Singapore Myocardial Infarction Registry Annual Report 2018

National Registry of Diseases Office
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Acknowledgement

This report was produced with joint efforts from the following staff of National Registry of Diseases Office.

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1. GLOSSARY

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

2. EXECUTIVE SUMMARY

The number of acute myocardial infarction (AMI) episodes increased from 6,796 episodes in 2009 to 11,887 episodes in 2018. The age-standardised incidence rate (ASIR) increased significantly from 189.4 to 225.8 per 100,000 population during this period.

The number of AMI deaths was 910 in 2018, a drop compared to 1,084 in 2009. The age-standardised mortality rate (ASMR) declined significantly from 29.6 to 15.9 per 100,000 population during this period. The number of AMI deaths within 30 days from onset fell from 1,021 in 2009 to 842 in 2018. The 30-day case fatality rate (CFR) decreased significantly from 16.0% in 2009 to 7.6% in 2018.

The three most common presenting symptoms of AMI were chest pain, breathlessness and diaphoresis consistently across the years. While about half of the patients had chest pain (52.8%) and breathlessness (51.0%) accompanying onset of AMI in 2018, about a quarter of them (23.0%) had diaphoresis. The proportions of patients with chest pain and diaphoresis dropped gradually over the years, while the proportion with breathlessness remained stable.

Hypertension and hyperlipidemia were the two most common risk factors among AMI patients consistently across the years. 74.8% of the patients had hypertension and 72.7% had hyperlipidemia in 2018. The proportions of patients with hypertension and hyperlipidemia rose slightly over the years.

The median door-to-balloon (DTB) time improved from 69 minutes in 2009 to 51 minutes in 2018. The proportion of ST-segment elevation myocardial infarction (STEMI) patients with DTB time of 90 minutes or less improved from 74.7% in 2009 to 95.2% in 2018. The median DTB time was consistently shorter for STEMI patients who utilised the Singapore Civil Defence Force (SCDF) ambulance (45 minutes in 2018) than those who relied on other modes of transport (61 minutes in 2018) across the years. The proportion of STEMI patients with DTB time of 90 minutes or less was consistently higher among those who arrived at the hospital via the SCDF ambulance (97.6% in 2018) than those who arrived via other modes of transport (92.1% in 2018) across the years.

3. INTRODUCTION

Ischaemic heart disease was the third most common cause of death in 2018, accounting for 18.1% of all deaths in Singapore[1]. 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 revascularisation of the blocked arteries, coupled with pharmacotherapy, are the recommended treatment for AMI. There are two main types of AMI - STEMI and NSTEMI. STEMI is more severe, while NSTEMI is more prevalent.

Singapore's population is rapidly ageing. The old-age support ratio dropped from 7.5 people aged 20 to 64 years per person aged 65 years and above in 2009 to 4.8 in 2018[2]. Common risk factors of AMI are hypertension, hyperlipidemia, diabetes, obesity, smoking and old age. With a rapidly ageing population, we can expect the incidence of AMI to rise. In order to mitigate the impact of AMI, preventive measures that reduce cardiovascular risk, as well as post-AMI interventions that improve prognosis and reduce recurrence risk, are essential.

[1] Principal Causes of Death. Ministry of Health, Singapore.
[2] SingStat Population Trends. Department of Statistics, Singapore.

4. METHODOLOGY

The National Registry of Diseases Office (NRDO) collects and analyses epidemiological data to support policy planning and programme evaluation.

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, 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 are certified by the general practitioners in Singapore. Legislation mandated notification from all healthcare institutions since September 2012.

Data sources

The SMIR receives AMI case notifications from

1. All healthcare institutions via the Hospital In-patient Discharge Summary and the cardiac biomarkers list,
2. MOH via the Mediclaims list and Casemix & Subvention list, and
3. Death Registry of the Ministry of Home Affairs (MHA) via the death list.

The International Classification of Diseases 9th Revision (ICD-9) Clinical Modification code 410 was used to identify AMI cases in the data sources prior to 2012, while the ICD-10 Australian Modification codes I21 and I22 were used for AMI cases diagnosed from 2012 onwards. A master patient list was created by merging data from these sources using the patients' unique National Registration Identification Card (NRIC) number.

The registry coordinators confirmed the diagnosis of AMI by viewing the patients' medical records, before extracting relevant detailed clinical information from the medical records at the healthcare institutions. All cases collected by the SMIR were diagnosed as AMI by a certified doctor, accompanied by symptoms of AMI, raised cardiac biomarkers or abnormal electrocardiogram (ECG).

The MONICA (Monitoring Trends and Determinants in Cardiovascular Disease) criterion was used for episode management, whereby a recurring AMI after 28 days of a preceding episode will be counted as another episode[3].

The death status of all patients registered in the SMIR were updated till 31 July 2019 by matching the patients' NRIC number with the death information from the MHA.

[3] Tunstall-Pedoe H et al. Myocardial infarction and coronary deaths in the World Health Organisation MONICA project. Circulation 1994; 90: 583-612.

Population estimate

The Singapore population estimates used to calculate the incidence rates and mortality rates 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[4]. The Segi World population estimates used for age standardisation are available on the World Health Organisation website[5].

Incidence rate

The incidence rate in each year was calculated 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 categorised into 5-year age groups and age standardisation was done using the direct method with the Segi World population as the standardisation weights.

Mortality rate

The mortality rate in each year was calculated 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 categorised into 5-year age groups and age standardisation was done using the direct method with the Segi World population as the standardisation weights.

Case fatality rate

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

This report focuses on Singapore residents, aged 15 years and above, diagnosed with AMI in the past decade, from 2009 to 2018 as they stood on 4 October 2019. All findings in this report, except mortality and case fatality, were based on episodes.

[4] SingStat Table Builder, Population and Population Structure, Annual Population, Singapore Residents by age group, ethnic group and sex. Department of Statistics, Singapore.
[5] 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

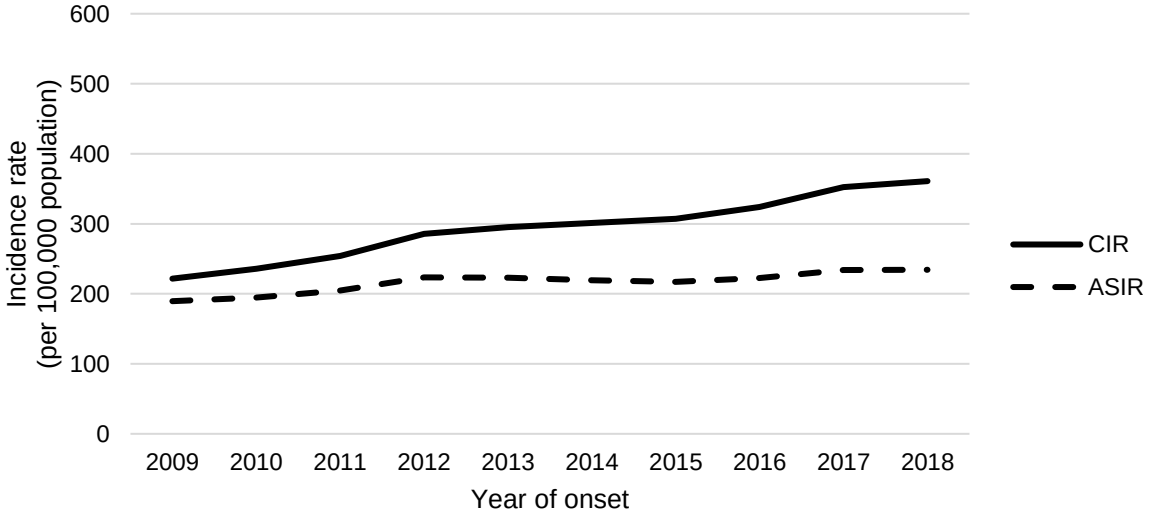
5.1 Incidence

The number of AMI episodes increased from 6,796 episodes in 2009 to 11,887 episodes in 2018 (Table 5.1.1). Similarly, the crude incidence rate (CIR) increased significantly from 221.6 per 100,000 population in 2009 to 349.3 per 100,000 population in 2018 (p<0.001) (Figure 5.1.1). Taking into account Singapore's ageing population, the ASIR also increased significantly from 189.4 per 100,000 population in 2009 to 225.8 per 100,000 population in 2018 (p=0.002).

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

Year of onset	Number	CIR	95% CI	ASIR	95% CI
2009	6796	221.6	216.4-226.9	189.4	184.9-194.0
2010	7344	235.6	230.2-241.0	194.5	190.0-199.1
2011	8014	254.2	248.7-259.8	204.7	200.1-209.3
2012	9122	285.8	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	9833	301.4	295.4-307.3	219.3	214.9-223.7
2015	10131	307.0	301.0-313.0	217.2	212.8-221.5
2016	10813	324.0	317.9-330.1	222.5	218.2-226.8
2017	11948	354.4	348.0-360.8	235.0	230.7-239.3
2018	11887	349.3	343.0-355.6	225.8	221.7-230.0
P for trend	-	<0.001	-	0.002	-

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



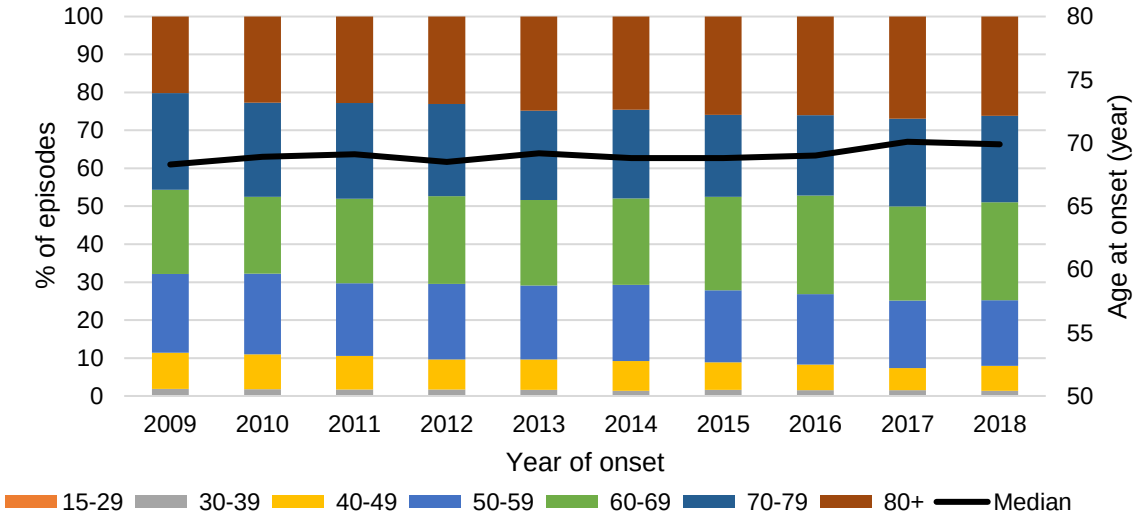
The median age at onset of AMI ranged from 68.3 to 70.1 years in the past decade (Table 5.1.2). About 3 in 4 of the patients were aged 60 years and above in 2018 (Figure 5.1.2).

Table 5.1.2: Age distribution at onset of AMI

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	68.3	13	0.2	112	1.6	649	9.5
2010	68.9	12	0.2	118	1.6	676	9.2
2011	69.1	13	0.2	126	1.6	709	8.8
2012	68.5	15	0.2	139	1.5	725	7.9
2013	69.2	13	0.1	139	1.5	765	8.0
2014	68.8	11	0.1	126	1.3	768	7.8
2015	68.8	13	0.1	148	1.5	742	7.3
2016	69.0	16	0.1	154	1.4	727	6.7
2017	70.1	16	0.1	162	1.4	700	5.9
2018	69.9	15	0.1	132	1.1	762	6.4

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2009	1410	20.7	1508	22.2	1735	25.5	1369	20.1
2010	1563	21.3	1484	20.2	1826	24.9	1665	22.7
2011	1536	19.2	1784	22.3	2016	25.2	1830	22.8
2012	1817	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	2240	22.8	2297	23.4	2419	24.6
2015	1922	19.0	2489	24.6	2189	21.6	2628	25.9
2016	2004	18.5	2814	26.0	2284	21.1	2814	26.0
2017	2116	17.7	2963	24.8	2767	23.2	3224	27.0
2018	2031	17.1	3019	25.4	2736	23.0	3192	26.9

Figure 5.1.2: Age distribution at onset of AMI



The age-specific incidence rate increased with age, with the oldest age group having the highest incidence rate (Figure 5.1.3a). Over the past decade, significant rise in incidence rates were observed for all age groups between 30 to 69 years, as well as those aged 80 years and above (Table 5.1.3). The rise in incidence rate was fastest among those aged 80 years and above (Figure 5.1.3b).

Table 5.1.3: Age-specific incidence rate of AMI (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
2009	221.6	216.4-226.9	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	248.7-259.8	1.7	0.8-2.6	20.5	16.9-24.1	112.4	104.2-120.7
2012	285.8	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	301.4	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	324.0	317.9-330.1	2.0	1.0-3.1	26.2	22.1-30.4	118.3	109.7-126.9
2017	354.4	348.0-360.8	2.0	1.0-3.0	27.9	23.6-32.2	113.8	105.4-122.3
2018	349.3	343.0-355.6	1.9	1.0-2.9	22.6	18.7-26.4	124.6	115.8-133.5
P for trend	<0.001	-	0.130	-	0.004	-	0.012	-
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
2009	262.4	248.7-276.1	527.5	500.8-554.1	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	2406.1	2290.5-2521.6
2011	270.1	256.6-283.6	556.6	530.8-582.5	1207.9	1155.2-1260.6	2500.0	2385.5-2614.5
2012	312.1	297.7-326.4	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	570.4	546.8-594.0	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	325.8	311.5-340.0	625.5	602.4-648.6	1191.1	1142.3-1240.0	2877.3	2771.0-2983.6
2017	344.3	329.7-359.0	635.0	612.1-657.9	1308.6	1259.8-1357.4	3183.4	3073.5-3293.3
2018	331.1	316.7-345.5	624.0	601.8-646.3	1195.4	1150.6-1240.2	2986.5	2882.9-3090.1
P for trend	<0.001	-	0.003	-	0.353	-	<0.001	-

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

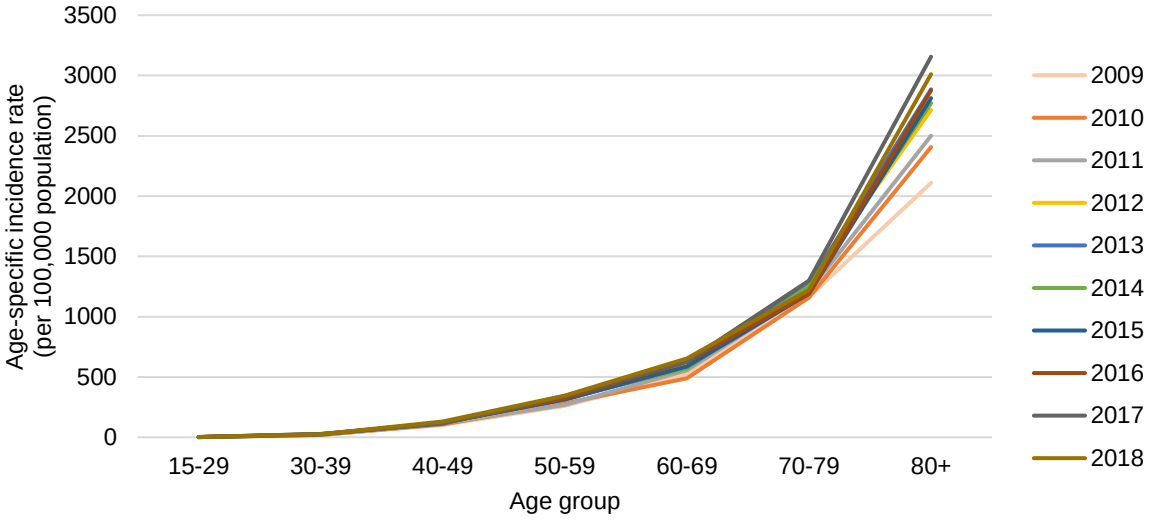
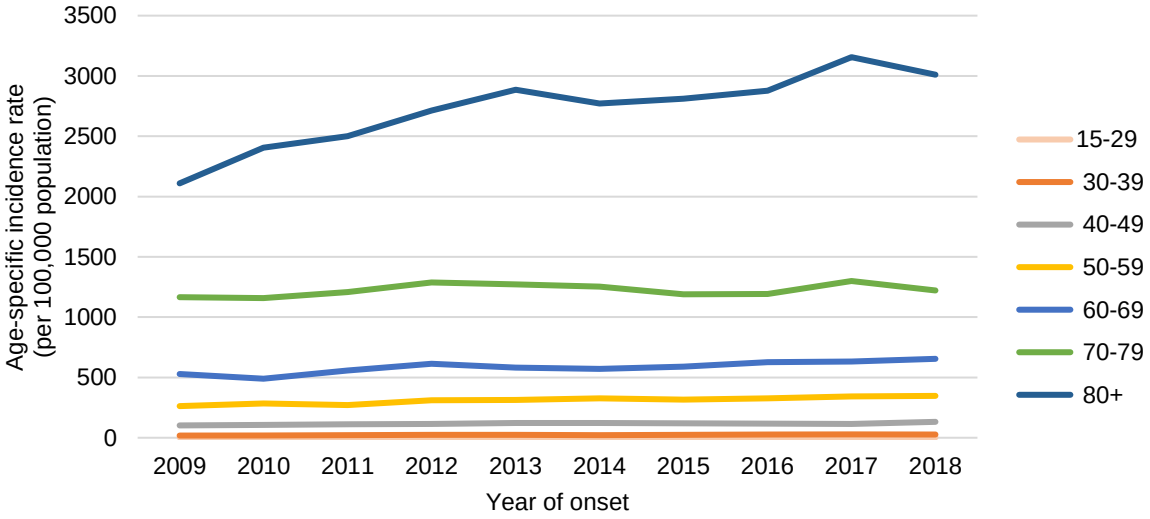


Figure 5.1.3b: Age-specific incidence rate of AMI (per 100,000 population) across years



Although the gender distribution was almost equal in the general population, there were more males suffering from AMI than females (Table 5.1.4). The ASIR for males was consistently higher than females across the years (Figure 5.1.4). Males had an ASIR of 337.1 per 100,000 population, while females had an ASIR of 124.2 per 100,000 population in 2018. The rise in ASIR over the years was significant for males ($p<0.001$) but not for females ($p=0.095$).

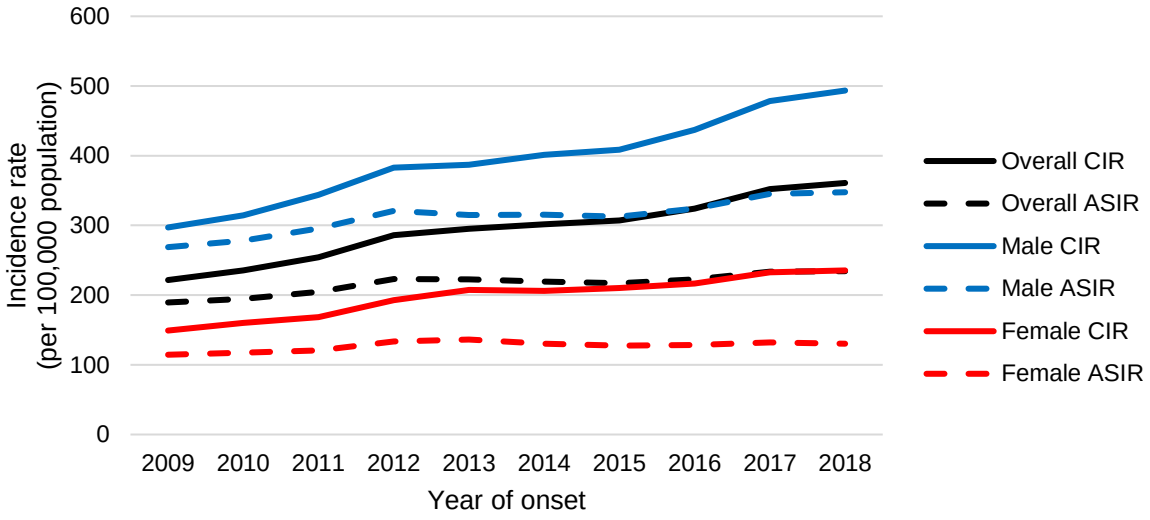
Males were known to have higher risk of AMI compared to females. The underlying causes were multifactorial and related to the pathophysiological gender differences in AMI[6]. Furthermore, the prevalence of hypertension, hyperlipidemia, diabetes and smoking were higher among males than females in the general population as shown in the National Population Health Survey 2017[7].

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

Male						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2009	4464	65.7	297.1	288.4-305.8	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	6105	64.1	387.1	377.4-396.8	314.8	306.9-322.8
2014	6389	65.0	401.2	391.4-411.1	315.3	307.5-323.1
2015	6580	64.9	408.8	398.9-418.7	312.7	305.0-320.3
2016	7104	65.7	436.9	426.8-447.1	324.2	316.6-331.9
2017	7889	66.0	480.9	470.2-491.5	346.5	338.8-354.2
2018	7936	66.8	479.7	469.2-490.3	337.1	329.6-344.6
P for trend	-	-	<0.001	-	<0.001	-
Female						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2009	2332	34.3	149.2	143.1-155.2	114.5	109.7-119.3
2010	2545	34.7	160.0	153.8-166.2	117.2	112.5-122.0
2011	2709	33.8	168.3	162.0-174.6	120.7	116.0-125.5
2012	3147	34.5	192.9	186.2-199.7	133.6	128.8-138.5
2013	3426	35.9	207.4	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	3709	34.3	216.7	209.7-223.7	128.6	124.3-132.9
2017	4059	34.0	234.5	227.3-241.7	133.3	129.0-137.5
2018	3951	33.2	225.9	218.9-233.0	124.2	120.2-128.3
P for trend	-	-	<0.001	-	0.095	-

[6] Mehta LS et al. Acute myocardial infarction in women. Circulation 2016; 133.
[7] National Population Health Survey 2017. Ministry of Health, Singapore.

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

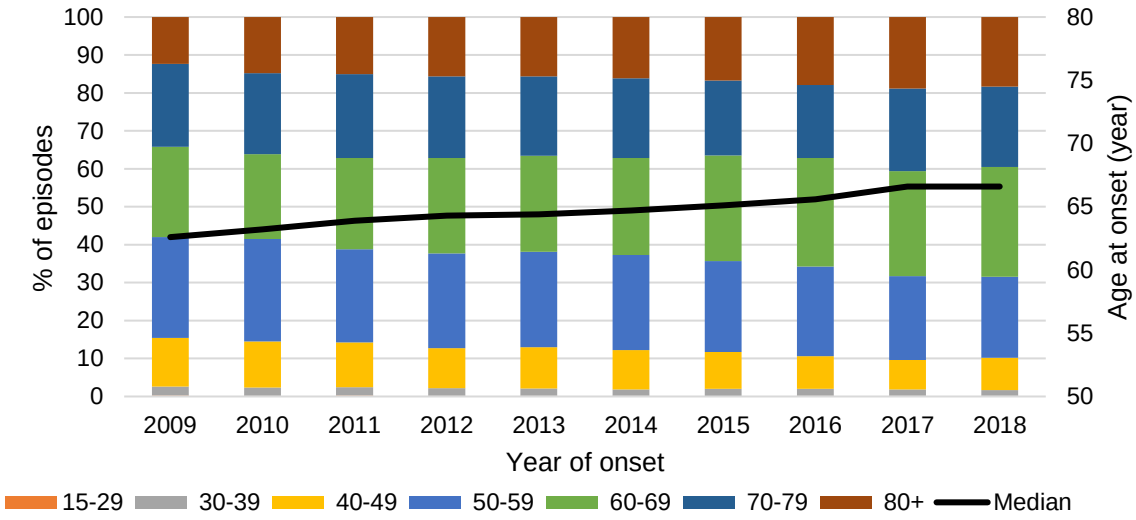


The median age at onset of AMI among males increased from 62.6 years in 2009 to 66.6 years in 2018 (Table 5.1.5a). The highest proportion of AMI episodes was found among males aged 60-69 years (28.4%) in 2018 (Figure 5.1.5a).

Table 5.1.5a: Age distribution at onset of AMI among males

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	62.6	10	0.2	105	2.4	573	12.8
2010	63.2	9	0.2	105	2.2	584	12.2
2011	63.9	12	0.2	116	2.2	627	11.8
2012	64.3	11	0.2	120	2.0	632	10.6
2013	64.4	10	0.2	121	2.0	661	10.8
2014	64.7	10	0.2	110	1.7	664	10.4
2015	65.1	8	0.1	126	1.9	637	9.7
2016	65.6	11	0.2	133	1.9	613	8.6
2017	66.6	14	0.2	134	1.7	607	7.7
2018	66.6	12	0.2	112	1.4	657	8.3
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2009	1188	26.6	1060	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	1546	25.3	1277	20.9	956	15.7
2014	1599	25.0	1631	25.5	1342	21.0	1033	16.2
2015	1575	23.9	1834	27.9	1298	19.7	1102	16.7
2016	1675	23.6	2036	28.7	1365	19.2	1271	17.9
2017	1740	22.1	2181	27.6	1715	21.7	1498	19.0
2018	1680	21.2	2256	28.4	1710	21.5	1509	19.0

Figure 5.1.5a: Age distribution at onset of AMI among males



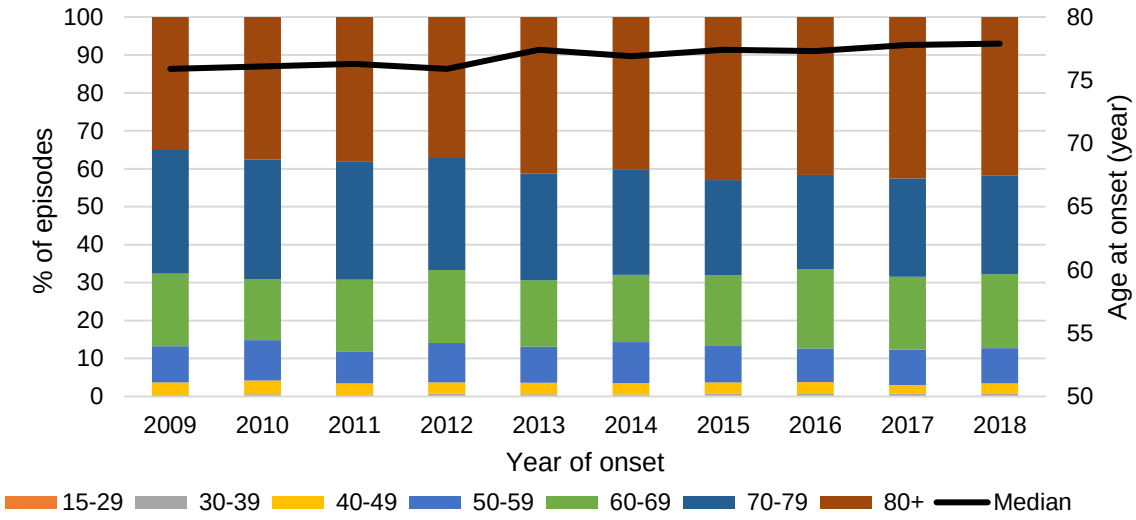
The median age at onset of AMI among females ranged from 75.9 to 77.9 years in the past decade (Table 5.1.5b), about 10 years older than the median age at onset among males (Table 5.1.5a). The highest proportion of AMI episodes was found among females aged 80 years and above (42.6%) in 2018 (Figure 5.1.5b).

Table 5.1.5b: Age distribution at onset of AMI among females

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	75.9	3	0.1	7	0.3	76	3.3
2010	76.1	3	0.1	13	0.5	92	3.6
2011	76.3	1	0.0	10	0.4	82	3.0
2012	75.9	4	0.1	19	0.6	93	3.0
2013	77.4	3	0.1	18	0.5	104	3.0
2014	76.9	1	0.0	16	0.5	104	3.0
2015	77.4	5	0.1	22	0.6	105	3.0
2016	77.3	5	0.1	21	0.6	114	3.1
2017	77.8	2	0.0	28	0.7	93	2.3
2018	77.9	3	0.1	20	0.5	105	2.7

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2009	222	9.5	448	19.2	759	32.5	817	35.0
2010	270	10.6	410	16.1	801	31.5	956	37.6
2011	230	8.5	511	18.9	842	31.1	1033	38.1
2012	327	10.4	607	19.3	927	29.5	1170	37.2
2013	325	9.5	599	17.5	964	28.1	1413	41.2
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	329	8.9	778	21.0	919	24.8	1543	41.6
2017	376	9.3	782	19.3	1052	25.9	1726	42.5
2018	351	8.9	763	19.3	1026	26.0	1683	42.6

Figure 5.1.5b: Age distribution at onset of AMI among females



Although the ethnic distribution of the AMI patients was similar to the ethnic distribution of the general population (Table 5.1.6), Chinese consistently had the lowest across the years (Figure 5.1.6). The ASIRs were 180.7, 442.6 and 429.2 per 100,000 population for Chinese, Malays and Indians respectively in 2018. The rise in ASIR over the years was significant for all the three ethnic groups (Chinese: p=0.001, Malays: p=0.013, Indians: p=0.020).

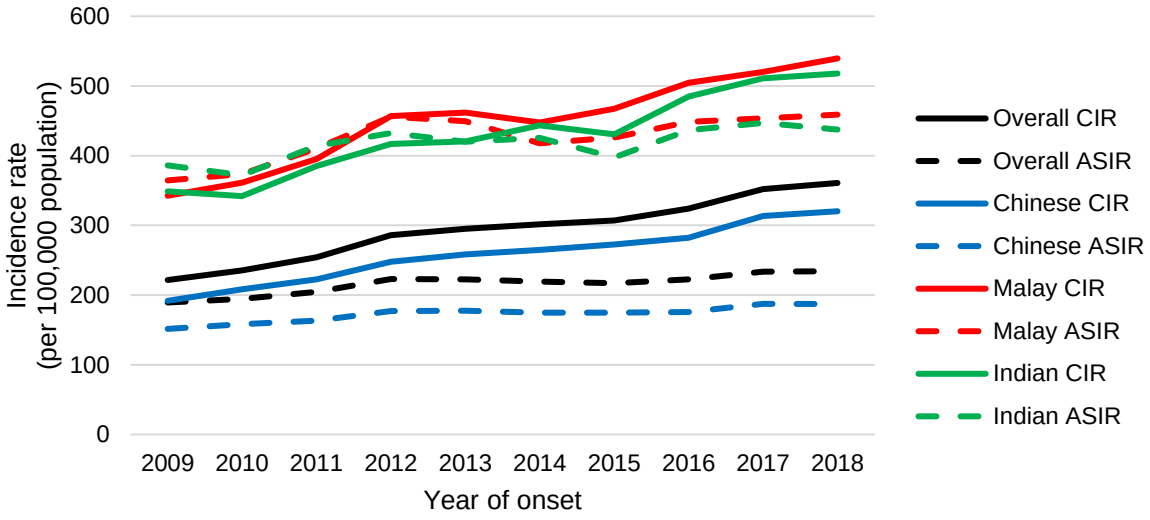
The prevalence of hypertension, high low-density lipoprotein cholesterol, obesity and smoking were higher among Malays, relative to Chinese and Indians in the general population as shown by the National Health Survey 2010[8]. Although the prevalence of hypertension among Indians were lower than Chinese, the prevalence of diabetes among Indians was higher than Chinese. Furthermore, Indians have ethnic-specific risk for coronary artery disease[9]. The high prevalence of AMI risk factors among Malays and the combination of AMI risk factors in the backdrop of genetic predisposition to coronary artery disease among Indians were likely the reasons for their higher ASIR, relative to Chinese.

[8] National Health Survey 2010. Ministry of Health, Singapore.
[9] Zheng H et al. Ethnic differences and trends in ST-segment elevation myocardial infarction incidence and mortality in a multi-ethnic population. Annuals Academy of Medicine Singapore. 2019; 48: 75-85.

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

Chinese						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2009	4453	65.5	191.8	186.2-197.4	151.5	147.0-156.0
2010	4906	66.8	208.3	202.4-214.1	158.2	153.7-162.7
2011	5296	66.1	222.4	216.4-228.4	163.4	158.9-167.9
2012	5981	65.6	248.0	241.8-254.3	176.9	172.3-181.5
2013	6308	66.2	258.6	252.2-265.0	177.5	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	7118	65.8	282.4	275.8-289.0	175.6	171.4-179.8
2017	8036	67.3	315.7	308.8-322.6	188.5	184.3-192.8
2018	7983	67.2	310.7	303.9-317.5	180.7	176.6-184.8
P for trend	-	-	<0.001	-	0.001	-
Malay						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2009	1316	19.4	342.6	324.1-361.1	364.6	344.2-384.9
2010	1415	19.3	361.4	342.8-380.5	373.8	353.5-394.0
2011	1569	19.6	395.1	375.6-414.7	410.6	389.5-431.7
2012	1843	20.2	457.3	436.4-478.2	456.3	434.9-477.7
2013	1889	19.8	462.1	441.2-482.9	449.3	428.6-470.0
2014	1855	18.9	447.5	427.1-467.9	417.9	398.5-437.3
2015	1964	19.4	467.5	446.8-488.2	426.2	407.0-445.5
2016	2147	19.9	504.2	482.9-525.5	448.2	428.9-467.6
2017	2255	18.9	523.4	501.8-545.0	456.1	437.0-475.2
2018	2269	19.1	521.3	499.8-542.7	442.6	424.2-461.0
P for trend	-	-	<0.001	-	0.013	-
Indian						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
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	1164	12.8	417.4	393.4-441.3	432.5	407.0-458.0
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	1399	12.9	485.0	459.6-510.4	436.4	413.2-459.6
2017	1496	12.5	513.6	487.5-539.6	449.2	426.3-472.2
2018	1498	12.6	509.4	483.6-535.2	429.2	407.4-451.0
P for trend	-	-	<0.001	-	0.020	-

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



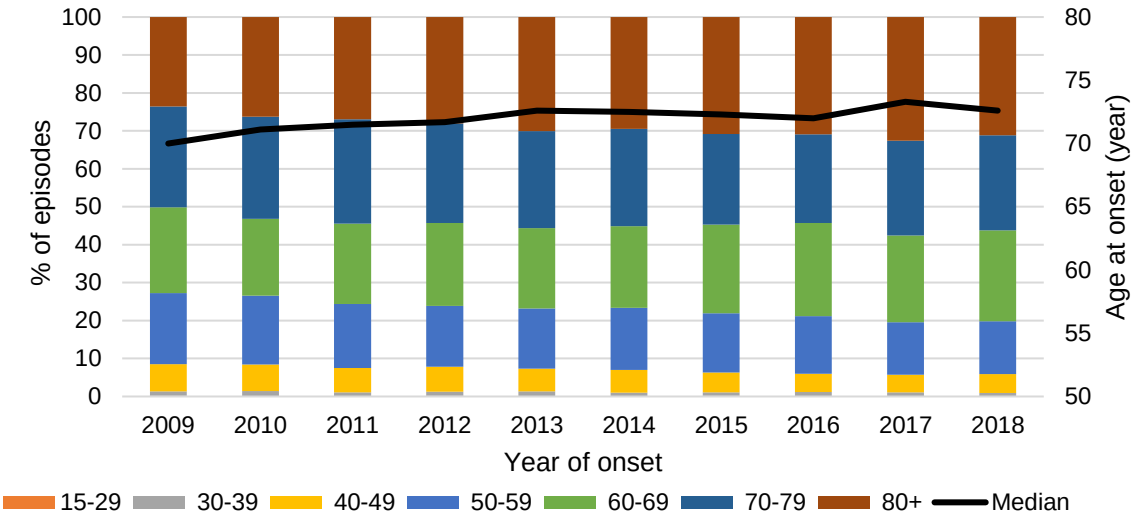
Chinese had the oldest median age at onset of AMI, which ranged from 70.0 to 73.3 years in the past decade (Table 5.1.7a). The highest proportion of AMI episodes was found among Chinese aged 80 years and above (31.8%) in 2018 (Figure 5.1.7a).

Table 5.1.7a: Age distribution at onset of AMI among Chinese

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	70.0	8	0.2	53	1.2	320	7.2
2010	71.1	3	0.1	67	1.4	346	7.1
2011	71.5	5	0.1	55	1.0	337	6.4
2012	71.7	10	0.2	66	1.1	392	6.6
2013	72.6	8	0.1	75	1.2	381	6.0
2014	72.5	6	0.1	59	0.9	389	6.0
2015	72.3	9	0.1	66	1.0	353	5.2
2016	72.0	4	0.1	80	1.1	344	4.8
2017	73.3	6	0.1	80	1.0	372	4.6
2018	72.6	6	0.1	61	0.8	390	4.9

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2009	833	18.7	1005	22.6	1184	26.6	1050	23.6
2010	887	18.1	994	20.3	1319	26.9	1290	26.3
2011	894	16.9	1123	21.2	1454	27.5	1428	27.0
2012	960	16.1	1308	21.9	1568	26.2	1677	28.0
2013	1002	15.9	1334	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	1079	15.2	1750	24.6	1662	23.3	2199	30.9
2017	1110	13.8	1835	22.8	2010	25.0	2623	32.6
2018	1079	13.5	1882	23.6	2026	25.4	2539	31.8

Figure 5.1.7a: Age distribution at onset of AMI among Chinese



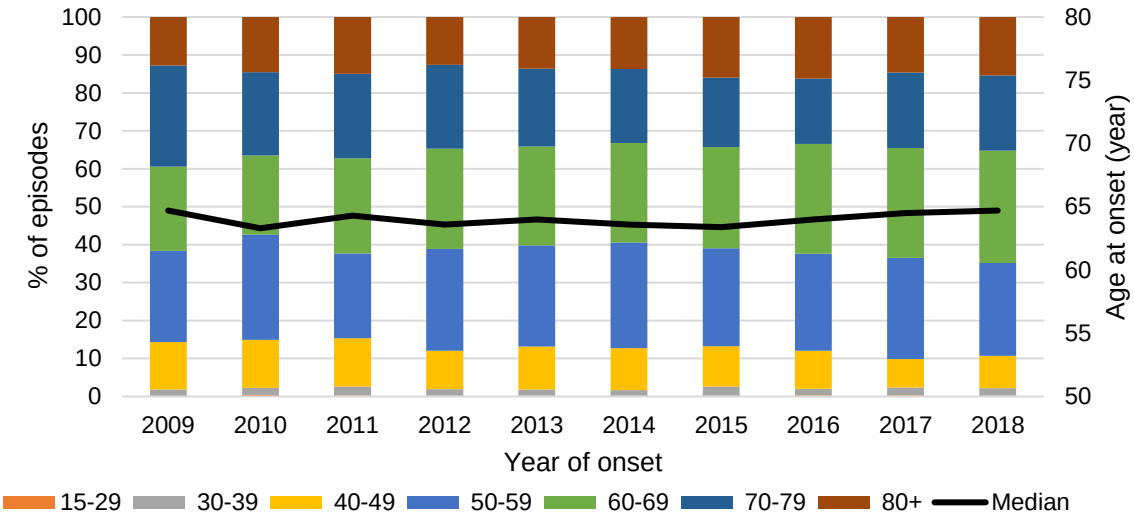
The median age at onset of AMI among Malays ranged from 63.3 to 64.7 years in the past decade (Table 5.1.7b). The highest proportion of AMI episodes was found among Malays aged 60-69 years (29.0%) in 2018 (Figure 5.1.7b).

Table 5.1.7b: Age distribution at onset of AMI among Malays

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	64.7	1	0.1	24	1.8	164	12.5
2010	63.3	6	0.4	26	1.8	179	12.7
2011	64.3	4	0.3	37	2.4	200	12.7
2012	63.6	3	0.2	32	1.7	187	10.1
2013	64.0	3	0.2	32	1.7	214	11.3
2014	63.6	3	0.2	28	1.5	206	11.1
2015	63.4	4	0.2	48	2.4	208	10.6
2016	64.0	7	0.3	37	1.7	215	10.0
2017	64.5	7	0.3	46	2.0	170	7.5
2018	64.7	6	0.3	45	2.0	190	8.4

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2009	316	24.0	292	22.2	351	26.7	168	12.8
2010	394	27.8	294	20.8	311	22.0	205	14.5
2011	351	22.4	393	25.0	349	22.2	235	15.0
2012	496	26.9	486	26.4	407	22.1	232	12.6
2013	503	26.6	493	26.1	387	20.5	257	13.6
2014	516	27.8	486	26.2	362	19.5	254	13.7
2015	507	25.8	524	26.7	359	18.3	314	16.0
2016	549	25.6	622	29.0	369	17.2	348	16.2
2017	599	26.6	654	29.0	449	19.9	330	14.6
2018	562	24.8	659	29.0	451	19.9	356	15.7

Figure 5.1.7b: Age distribution at onset of AMI among Malays



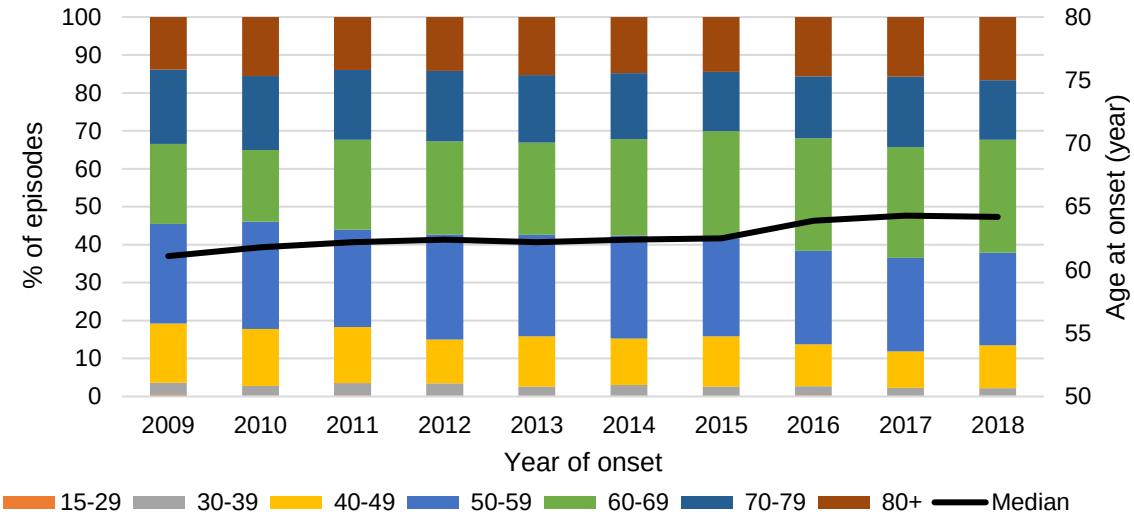
The median age at onset of AMI among Indians increased from 61.1 years in 2009 to 64.2 years in 2018 (Table 5.1.7c). The highest proportion of AMI episodes was found among Indians aged 60-69 years (29.4%) in 2018 (Figure 5.1.7c).

Table 5.1.7c: Age distribution at onset of AMI among Indians

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	61.1	4	0.4	30	3.2	146	15.6
2010	61.8	2	0.2	24	2.6	140	15.0
2011	62.2	4	0.4	34	3.2	156	14.7
2012	62.4	2	0.2	38	3.3	135	11.6
2013	62.2	2	0.2	29	2.5	156	13.2
2014	62.4	2	0.2	36	2.9	154	12.2
2015	62.5	0	0.0	32	2.6	163	13.2
2016	63.9	5	0.4	33	2.4	155	11.1
2017	64.3	2	0.1	32	2.1	143	9.6
2018	64.2	3	0.2	22	1.5	162	10.8

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	166	14.3
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	344	24.6	416	29.7	227	16.2	219	15.7
2017	367	24.5	438	29.3	278	18.6	236	15.8
2018	356	23.8	440	29.4	243	16.2	272	18.2

Figure 5.1.7c: Age distribution at onset of AMI among Indians



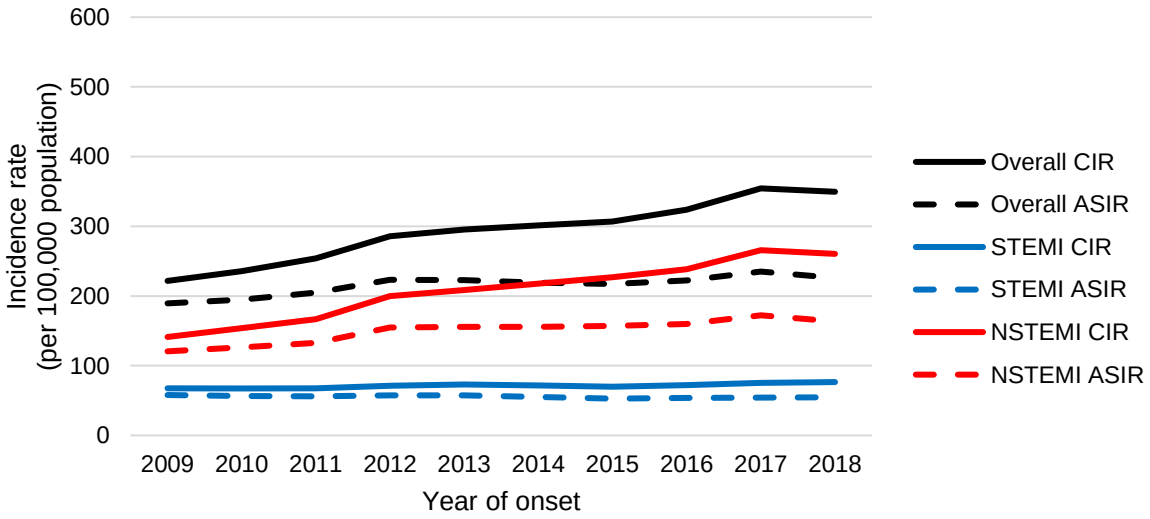
There were more NSTEMI than STEMI episodes (Table 5.1.8) and the ASIR for NSTEMI was consistently higher than STEMI across the years (Figure 5.1.8). NSTEMI was more prevalent as it could occur on its own or as a complication in very sick patients. Critically ill patients had increased risk for NSTEMI as myocardial demand was higher in these patients[10]. The ASIR for STEMI decreased significantly from 57.9 per 100,000 population in 2009 to 54.7 per 100,000 population in 2018 (p=0.011), while the ASIR for NSTEMI increased significantly from 120.6 per 100,000 population in 2009 to 163.3 per 100,000 population in 2018 (p=0.001).

[10]Jeremy B. Richards, Renee D. Stapleton. Non-pulmonary complications of critical care. A clinical guide. Respiratory Medicine.

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

STEMI						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
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	2406	22.3	72.1	69.2-75.0	53.9	51.7-56.1
2017	2540	21.3	75.3	72.4-78.3	54.4	52.3-56.6
2018	2602	21.9	76.5	73.5-79.4	54.7	52.6-56.9
P for trend	-	-	0.001	-	0.011	-
NSTEMI						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2009	4330	63.7	141.2	137.0-145.4	120.6	117.0-124.3
2010	4799	65.3	153.9	149.6-158.3	126.4	122.8-130.1
2011	5251	65.5	166.6	162.1-171.1	132.7	129.0-136.4
2012	6378	69.9	199.8	194.9-204.7	154.6	150.7-158.4
2013	6730	70.6	208.4	203.4-213.4	155.6	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	7952	73.5	238.3	233.0-243.5	159.8	156.2-163.4
2017	8958	75.0	265.7	260.2-271.2	172.3	168.7-176.0
2018	8856	74.5	260.2	254.8-265.6	163.3	159.8-166.8
P for trend	-	-	<0.001	-	0.001	-

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



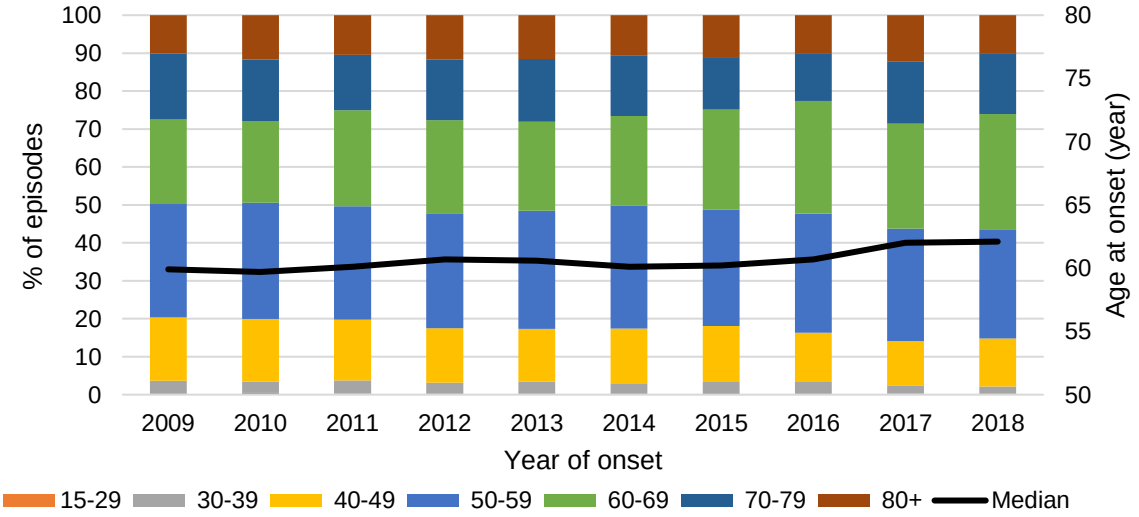
The median age at onset of STEMI increased from 59.9 years in 2009 to 62.1 years in 2018 (Table 5.1.9a). The highest proportion of STEMI episodes was found among patients aged 60-69 years (30.6%) in 2018 (Figure 5.1.9a).

Table 5.1.9a: Age distribution at onset of STEMI

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	59.9	7	0.3	69	3.3	346	16.7
2010	59.7	9	0.4	62	3.0	348	16.6
2011	60.1	7	0.3	72	3.4	342	16.1
2012	60.7	5	0.2	67	2.9	326	14.3
2013	60.6	5	0.2	76	3.2	329	13.9
2014	60.1	8	0.3	62	2.6	338	14.4
2015	60.2	3	0.1	74	3.2	340	14.7
2016	60.7	9	0.4	71	3.0	312	13.0
2017	62.0	7	0.3	52	2.0	299	11.8
2018	62.1	5	0.2	52	2.0	329	12.6

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	756	31.4	714	29.7	299	12.4	245	10.2
2017	754	29.7	702	27.6	417	16.4	309	12.2
2018	743	28.6	795	30.6	412	15.8	266	10.2

Figure 5.1.9a: Age distribution at onset of STEMI



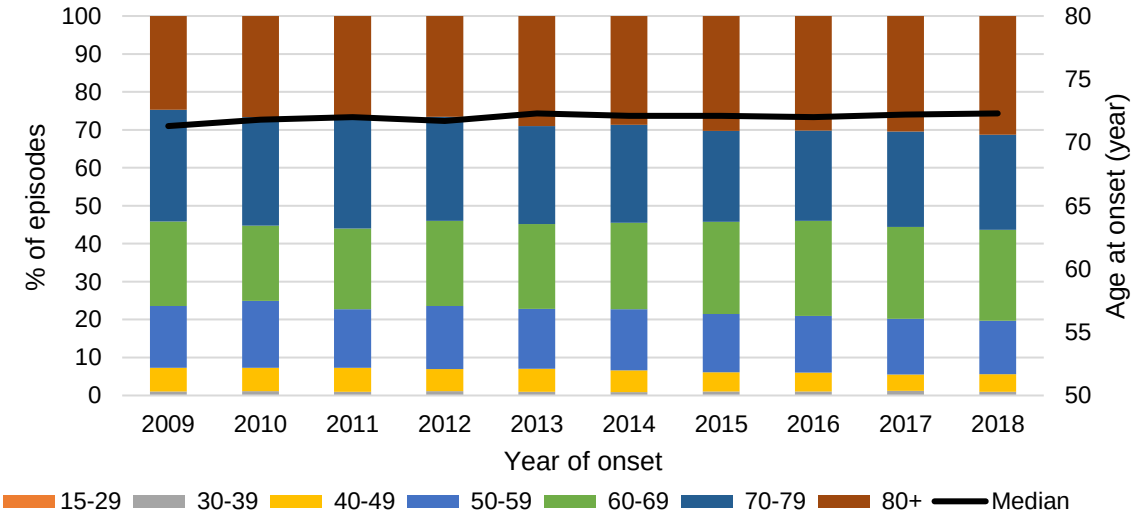
The median age at onset of NSTEMI increased from 71.3 years in 2009 to 72.3 years in 2018 (Table 5.1.9b), and it was about 10 years older than the median age at onset of STEMI (Table 5.1.9a). The highest proportion of NSTEMI episodes was found among patients aged 80 years and above (31.3%) in 2018 (Figure 5.1.9b).

Table 5.1.9b: Age distribution at onset of NSTEMI

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	71.3	5	0.1	39	0.9	273	6.3
2010	71.8	1	0.0	53	1.1	295	6.1
2011	72.0	5	0.1	46	0.9	331	6.3
2012	71.7	9	0.1	62	1.0	373	5.8
2013	72.3	8	0.1	60	0.9	407	6.0
2014	72.1	3	0.0	59	0.8	411	5.8
2015	72.1	10	0.1	67	0.9	381	5.1
2016	72.0	7	0.1	79	1.0	393	4.9
2017	72.2	9	0.1	104	1.2	382	4.3
2018	72.3	10	0.1	73	0.8	414	4.7

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2009	704	16.3	966	22.3	1275	29.4	1068	24.7
2010	847	17.6	953	19.9	1371	28.6	1279	26.7
2011	812	15.5	1115	21.2	1536	29.3	1406	26.8
2012	1059	16.6	1431	22.4	1749	27.4	1695	26.6
2013	1061	15.8	1502	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	1186	14.9	1996	25.1	1890	23.8	2401	30.2
2017	1312	14.6	2175	24.3	2251	25.1	2725	30.4
2018	1244	14.0	2122	24.0	2224	25.1	2769	31.3

Figure 5.1.9b: Age distribution at onset of NSTEMI



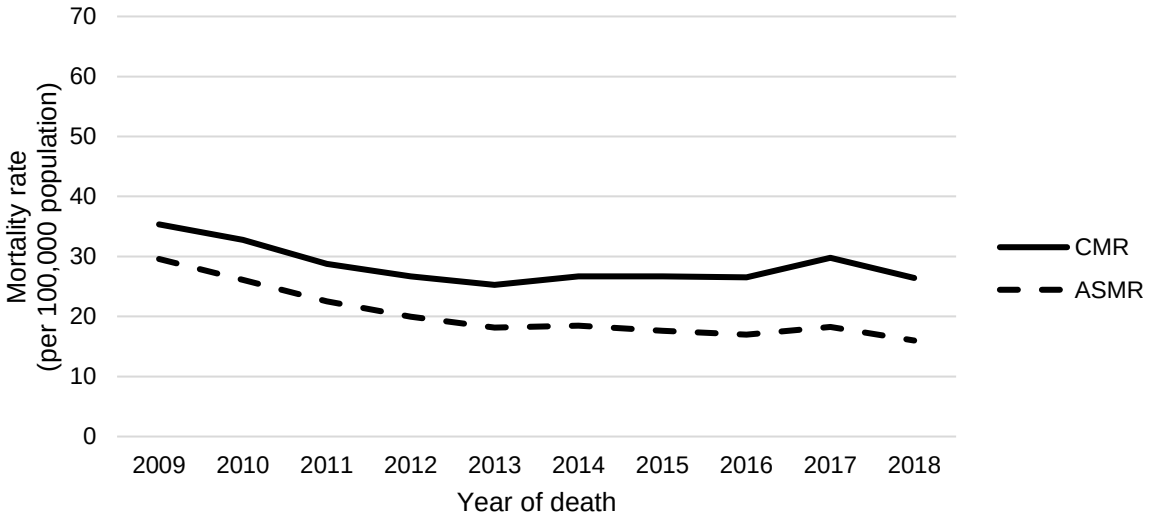
5.2 Mortality

The number of AMI deaths was 910 in 2018, a slight drop compared to 1,084 in 2009 (Table 5.2.1). Correspondingly, the crude mortality rate (CMR) declined slightly from 35.4 per 100,000 population in 2009 to 26.7 per 100,000 population in 2018 (Figure 5.2.1). However, taking into account Singapore's ageing population, the ASMR declined significantly from 29.6 per 100,000 population in 2009 to 15.9 per 100,000 population in 2018 ($p<0.001$). This decreasing trend in ASMR was likely due to the higher rates of revascularisation and pharmacotherapy.

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

Year of death	Number	CMR	95% CI	ASMR	95% CI
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
2017	1018	30.2	28.3-32.1	18.5	17.3-19.7
2018	910	26.7	25.0-28.5	15.9	14.8-17.0
P for trend	-	0.075	-	<0.001	-

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



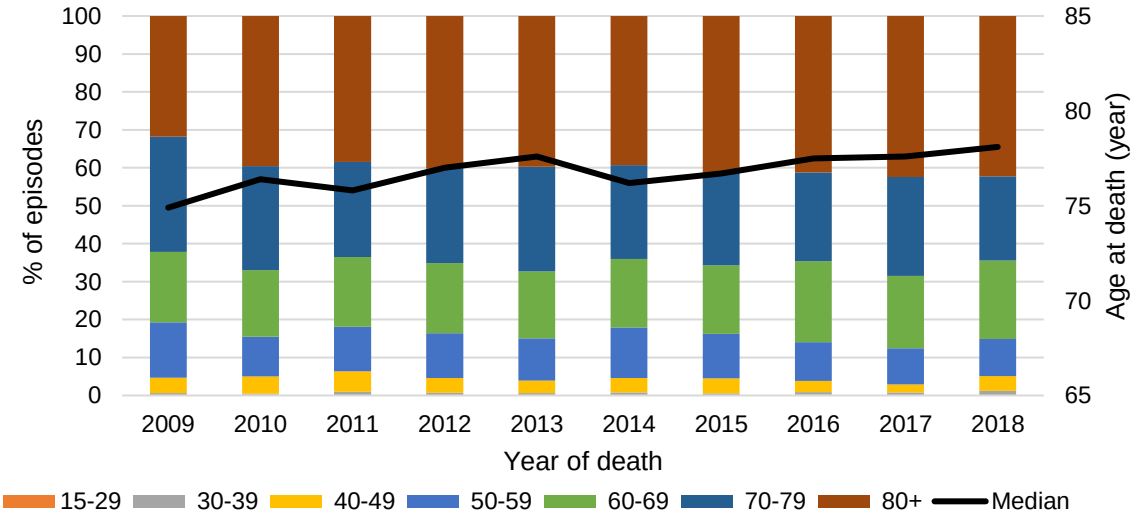
The median age at death increased from 74.9 years in 2009 to 78.1 years in 2018 (Table 5.2.2). About 4 in 10 of the patients aged 80 years and above died of AMI in 2018 (Figure 5.2.2).

Table 5.2.2: Age distribution at death of AMI

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	74.9	1	0.1	6	0.6	44	4.1
2010	76.4	2	0.2	3	0.3	46	4.5
2011	75.8	0	0.0	9	1.0	49	5.4
2012	77.0	1	0.1	5	0.6	33	3.9
2013	77.6	0	0.0	5	0.6	27	3.3
2014	76.2	1	0.1	6	0.7	33	3.8
2015	76.7	0	0.0	5	0.6	35	4.0
2016	77.5	2	0.2	6	0.7	26	2.9
2017	77.6	1	0.1	7	0.7	21	2.1
2018	78.1	0	0.0	5	0.5	25	2.7

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2017	96	9.4	193	19.0	266	26.1	434	42.6
2018	89	9.8	186	20.4	209	23.0	396	43.5

Figure 5.2.2: Age distribution at death of AMI



The age-specific mortality rate increased with age, with the oldest age group having the highest mortality rate (Figure 5.2.3a). Over the past decade, significant drop in mortality rates were observed for all the age groups aged 40 years and above (Table 5.2.3). The drop in mortality rate was fastest among those aged 80 years and above (Figure 5.2.3b).

Table 5.2.3: Age-specific mortality rate of AMI (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
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	-	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	-	0.8	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	-	0.8	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
2017	30.2	28.3-32.1	0.1	0.0-0.4	1.2	0.3-2.1	3.4	2.0-4.9
2018	26.7	25.0-28.5	0.0	-	0.9	0.1-1.6	4.1	2.5-5.7
P for trend	0.075	-	-	-	0.555	-	0.002	-
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
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
2017	15.6	12.5-18.7	41.4	35.5-47.2	125.8	110.7-140.9	428.5	388.2-468.8
2018	14.5	11.5-17.5	38.4	32.9-44.0	91.3	78.9-103.7	370.5	334.0-407.0
P for trend	0.007	-	0.002	-	0.001	-	0.003	-

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

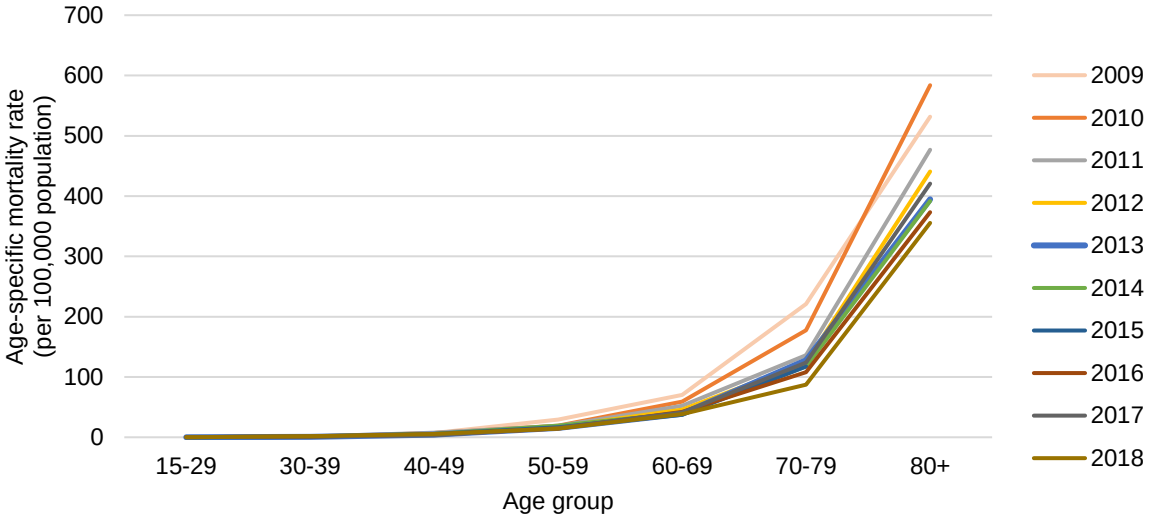
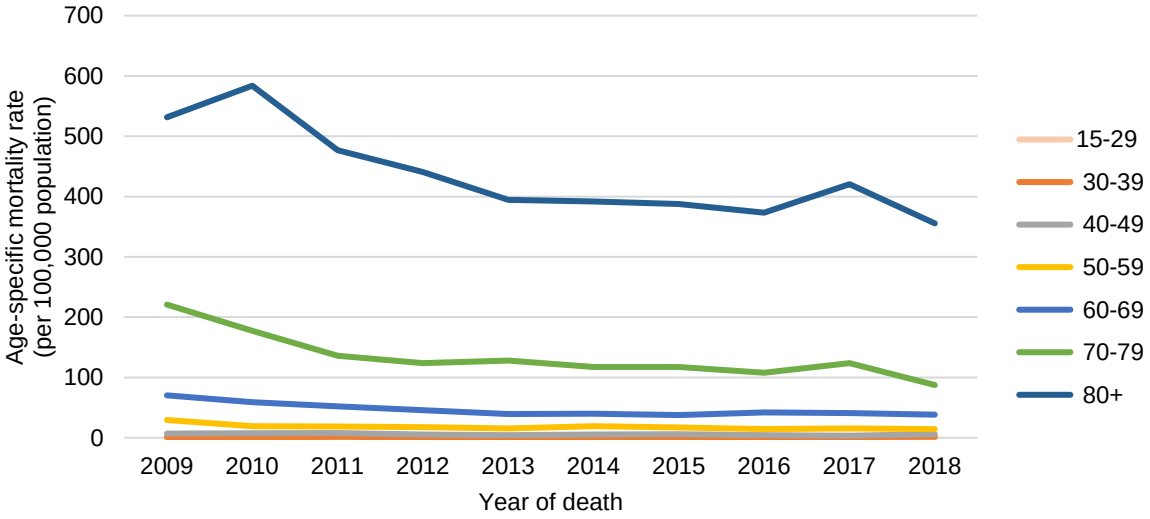


Figure 5.2.3b: Age-specific mortality rate of AMI (per 100,000 population) across years

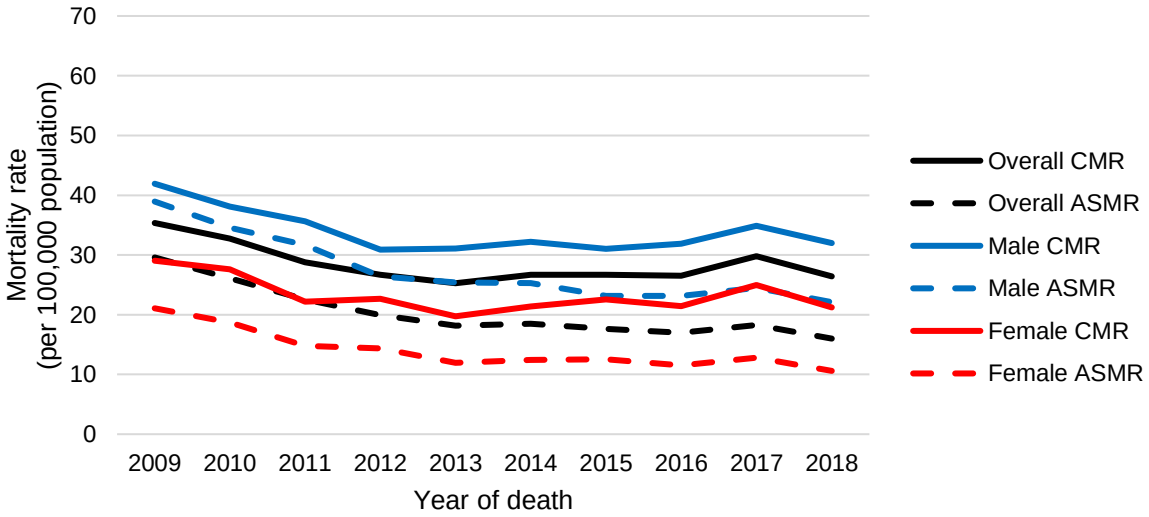


As the ASIR was consistently higher among males than females across the years (Table 5.1.4), the ASMR was also consistently higher among males (Table 5.2.4). Males had an ASMR of 22.0 per 100,000 population, while females had an ASMR of 10.4 per 100,000 population in 2018. The ASMR declined significantly over the years for both genders (males: $p<0.001$, females: $p=0.001$) (Figure 5.2.4).

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

Male						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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
2017	577	56.7	35.2	32.3-38.0	24.7	22.6-26.7
2018	536	58.9	32.4	29.7-35.1	22.0	20.1-23.9
P for trend	-	-	0.064	-	<0.001	-
Female						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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
2017	441	43.3	25.5	23.1-27.9	13.1	11.8-14.3
2018	374	41.1	21.4	19.2-23.6	10.4	9.3-11.5
P for trend	-	-	0.136	-	0.001	-

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



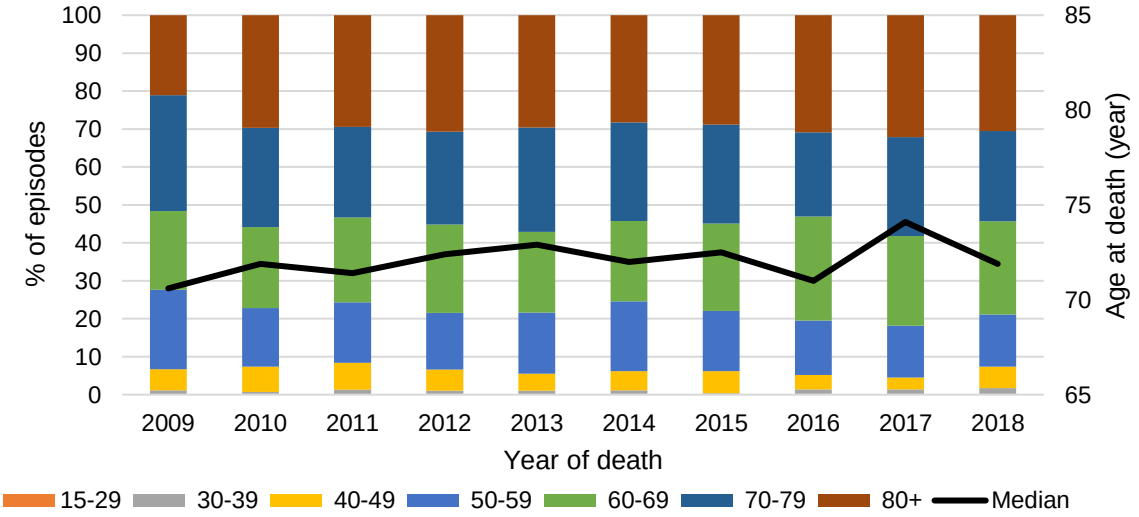
The median age at death among males ranged from 70.6 to 74.1 years in the past decade (Table 5.2.5a). The highest proportion of AMI deaths was observed among males aged 80 years and above (30.6%) in 2018 (Figure 5.2.5a).

Table 5.2.5a: Age distribution at death of AMI among males

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	70.6	1	0.2	6	1.0	35	5.6
2010	71.9	1	0.2	3	0.5	39	6.7
2011	71.4	0	0.0	7	1.3	39	7.1
2012	72.4	1	0.2	4	0.8	27	5.6
2013	72.9	0	0.0	5	1.0	22	4.5
2014	72.0	1	0.2	5	1.0	26	5.1
2015	72.5	0	0.0	2	0.4	29	5.8
2016	71.0	1	0.2	6	1.2	20	3.9
2017	74.1	1	0.2	7	1.2	18	3.1
2018	71.9	0	0.0	3	0.6	22	4.1

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2017	78	13.5	136	23.6	150	26.0	187	32.4
2018	74	13.8	138	25.7	135	25.2	164	30.6

Figure 5.2.5a: Age distribution at death of AMI among males



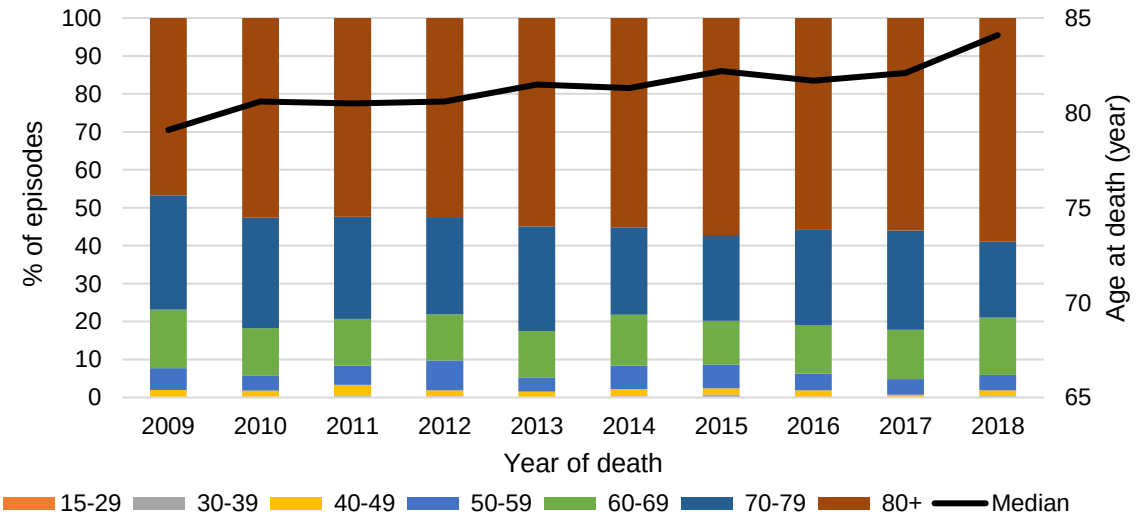
Similar to the median age at onset of AMI (Tables 5.1.5a and 5.1.5b), females had an older median age at death than males, which increased from 79.1 years in 2009 to 84.1 years in 2018 (Table 5.2.5b). The highest proportion of AMI deaths was observed among females aged 80 years and above (62.0%) in 2018 (Figure 5.2.5b).

Table 5.2.5b: Age distribution at death of AMI among females

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	79.1	0	0.0	0	0.0	9	2.0
2010	80.6	1	0.2	0	0.0	7	1.6
2011	80.5	0	0.0	2	0.6	10	2.8
2012	80.6	0	0.0	1	0.3	6	1.6
2013	81.5	0	0.0	0	0.0	5	1.5
2014	81.3	0	0.0	1	0.3	7	2.0
2015	82.2	0	0.0	3	0.8	6	1.6
2016	81.7	1	0.3	0	0.0	6	1.6
2017	82.1	0	0.0	0	0.0	3	0.7
2018	84.1	0	0.0	2	0.5	3	0.8

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2017	18	4.1	57	12.9	116	26.3	247	56.0
2018	15	4.0	48	12.8	74	19.8	232	62.0

Figure 5.2.5b: Age distribution at death of AMI among females

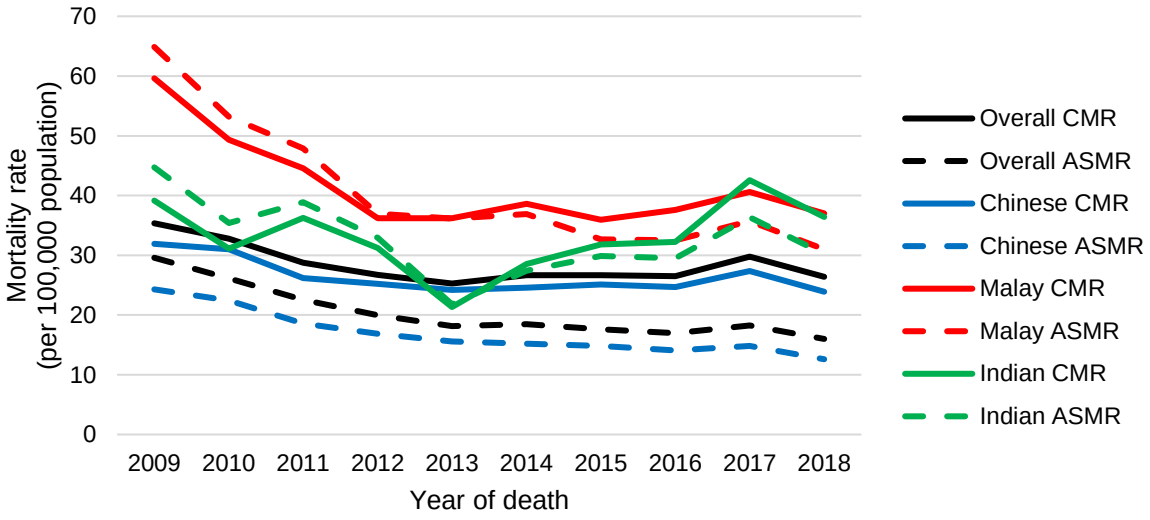


As Chinese consistently had the lowest ASIR across the years (Table 5.1.6), they also consistently had the lowest ASMR (Table 5.2.6). The ASMR of 12.9 per 100,000 population among Chinese was lower than the ASMR for Malays (33.3 per 100,000 population) and Indians (26.7 per 100,000 population) in 2018. The ASMR showed a significant downward trend over the years for Chinese (p<0.001) and Malays (p=0.001) but not for Indians (p=0.131) (Figure 5.2.6).

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

Chinese						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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
2017	707	69.4	27.8	25.7-29.8	15.0	13.9-16.2
2018	633	69.6	24.6	22.7-26.6	12.9	11.9-13.9
P for trend	-	-	0.056	-	<0.001	-
Malay						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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
2017	176	17.3	40.8	34.8-46.9	35.9	30.5-41.3
2018	173	19.0	39.7	33.8-45.7	33.3	28.3-38.4
P for trend	-	-	0.042	-	0.001	-
Indian						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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
2017	125	12.3	42.9	35.4-50.4	36.7	30.2-43.2
2018	96	10.5	32.6	26.1-39.2	26.7	21.3-32.1
P for trend	-	-	0.928	-	0.131	-

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



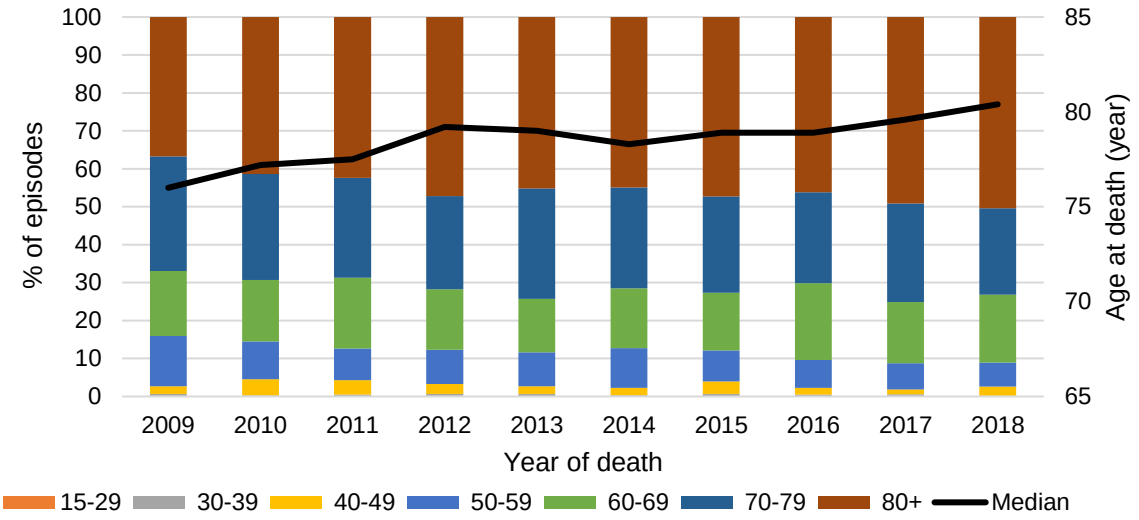
Similar to the median age at onset of AMI (Tables 5.1.7a to 5.1.7c), Chinese had the oldest median age at death, which increased from 76.0 years in 2009 to 80.4 years in 2018 (Table 5.2.7a). The highest proportion of AMI deaths was observed among Chinese aged 80 years and above (50.9%) in 2018 (Figure 5.2.7a).

Table 5.2.7a: Age distribution at death of AMI among Chinese

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	76.0	1	0.1	4	0.5	15	2.0
2010	77.2	0	0.0	2	0.3	31	4.2
2011	77.5	0	0.0	3	0.5	24	3.9
2012	79.2	1	0.2	3	0.5	16	2.6
2013	79.0	0	0.0	4	0.7	12	2.0
2014	78.3	1	0.2	1	0.2	12	2.0
2015	78.9	0	0.0	4	0.6	21	3.4
2016	78.9	0	0.0	3	0.5	11	1.8
2017	79.6	1	0.1	3	0.4	9	1.3
2018	80.4	0	0.0	1	0.2	12	1.9

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2017	48	6.8	114	16.1	183	25.9	349	49.4
2018	39	6.2	111	17.5	148	23.4	322	50.9

Figure 5.2.7a: Age distribution at death of AMI among Chinese



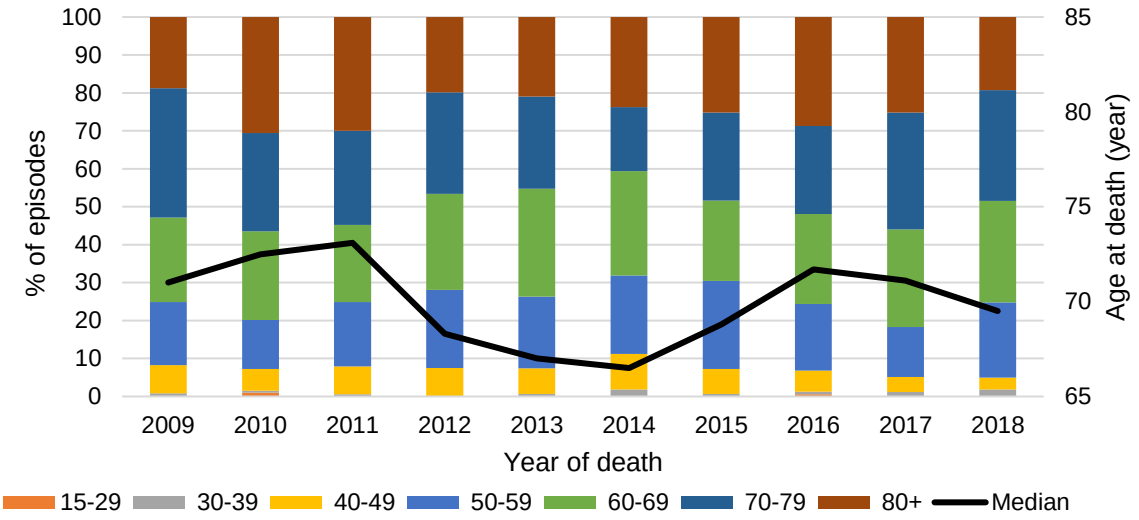
The median age at death among Malays ranged from 66.5 to 73.1 years in the past decade (Table 5.2.7b). The highest proportion of AMI deaths was observed among Malays aged 70-79 years (28.3%) in 2018 (Figure 5.2.7b).

Table 5.2.7b: Age distribution at death of AMI among Malays

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	71.0	0	0.0	2	0.9	17	7.4
2010	72.5	2	1.0	1	0.5	11	5.7
2011	73.1	0	0.0	1	0.6	13	7.3
2012	68.3	0	0.0	0	0.0	11	7.5
2013	67.0	0	0.0	1	0.7	10	6.8
2014	66.5	0	0.0	3	1.9	15	9.4
2015	68.8	0	0.0	1	0.7	10	6.6
2016	71.7	1	0.6	1	0.6	9	5.6
2017	71.1	0	0.0	2	1.1	7	4.0
2018	69.5	0	0.0	3	1.7	6	3.5

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2017	23	13.1	45	25.6	55	31.3	44	25.0
2018	34	19.7	45	26.0	49	28.3	36	20.8

Figure 5.2.7b: Age distribution at death of AMI among Malays



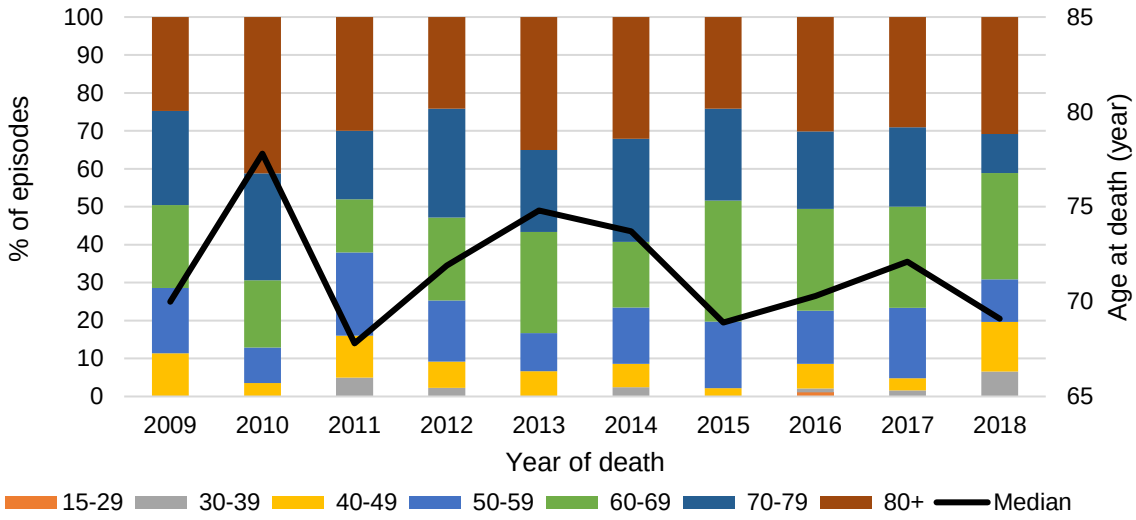
The median age at death among Indians ranged from 67.8 to 77.8 years in the past decade (Table 5.2.7c). The highest proportion of AMI deaths was observed among Indians aged 80 years and above (35.4%) in 2018 (Figure 5.2.7c).

Table 5.2.7c: Age distribution at death of AMI among Indians

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	70.0	0	0.0	0	0.0	12	11.4
2010	77.8	0	0.0	0	0.0	3	3.5
2011	67.8	0	0.0	5	5.0	11	11.0
2012	71.9	0	0.0	2	2.3	6	6.9
2013	74.8	0	0.0	0	0.0	4	6.7
2014	73.7	0	0.0	2	2.5	5	6.2
2015	68.9	0	0.0	0	0.0	2	2.2
2016	70.3	1	1.1	1	1.1	6	6.5
2017	72.1	0	0.0	2	1.6	4	3.2
2018	69.1	0	0.0	1	1.0	7	7.3

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2017	23	18.5	33	26.6	27	21.8	36	29.0
2018	14	14.6	29	30.2	11	11.5	34	35.4

Figure 5.2.7c: Age distribution at death of AMI among Indians

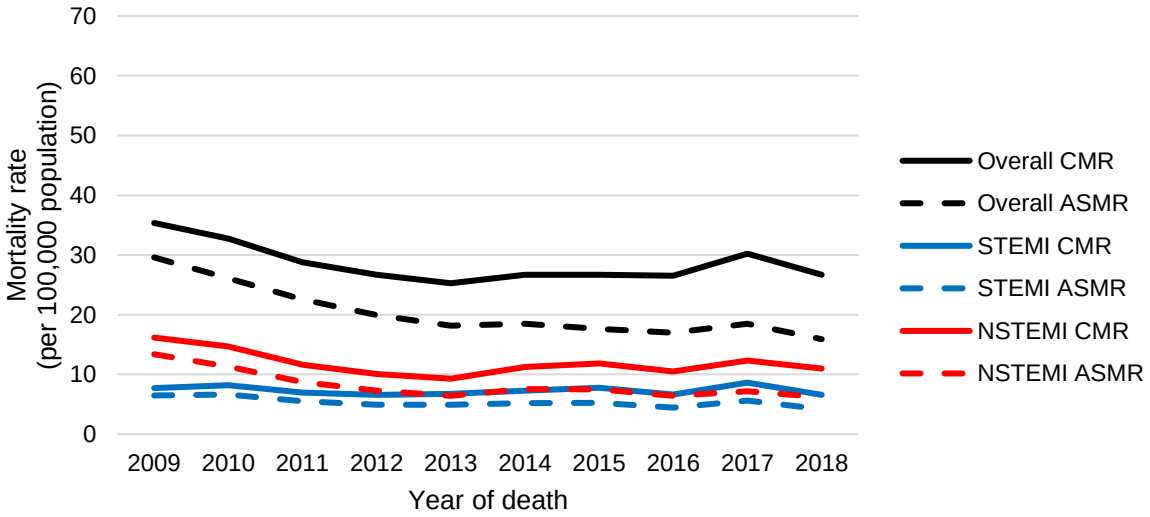


As the ASIR of NSTEMI was consistently higher than STEMI across the years (Table 5.1.8), the ASMR of NSTEMI was also consistently higher (Table 5.2.8). The ASMR of STEMI declined significantly from 6.5 per 100,000 population in 2009 to 4.2 per 100,000 population in 2018 (p=0.015). Similarly, the ASMR of NSTEMI declined significantly from 13.4 per 100,000 population in 2009 to 6.2 per 100,000 population in 2018 (p=0.004) (Figure 5.2.8).

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

STEMI						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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
2017	291	28.6	8.6	7.6-9.6	5.6	5.0-6.3
2018	226	24.8	6.6	5.8-7.5	4.2	3.6-4.7
P for trend	-	-	0.716	-	0.015	-
NSTEMI						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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
2017	414	40.7	12.3	11.0-13.5	7.2	6.5-7.9
2018	376	41.3	11.0	9.9-12.2	6.2	5.6-6.9
P for trend	-	-	0.140	-	0.004	-

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



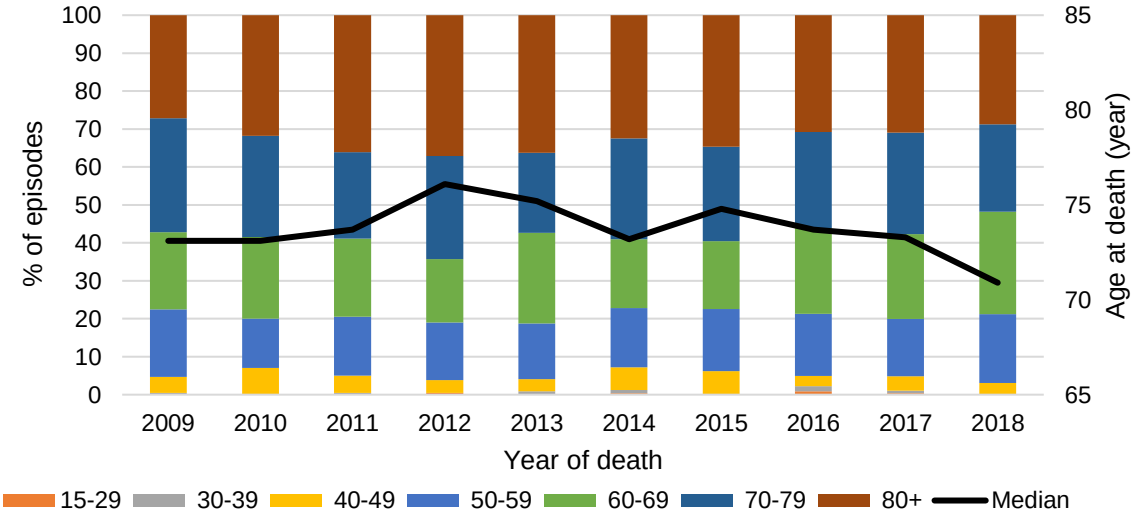
The median age at death among STEMI patients ranged from 70.9 to 76.1 years in the past decade (Table 5.2.9a). The highest proportion of AMI deaths was observed among STEMI patients aged 80 years and above (28.8%) in 2018 (Figure 5.2.9a).

Table 5.2.9a: Age distribution at death of STEMI

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	73.1	0	0.0	1	0.4	10	4.2
2010	73.1	0	0.0	0	0.0	18	7.1
2011	73.7	0	0.0	1	0.5	10	4.6
2012	76.1	1	0.5	0	0.0	7	3.3
2013	75.2	0	0.0	2	0.9	7	3.2
2014	73.2	1	0.4	2	0.8	14	5.9
2015	74.8	0	0.0	0	0.0	16	6.2
2016	73.7	2	0.9	3	1.4	6	2.7
2017	73.3	1	0.3	2	0.7	11	3.8
2018	70.9	0	0.0	0	0.0	7	3.1

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2017	44	15.1	65	22.3	78	26.8	90	30.9
2018	41	18.1	61	27.0	52	23.0	65	28.8

Figure 5.2.9a: Age distribution at death of STEMI



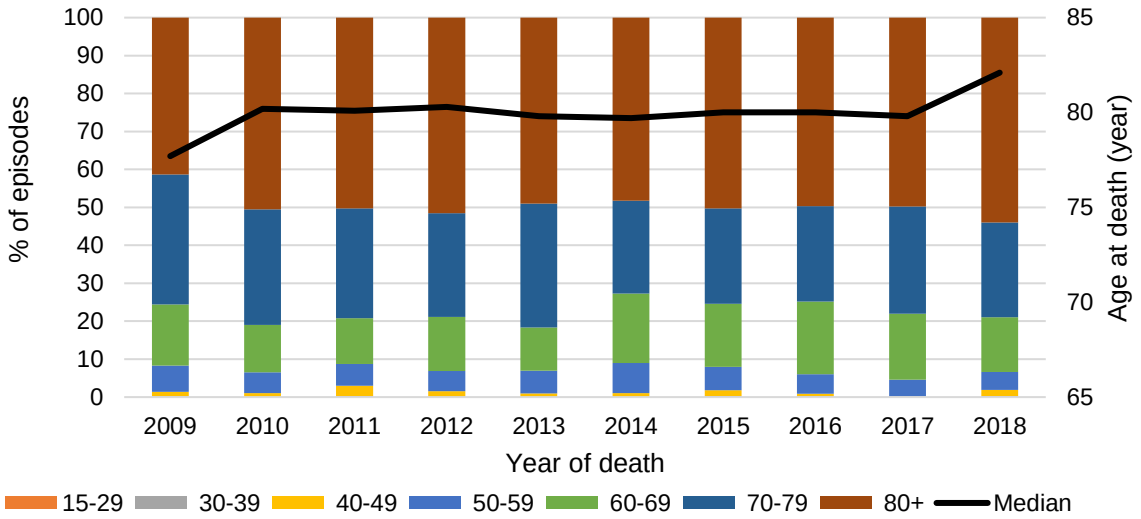
Similar to the median age at onset (Tables 5.1.9a and 5.1.9b), NSTEMI patients had an older median age at death than STEMI patients, which ranged from 77.7 to 82.1 years in the past decade (Table 5.2.9b). The highest proportion of AMI deaths was observed among NSTEMI patients aged 80 years and above (54.0%) in 2018 (Figure 5.2.9b).

Table 5.2.9b: Age distribution at death of NSTEMI

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2009	77.7	0	0.0	1	0.2	6	1.2
2010	80.2	0	0.0	0	0.0	5	1.1
2011	80.1	0	0.0	1	0.3	10	2.7
2012	80.3	0	0.0	0	0.0	5	1.6
2013	79.8	0	0.0	0	0.0	3	1.0
2014	79.7	0	0.0	0	0.0	4	1.1
2015	80.0	0	0.0	1	0.3	6	1.5
2016	80.0	0	0.0	1	0.3	2	0.6
2017	79.8	0	0.0	1	0.2	0	0.0
2018	82.1	0	0.0	1	0.3	6	1.6

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2017	18	4.3	72	17.4	117	28.3	206	49.8
2018	18	4.8	54	14.4	94	25.0	203	54.0

Figure 5.2.9b: Age distribution at death of NSTEMI



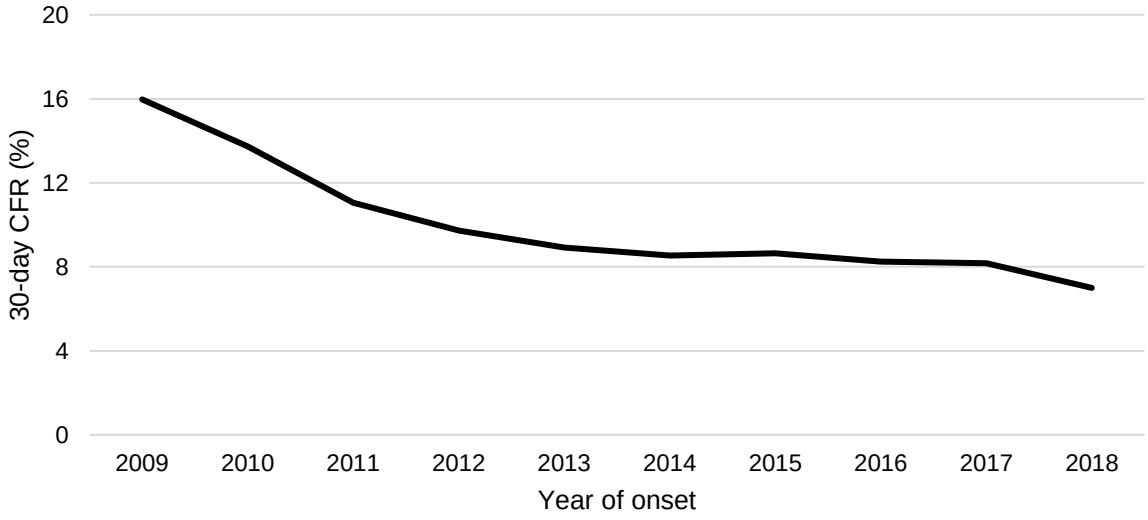
5.3 30-Day Case Fatality

The number of AMI deaths within 30 days from onset fell from 1,021 in 2009 to 842 in 2018 (Table 5.3.1). Similarly, the CFR decreased significantly from 16.0% in 2009 to 7.6% in 2018 (p<0.001) (Figure 5.3.1). Higher rates of revascularisation and pharmacotherapy were likely to have contributed to the decreasing trend in case fatality.

Table 5.3.1: Case fatality number and rate of AMI (%)

Year of onset	Number	CFR	95% CI
2009	1021	16.0	15.0-17.0
2010	949	13.7	12.9-14.6
2011	831	11.1	10.3-11.8
2012	824	9.7	9.1-10.4
2013	786	8.9	8.3-9.5
2014	784	8.5	7.9-9.1
2015	820	8.7	8.1-9.2
2016	833	8.2	7.7-8.8
2017	922	8.3	7.7-8.8
2018	842	7.6	7.1-8.1
P for trend	-	<0.001	-

Figure 5.3.1: Case fatality rate of AMI (%)



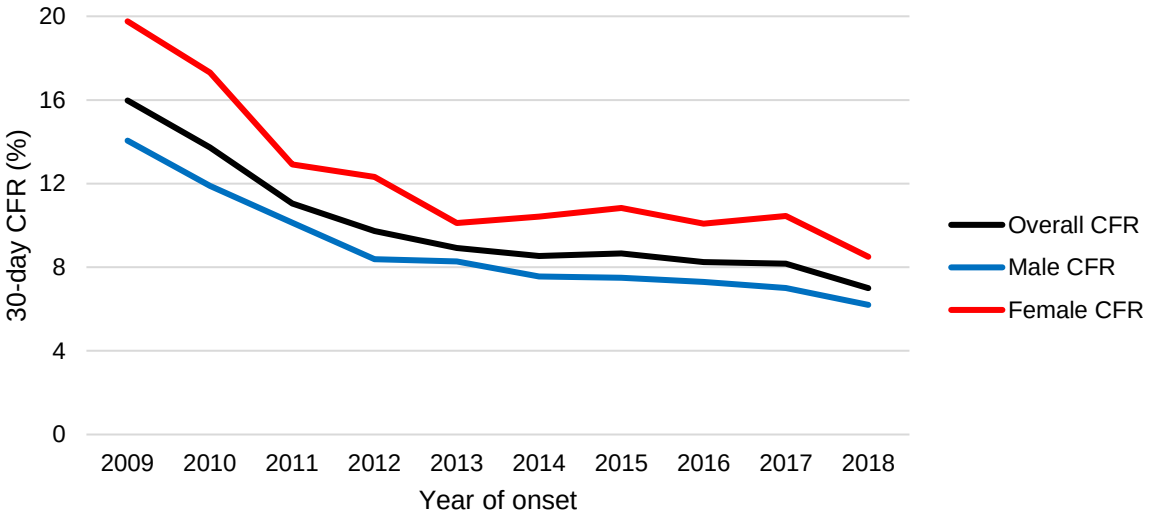
Although the ASMR for males was consistently higher than females across the years (Table 5.2.4), the CFR for males was consistently lower than females (Table 5.3.2). The CFR was 6.6% for males and 9.6% for females in 2018. As females tended to have AMI at an older age than males (Tables 5.1.5a and 5.1.5b), they were likely to have more co-morbidities when AMI happened, making them more susceptible to the contraindications of revascularisation or declining revascularisation. Lower rate of revascularisation of the blocked arteries could have led to the higher CFR among females[11]. The CFR fell significantly over the years for both genders (males: p<0.001, females: p=0.001) (Figure 5.3.2).

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

Male				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2009	596	58.4	14.1	12.9-15.2
2010	543	57.2	11.9	10.9-12.9
2011	509	61.3	10.1	9.3-11.0
2012	468	56.8	8.4	7.6-9.2
2013	474	60.3	8.3	7.5-9.0
2014	455	58.0	7.6	6.9-8.3
2015	464	56.6	7.5	6.8-8.2
2016	487	58.5	7.3	6.7-7.9
2017	520	56.4	7.0	6.4-7.6
2018	492	58.4	6.6	6.0-7.2
P for trend	-	-	<0.001	-
Female				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2009	425	41.6	19.8	17.9-21.6
2010	406	42.8	17.3	15.6-19.0
2011	322	38.7	12.9	11.5-14.3
2012	356	43.2	12.3	11.0-13.6
2013	312	39.7	10.1	9.0-11.2
2014	329	42.0	10.4	9.3-11.5
2015	356	43.4	10.8	9.7-12.0
2016	346	41.5	10.1	9.0-11.2
2017	402	43.6	10.6	9.6-11.7
2018	350	41.6	9.6	8.6-10.6
P for trend	-	-	0.001	-

[11] 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 of AMI (%) by gender

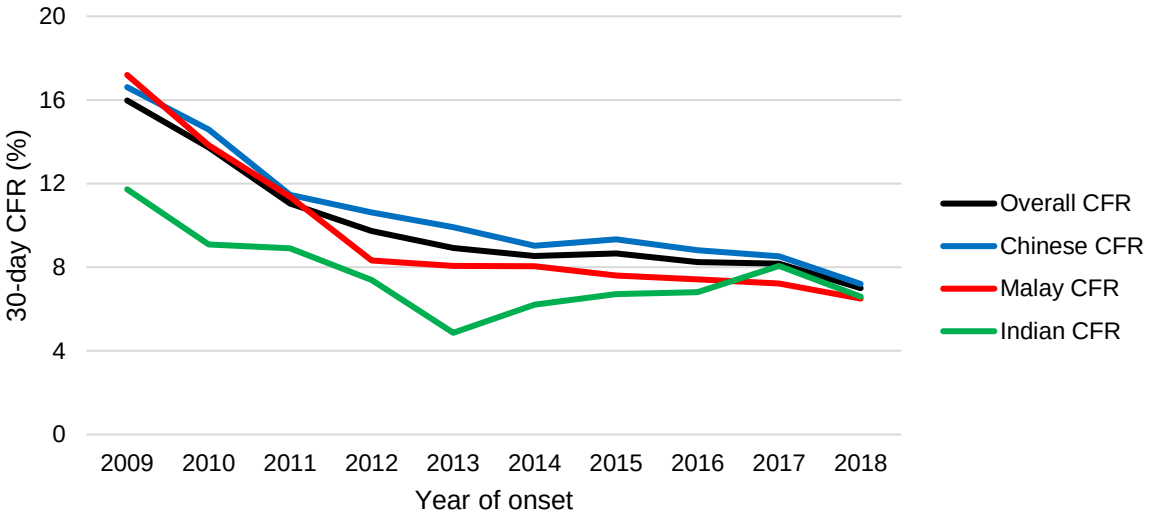


Although Chinese generally had the lowest ASMR (Table 5.2.6), they generally had the highest CFR across the years (Table 5.3.3). The CFRs were 8.0%, 7.1% and 6.4% for Chinese, Malays and Indians respectively in 2018. This was likely due to Chinese being oldest at onset of AMI (Tables 5.1.7a to 5.1.7c). The CFR fell significantly over the years for Chinese ($p<0.001$) and Malays ($p=0.001$) but not for Indians ($p=0.081$) (Figure 5.3.3).

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

Chinese				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2009	698	68.4	16.6	15.4-17.8
2010	675	71.1	14.6	13.5-15.7
2011	570	68.6	11.5	10.5-12.4
2012	592	71.8	10.6	9.8-11.5
2013	578	73.5	9.9	9.1-10.7
2014	549	70.0	9.0	8.3-9.8
2015	593	72.3	9.3	8.6-10.1
2016	587	70.5	8.8	8.1-9.5
2017	650	70.5	8.6	8.0-9.3
2018	596	70.8	8.0	7.3-8.6
P for trend	-	-	<0.001	-
Malay				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
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	9.6-13.1
2012	140	17.0	8.3	6.9-9.7
2013	139	17.7	8.1	6.7-9.4
2014	140	17.9	8.0	6.7-9.4
2015	140	17.1	7.6	6.3-8.9
2016	149	17.9	7.4	6.2-8.6
2017	150	16.3	7.2	6.1-8.4
2018	150	17.8	7.1	6.0-8.2
P for trend	-	-	0.001	-
Indian				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
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	6.8	5.4-8.2
2017	113	12.3	8.1	6.6-9.6
2018	88	10.5	6.4	5.0-7.7
P for trend	-	-	0.081	-

Figure 5.3.3: Case fatality rate of AMI (%) by ethnicity

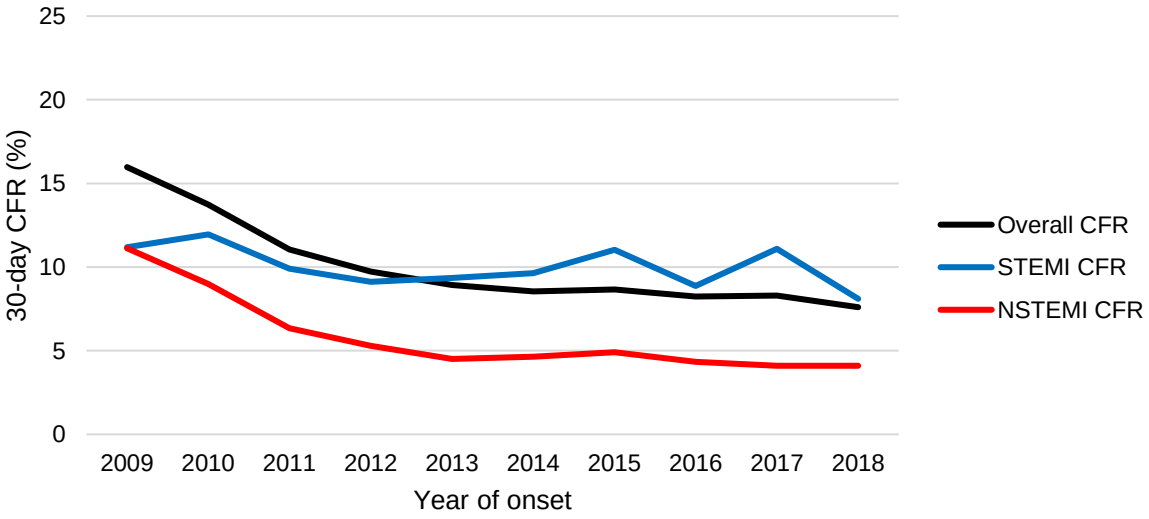


Although STEMI patients consistently had lower ASMR than NSTEMI patients across the years (Table 5.2.8), the CFR among STEMI patients was consistently higher than NSTEMI patients (Table 5.3.4). The CFRs were 8.1% and 4.1% for STEMI and NSTEMI patients respectively in 2018. A plausible reason was the severity of STEMI and possible fatality if intervention was not provided promptly. While the CFR for STEMI patients fluctuated over the years, it fell significantly for NSTEMI patients (p=0.001) (Figure 5.3.4).

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

STEMI				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
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	27.9	9.6	8.4-10.9
2015	249	30.4	11.0	9.7-12.4
2016	208	25.0	8.9	7.7-10.1
2017	273	29.6	11.1	9.8-12.4
2018	206	24.5	8.1	7.0-9.2
P for trend	-	-	0.141	-
NSTEMI				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2009	444	43.5	11.1	10.1-12.2
2010	397	41.8	9.0	8.1-9.9
2011	306	36.8	6.3	5.6-7.0
2012	306	37.1	5.3	4.7-5.9
2013	274	34.9	4.5	4.0-5.0
2014	303	38.6	4.6	4.1-5.2
2015	338	41.2	4.9	4.4-5.4
2016	316	37.9	4.3	3.8-4.8
2017	335	36.3	4.1	3.6-4.5
2018	333	39.5	4.1	3.7-4.5
P for trend	-	-	0.001	-

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

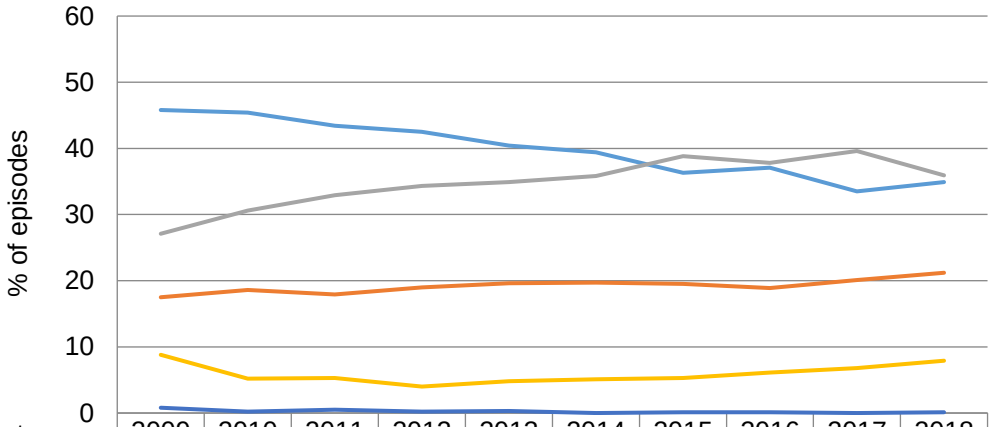


5.4 Symptoms

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

Most of the patients experienced typical symptoms of AMI in the 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 45.8% in 2009 to 34.9% in 2018. The proportion of patients with other symptoms that were neither typical nor atypical, rose from 27.1% in 2009 to 35.9% in 2018. STEMI patients were likely to have typical symptoms, whereas NSTEMI patients tended to have non-typical symptoms[12]. The drop in the proportion of patients with typical symptoms was likely caused by the drop in proportion of STEMI patients over the years (Table 5.1.8).

Figure 5.4.1: Type of AMI symptoms (%)



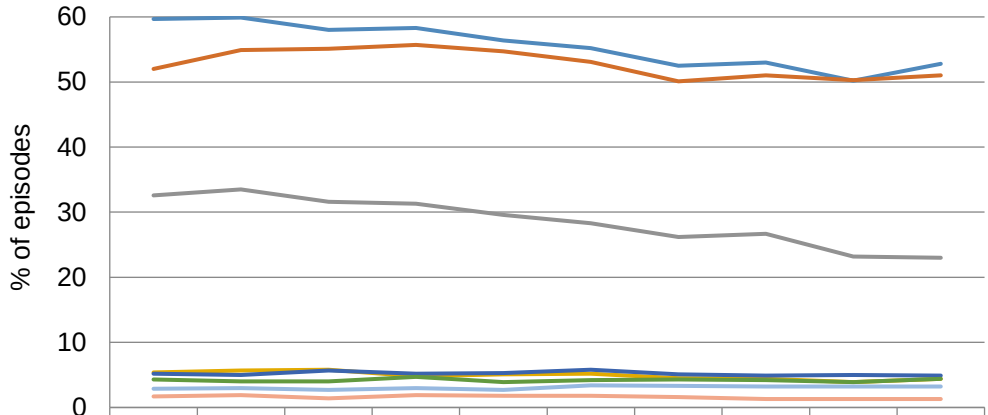
Year of onset	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Typical	45.8	45.4	43.4	42.5	40.4	39.4	36.3	37.1	33.5	34.9
Atypical	17.5	18.6	17.9	19.0	19.6	19.7	19.5	18.9	20.1	21.2
Others	27.1	30.6	32.9	34.3	34.9	35.8	38.8	37.8	39.6	35.9
None	8.8	5.2	5.3	4.0	4.8	5.1	5.3	6.1	6.8	7.9
Insufficient data	0.8	0.2	0.5	0.2	0.3	0.0	0.1	0.1	0.0	0.1

[12] 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 across the years, the three most common presenting symptoms of AMI were chest pain, breathlessness and diaphoresis. While about half of the patients had chest pain (52.8%) and breathlessness (51.0%) accompanying onset of AMI in 2018, about a quarter of them (23.0%) had diaphoresis (Figure 5.4.2). The proportions of patients with chest pain and diaphoresis dropped gradually over the years. As STEMI patients are more likely to experience these two symptoms compared to NSTEMI patients, the drop in proportion of STEMI patients (Table 5.1.8) likely resulted in the drop in proportions of patients who encountered chest pain and diaphoresis over the 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 of AMI (%)



Year of onset	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Chest pain	59.7	59.9	58.0	58.3	56.4	55.2	52.5	53.0	50.2	52.8
Breathlessness	52.0	54.9	55.1	55.7	54.7	53.1	50.1	51.0	50.3	51.0
Diaphoresis	32.6	33.5	31.6	31.3	29.6	28.3	26.2	26.7	23.2	23.0
Epigastric pain	5.4	5.7	5.8	4.8	5.1	5.2	4.5	4.4	3.9	4.4
Back pain	5.2	5.0	5.7	5.2	5.3	5.8	5.1	4.9	5.0	4.9
Shoulder pain	4.3	4.0	4.0	4.7	3.9	4.2	4.3	4.2	3.9	4.4
Jaw pain	2.9	3.0	2.7	3.0	2.7	3.4	3.3	3.2	3.2	3.2
Syncope	1.7	1.9	1.4	1.9	1.8	1.8	1.6	1.3	1.3	1.3

5.5 Risk Factors

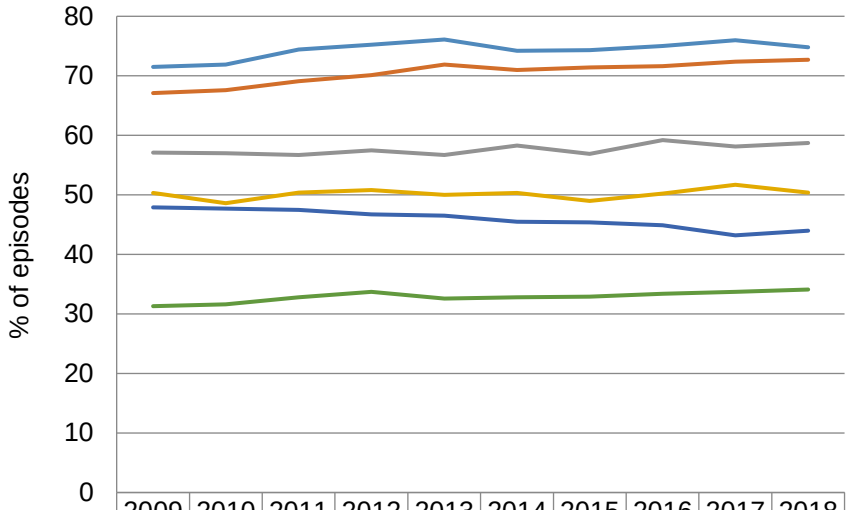
Hypertension, hyperlipidemia, diabetes, overweight and smoking are well established modifiable risk factors of AMI[13]. Hypertension, hyperlipidemia and diabetes were defined as positive if there was history of the condition or if it was newly diagnosed during index admission. Overweight referred to body mass index (BMI) of 23 kg/m^2 and above as increased risk for cardiovascular disease and diabetes was found among Asian populations with this BMI range[14]. Smoking included former and current smoker. Past AMI or revascularisation (CABG or PCI) included history of AMI and revascularisation done for any heart disease. As a patient could have multiple risk factors, the percentages in Figure 5.5.1 will not add up to 100% for each year.

Hypertension and hyperlipidemia were consistently the two most common risk factors among AMI patients across the years (Figure 5.5.1). 74.8% of the patients had hypertension and 72.7% had hyperlipidemia in 2018. Overweight, diabetes and smoking were also prevalent among AMI patients, with 58.7%, 50.4% and 44.0% of them being overweight, diabetic and smokers respectively in 2018. The proportions of patients with hypertension, hyperlipidemia, overweight and history of AMI or revascularisation rose slightly over the years, while the proportion of patients who smoked dropped slightly.

As NSTEMI patients tend to be older (Table 5.1.9a and 5.1.9b), hypertension, diabetes, hyperlipidemia and history of AMI or revascularisation were more prevalent among NSTEMI than STEMI patients (Figure 5.5.2). However, overweight and smoking were more prevalent among STEMI patients.

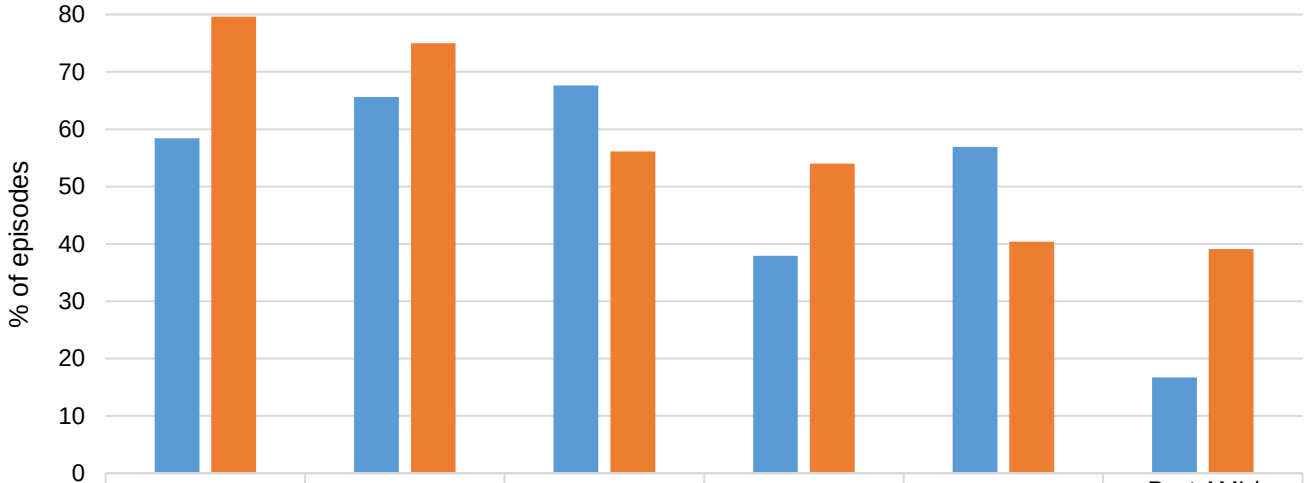
[13] Salim Y et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. Lancet 2014; 364: 937-952.
[14] WHO expert consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004; 363: 157-163.

Figure 5.5.1: Risk factors of AMI (%)



Year of onset	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Hypertension	71.5	71.9	74.4	75.2	76.1	74.2	74.3	75.0	76.0	74.8
Hyperlipidemia	67.1	67.6	69.1	70.1	71.9	71.0	71.4	71.6	72.4	72.7
Overweight	57.1	57.0	56.7	57.5	56.7	58.3	56.9	59.2	58.1	58.7
Diabetes	50.3	48.6	50.4	50.8	50.0	50.3	49.0	50.2	51.7	50.4
Smoking	47.9	47.7	47.5	46.7	46.5	45.5	45.4	44.9	43.2	44.0
Past AMI / revascularisation	31.3	31.6	32.8	33.7	32.6	32.8	32.9	33.4	33.7	34.1

Figure 5.5.2: Risk factors (%) by AMI subtype in 2018



	Hypertension	Hyperlipidemia	Overweight	Diabetes	Smoking	Past AMI / revascularisation
STEMI	58.4	65.6	67.6	37.9	56.9	16.7
NSTEMI	79.6	75.0	56.1	54.0	40.4	39.1

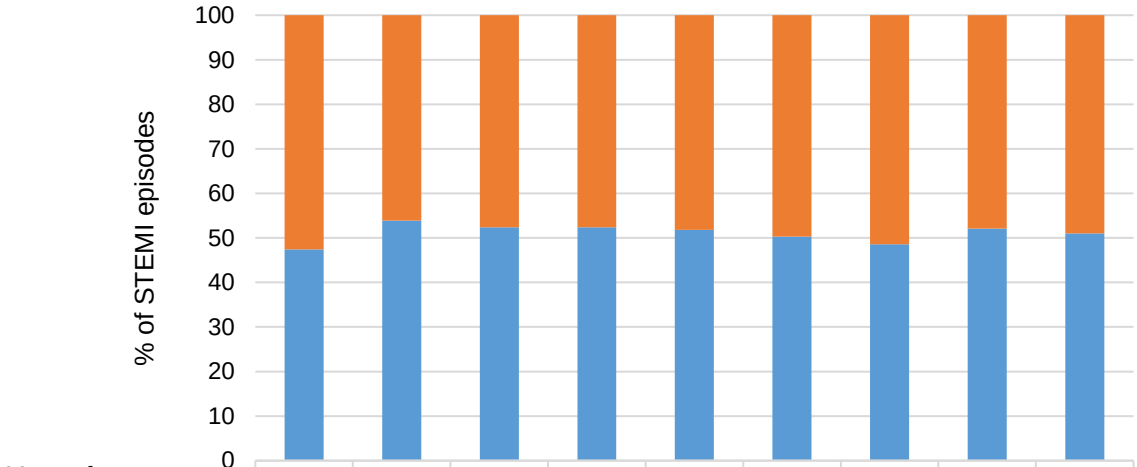
Door-to-Balloon Time

Door-to-balloon (DTB) time refers to the time from the first medical contact to the start of primary PCI (first device time). The timeliness of hospitals in treating STEMI through primary PCI is indicated by the DTB time. Imprecise recording of the time of first medical contact and the start time of primary PCI by the hospitals will affect the accuracy of DTB time. The targeted DTB time recommended by the American Heart Association is within 90 minutes[15].

Studies have shown that direct ambulance admission to the catheterisation laboratory significantly reduces DTB time[16]. There are two main types of ambulance in Singapore: SCDF public emergency ambulance and non-SCDF private non-emergency ambulance. The utilisation of SCDF ambulance was captured by the SMIR from 2010 onwards.

The utilisation of SCDF ambulance among STEMI patients fluctuated at around 50% over the years (Figure 5.6.1). Non-SCDF transport included non-SCDF private ambulance, public transport, personal private transport and walk-in.

Figure 5.6.1: Mode of arrival (%) among STEMI



Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018
Non-SCDF transport	52.6	46.1	47.6	47.6	48.2	49.7	51.4	47.9	49.0
SCDF ambulance	47.4	53.9	52.4	52.4	51.8	50.3	48.6	52.1	51.0

[15] 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.

[16] Dorsch MF et al. Direct ambulance admission to the cardiac catheterization laboratory significantly reduces door-to-balloon times in primary percutaneous coronary intervention. American Heart Journal 2008; 155(6): 1054-1058.

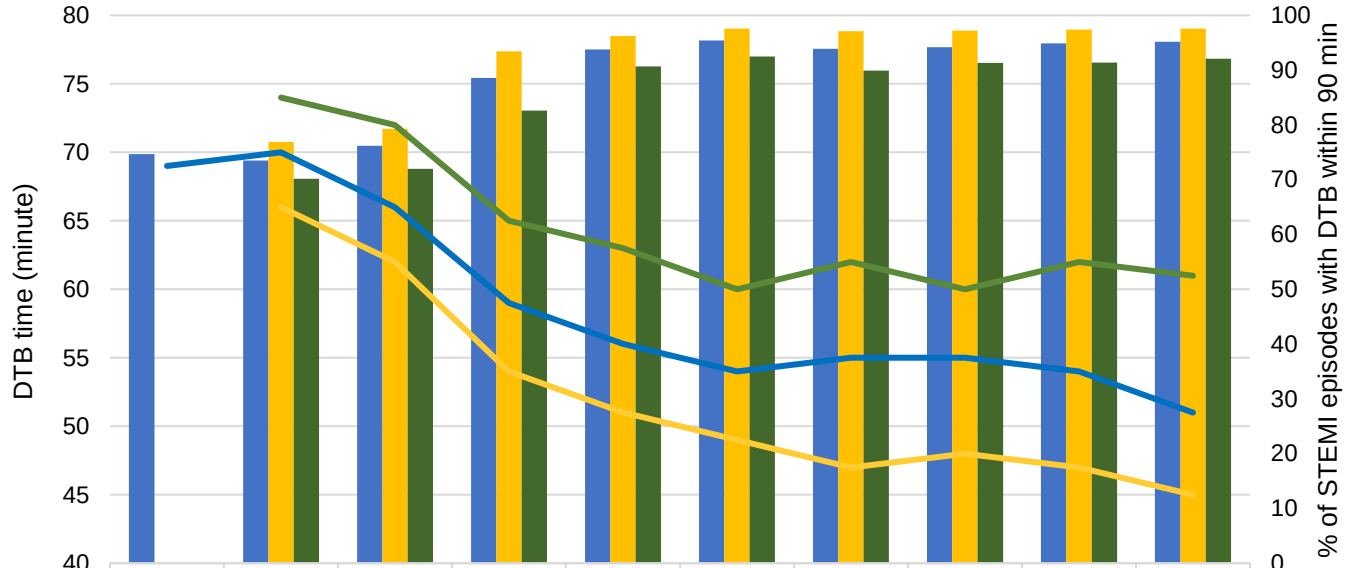
Patients who were admitted for a non-AMI condition but developed AMI during hospitalisation, patients who were transferred from another hospital, and patients who experienced non-system delays[17], were excluded from the calculation of DTB time. These exclusion criteria were applied as the DTB time would be abnormally short or long under such scenarios.

The median DTB time improved from 69 (IQR 54 – 91) minutes in 2009 to 51 (IQR 41 – 66) minutes in 2018 among STEMI patients (Figure 5.6.2). Similarly, the proportion of STEMI patients with DTB time of 90 minutes or less improved from 74.7% in 2009 to 95.2% in 2018. This improvement was driven by the efficiency in the healthcare delivery system comprising of the early response teams and hospitals. For example, acute hospitals within the National University Health System cluster has been collaborating by having a joint manpower support in the delivery of primary PCI within the western region of Singapore to ensure that STEMI patients receive timely medical attention.

The median DTB time was consistently shorter for STEMI patients who utilised the SCDF ambulance (45 minutes in 2018) than those who relied on other modes of transport (61 minutes in 2018) across the years. Similarly, the proportion of STEMI patients with DTB time of 90 minutes or less was consistently higher among those who arrived at the hospital via the SCDF ambulance (97.6% in 2018) than those who arrived via other modes of transport (92.1% in 2018) across the years. When a STEMI diagnosis is determined in the pre-hospital setting through the SCDF emergency medical system and the patient is triaged for a primary PCI, he/she will bypass the Emergency Department upon arrival at the hospital and be transported directly to the catheterisation laboratory, thereby saving DTB time, which translates to reduction in mortality[18].

[17] The SMIR only started collecting this variable from 2012 onwards.
Non-system delay refers to delay in 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 primary PCI due to hospital's system. It includes: delay in the process leading to the start of primary PCI, catheterisation laboratory being occupied, procedure difficulty, uptriage, missed diagnosis, unknown reason.
[18] Nallamothu BK et al. Relation between door-to-balloon times and mortality after primary percutaneous coronary intervention over time: a retrospective study. Lancet 2015; 385(9973): 1114-1122.

Figure 5.6.2: DTB time by mode of arrival among STEMI



Year of onset	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Overall DTB time within 90 min (%)	74.7	73.5	76.2	88.6	93.8	95.4	93.9	94.2	94.9	95.2
SCDF DTB time within 90 min (%)		76.9	79.3	93.4	96.2	97.6	97.1	97.2	97.4	97.6
Non-SCDF DTB time within 90 min (%)		70.2	72.0	82.6	90.7	92.5	89.9	91.3	91.4	92.1
Overall median DTB time (min)	69	70	66	59	56	54	55	55	54	51
SCDF median DTB time (min)		66	62	54	51	49	47	48	47	45
Non-SCDF median DTB time (min)		74	72	65	63	60	62	60	62	61

6. CONCLUSION

The top contributor to the combined burden of early death and disability in Singapore was cardiovascular diseases and they accounted for 14.2% of the total disability-adjusted life years in 2017[19]. It is therefore important for individuals with high risk of AMI to take preventive action. One can reduce his/her chances of developing AMI by adopting a healthy lifestyle, such as eating all food in moderation and opting for healthier products, exercising and maintaining a healthy weight, avoiding smoking, going for health screening and follow-ups, and controlling blood pressure, cholesterol and glucose levels well. For individuals with symptoms of AMI, seeking medical help promptly plays a crucial role in prognosis. For individuals who survived an AMI, adherence to medication and healthy lifestyle can reduce the risk of subsequent cardiovascular event and death.

[19] The Burden of Disease in Singapore, 1990-2017. Ministry of Health, Singapore.