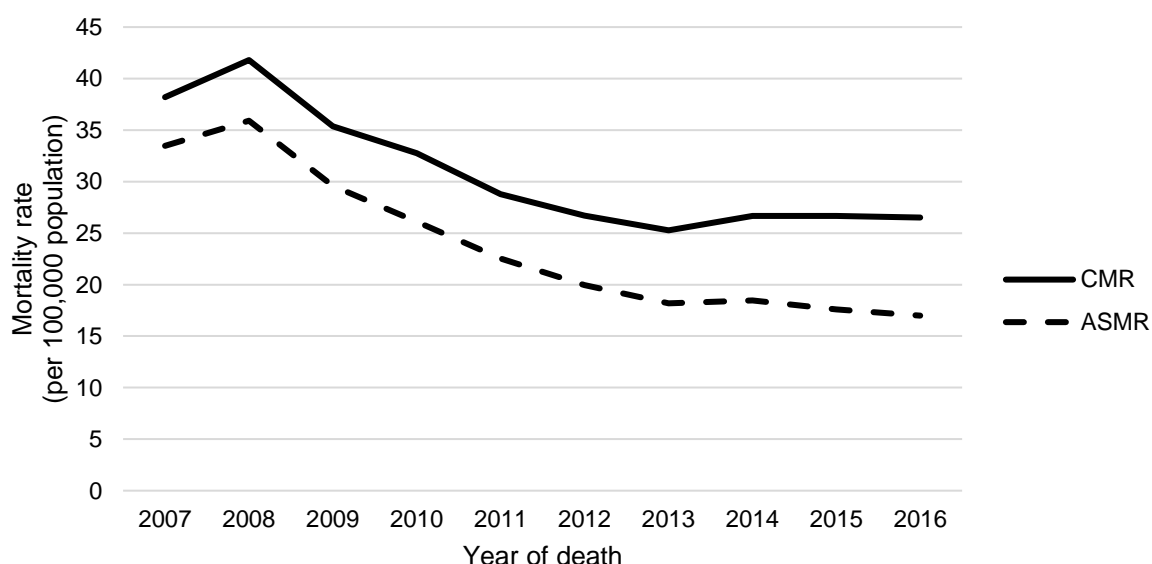
## 5.2 Mortality of AMI

The number of AMI deaths was 885 in 2016, a drop compared to 1,109 in 2007 (Table 5.2.1). Correspondingly, the crude mortality rate (CMR) declined significantly from 38.2 per 100,000 population in 2007 to 26.5 per 100,000 population in 2016 ( $p=0.001$ ) (Figure 5.2.1). However, a slight rise in number of AMI deaths and CMR were observed from 2013 onwards. The rise in crude death numbers and rates are likely due to the rise in AMI incidence in recent years (Table 5.1.1). The ASMR declined significantly from 33.5 per 100,000 population in 2007 to 17.0 per 100,000 population in 2016 ( $p<0.001$ ). This decreasing trend in ASMR is possibly due to improvement in AMI treatment.

**Table 5.2.1: Mortality number and rate (per 100,000 population)**

Year of death	Number	CMR	95% CI	ASMR	95% CI
2007	1109	38.2	35.9-40.4	33.5	31.5-35.5
2008	1242	41.8	39.5-44.1	35.9	33.9-37.9
2009	1084	35.4	33.2-37.5	29.6	27.8-31.4
2010	1021	32.8	30.7-34.8	26.1	24.5-27.8
2011	907	28.8	26.9-30.6	22.5	21.0-24.0
2012	852	26.7	24.9-28.5	20.0	18.6-21.3
2013	816	25.3	23.5-27.0	18.2	16.9-19.4
2014	870	26.7	24.9-28.4	18.5	17.2-19.7
2015	880	26.7	24.9-28.4	17.6	16.4-18.8
2016	885	26.5	24.8-28.3	17.0	15.8-18.1
<b>P for trend</b>	-	0.001	-	<0.001	-

**Figure 5.2.1: Mortality rate (per 100,000 population)**



The average age at death ranged from 72 to 75 years (Table 5.2.2 and Figure 5.2.2). About 6 in 10 of the patients died at age 70 years or above.

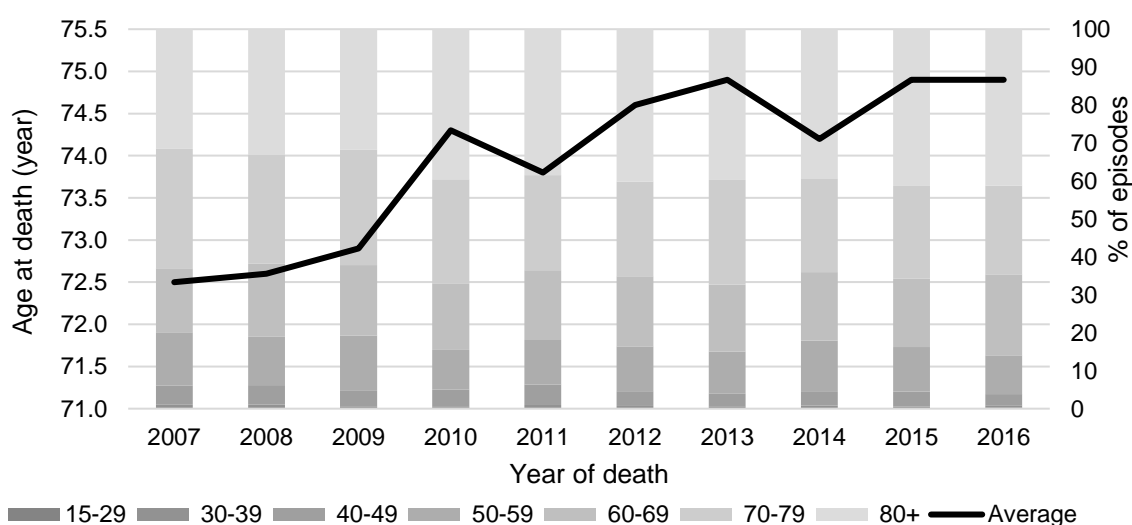
**Table 5.2.2: Average age at death (year) and age distribution (%)**

Year of death	Average age	Age 15-29		Age 30-39		Age 40-49	
		Number	%	Number	%	Number	%
2007	72.5	1	0.1	12	1.1	55	5.0
2008	72.6	1	0.1	12	1.0	64	5.2
2009	72.9	1	0.1	6	0.6	44	4.1
2010	74.3	2	0.2	3	0.3	46	4.5
2011	73.8	0	0.0	9	1.0	49	5.4
2012	74.6	1	0.1	5	0.6	33	3.9
2013	74.9	0	0.0	5	0.6	27	3.3
2014	74.2	1	0.1	6	0.7	33	3.8
2015	74.9	0	0.0	5	0.6	35	4.0
2016	74.9	2	0.2	6	0.7	26	2.9

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	155	14.0	187	16.9	349	31.5	350	31.6
2008	158	12.7	240	19.3	355	28.6	412	33.2
2009	158	14.6	201	18.5	329	30.4	345	31.8
2010	107	10.5	179	17.5	280	27.4	404	39.6
2011	106	11.7	167	18.4	227	25.0	349	38.5
2012	101	11.9	157	18.4	213	25.0	342	40.1
2013	91	11.2	144	17.6	225	27.6	324	39.7
2014	116	13.3	157	18.0	215	24.7	342	39.3
2015	103	11.7	159	18.1	216	24.5	362	41.1
2016	90	10.2	189	21.4	207	23.4	365	41.2

**Figure 5.2.2: Average age at death (year) and age distribution (%)**

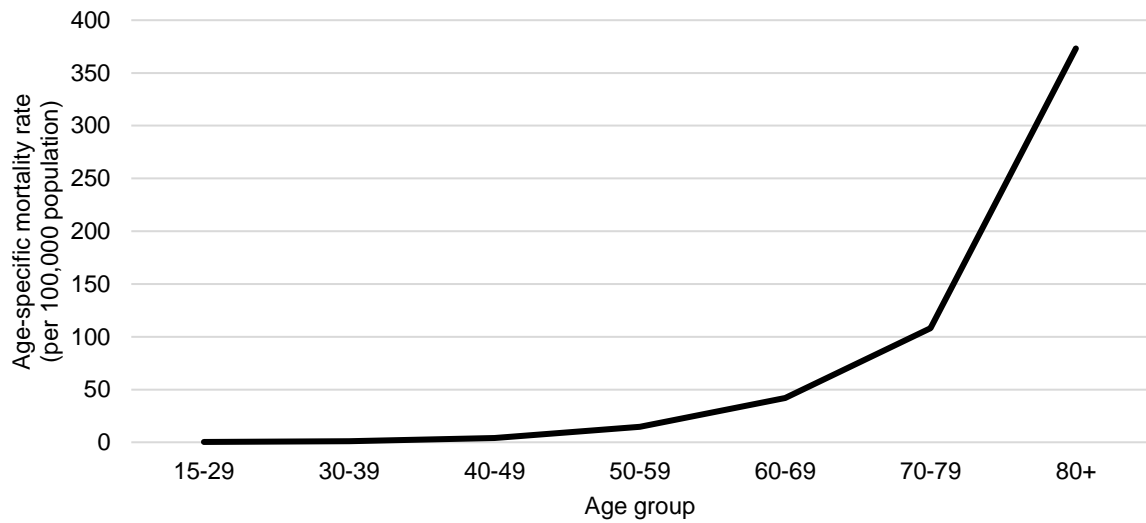


The age-specific mortality rate increased with age (Table 5.2.3), with the oldest age group having the highest mortality rate (Figure 5.2.3a). There was a drop in overall mortality rate from 2010 onwards and the drop in mortality rate for patients aged 70 years or above was higher than those aged below 70 years (Figure 5.2.3b).

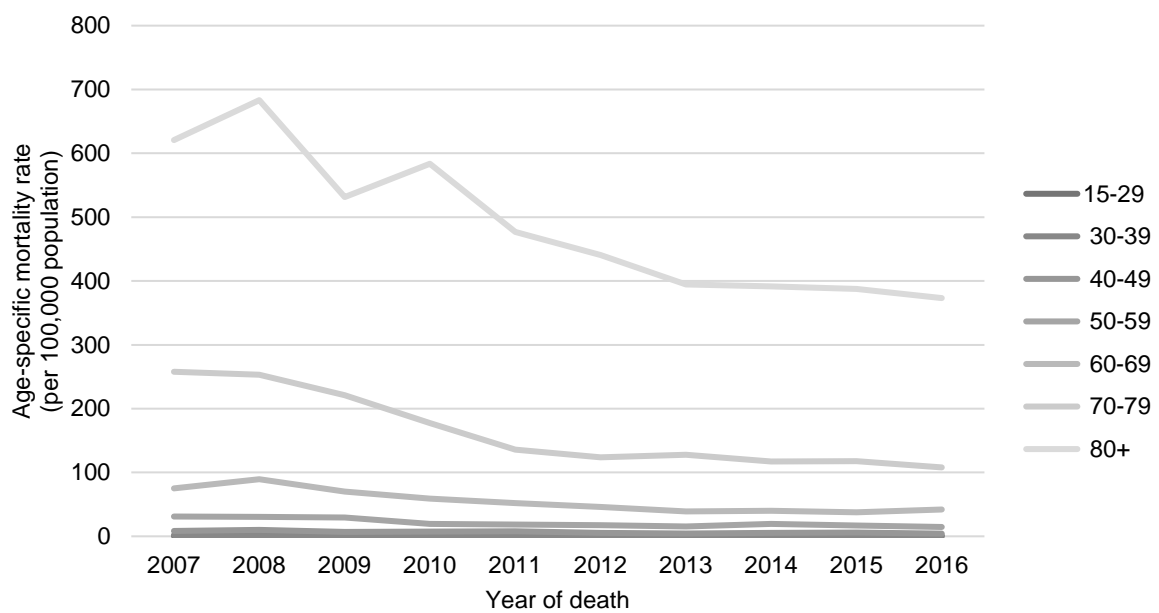
**Table 5.2.3: Age-specific mortality rate (per 100,000 population)**

Year of death	Overall		Age 15-29		Age 30-39		Age 40-49	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2007	38.2	35.9-40.4	0.1	0.0-0.4	2.0	0.9-3.2	8.6	6.4-10.9
2008	41.8	39.5-44.1	0.1	0.0-0.4	2.0	0.9-3.1	10.1	7.6-12.5
2009	35.4	33.2-37.5	0.1	0.0-0.4	1.0	0.2-1.8	6.9	4.9-9.0
2010	32.8	30.7-34.8	0.3	0.0-0.6	0.5	0.0-1.0	7.3	5.2-9.4
2011	28.8	26.9-30.6	0.0	0.0-0.0	1.5	0.5-2.4	7.8	5.6-9.9
2012	26.7	24.9-28.5	0.1	0.0-0.4	0.8	0.1-1.5	5.2	3.5-7.0
2013	25.3	23.5-27.0	0.0	0.0-0.0	0.8	0.1-1.6	4.3	2.7-5.9
2014	26.7	24.9-28.4	0.1	0.0-0.4	1.0	0.2-1.8	5.3	3.5-7.1
2015	26.7	24.9-28.4	0.0	0.0-0.0	0.8	0.1-1.6	5.6	3.8-7.5
2016	26.5	24.8-28.3	0.3	0.0-0.6	1.0	0.2-1.8	4.2	2.6-5.9
P for trend	0.001	-	0.317	-	0.145	-	0.001	-
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2007	31.0	26.1-35.9	75.0	64.3-85.8	257.8	230.7-284.8	620.6	555.6-685.6
2008	30.5	25.7-35.2	89.5	78.1-100.8	253.2	226.9-279.6	683.3	617.3-749.2
2009	29.4	24.8-34.0	70.3	60.6-80.0	220.8	196.9-244.7	531.6	475.5-587.7
2010	19.4	15.7-23.1	59.0	50.4-67.7	177.6	156.8-198.3	583.8	526.9-640.7
2011	18.6	15.1-22.2	52.1	44.2-60.0	136.0	118.3-153.7	476.8	426.8-526.8
2012	17.3	14.0-20.7	45.8	38.6-53.0	123.8	107.2-140.5	440.7	394.0-487.4
2013	15.3	12.2-18.5	39.1	32.7-45.5	127.8	111.1-144.5	394.6	351.7-437.6
2014	19.2	15.7-22.7	40.0	33.7-46.2	117.4	101.7-133.1	391.8	350.3-433.3
2015	16.9	13.6-20.1	37.6	31.8-43.4	117.5	101.8-133.2	387.4	347.5-427.3
2016	14.6	11.6-17.7	42.0	36.0-48.0	108.0	93.2-122.7	373.2	334.9-411.5
P for trend	0.001	-	<0.001	-	<0.001	-	<0.001	-

**Figure 5.2.3a: Age-specific mortality rate (per 100,000 population) across age groups**



**Figure 5.2.3b: Age-specific mortality rate (per 100,000 population) across years**



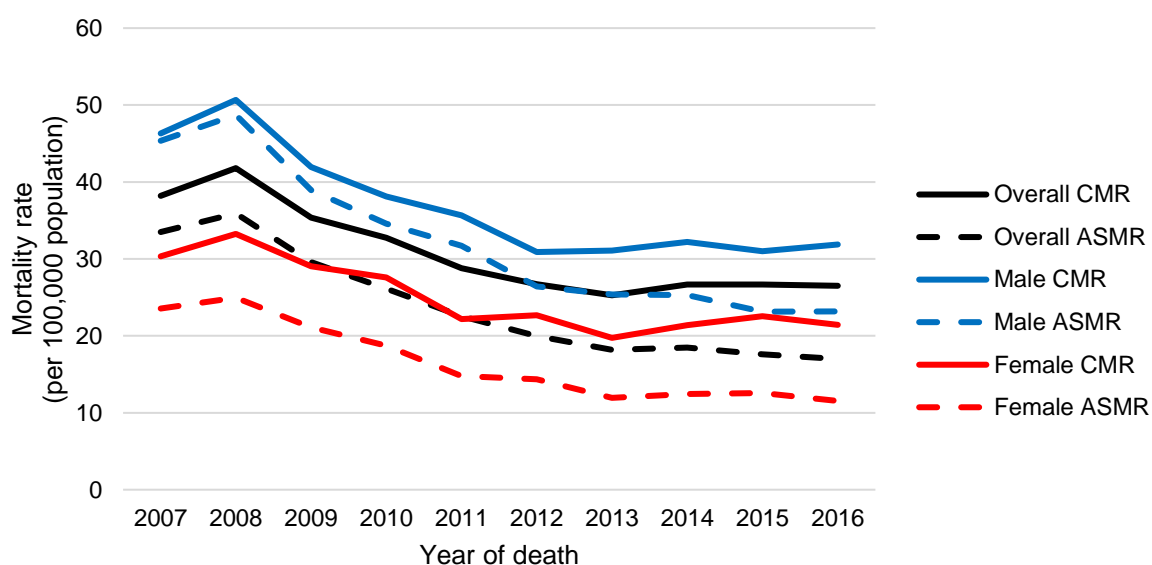
The ASMR declined significantly over the years for both genders ( $p < 0.001$  for both) (Table 5.2.4 and Figure 5.2.4). As the ASIR was consistently higher among men than women (Table 5.1.4), it is expected that the ASMR was also consistently higher among men than women across the years. Men had an ASMR of 23.2 per 100,000 population, while women had an ASMR of 11.5 per 100,000 population in 2016.



**Table 5.2.4: Mortality number and rate (per 100,000 population) by gender**

Male						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
2007	661	59.6	46.3	42.8-49.9	45.4	41.8-48.9
2008	739	59.5	50.7	47.0-54.3	48.7	45.1-52.3
2009	630	58.1	41.9	38.7-45.2	38.9	35.8-42.0
2010	582	57.0	38.1	35.0-41.2	34.6	31.7-37.4
2011	550	60.6	35.7	32.7-38.6	31.7	29.0-34.4
2012	482	56.6	30.9	28.1-33.7	26.4	24.0-28.8
2013	490	60.0	31.1	28.3-33.8	25.4	23.1-27.7
2014	513	59.0	32.2	29.4-35.0	25.3	23.1-27.5
2015	499	56.7	31.0	28.3-33.7	23.1	21.1-25.2
2016	518	58.5	31.9	29.1-34.6	23.2	21.1-25.2
<b>P for trend</b>	-	-	0.001	-	<0.001	-
Female						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
2007	448	40.4	30.3	27.5-33.1	23.6	21.3-25.8
2008	503	40.5	33.2	30.3-36.2	24.9	22.7-27.2
2009	454	41.9	29.0	26.4-31.7	21.1	19.1-23.1
2010	439	43.0	27.6	25.0-30.2	18.7	16.9-20.5
2011	357	39.4	22.2	19.9-24.5	14.8	13.2-16.4
2012	370	43.4	22.7	20.4-25.0	14.4	12.8-15.9
2013	326	40.0	19.7	17.6-21.9	11.9	10.6-13.3
2014	357	41.0	21.4	19.2-23.6	12.5	11.1-13.8
2015	381	43.3	22.5	20.3-24.8	12.6	11.2-13.9
2016	367	41.5	21.4	19.2-23.6	11.5	10.3-12.8
<b>P for trend</b>	-	-	0.001	-	<0.001	-

**Figure 5.2.4: Mortality rate (per 100,000 population) by gender**

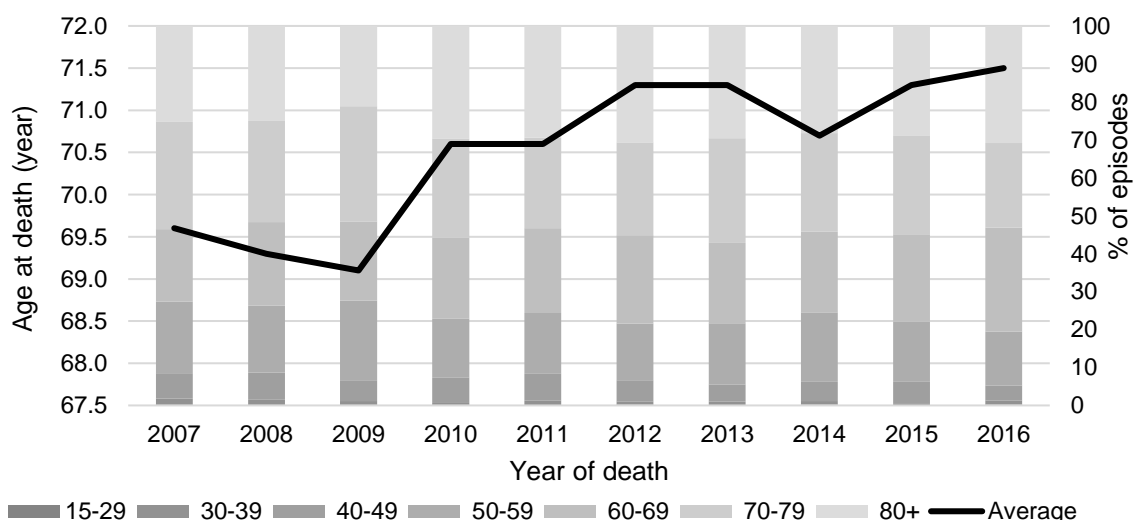


The average age at death ranged from 69 to 72 years among men (Table 5.2.5a and Figure 5.2.5a). The majority of the male patients died at age 80 years or above, with 30.9% in this age group in 2016.

**Table 5.2.5a: Average age at death (year) and age distribution (%) among men**

Year of death	Average age	Age 15-29		Age 30-39		Age 40-49		
		Number	%	Number	%	Number	%	
2007	69.6	1	0.2	11	1.7	44	6.7	
2008	69.3	1	0.1	10	1.4	53	7.2	
2009	69.1	1	0.2	6	1.0	35	5.6	
2010	70.6	1	0.2	3	0.5	39	6.7	
2011	70.6	0	0.0	7	1.3	39	7.1	
2012	71.3	1	0.2	4	0.8	27	5.6	
2013	71.3	0	0.0	5	1.0	22	4.5	
2014	70.7	1	0.2	5	1.0	26	5.1	
2015	71.3	0	0.0	2	0.4	29	5.8	
2016	71.5	1	0.2	6	1.2	20	3.9	
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	125	18.9	126	19.1	187	28.3	167	25.3
2008	130	17.6	163	22.1	197	26.7	185	25.0
2009	132	21.0	131	20.8	192	30.5	133	21.1
2010	90	15.5	124	21.3	152	26.1	173	29.7
2011	88	16.0	123	22.4	131	23.8	162	29.5
2012	72	14.9	112	23.2	118	24.5	148	30.7
2013	79	16.1	104	21.2	135	27.6	145	29.6
2014	94	18.3	109	21.2	133	25.9	145	28.3
2015	79	15.8	115	23.0	130	26.1	144	28.9
2016	74	14.3	142	27.4	115	22.2	160	30.9

**Figure 5.2.5a: Average age at death (year) and age distribution (%) among men**

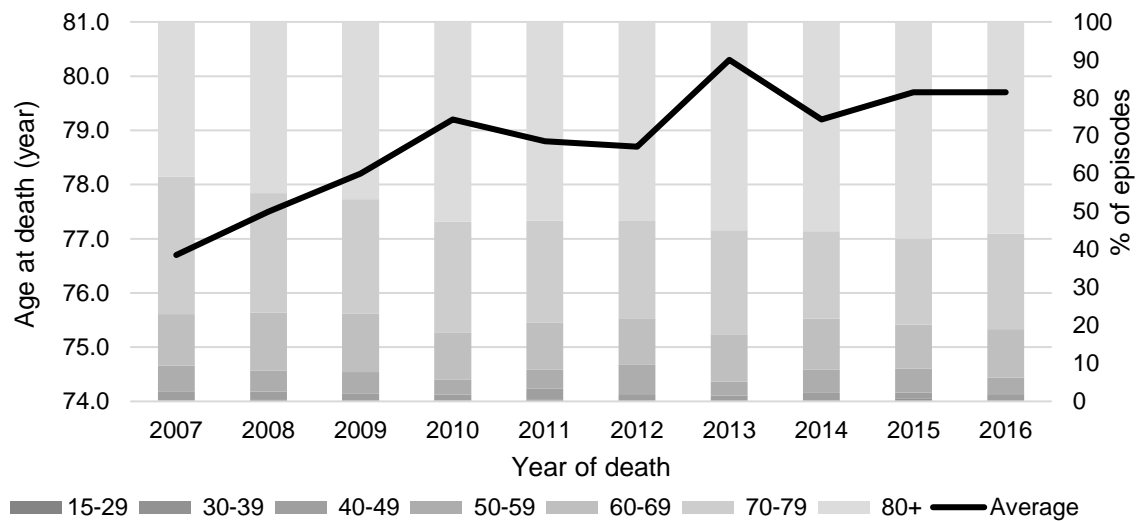


The average age at death ranged from 76 to 81 years among women, a few years older than the average age at death among men (Table 5.2.5b and Figure 5.2.5b). The majority of the female patients died at age 80 years or above, with 55.9% in this age group in 2016.

**Table 5.2.5b: Average age at death (year) and age distribution (%) among women**

Year of death	Average age		Age 15-29		Age 30-39		Age 40-49	
			Number	%	Number	%	Number	%
2007	76.7		0	0.0	1	0.2	11	2.5
2008	77.5		0	0.0	2	0.4	11	2.2
2009	78.2		0	0.0	0	0.0	9	2.0
2010	79.2		1	0.2	0	0.0	7	1.6
2011	78.8		0	0.0	2	0.6	10	2.8
2012	78.7		0	0.0	1	0.3	6	1.6
2013	80.3		0	0.0	0	0.0	5	1.5
2014	79.2		0	0.0	1	0.3	7	2.0
2015	79.7		0	0.0	3	0.8	6	1.6
2016	79.7		1	0.3	0	0.0	6	1.6
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	30	6.7	61	13.6	162	36.2	183	40.8
2008	28	5.6	77	15.3	158	31.4	227	45.1
2009	26	5.7	70	15.4	137	30.2	212	46.7
2010	17	3.9	55	12.5	128	29.2	231	52.6
2011	18	5.0	44	12.3	96	26.9	187	52.4
2012	29	7.8	45	12.2	95	25.7	194	52.4
2013	12	3.7	40	12.3	90	27.6	179	54.9
2014	22	6.2	48	13.4	82	23.0	197	55.2
2015	24	6.3	44	11.5	86	22.6	218	57.2
2016	16	4.4	47	12.8	92	25.1	205	55.9

**Figure 5.2.5b: Average age at death (year) and age distribution (%) among women**

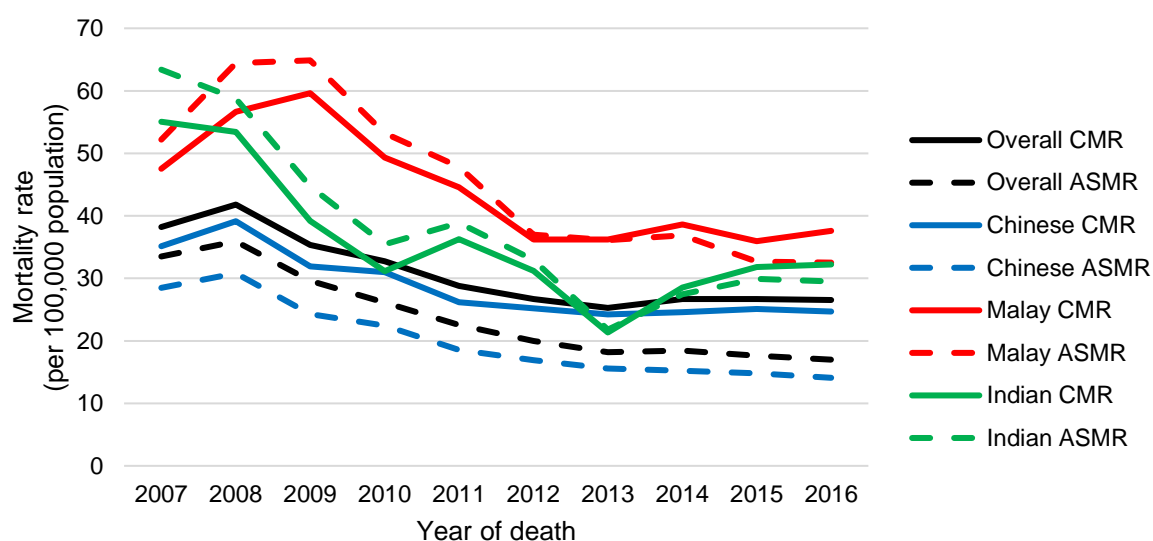


The ASMR showed a significant downward trend over the years for all the three main ethnic groups ( $p < 0.001$  for Chinese and Malays;  $p = 0.002$  for Indians) (Table 5.2.6 and Figure 5.2.6). As the Chinese consistently had the lowest ASIR (Table 5.1.6), they also generally had the lowest ASMR across the years. In 2016, the ASMR of 14.1 per 100,000 population among the Chinese was significantly lower than the Malays (32.5 per 100,000 population) and Indians (29.5 per 100,000 population).

**Table 5.2.6: Mortality number and rate (per 100,000 population) by ethnicity**

<b>Chinese</b>						
<b>Year of death</b>	<b>Number</b>	<b>%</b>	<b>CMR</b>	<b>95% CI</b>	<b>ASMR</b>	<b>95% CI</b>
2007	782	70.5	35.2	32.7-37.6	28.5	26.5-30.5
2008	887	71.4	39.1	36.6-41.7	30.8	28.7-32.9
2009	741	68.4	31.9	29.6-34.2	24.3	22.5-26.1
2010	730	71.5	31.0	28.7-33.2	22.4	20.8-24.1
2011	623	68.7	26.2	24.1-28.2	18.6	17.1-20.1
2012	608	71.4	25.2	23.2-27.2	16.9	15.5-18.3
2013	591	72.4	24.2	22.3-26.2	15.6	14.3-16.8
2014	606	69.7	24.6	22.6-26.6	15.2	14.0-16.4
2015	626	71.1	25.1	23.1-27.1	14.8	13.6-16.0
2016	622	70.3	24.7	22.7-26.6	14.1	12.9-15.2
<b>P for trend</b>	-	-	0.001	-	<0.001	-
<b>Malay</b>						
<b>Year of death</b>	<b>Number</b>	<b>%</b>	<b>CMR</b>	<b>95% CI</b>	<b>ASMR</b>	<b>95% CI</b>
2007	175	15.8	47.6	40.5-54.6	52.2	44.2-60.2
2008	213	17.1	56.6	49.0-64.3	64.4	55.5-73.4
2009	229	21.1	59.6	51.9-67.3	64.9	56.1-73.6
2010	193	18.9	49.3	42.4-56.3	53.2	45.4-61.0
2011	177	19.5	44.6	38.0-51.1	47.9	40.5-55.2
2012	146	17.1	36.2	30.4-42.1	37.0	30.8-43.2
2013	148	18.1	36.2	30.4-42.0	36.1	30.1-42.1
2014	160	18.4	38.6	32.6-44.6	36.9	31.0-42.7
2015	151	17.2	35.9	30.2-41.7	32.7	27.3-38.0
2016	160	18.1	37.6	31.8-43.4	32.5	27.3-37.7
<b>P for trend</b>	-	-	0.004	-	<0.001	-
<b>Indian</b>						
<b>Year of death</b>	<b>Number</b>	<b>%</b>	<b>CMR</b>	<b>95% CI</b>	<b>ASMR</b>	<b>95% CI</b>
2007	133	12.0	55.0	45.7-64.4	63.4	52.2-74.6
2008	134	10.8	53.4	44.4-62.5	58.7	48.4-69.1
2009	105	9.7	39.2	31.7-46.7	44.7	35.8-53.6
2010	85	8.3	31.1	24.5-37.7	35.4	27.6-43.2
2011	100	11.0	36.3	29.2-43.4	38.9	30.9-46.8
2012	87	10.2	31.2	24.6-37.7	32.9	25.8-40.0
2013	60	7.4	21.3	15.9-26.7	21.8	16.1-27.5
2014	81	9.3	28.5	22.3-34.8	27.4	21.3-33.6
2015	91	10.3	31.8	25.3-38.3	29.9	23.6-36.2
2016	93	10.5	32.2	25.7-38.8	29.5	23.4-35.6
<b>P for trend</b>	-	-	0.016	-	0.002	-

**Figure 5.2.6: Mortality rate (per 100,000 population) by ethnicity**

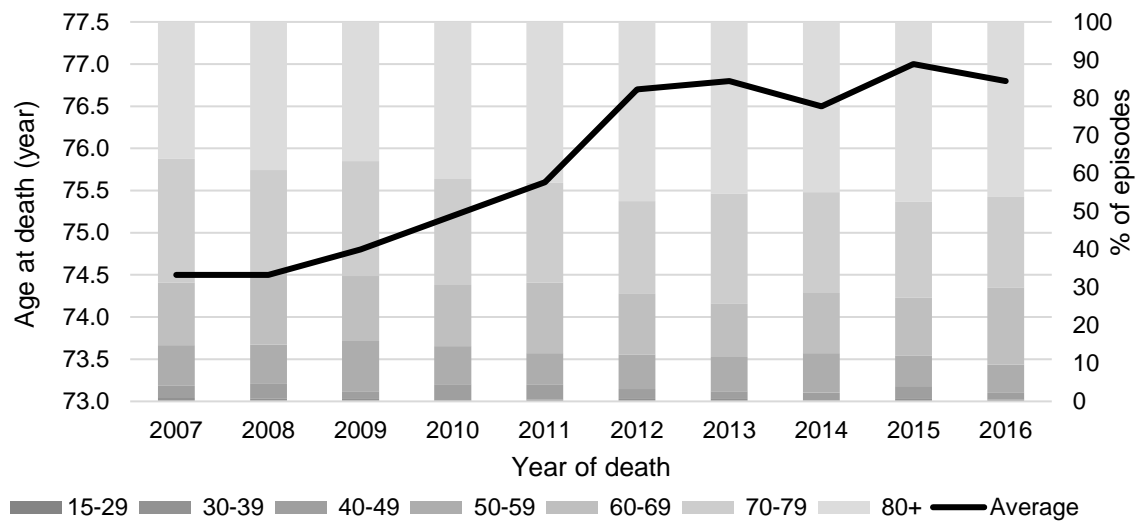


The average age at death ranged from 74 to 77 years among the Chinese (Table 5.2.7a and Figure 5.2.7a). The majority of the Chinese patients died at age 80 years or above, with 46.1% in this age group in 2016.

**Table 5.2.7a: Average age at death (year) and age distribution (%) among Chinese**

Year of death	Average age	Age 15-29		Age 30-39		Age 40-49		
		Number	%	Number	%	Number	%	
2007	74.5	0	0.0	7	0.9	25	3.2	
2008	74.5	1	0.1	6	0.7	34	3.8	
2009	74.8	1	0.1	4	0.5	15	2.0	
2010	75.2	0	0.0	2	0.3	31	4.2	
2011	75.6	0	0.0	3	0.5	24	3.9	
2012	76.7	1	0.2	3	0.5	16	2.6	
2013	76.8	0	0.0	4	0.7	12	2.0	
2014	76.5	1	0.2	1	0.2	12	2.0	
2015	77.0	0	0.0	4	0.6	21	3.4	
2016	76.8	0	0.0	3	0.5	11	1.8	
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	84	10.7	129	16.5	255	32.6	282	36.1
2008	92	10.4	168	18.9	240	27.1	346	39.0
2009	98	13.2	127	17.1	224	30.2	272	36.7
2010	73	10.0	118	16.2	204	27.9	302	41.4
2011	52	8.3	116	18.6	164	26.3	264	42.4
2012	55	9.0	97	16.0	149	24.5	287	47.2
2013	53	9.0	83	14.0	172	29.1	267	45.2
2014	63	10.4	96	15.8	161	26.6	272	44.9
2015	51	8.1	95	15.2	159	25.4	296	47.3
2016	46	7.4	126	20.3	149	24.0	287	46.1

**Figure 5.2.7a: Average age at death (year) and age distribution (%) among Chinese**



The average age at death ranged from 67 to 71 years among the Malays, a few years younger than the average age at death among the Chinese (Table 5.2.7b and Figure 5.2.7b). The majority of the Malay patients died at age 60 years or above (23.8%, 23.1% and 28.8% in the 60-69, 70-79 and 80+ age groups respectively in 2016).

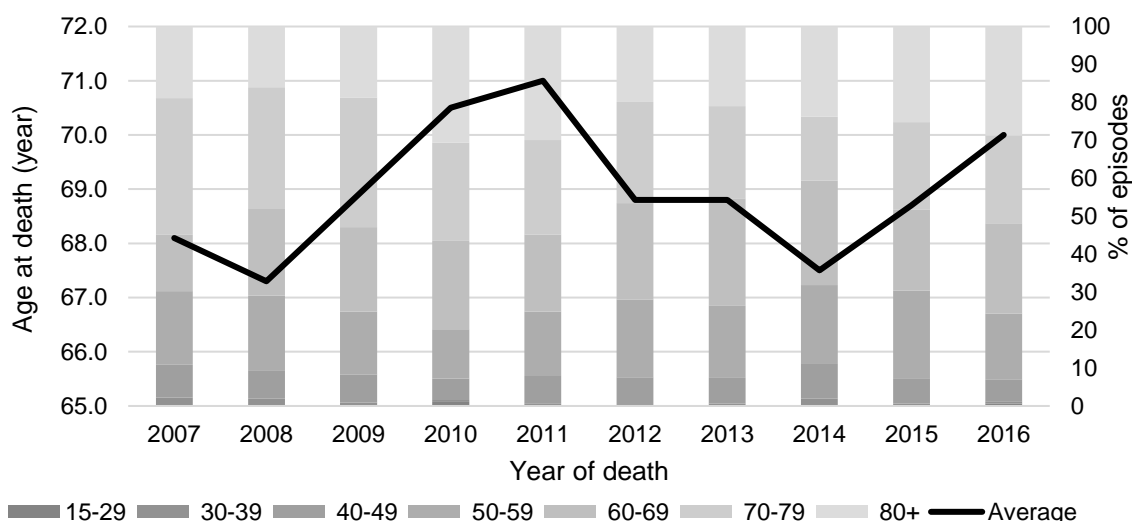
**Table 5.2.7b: Average age at death (year) and age distribution (%) among Malays**

Year of death	Average age	Age 15-29		Age 30-39		Age 40-49	
		Number	%	Number	%	Number	%
2007	68.1	0	0.0	4	2.3	15	8.6
2008	67.3	0	0.0	4	1.9	16	7.5
2009	68.9	0	0.0	2	0.9	17	7.4
2010	70.5	2	1.0	1	0.5	11	5.7
2011	71.0	0	0.0	1	0.6	13	7.3
2012	68.8	0	0.0	0	0.0	11	7.5
2013	68.8	0	0.0	1	0.7	10	6.8
2014	67.5	0	0.0	3	1.9	15	9.4
2015	68.7	0	0.0	1	0.7	10	6.6
2016	70.0	1	0.6	1	0.6	9	5.6

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	34	19.4	26	14.9	63	36.0	33	18.9
2008	42	19.7	49	23.0	68	31.9	34	16.0
2009	38	16.6	51	22.3	78	34.1	43	18.8
2010	25	13.0	45	23.3	50	25.9	59	30.6
2011	30	16.9	36	20.3	44	24.9	53	29.9
2012	30	20.5	37	25.3	39	26.7	29	19.9
2013	28	18.9	42	28.4	36	24.3	31	20.9
2014	33	20.6	44	27.5	27	16.9	38	23.8
2015	35	23.2	32	21.2	35	23.2	38	25.2
2016	28	17.5	38	23.8	37	23.1	46	28.8

**Figure 5.2.7b: Average age at death (year) and age distribution (%) among Malays**



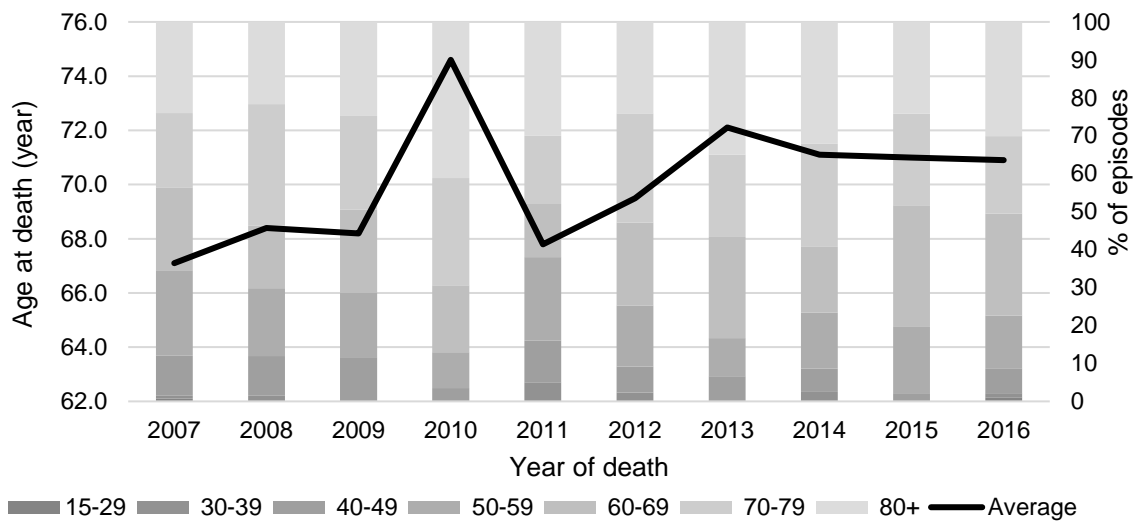


The average age at death ranged from 67 to 75 years among the Indians, close to average age at death among the Malays and a few years younger than the average age at death among the Chinese (Table 5.2.7c and Figure 5.2.7c). Similar to the Malays, the majority of the Indian patients died at age 60 years or above (26.9%, 20.4% and 30.1% in the 60-69, 70-79 and 80+ age groups respectively in 2016).

**Table 5.2.7c: Average age at death (year) and age distribution (%) among Indians**

Year of death	Average age		Age 15-29		Age 30-39		Age 40-49	
			Number	%	Number	%	Number	%
2007	67.1		1	0.8	1	0.8	14	10.5
2008	68.4		0	0.0	2	1.5	14	10.4
2009	68.2		0	0.0	0	0.0	12	11.4
2010	74.6		0	0.0	0	0.0	3	3.5
2011	67.8		0	0.0	5	5.0	11	11.0
2012	69.5		0	0.0	2	2.3	6	6.9
2013	72.1		0	0.0	0	0.0	4	6.7
2014	71.1		0	0.0	2	2.5	5	6.2
2015	71.0		0	0.0	0	0.0	2	2.2
2016	70.9		1	1.1	1	1.1	6	6.5
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	30	22.6	29	21.8	26	19.5	32	24.1
2008	24	17.9	22	16.4	43	32.1	29	21.6
2009	18	17.1	23	21.9	26	24.8	26	24.8
2010	8	9.4	15	17.6	24	28.2	35	41.2
2011	22	22.0	14	14.0	18	18.0	30	30.0
2012	14	16.1	19	21.8	25	28.7	21	24.1
2013	6	10.0	16	26.7	13	21.7	21	35.0
2014	12	14.8	14	17.3	22	27.2	26	32.1
2015	16	17.6	29	31.9	22	24.2	22	24.2
2016	13	14.0	25	26.9	19	20.4	28	30.1

**Figure 5.2.7c: Average age at death (year) and age distribution (%) among Indians**

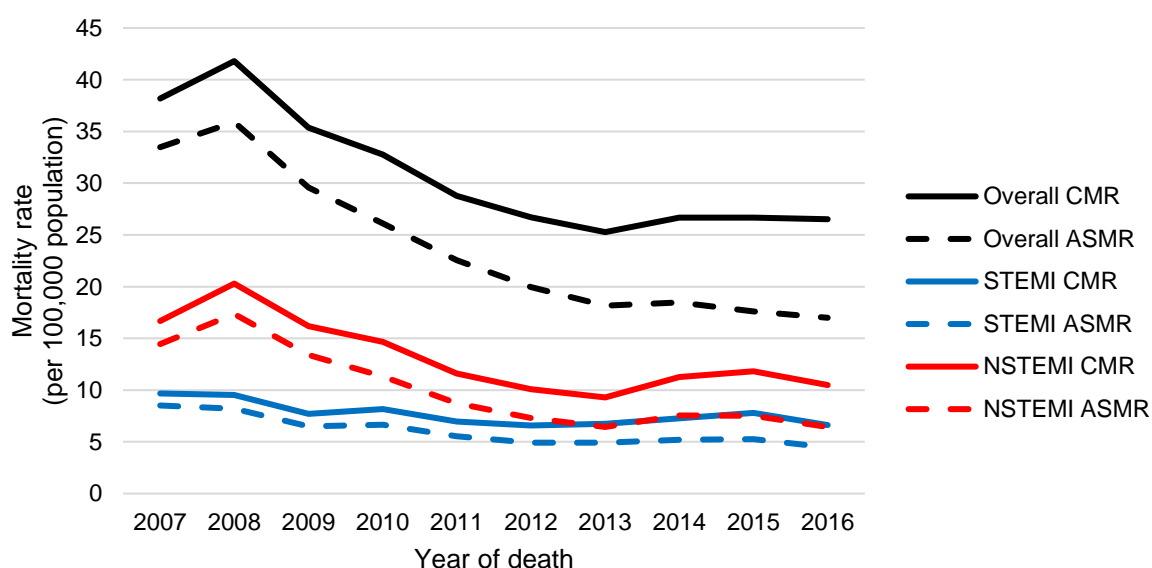


The ASMR among patients with STEMI declined significantly from 8.5 per 100,000 population in 2007 to 4.5 per 100,000 population in 2016 ( $p < 0.001$ ) (Table 5.2.8 and Figure 5.2.8). Similarly, the ASMR among patients with NSTEMI declined significantly from 14.5 per 100,000 population in 2007 to 6.4 per 100,000 population in 2016 ( $p < 0.001$ ). As the ASIR was consistently higher among the NSTEMI patients (Table 5.1.8), the ASMR of patients with NSTEMI was also consistently higher than that of their STEMI counterparts across the years.

**Table 5.2.8: Mortality number and rate (per 100,000 population) by AMI subtype**

STEMI						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
2007	281	25.3	9.7	8.5-10.8	8.5	7.5-9.5
2008	283	22.8	9.5	8.4-10.6	8.2	7.2-9.2
2009	236	21.8	7.7	6.7-8.7	6.5	5.6-7.3
2010	255	25.0	8.2	7.2-9.2	6.6	5.8-7.5
2011	219	24.1	6.9	6.0-7.9	5.5	4.8-6.3
2012	210	24.6	6.6	5.7-7.5	4.9	4.2-5.6
2013	218	26.7	6.8	5.9-7.6	4.9	4.3-5.6
2014	237	27.2	7.3	6.3-8.2	5.2	4.5-5.9
2015	257	29.2	7.8	6.8-8.7	5.3	4.6-5.9
2016	221	25.0	6.6	5.7-7.5	4.5	3.9-5.1
P for trend	-	-	0.014	-	<0.001	-
NSTEMI						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
2007	484	43.6	16.7	15.2-18.2	14.5	13.1-15.8
2008	603	48.6	20.3	18.7-21.9	17.4	15.9-18.8
2009	496	45.8	16.2	14.8-17.6	13.4	12.2-14.6
2010	457	44.8	14.7	13.3-16.0	11.3	10.3-12.4
2011	366	40.4	11.6	10.4-12.8	8.7	7.8-9.6
2012	322	37.8	10.1	9.0-11.2	7.3	6.5-8.1
2013	300	36.8	9.3	8.2-10.3	6.4	5.7-7.2
2014	367	42.2	11.2	10.1-12.4	7.5	6.8-8.3
2015	390	44.3	11.8	10.6-13.0	7.5	6.8-8.3
2016	350	39.5	10.5	9.4-11.6	6.4	5.7-7.1
P for trend	-	-	0.004	-	<0.001	-

**Figure 5.2.8: Mortality rate (per 100,000 population) by AMI subtype**

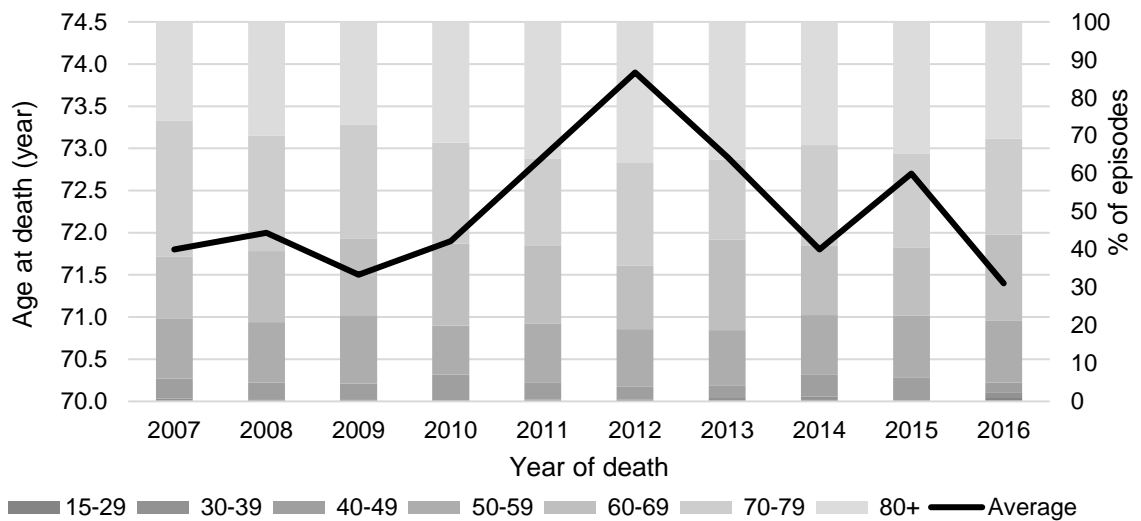


The average age at death ranged from 71 to 74 years among the STEMI patients (Table 5.2.9a and Figure 5.2.9a). The majority of the STEMI patients died at age 70 years or above (25.3% and 30.8% in the 70-79 and 80+ age groups respectively in 2016).

**Table 5.2.9a: Average age at death (year) and age distribution (%) among STEMI**

Year of death	Average age	Age 15-29		Age 30-39		Age 40-49		
		Number	%	Number	%	Number	%	
2007	71.8	0	0.0	2	0.7	15	5.3	
2008	72.0	0	0.0	1	0.4	13	4.6	
2009	71.5	0	0.0	1	0.4	10	4.2	
2010	71.9	0	0.0	0	0.0	18	7.1	
2011	72.9	0	0.0	1	0.5	10	4.6	
2012	73.9	1	0.5	0	0.0	7	3.3	
2013	72.9	0	0.0	2	0.9	7	3.2	
2014	71.8	1	0.4	2	0.8	14	5.9	
2015	72.7	0	0.0	0	0.0	16	6.2	
2016	71.4	2	0.9	3	1.4	6	2.7	
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	44	15.7	46	16.4	101	35.9	73	26.0
2008	45	15.9	53	18.7	86	30.4	85	30.0
2009	42	17.8	48	20.3	71	30.1	64	27.1
2010	33	12.9	55	21.6	68	26.7	81	31.8
2011	34	15.5	45	20.5	50	22.8	79	36.1
2012	32	15.2	35	16.7	57	27.1	78	37.1
2013	32	14.7	52	23.9	46	21.1	79	36.2
2014	37	15.6	43	18.1	63	26.6	77	32.5
2015	42	16.3	46	17.9	64	24.9	89	34.6
2016	36	16.3	50	22.6	56	25.3	68	30.8

**Figure 5.2.9a: Average age at death (year) and age distribution (%) among STEMI**

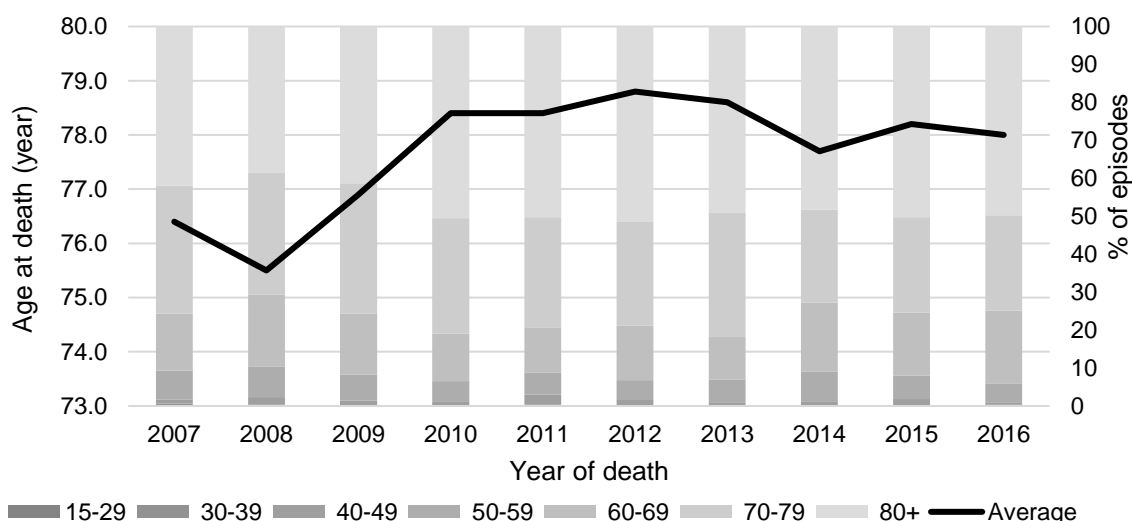


The average age at death ranged from 75 to 79 years among the NSTEMI patients, a few years older than the average age at death among the STEMI patients (Table 5.2.9b and Figure 5.2.9b). The majority of the NSTEMI patients died at age 80 years or above, with 49.7% in this age group in 2016.

**Table 5.2.9b: Average age at death (year) and age distribution (%) among NSTEMI**

Year of death	Average age	Age 15-29		Age 30-39		Age 40-49		
		Number	%	Number	%	Number	%	
2007	76.4	0	0.0	3	0.6	5	1.0	
2008	75.5	0	0.0	2	0.3	12	2.0	
2009	76.9	0	0.0	1	0.2	6	1.2	
2010	78.4	0	0.0	0	0.0	5	1.1	
2011	78.4	0	0.0	1	0.3	10	2.7	
2012	78.8	0	0.0	0	0.0	5	1.6	
2013	78.6	0	0.0	0	0.0	3	1.0	
2014	77.7	0	0.0	0	0.0	4	1.1	
2015	78.2	0	0.0	1	0.3	6	1.5	
2016	78.0	0	0.0	1	0.3	2	0.6	
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2007	37	7.6	73	15.1	163	33.7	203	41.9
2008	49	8.1	114	18.9	194	32.2	231	38.3
2009	34	6.9	80	16.1	170	34.3	205	41.3
2010	25	5.5	57	12.5	139	30.4	231	50.5
2011	21	5.7	44	12.0	106	29.0	184	50.3
2012	17	5.3	46	14.3	88	27.3	166	51.6
2013	18	6.0	34	11.3	98	32.7	147	49.0
2014	29	7.9	67	18.3	90	24.5	177	48.2
2015	24	6.2	65	16.7	98	25.1	196	50.3
2016	18	5.1	67	19.1	88	25.1	174	49.7

**Figure 5.2.9b: Average age at death (year) and age distribution (%) among NSTEMI**



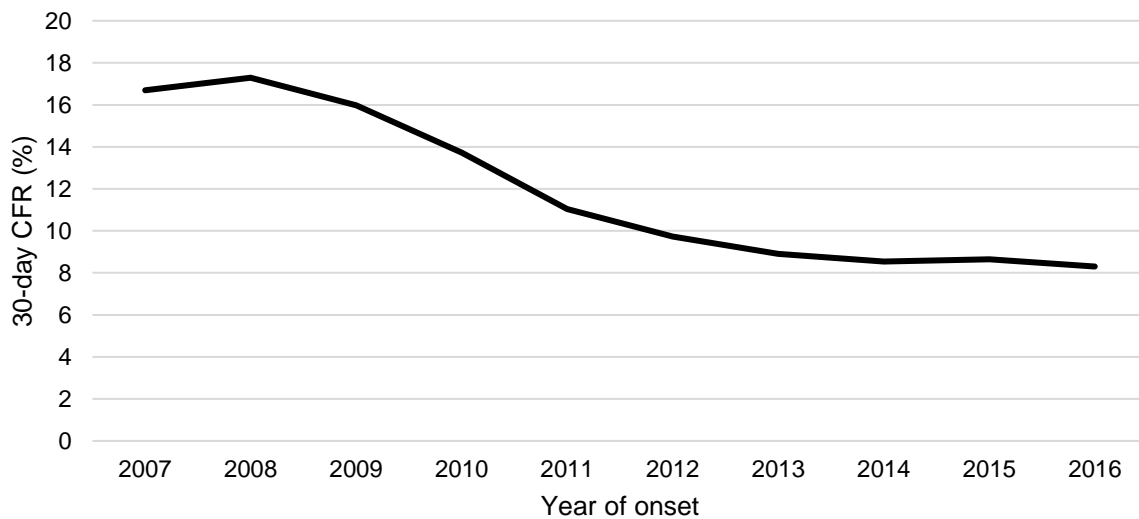
### 5.3 30-Day Case Fatality

The number of AMI deaths within 30 days from onset fell from 1,076 in 2007 to 832 in 2016 (Table 5.3.1 and Figure 5.3.1). Similarly, the CFR decreased significantly from 16.7% in 2007 to 8.3% in 2016 ( $p < 0.001$ ). Advancement in medical technology and skills of the healthcare professionals are likely to have contributed to the decreasing trend in case fatality.

**Table 5.3.1: Case fatality number and rate (%)**

Year of onset	Number	CFR	95% CI
2007	1076	16.7	15.7-17.7
2008	1182	17.3	16.3-18.3
2009	1021	16.0	15.0-17.0
2010	949	13.7	12.9-14.6
2011	830	11.0	10.3-11.8
2012	824	9.7	9.1-10.4
2013	785	8.9	8.3-9.5
2014	783	8.5	7.9-9.1
2015	820	8.7	8.1-9.2
2016	832	8.3	7.7-8.9
P for trend	-	<0.001	-

**Figure 5.3.1: Case fatality rate (%)**



The CFR fell significantly over the years for both genders ( $p < 0.001$  for both) (Table 5.3.2 and Figure 5.3.2). Although the ASMR for men was consistently higher than that for women (Table 5.2.4), the CFR for men was consistently lower than that for women across the years. In 2016, the CFR was 7.3% for men and 10.2% for women. As women tend to have AMI at an older age than men (Tables 5.1.5a and 5.1.5b), they are likely to have more co-morbidities when AMI happened, making them more susceptible to the contraindications of revascularization or decline revascularization. Without revascularization of the blocked arteries, this may lead to higher CFR among women<sup>15</sup>.

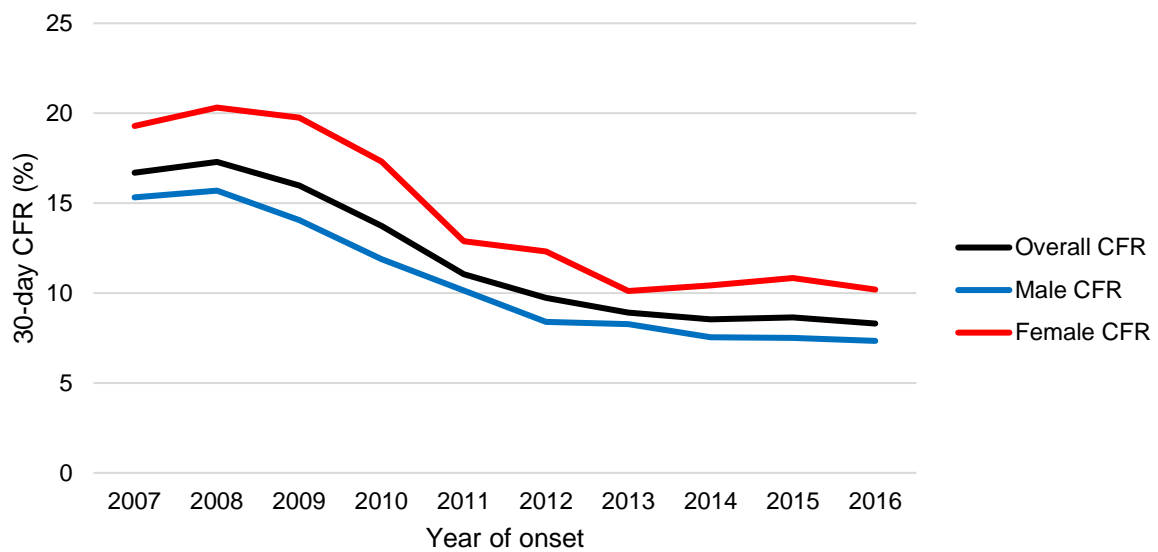
**Table 5.3.2: Case fatality number and rate (%) by gender**

<b>Male</b>				
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CFR</b>	<b>95% CI</b>
<b>2007</b>	646	60.0	15.3	14.1-16.5
<b>2008</b>	702	59.4	15.7	14.5-16.9
<b>2009</b>	596	58.4	14.1	12.9-15.2
<b>2010</b>	543	57.2	11.9	10.9-12.9
<b>2011</b>	509	61.3	10.1	9.3-11.0
<b>2012</b>	468	56.8	8.4	7.6-9.2
<b>2013</b>	473	60.3	8.3	7.5-9.0
<b>2014</b>	454	58.0	7.5	6.9-8.2
<b>2015</b>	464	56.6	7.5	6.8-8.2
<b>2016</b>	486	58.4	7.3	6.7-8.0
<b>P for trend</b>	-	-	<0.001	-
<b>Female</b>				
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CFR</b>	<b>95% CI</b>
<b>2007</b>	430	40.0	19.3	17.5-21.1
<b>2008</b>	480	40.6	20.3	18.5-22.1
<b>2009</b>	425	41.6	19.8	17.9-21.6
<b>2010</b>	406	42.8	17.3	15.6-19.0
<b>2011</b>	321	38.7	12.9	11.5-14.3
<b>2012</b>	356	43.2	12.3	11.0-13.6
<b>2013</b>	312	39.7	10.1	9.0-11.2
<b>2014</b>	329	42.0	10.4	9.3-11.5
<b>2015</b>	356	43.4	10.8	9.7-12.0
<b>2016</b>	346	41.6	10.2	9.1-11.3
<b>P for trend</b>	-	-	<0.001	-

<sup>15</sup> Berger JS et al. Sex differences in mortality following acute coronary syndromes. JAMA 2009; 302(8): 874-882.



**Figure 5.3.2: Case fatality rate (%) by gender**

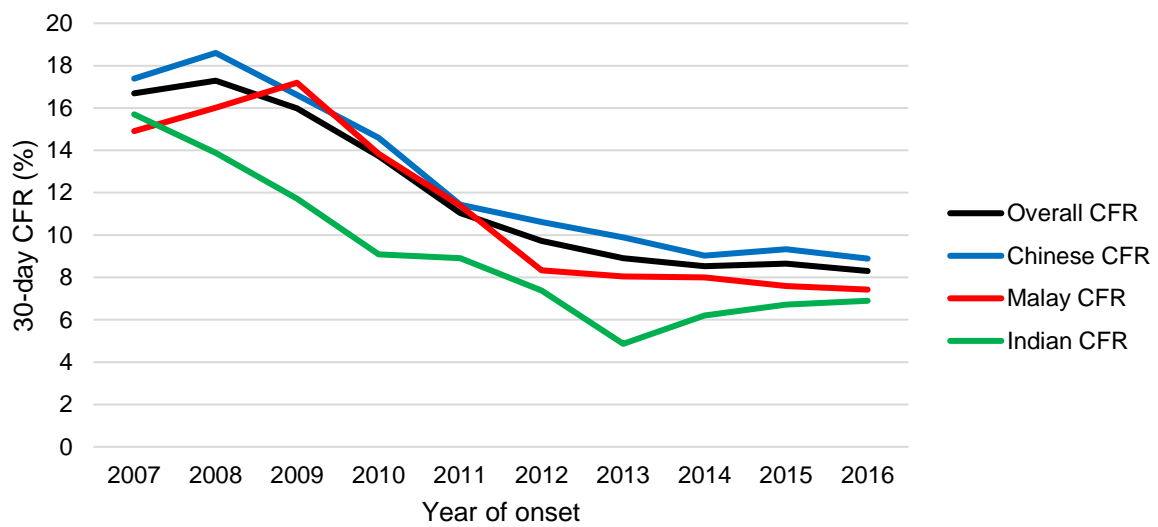


The CFR fell significantly over the years for all the three main ethnic groups ( $p < 0.001$  for Chinese and Malays;  $p = 0.001$  for Indians) (Table 5.3.3 and Figure 5.3.3). Although the Chinese consistently had the lowest ASMR among the three main ethnic groups (Table 5.2.6), they generally had the highest CFR across the years. In 2016, the CFR for the Chinese, Malays and Indians was 8.9%, 7.4% and 6.9% respectively. This is likely due to the Chinese being older at the onset of AMI than the Malays and Indians (Tables 5.1.7a to 5.1.7c), and hence more likely to have more co-morbidities when AMI happened.

**Table 5.3.3: Case fatality number and rate (%) by ethnicity**

<b>Chinese</b>				
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CFR</b>	<b>95% CI</b>
2007	762	70.8	17.4	16.2-18.6
2008	848	71.7	18.6	17.3-19.9
2009	698	68.4	16.6	15.4-17.8
2010	675	71.1	14.6	13.5-15.7
2011	569	68.6	11.4	10.5-12.4
2012	592	71.8	10.6	9.8-11.5
2013	577	73.5	9.9	9.1-10.7
2014	549	70.1	9.0	8.3-9.8
2015	593	72.3	9.3	8.6-10.1
2016	587	70.6	8.9	8.2-9.6
<b>P for trend</b>	-	-	<0.001	-
<b>Malay</b>				
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CFR</b>	<b>95% CI</b>
2007	165	15.3	14.9	12.6-17.2
2008	202	17.1	16.0	13.8-18.2
2009	212	20.8	17.2	14.9-19.5
2010	182	19.2	13.8	11.8-15.9
2011	167	20.1	11.4	9.7-13.1
2012	140	17.0	8.3	6.9-9.7
2013	139	17.7	8.1	6.7-9.4
2014	139	17.8	8.0	6.7-9.3
2015	140	17.1	7.6	6.3-8.9
2016	148	17.8	7.4	6.2-8.6
<b>P for trend</b>	-	-	<0.001	-
<b>Indian</b>				
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CFR</b>	<b>95% CI</b>
2007	130	12.1	15.7	13.0-18.4
2008	128	10.8	13.9	11.5-16.3
2009	102	10.0	11.7	9.4-14.0
2010	80	8.4	9.1	7.1-11.1
2011	88	10.6	8.9	7.0-10.8
2012	80	9.7	7.4	5.8-9.0
2013	54	6.9	4.9	3.6-6.2
2014	73	9.3	6.2	4.8-7.6
2015	77	9.4	6.7	5.2-8.2
2016	88	10.6	6.9	5.5-8.3
<b>P for trend</b>	-	-	0.001	-

**Figure 5.3.3: Case fatality rate (%) by ethnicity**

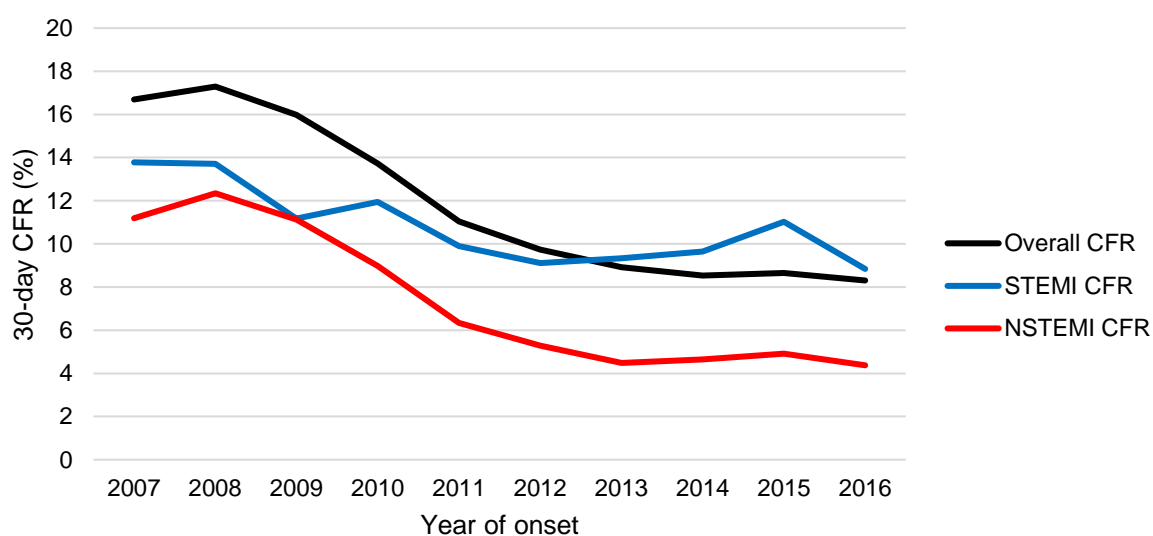


The CFR fell significantly over the years for both STEMI and NSTEMI patients ( $p=0.005$  for STEMI;  $p<0.001$  for NSTEMI) (Table 5.3.4 and Figure 5.3.4). Although patients with STEMI consistently had lower ASMR than patients with NSTEMI (Table 5.2.8), the CFR among patients with STEMI was consistently higher than that among patients with NSTEMI. The CFR for STEMI and NSTEMI patients in 2016 was 8.8% and 4.4% respectively. A plausible reason is that compared to NSTEMI, STEMI is more severe and likely to be fatal if intervention was not provided promptly.

**Table 5.3.4: Case fatality number and rate (%) by AMI subtype**

STEMI				
Year of onset	Number	%	CFR	95% CI
2007	279	25.9	13.8	12.2-15.4
2008	276	23.4	13.7	12.1-15.3
2009	224	21.9	11.2	9.7-12.6
2010	245	25.8	12.0	10.5-13.4
2011	205	24.7	9.9	8.5-11.3
2012	201	24.4	9.1	7.9-10.4
2013	213	27.1	9.3	8.1-10.6
2014	219	28.0	9.6	8.4-10.9
2015	249	30.4	11.0	9.7-12.4
2016	207	24.9	8.8	7.6-10.0
P for trend	-	-	0.005	-
NSTEMI				
Year of onset	Number	%	CFR	95% CI
2007	453	42.1	11.2	10.2-12.2
2008	549	46.4	12.3	11.3-13.4
2009	444	43.5	11.1	10.1-12.2
2010	397	41.8	9.0	8.1-9.9
2011	306	36.9	6.3	5.6-7.0
2012	306	37.1	5.3	4.7-5.9
2013	273	34.8	4.5	4.0-5.0
2014	303	38.7	4.6	4.1-5.2
2015	338	41.2	4.9	4.4-5.4
2016	316	38.0	4.4	3.9-4.9
P for trend	-	-	<0.001	-

**Figure 5.3.4: Case fatality rate (%) by AMI subtype**

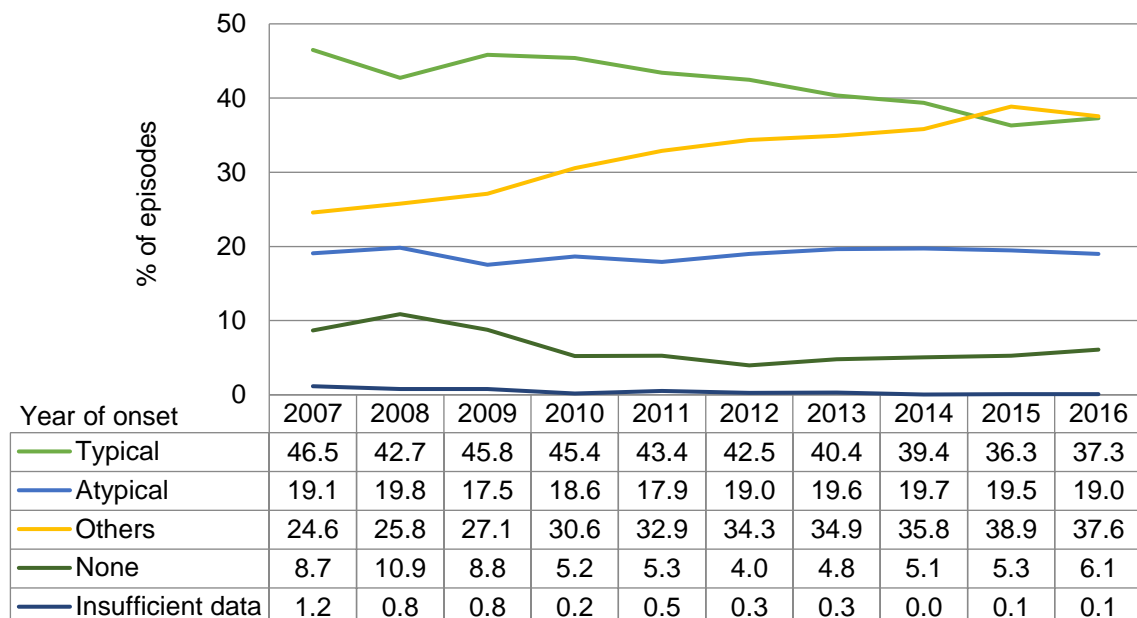


## 5.4 Symptoms

Clinical presentation has consequences on triage categorization at the Emergency Department, prescription of diagnostic tests and disease management. Symptoms of AMI are considered to be typical when chest pain was present or if the pain was described as feeling of tightness, pressure or protracted, and characterized by a duration of at least 20 minutes. Atypical symptoms are defined as presence of chest pain of short duration, intermittent with each bout lasting for less than 20 minutes or pain at unusual sites such as upper abdomen, arm, jaw and neck. Symptoms are classified as others when they were well described, but did not satisfy the criteria for typical or atypical. It includes symptoms due to a definite non-cardiac cause, a definite non-atherosclerotic cardiac cause and collapse, whereby patients complained of symptoms before death. Data are deemed to be insufficient when symptoms were not stated in the case notes or electronic medical records, or lacking in details such as description and duration of symptoms.

Most of the patients experienced typical symptoms of AMI in earlier years (Figure 5.4.1). However, symptoms that were neither typical nor atypical became almost as common in later years. The proportion of patients with typical symptoms dropped from 46.5% in 2007 to 37.3% in 2016. The proportion of patients with other symptoms that were neither typical nor atypical, rose from 24.6% in 2007 to 37.6% in 2016. STEMI patients are likely to have typical symptoms, whereas NSTEMI patients tend to have non-typical symptoms<sup>16</sup>. Hence, the drop in proportion of patients with typical symptoms is largely attributed to the drop in proportion of STEMI patients over the years (Table 5.1.8).

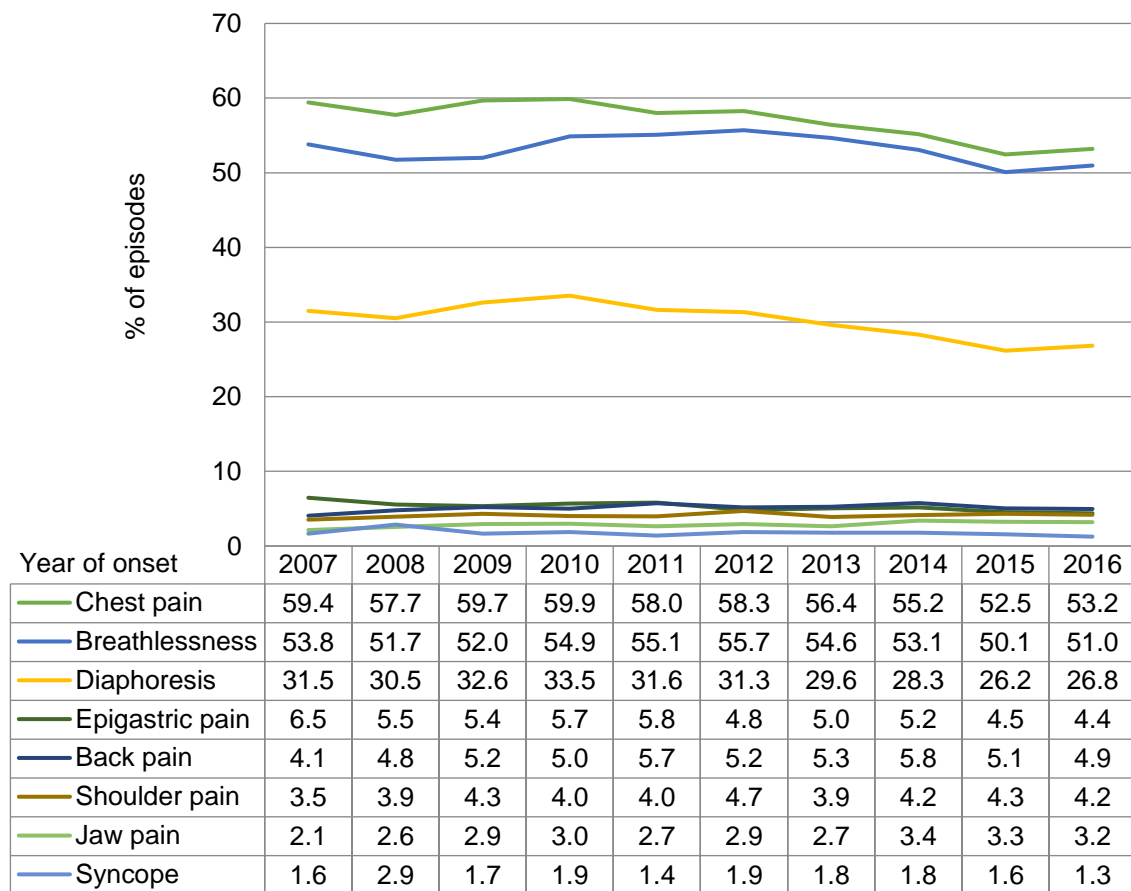
**Figure 5.4.1: Types of symptoms (%)**



<sup>16</sup> Kirchberger I et al. Patient-reported symptoms in acute myocardial infarction: differences related to ST-segment elevation. *Journal of Internal Medicine* 2011; 270(1): 58-64.

Consistently over the years, the common presenting symptoms of AMI were chest pain, breathlessness and diaphoresis. While about half of the patients had chest pain (53.2%) and breathlessness (51.0%) accompanying the onset of AMI in 2016, about a quarter of them (26.8%) had diaphoresis (Figure 5.4.2). The proportions of patients who showed these symptoms dropped slightly every year from 2012 onwards. Since STEMI patients are likely to experience typical symptoms such as chest pain compared to NSTEMI patients, the drop in proportion of STEMI patients had led to a drop in proportions of patients who encountered chest pain, breathlessness and diaphoresis in recent years. As a patient could have multiple symptoms, the percentages in Figure 5.4.2 will not add up to 100% for each year.

**Figure 5.4.2: Presenting symptoms (%)**



## 5.5 Risk Factors

Hypertension, hyperlipidemia, diabetes, smoking and obesity are well established modifiable risk factors of AMI<sup>17</sup>. Hypertension, hyperlipidemia and diabetes are defined as positive if there was a past medical history of the condition or if it was newly diagnosed during index admission. Obesity refers to body mass index (BMI) of 23 kg/m<sup>2</sup> or above as increased risk for cardiovascular disease and diabetes is found among Asian populations with such BMI<sup>18</sup>. Smoking includes former and current smoker on admission. Past AMI or revascularization includes history of AMI and history of coronary artery bypass graft or percutaneous coronary intervention (PCI) done for any heart disease.

Hypertension and hyperlipidemia were consistently the two most common risk factors among the AMI patients across the years (Figure 5.5.1). In 2016, 75.0% of the patients had hypertension and 71.6% of them had hyperlipidemia. Since 2009, the proportions of patients with hypertension and hyperlipidemia increased slightly. The proportion of patients who smoked decreased slightly since 2009, while those with diabetes, obesity and history of AMI or revascularization fluctuated slightly over time.

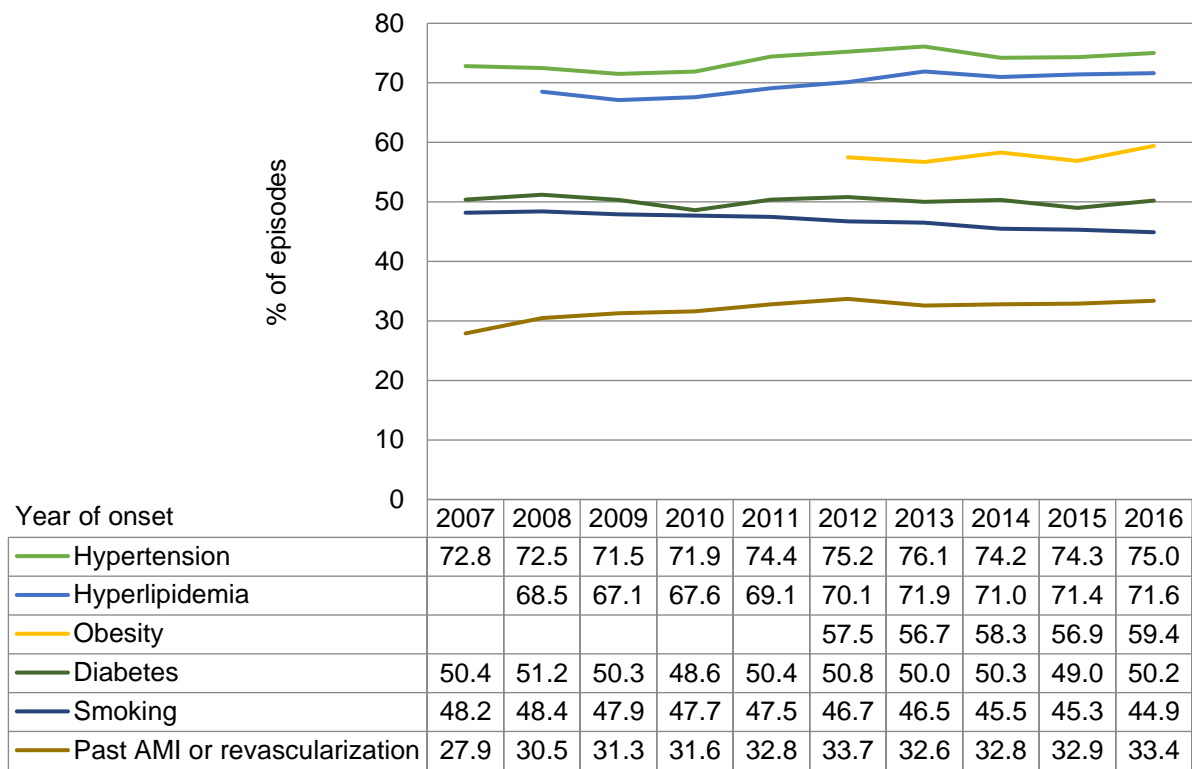
Due to a change in the Registry's definition of hyperlipidemia in 2008, the proportion of patients with hyperlipidemia in 2007 is not shown in Figure 5.5.1. As BMI had relatively more unknown values than the other risk factors due to unknown weight, unknown height, or both, obesity is also not shown in Figure 5.5.1 for earlier years, where the completeness of BMI was less than 80%. As a patient could have multiple risk factors, the percentages in Figure 5.5.1 will not add up to 100% for each year.

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<sup>17</sup> Salim Y et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet* 2014; 364: 937-952.

<sup>18</sup> WHO expert consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004; 363: 157-163.

**Figure 5.5.1: Risk factors (%)**





## 5.6 Door-to-balloon Time

Door-to-balloon (DTB) time refers to the time from the first medical contact to the first device of primary PCI. The timeliness of hospitals in treating STEMI through primary PCI is indicated by the DTB time. Imprecise recording of the first medical contact time and the first device time by the hospitals will affect the accuracy of DTB time. The targeted DTB time recommended by the American Heart Association is within 90 minutes<sup>19</sup>.

Patients that were admitted for a non-AMI condition but developed AMI during hospitalization, patients that were transferred to another hospital, and patients that experienced non-system delays<sup>20</sup>, were excluded from the calculation of DTB time. These exclusion criteria were applied as the DTB time would be abnormally short or long under such scenarios and hence the inclusion of them would skew the numbers.

The median DTB time improved from 95 (interquartile range, IQR 72 – 124) minutes in 2007 to 55 (IQR 44 – 68) minutes in 2016 (Figure 5.6.1). The proportion of STEMI with DTB time of 90 minutes or less improved from 45.5% in 2007 to 94.3% in 2016. This improvement was largely driven by the efficiency in the healthcare delivery system comprising of the early response teams and the hospitals.

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<sup>19</sup> Antman EM et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to revise the 1999 guidelines for the management of patients with acute myocardial infarction). *Journal of American College of Cardiology* 2004; 94: 722-774.

<sup>20</sup> The SMIR only started collecting this variable from 2012 onwards.

Non-system delay refers to delay in doing primary PCI due to patient's condition. It includes: unfit for primary PCI at the point of hospital arrival (indicated by cardiopulmonary resuscitation, direct current shock, cardiogenic shock, deterioration before or during primary PCI), requirement for other procedure or test prior to primary PCI, equivocal ECG, late presentation, delayed consent.

System delay refers to delay in doing primary PCI due to hospital's system. It includes: delay in the process leading to the start of primary PCI, CATH laboratory being occupied, procedure difficulty, uptriaged case, missed diagnosis, unknown reason.

**Figure 5.6.1: DTB time by mode of arrival among STEMI**

