Singapore Myocardial Infarction Registry Annual Report 2019

National Registry of Diseases Office
30 Jul 2021

Acknowledgement

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

Registry Coordinators	Ms Yvonne Yeo Ms Halimahton Abdul Kadir Ms Li Yuan Ms Linda Ho Ms Ng Keat Siew Ms Wendy Loke
Data Manager	Mr Eric Lee
Biostatistician	Ms Zheng Huili
Deputy Director	Dr Foo Ling Li
Group Director	Dr Annie Ling

Contents

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
MHA	Ministry of Home Affairs
MOH	Ministry of Health
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 7,344 episodes in 2010 to 12,533 episodes in 2019. The age-standardised incidence rate (ASIR) also increased significantly from 194.5 to 228.9 per 100,000 population during this period.

The number of AMI deaths was 982 in 2019, a drop compared to 1,021 in 2010. Similarly, the age-standardised mortality rate (ASMR) declined significantly from 26.1 to 16.2 per 100,000 population during this period. A notable decrease in the 30-day case fatality rate (CFR) from 13.8% in 2010 to 8.4% in 2019, was also observed.

The proportions of patients experiencing typical symptoms of AMI were higher in the earlier years. However, the proportions of patients experiencing symptoms that were non-typical became more common in later years. Across the decade, it was consistently observed that the two most common presenting symptoms of AMI were chest pain and breathlessness. In 2019, approximately half of the AMI patients experienced these symptoms (chest pain: 52.4%, breathlessness: 49.4%). The proportion of patients with chest pain and those with breathlessness dropped over the years.

Between 2010 and 2019, hypertension and hyperlipidemia were consistently noted to be the two most common risk factors among AMI patients. The proportion of patients with hypertension as well as those with hyperlipidemia rose over the years. In 2019, it was found that 75.3% of the AMI patients had hypertension while 73.4% had hyperlipidemia.

The median door-to-balloon (DTB) time improved from 70 minutes in 2010 to 53 minutes in 2019. The proportion of ST-segment elevation myocardial infarction (STEMI) patients with DTB time of 90 minutes or less improved from 73.5% in 2010 to 96.8% in 2019. The median DTB time was consistently shorter for STEMI patients who utilised the Singapore Civil Defence Force (SCDF) ambulance (47 minutes in 2019) than those who relied on other modes of transport (60 minutes in 2019) across the years. The proportion of STEMI patients with DTB time of 90 minutes or less was consistently observed to be higher among those who arrived at the hospital via the SCDF ambulance (98.1% in 2019) than those who arrived via other modes of transport (95.0% in 2019) across the years.

3. INTRODUCTION

Ischaemic heart disease was the third most common cause of death in 2019, accounting for 18.8% 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 treatments for AMI. There are two main types of AMI - STEMI and NSTEMI. STEMI is more severe, while NSTEMI is more prevalent.

The common risk factors of AMI are hypertension, hyperlipidemia, diabetes, obesity, smoking and old age. The median age of Singapore residents rose from 37.4 years in 2010 to 41.1 years in 2019[2]. With Singapore's rapidly ageing population, the incidence of AMI is expected to rise. 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. www.moh.gov.sg/resources-statistics/singapore-health-facts/principal-causes-of-death Accessed on 1 Mar 2021.
[2] Population Trends 2020. Department of Statistics, Singapore. www.singstat.gov.sg/-/media/files/publications/population/population2020.pdf Accessed on 1 Mar 2021.

4. METHODOLOGY

The National Registry of Diseases Office (NRDO) collects and analyses epidemiological data to support policy planning and review as well as 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 MediClaim list and Casemix and 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 there. 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).

AMIs are broadly classified into STEMI and NSTEMI based on the documentation by doctors in the patients' medical records. There is a small group of patients (<10%) without documentation of STEMI or NSTEMI. This group of patients usually died out-of-hospital or soon after arrival at the hospitals, before the doctors could diagnose if the AMI was a STEMI or NSTEMI. 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 Heart Association[3]. For type 2 AMI, they were eventually combined with NSTEMI in this report as their clinical characteristics are similar[4].

[3] American College of Cardiology Foundation. Universal definition of myocardial infarction. Journal of the American College of Cardiology 2007; 50(22): 2173-2195.
[4] Stein YG et al. Type-II myocardial infarction – patient characteristics, management and outcomes. PLoS One 2014; 9(1): e84285.

Cases that were transfers between hospitals were merged to avoid multiple counting of the same AMI episode. As the registry moves towards automated data collection and ceased collection of ECG data from 2019 onwards, recurring AMI within 28 days of a preceding episode is no longer merged with the preceding episode unlike earlier years. Fewer than 2% of the AMI patients had another AMI within 28 days in each year prior to 2019.

The death status of all patients registered in the SMIR were updated till 30 November 2020 by matching the patients' NRIC number with the death information from the MHA.

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[5]. The Segi World population estimates used for age standardisation are available on the World Health Organisation website[6].

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. 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. 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, divided by the number of AMI episodes in the same year. This indicator reflects the severity of AMI, the timeliness of healthcare delivery and the effectiveness of AMI treatment.

[5] SingStat Table Builder, Population and Population Structure, Annual Population, Singapore Residents by age group, ethnic group and sex. Department of Statistics, Singapore. tablebuilder.singstat.gov.sg/publicfacing/mainMenu.action. Accessed on 1 Mar 2021.
[6] 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.

This report focuses on Singapore residents, aged 15 years or above, diagnosed with AMI in the past decade, from 2010 to 2019 as they stood on 16 February 2021. All findings in this report, except mortality and case fatality, were based on AMI episodes.

5. FINDINGS

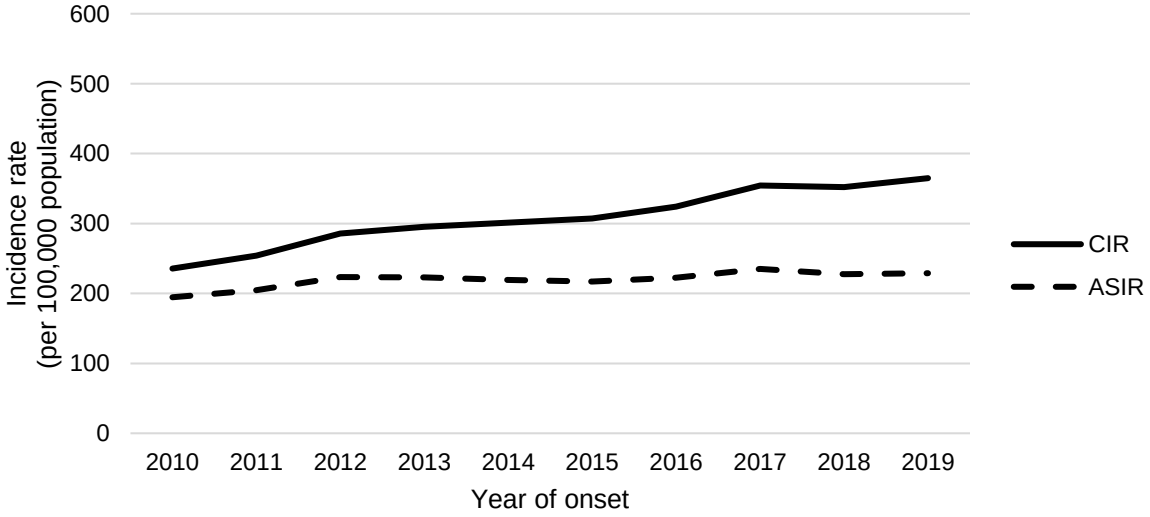
5.1 Incidence

The number of AMI episodes increased from 7,344 episodes in 2010 to 12,533 episodes in 2019 (Table 5.1.1). Similarly, the crude incidence rate (CIR) increased significantly from 235.6 per 100,000 population in 2010 to 364.8 per 100,000 population in 2019 (p<0.001) (Figure 5.1.1). Even after accounting for Singapore's ageing population, the ASIR increased significantly from 194.5 per 100,000 population in 2010 to 228.9 per 100,000 population in 2019 (p=0.005).

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

Year of onset	Number	CIR	95% CI	ASIR	95% CI
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	11949	354.4	348.1-360.8	235.0	230.7-239.3
2018	11982	352.1	345.8-358.4	227.4	223.3-231.6
2019	12533	364.8	358.5-371.2	228.9	224.8-233.0
P for trend	-	<0.001	-	0.005	-

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



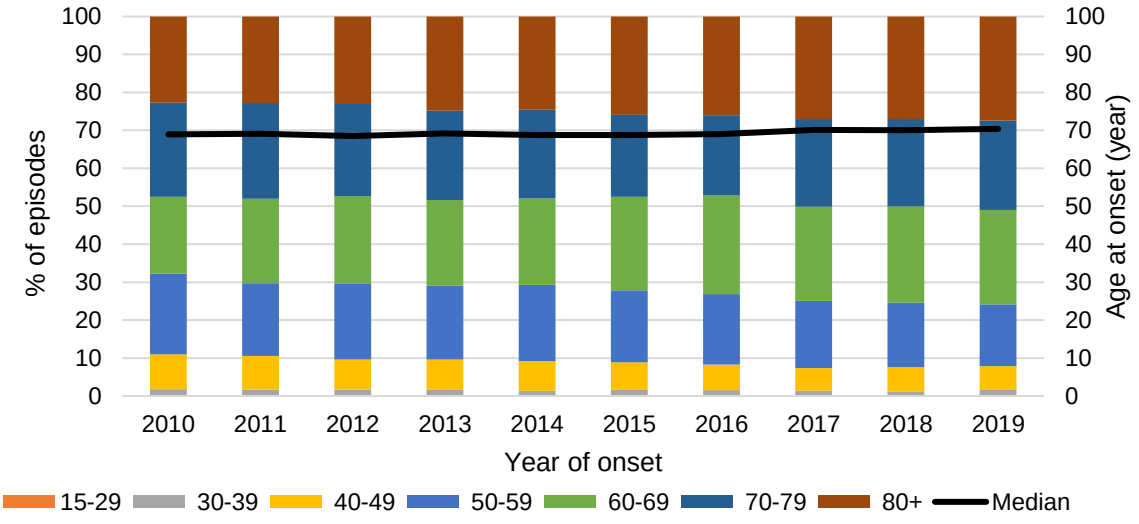
The median age at onset of AMI increased slightly from 68.9 years in 2010 to 70.4 years in 2019 (Table 5.1.2). About 3 in 4 of the patients were aged 60 years or above in 2019 (Figure 5.1.2).

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	%
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	70.0	15	0.1	132	1.1	766	6.4
2019	70.4	22	0.2	178	1.4	782	6.2

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	2768	23.2	3224	27.0
2018	2035	17.0	3040	25.4	2761	23.0	3233	27.0
2019	2049	16.3	3113	24.8	2948	23.5	3441	27.5

Figure 5.1.2: Age distribution at onset of AMI



The age-specific incidence rate of AMI 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 seen in all age groups, except those aged 70-79 years (Table 5.1.3). The rise in incidence rate was fastest among those aged 80 years or 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
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	348.1-360.8	2.0	1.0-3.0	27.9	23.6-32.2	113.8	105.4-122.3
2018	352.1	345.8-358.4	1.9	1.0-2.9	22.6	18.7-26.4	125.3	116.4-134.1
2019	364.8	358.5-371.2	2.9	1.7-4.1	30.0	25.6-34.4	127.7	118.7-136.6
P for trend	<0.001	-	0.023	-	0.004	-	0.015	-
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
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	1309.1	1260.3-1357.8	3183.4	3073.5-3293.3
2018	331.8	317.4-346.2	628.4	606.0-650.7	1206.3	1161.3-1251.3	3024.9	2920.6-3129.2
2019	336.8	322.2-351.3	622.4	600.6-644.3	1204.6	1161.1-1248.1	2975.2	2875.8-3074.6
P for trend	0.001	-	0.007	-	0.817	-	0.001	-

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

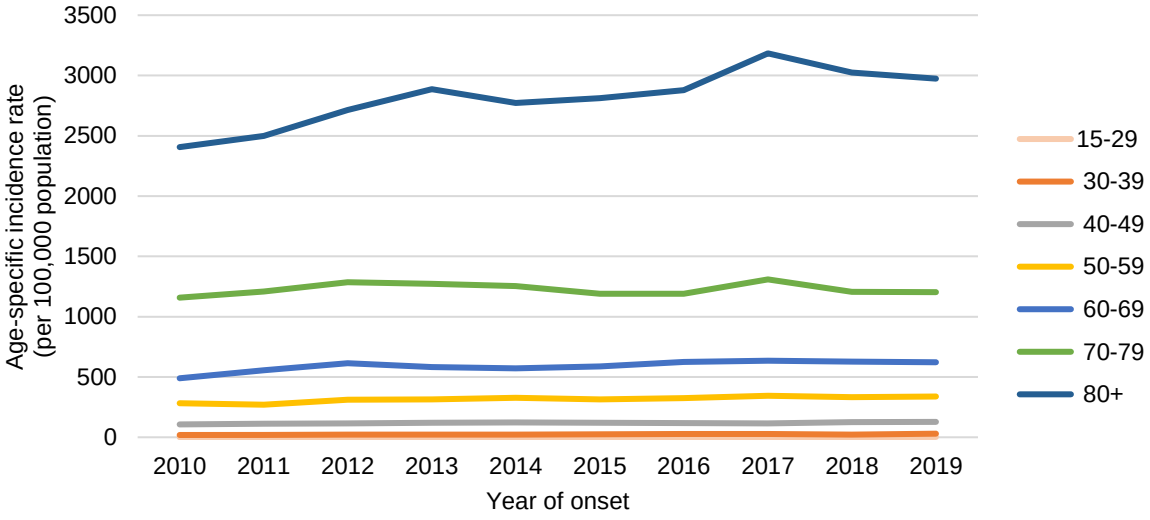
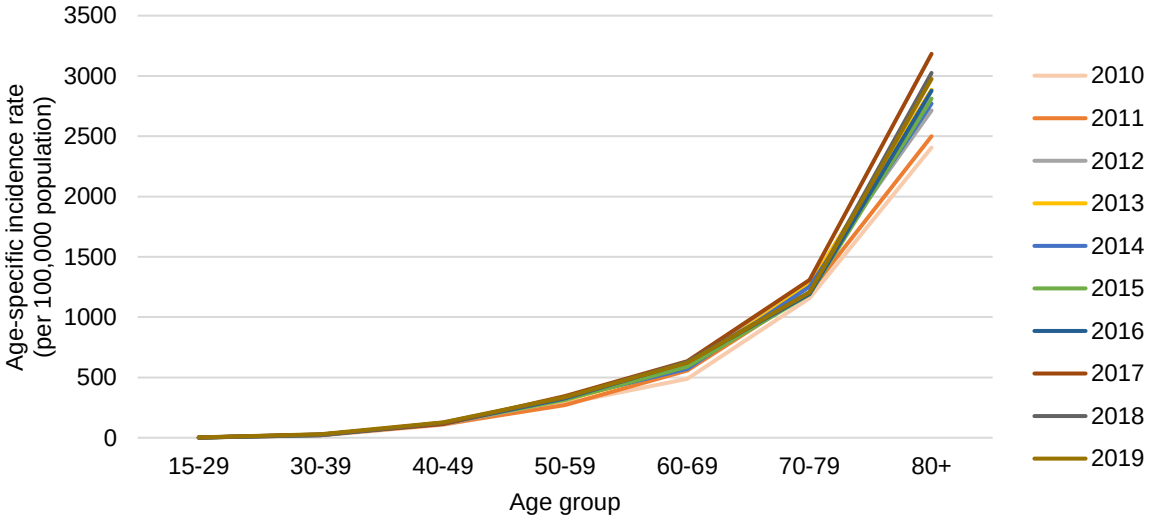


Figure 5.1.3b: Age-specific incidence rate of AMI (per 100,000 population) across age groups



Although gender distribution was almost equal in the general population, there were more males suffering from AMI than females (Table 5.1.4). The ASIRs for males were consistently higher than females across the years (Figure 5.1.4). Males had an ASIR of 335.4 per 100,000 population, while females had an ASIR of 131.0 per 100,000 population in 2019. The rise in ASIR over the years was significant for males (p=0.001) but not for females (p=0.230).

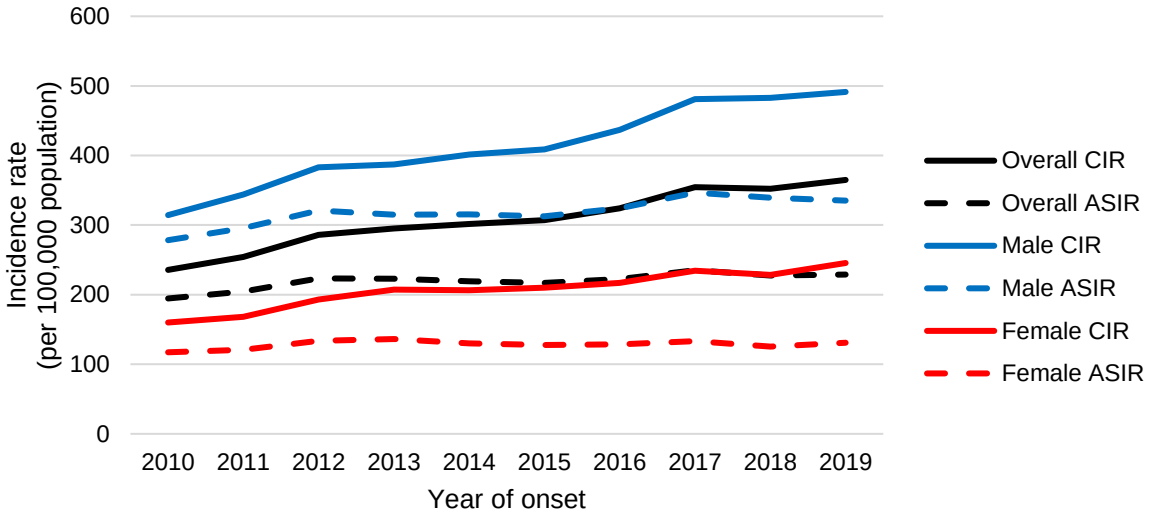
Males were known to have a higher risk of AMI than females. The underlying causes were multifactorial and related to the pathophysiological gender differences in AMI[7]. Furthermore, self-reported age-standardised prevalence of hypertension, hyperlipidemia and diabetes, which are common risk factors of AMI, were higher among males than females in the general population based on the National Population Health Survey 2019[8].

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**
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	7890	66.0	480.9	470.3-491.5	346.6	338.9-354.3
2018	7989	66.7	482.9	472.3-493.5	339.2	331.7-346.7
2019	8195	65.4	491.3	480.7-501.9	335.4	328.0-342.7
P for trend	-	-	<0.001	-	0.001	-
Female						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
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	3993	33.3	228.3	221.2-235.4	125.4	121.4-129.5
2019	4338	34.6	245.5	238.2-252.8	131.0	126.9-135.1
P for trend	-	-	<0.001	-	0.230	-

[7] Mehta LS et al. Acute myocardial infarction in women. Circulation 2016; 133.
[8] National Population Health Survey 2019 (Household Interview). Ministry of Health, Singapore. www.moh.gov.sg/docs/librariesprovider5/default-document-library/nphs-2019-survey-report.pdf Accessed on 1 Mar 2021.

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



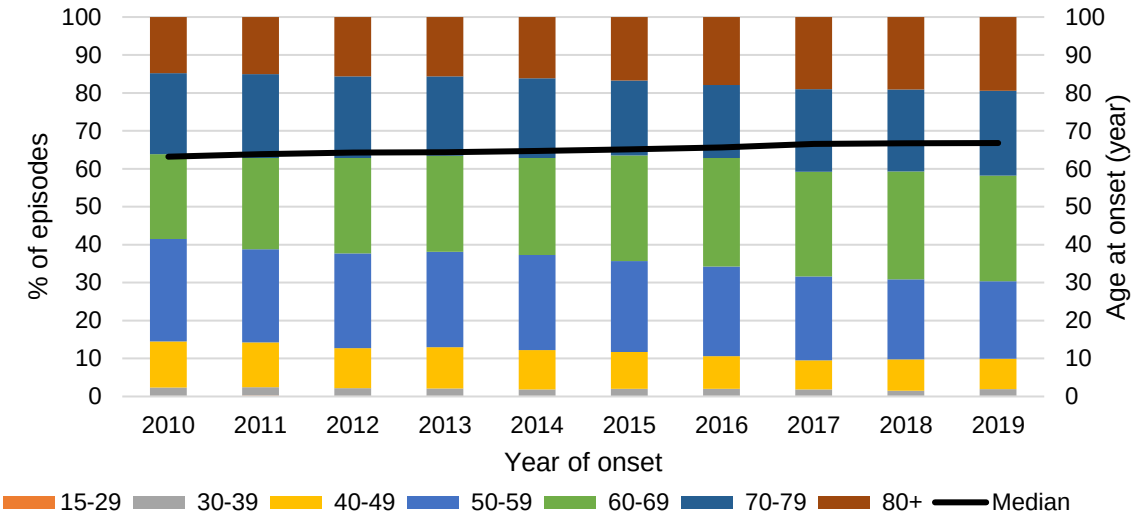
The median age at onset of AMI among males increased slightly from 63.2 years in 2010 to 66.8 years in 2019 (Table 5.1.5a). The highest proportion of male AMI patients in 2019 was among those aged 60-69 years (27.9%) (Figure 5.1.5a).

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	%
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	66.7	12	0.2	112	1.4	661	8.3
2019	66.8	16	0.2	143	1.7	658	8.0

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1716	21.7	1498	19.0
2018	1683	21.1	2270	28.4	1724	21.6	1527	19.1
2019	1672	20.4	2283	27.9	1834	22.4	1589	19.4

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



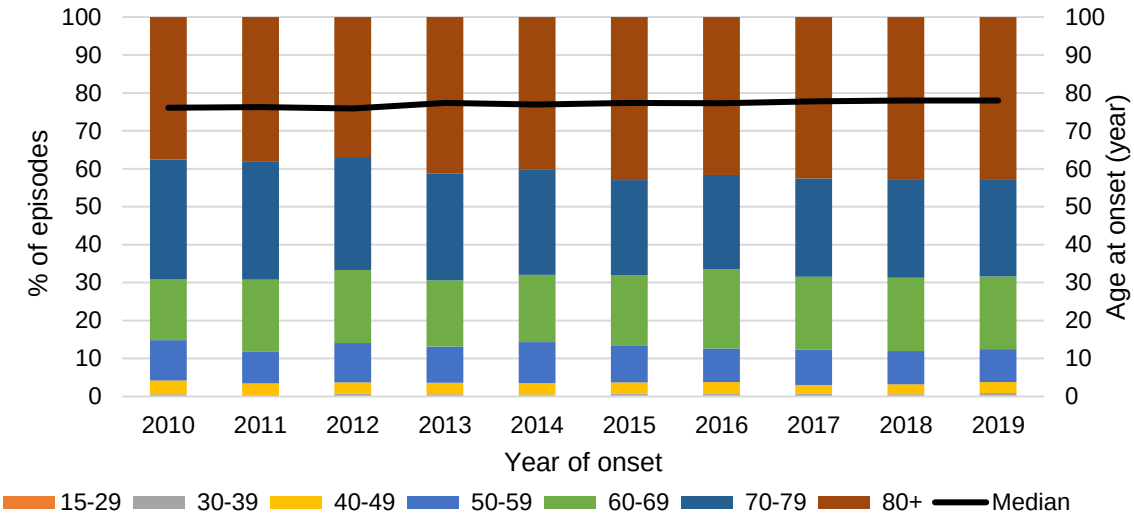
The median age at onset of AMI among females increased slightly from 76.1 years to 78.0 years in 2019 (Table 5.1.5b), about 10 years older than the median age at onset among males (Table 5.1.5a). The highest proportion of female AMI patients in 2019 was among those aged 80 years or above (42.7%) (Figure 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	%
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	78.0	3	0.1	20	0.5	105	2.6
2019	78.0	6	0.1	35	0.8	124	2.9

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	352	8.8	770	19.3	1037	26.0	1706	42.7
2019	377	8.7	830	19.1	1114	25.7	1852	42.7

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 ASIR across the years (Figure 5.1.6). The ASIRs were 180.3, 458.5 and 442.9 per 100,000 population for Chinese, Malays and Indians respectively in 2019. The rise in ASIR over the years was significant for all the three ethnic groups (Chinese: p=0.005, Malays: p=0.034, Indians: p=0.020).

Self-reported age-standardised prevalence of hypertension, hyperlipidemia and diabetes, which are common risk factors of AMI, were generally higher among Malays and Indians than Chinese in the general population based on the National Population Health Survey 2019[9]. Furthermore, Indians have ethnic-specific risk for coronary artery disease[10]. 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 ASIRs, relative to Chinese.

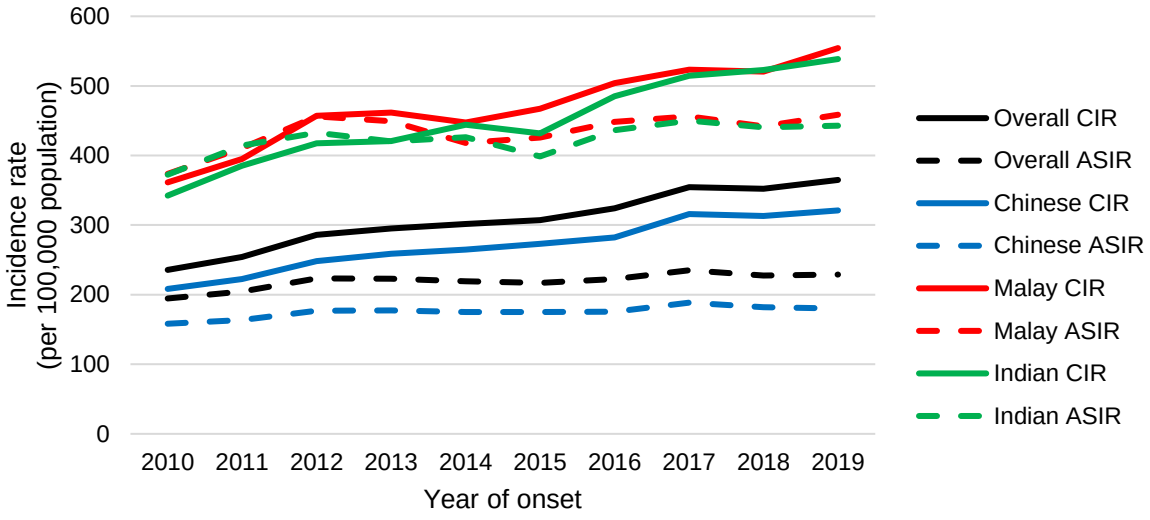
[9] National Population Health Survey 2019 (Household Interview). Ministry of Health, Singapore. www.moh.gov.sg/docs/librariesprovider5/default-document-library/nphs-2019-survey-report.pdf Accessed on 1 Mar 2021.

[10] 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**
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	8047	67.2	313.2	306.4-320.1	182.0	177.9-186.1
2019	8325	66.4	321.0	314.2-327.9	180.3	176.3-184.4
P for trend	-	-	<0.001	-	0.005	-
Malay						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2010	1414	19.3	361.4	342.5-380.2	373.6	353.4-393.8
2011	1568	19.6	394.9	375.3-414.4	410.4	389.3-431.5
2012	1842	20.2	457.1	436.2-477.9	456.1	434.7-477.5
2013	1888	19.8	461.8	441.0-482.7	449.1	428.4-469.8
2014	1855	18.9	447.5	427.1-467.9	417.9	398.5-437.3
2015	1962	19.4	467.0	446.4-487.7	425.9	406.7-445.2
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	2265	18.9	520.3	498.9-541.8	441.7	423.3-460.1
2019	2434	19.4	554.3	532.3-576.3	458.5	440.1-477.0
P for trend	-	-	<0.001	-	0.034	-
Indian						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2010	935	12.7	342.4	320.4-364.3	372.4	347.8-397.0
2011	1063	13.3	385.4	362.3-408.6	414.3	388.5-440.1
2012	1165	12.8	417.7	393.7-441.7	432.8	407.3-458.3
2013	1183	12.4	420.7	396.7-444.7	420.4	395.9-444.8
2014	1260	12.8	444.0	419.5-468.5	426.3	402.3-450.2
2015	1235	12.2	431.7	407.6-455.8	398.5	375.9-421.1
2016	1399	12.9	485.0	459.6-510.4	436.4	413.2-459.6
2017	1499	12.5	514.6	488.5-540.6	450.1	427.1-473.1
2018	1537	12.8	522.6	496.5-548.8	440.4	418.3-462.4
2019	1602	12.8	538.6	512.2-564.9	442.9	421.2-464.5
P for trend	-	-	<0.001	-	0.020	-

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



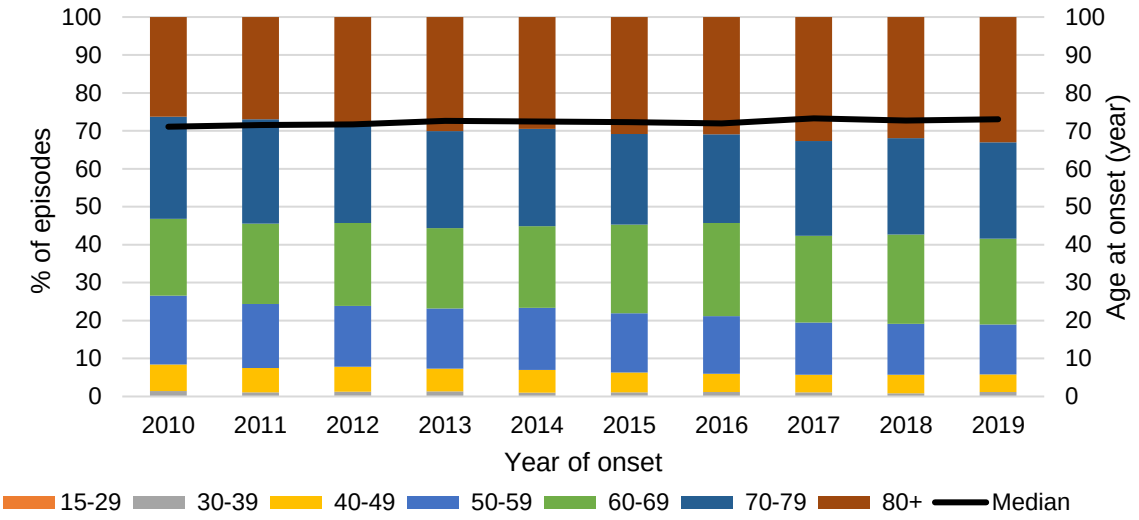
Chinese had the oldest median age at onset of AMI, which increased slightly from 71.1 years in 2010 to 73.1 years in 2019 (Table 5.1.7a). The highest proportion of Chinese AMI patients in 2019 was among those aged 80 years or above (33.0%) (Figure 5.1.7a).

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	%
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	72.7	6	0.1	61	0.8	394	4.9
2019	73.1	10	0.1	86	1.0	391	4.7

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	13.4	1895	23.5	2045	25.4	2567	31.9
2019	1092	13.1	1884	22.6	2117	25.4	2745	33.0

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



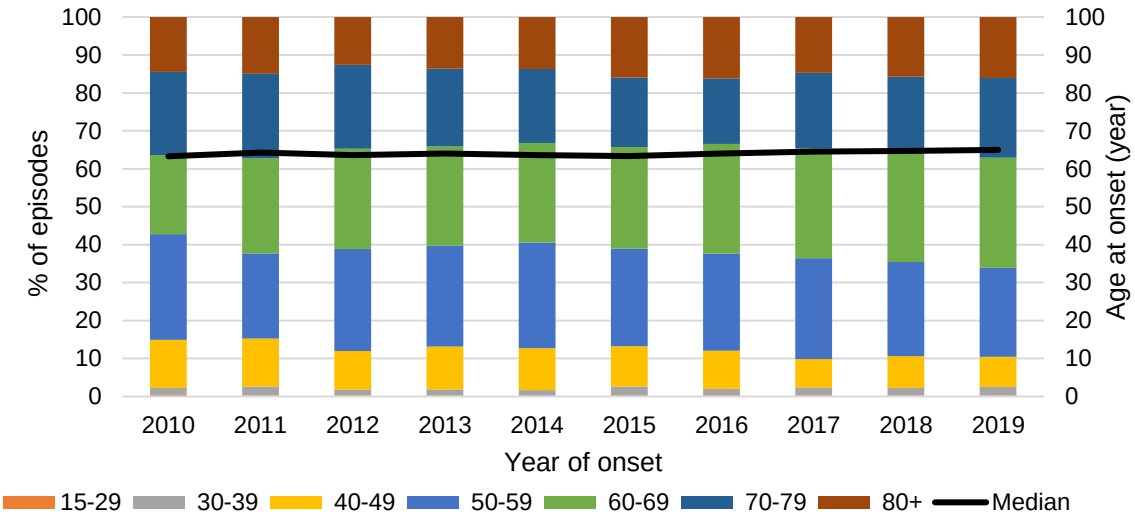
The median age at onset of AMI among Malays increased slightly from 63.3 years in 2010 to 65.0 years in 2019 (Table 5.1.7b). The highest proportion of Malay AMI patients in 2019 was among those aged 60-69 years (29.0%) (Figure 5.1.7b).

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	%
2010	63.3	6	0.4	26	1.8	179	12.7
2011	64.3	4	0.3	37	2.4	199	12.7
2012	63.6	3	0.2	32	1.7	186	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
2019	65.0	7	0.3	54	2.2	193	7.9

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	394	27.9	294	20.8	311	22.0	204	14.4
2011	351	22.4	393	25.1	349	22.3	235	15.0
2012	496	26.9	486	26.4	407	22.1	232	12.6
2013	502	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	505	25.7	524	26.7	359	18.3	314	16.0
2016	549	25.6	622	29.0	369	17.2	348	16.2
2017	598	26.5	653	29.0	450	20.0	331	14.7
2018	562	24.8	659	29.1	447	19.7	356	15.7
2019	572	23.5	706	29.0	511	21.0	391	16.1

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



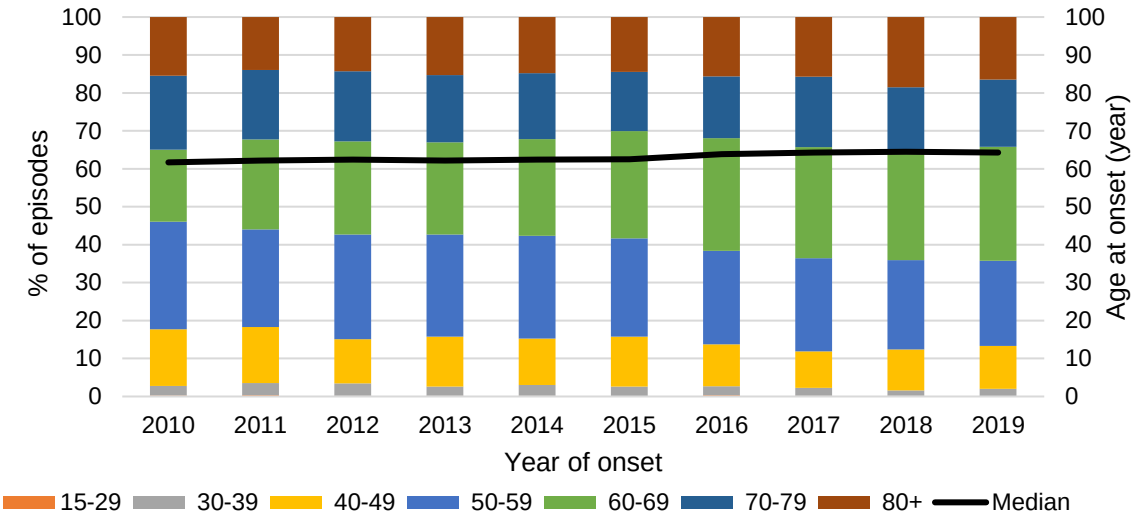
The median age at onset of AMI among Indians increased slightly from 61.7 years in 2010 to 64.3 years in 2019 (Table 5.1.7c). The highest proportion of Indian AMI patients in 2019 was among those aged 60-69 years (30.0%) (Figure 5.1.7c).

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	%
2010	61.7	2	0.2	24	2.6	140	15.0
2011	62.2	4	0.4	34	3.2	157	14.8
2012	62.4	2	0.2	38	3.3	136	11.7
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	144	9.6
2018	64.5	3	0.2	22	1.4	165	10.7
2019	64.3	2	0.1	31	1.9	181	11.3

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	265	28.3	177	18.9	182	19.5	145	15.5
2011	273	25.7	252	23.7	195	18.3	148	13.9
2012	321	27.6	286	24.5	216	18.5	166	14.2
2013	318	26.9	287	24.3	210	17.8	181	15.3
2014	342	27.1	321	25.5	219	17.4	186	14.8
2015	320	25.9	349	28.3	192	15.5	179	14.5
2016	344	24.6	416	29.7	227	16.2	219	15.7
2017	368	24.5	439	29.3	278	18.5	236	15.7
2018	362	23.6	448	29.1	253	16.5	284	18.5
2019	359	22.4	481	30.0	284	17.7	264	16.5

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 ASIRs for NSTEMI were 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[11]. The ASIR for STEMI remained stable at between 52.8 to 57.3 per 100,000 population over the past decade (p=0.111), while the ASIR for NSTEMI increased significantly from 126.4 per 100,000 population in 2010 to 164.4 per 100,000 population in 2019 (p=0.002).

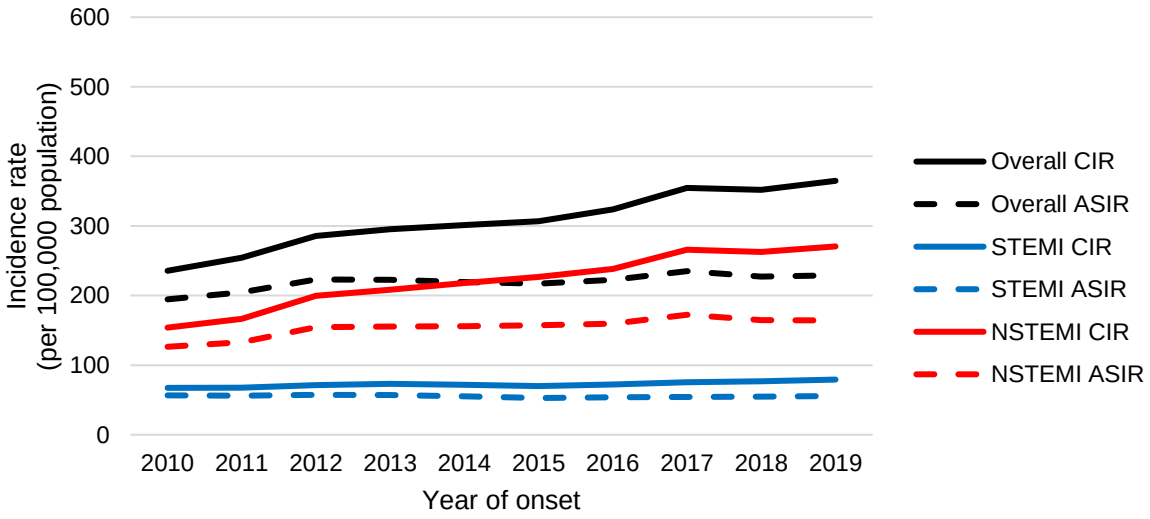
As patients without documentation of STEMI or NSTEMI were excluded from Table 5.1.8, the sum of the percentages for STEMI and NSTEMI will be less than 100% for each year.

[11]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**
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	2608	21.8	76.6	73.7-79.6	54.8	52.7-57.0
2019	2723	21.7	79.3	76.3-82.2	55.6	53.5-57.8
P for trend	-	-	<0.001	-	0.111	-
NSTEMI						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
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	8959	75.0	265.7	260.2-271.2	172.4	168.7-176.0
2018	8941	74.6	262.7	257.3-268.2	164.8	161.3-168.3
2019	9295	74.2	270.6	265.1-276.1	164.4	161.0-167.8
P for trend	-	-	<0.001	-	0.002	-

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



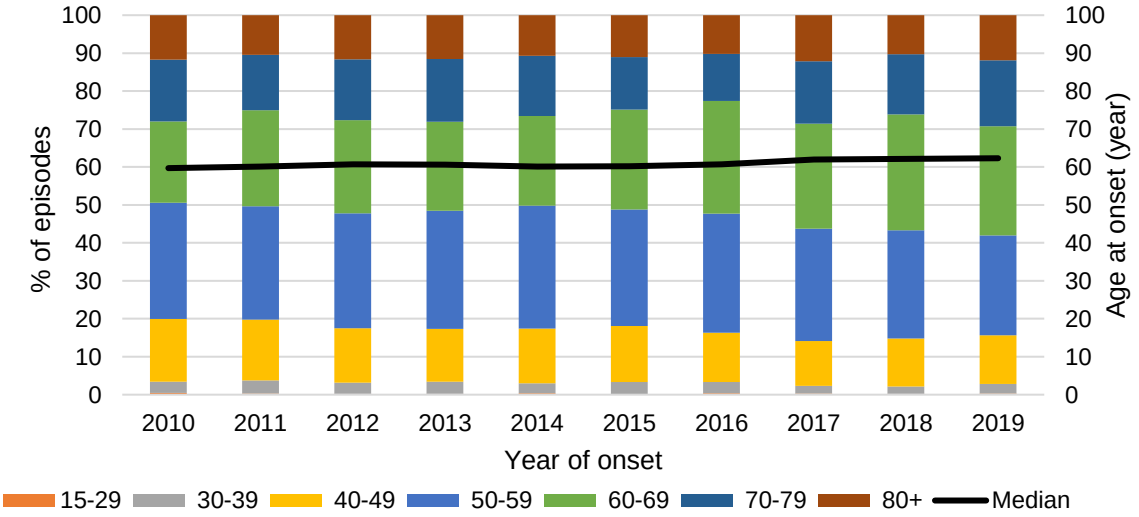
The median age at onset of STEMI increased slightly from 59.7 years in 2010 to 62.3 years in 2019 (Table 5.1.9a). The highest proportion of STEMI patients in 2019 was among those aged 60-69 years (28.8%) (Figure 5.1.9a).

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	%
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
2019	62.3	9	0.3	67	2.5	350	12.9

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	28.5	797	30.6	414	15.9	268	10.3
2019	716	26.3	784	28.8	474	17.4	323	11.9

Figure 5.1.9a: Age distribution at onset of STEMI



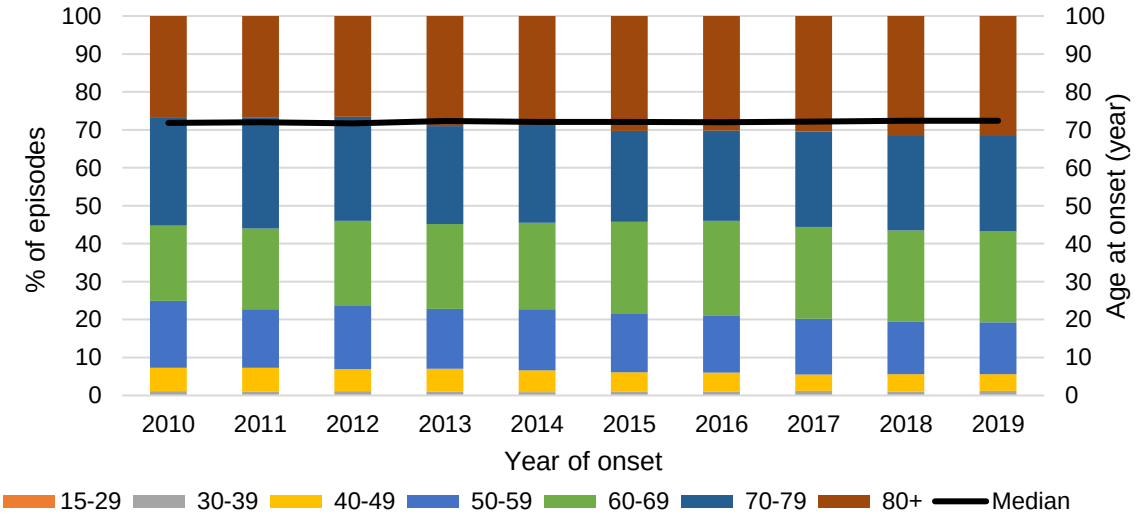
The median age at onset of NSTEMI remained stable at around 72 years (Table 5.1.9b), and it was about 10 years older than the median age at onset of STEMI (Table 5.1.9a). The highest proportion of NSTEMI patients in 2019 was among those aged 80 years or above (31.4%) (Figure 5.1.9b).

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	%
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	72.4	10	0.1	73	0.8	418	4.7
2019	72.4	11	0.1	105	1.1	407	4.4

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	2252	25.1	2725	30.4
2018	1248	14.0	2140	23.9	2247	25.1	2805	31.4
2019	1267	13.6	2228	24.0	2362	25.4	2915	31.4

Figure 5.1.9b: Age distribution at onset of NSTEMI



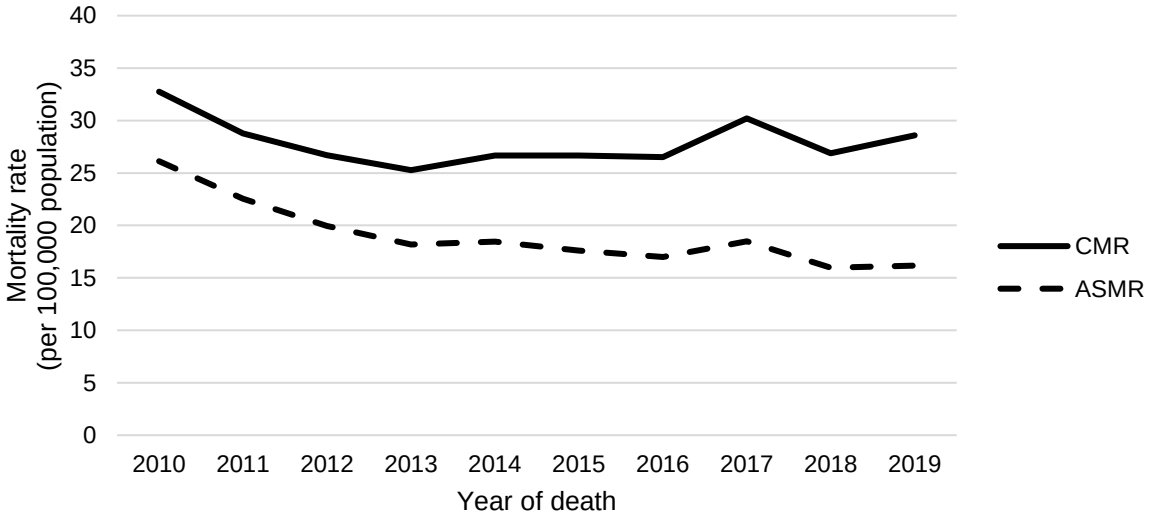
5.2 Mortality

The number of AMI deaths was 982 in 2019, a slight drop compared to 1,021 in 2010 (Table 5.2.1), despite a rise in the number of AMI episodes (Table 5.1.1). Similarly, the crude mortality rate (CMR) dropped slightly from 32.8 per 100,000 population in 2010 to 28.6 per 100,000 population in 2019 (Figure 5.2.1). Accounting for Singapore's ageing population, the drop in ASMR from 26.1 per 100,000 population in 2010 to 16.2 per 100,000 population in 2019 was significant (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
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	915	26.9	25.1-28.6	16.0	14.9-17.0
2019	982	28.6	26.8-30.4	16.2	15.1-17.2
P for trend	-	0.527	-	0.001	-

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



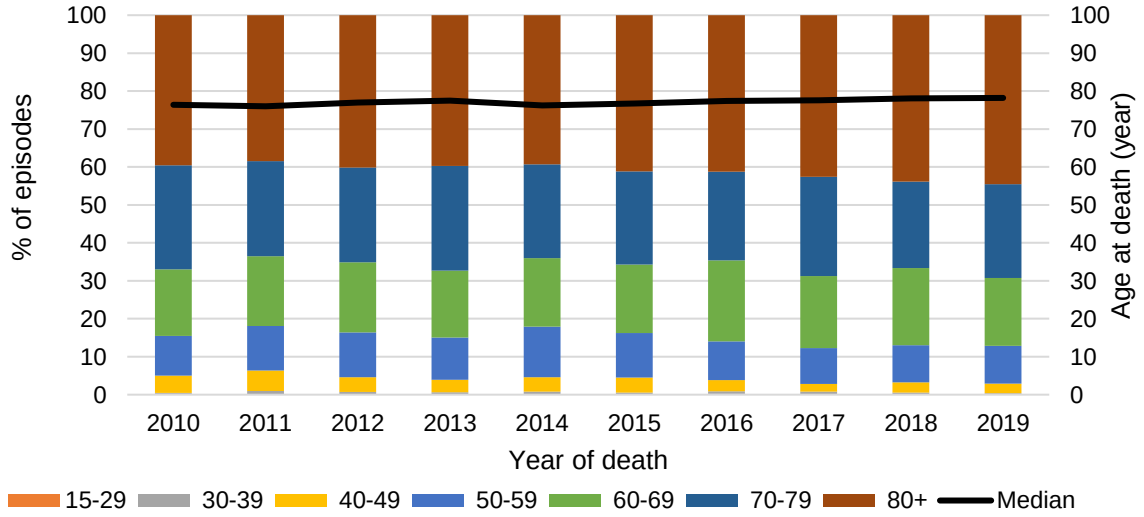
The median age at death increased slightly from 76.4 years in 2010 to 78.2 years in 2019 (Table 5.2.2). About 4 in 10 of the patients who died of AMI in 2019 were aged 80 years or above (Figure 5.2.2).

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	%
2010	76.4	2	0.2	3	0.3	46	4.5
2011	76.0	0	0.0	9	1.0	49	5.4
2012	77.0	1	0.1	5	0.6	33	3.9
2013	77.5	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	77.4	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
2019	78.2	0	0.0	4	0.4	25	2.5

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	9.7	186	20.3	209	22.8	401	43.8
2019	97	9.9	176	17.9	243	24.7	437	44.5

Figure 5.2.2: Age distribution at death of AMI



The age-specific mortality rate of AMI 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 seen in all the age groups aged 40 years or above (Table 5.2.3). The drop in mortality rate was fastest among those aged 80 years or 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
2010	32.8	30.7-34.8	0.3	0-0.6	0.5	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	0-0.4	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	0-0.4	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	0-0.6	1.0	0.2-1.8	4.2	2.6-5.9
2017	30.2	28.3-32.1	0.1	0-0.4	1.2	0.3-2.1	3.4	2.0-4.9
2018	26.9	25.1-28.6	0.0	-	0.9	0.1-1.6	4.1	2.5-5.7
2019	28.6	26.8-30.4	0.0	-	0.7	0.0-1.3	4.1	2.5-5.7
P for trend	0.527	-	-	-	0.746	-	0.004	-
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
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	375.2	338.5-411.9
2019	15.9	12.8-19.1	35.2	30.0-40.4	99.3	86.8-111.8	377.8	342.4-413.3
P for trend	0.018	-	0.003	-	0.002	-	0.010	-

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

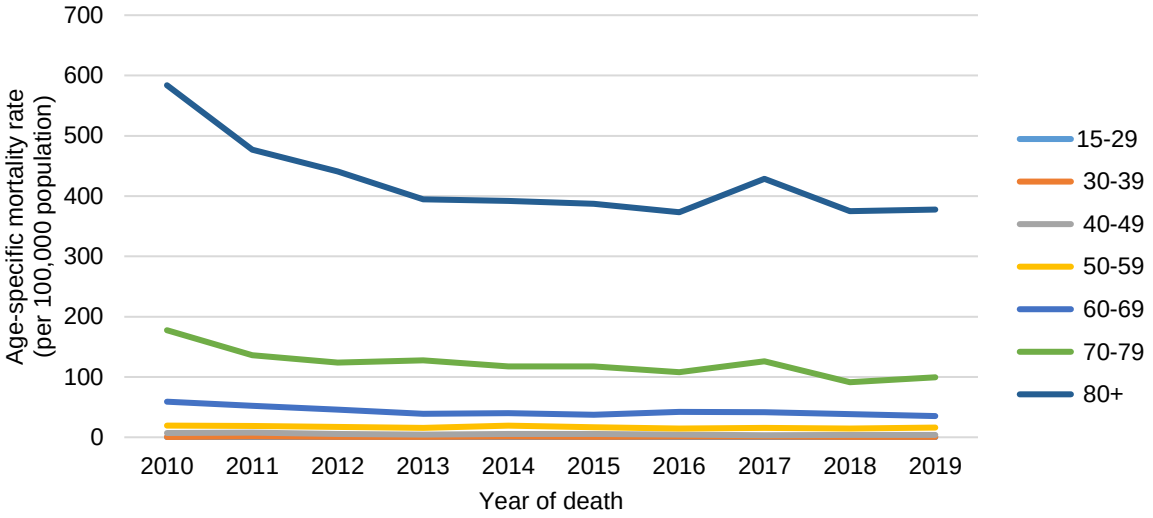
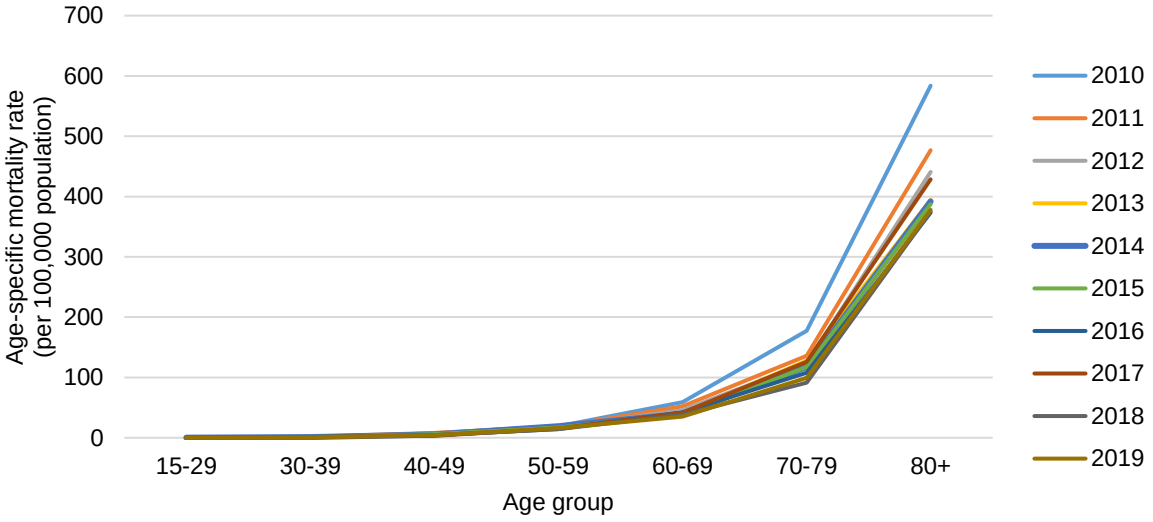


Figure 5.2.3b: Age-specific mortality rate of AMI (per 100,000 population) across age groups

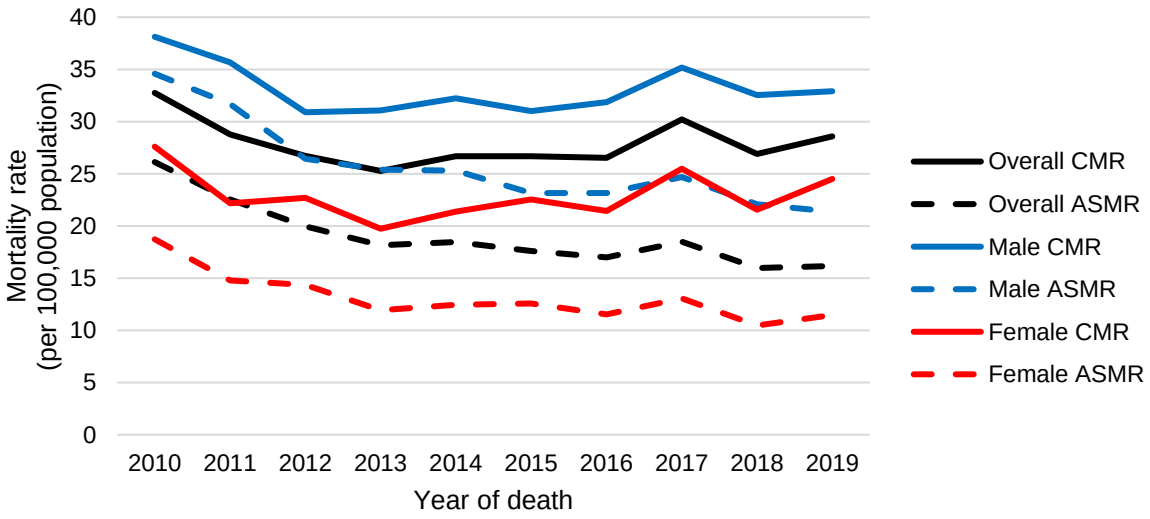


As the ASIRs were consistently higher among males than females across the years (Table 5.1.4), the ASMRs were also consistently higher among males (Table 5.2.4). Males had an ASMR of 21.4 per 100,000 population, while females had an ASMR of 11.5 per 100,000 population in 2019. The ASMR dropped significantly over the years for both genders (males: $p<0.001$, females: $p=0.004$) (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**
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	538	58.8	32.5	29.8-35.3	22.1	20.2-24.0
2019	549	55.9	32.9	30.2-35.7	21.4	19.6-23.2
P for trend	-	-	0.343	-	<0.001	-
Female						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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	377	41.2	21.6	19.4-23.7	10.5	9.4-11.6
2019	433	44.1	24.5	22.2-26.8	11.5	10.4-12.6
P for trend	-	-	0.844	-	0.004	-

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



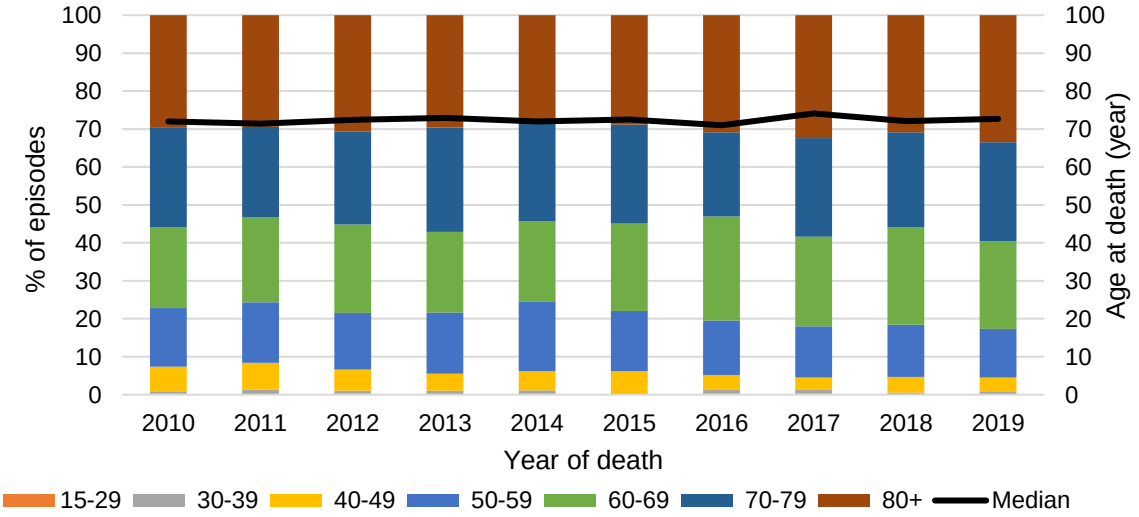
The median age at death among male AMI patients remained stable at between 71.0 to 74.1 years in the past decade (Table 5.2.5a). The highest proportion of males who died of AMI in 2019 was among those aged 80 years or above (33.5%) (Figure 5.2.5a).

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	%
2010	72.0	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	72.1	0	0.0	3	0.6	22	4.1
2019	72.7	0	0.0	4	0.7	21	3.8

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	25.1	166	30.9
2019	70	12.8	127	23.1	143	26.0	184	33.5

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



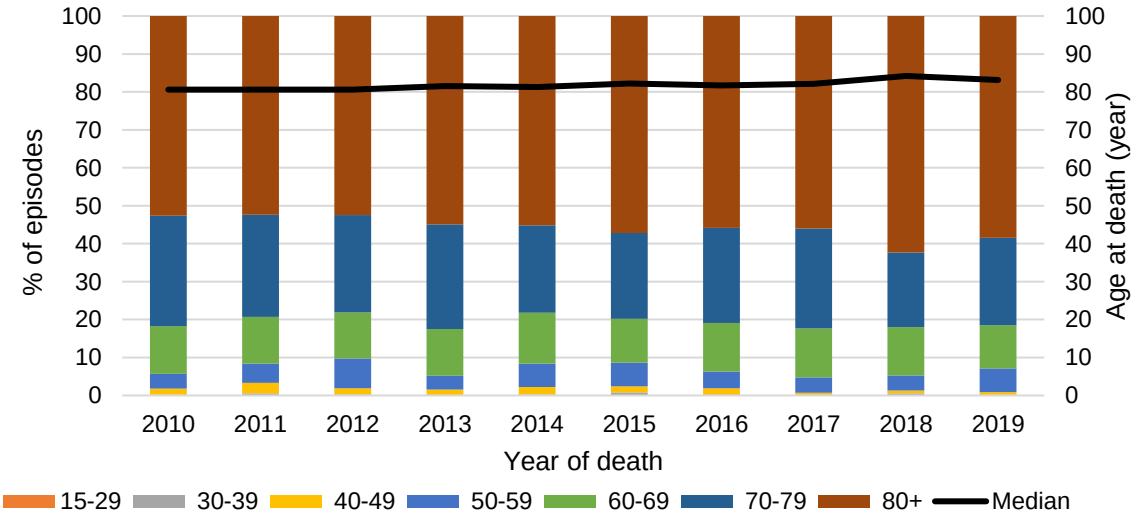
Similar to the median age at onset of AMI (Tables 5.1.5a and 5.1.5b), females had an older median age at death than males, which increased slightly from 80.6 years in 2010 to 83.1 years in 2019 (Table 5.2.5b). The highest proportion of females who died of AMI in 2019 was among those aged 80 years or above (58.4%) (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	%
2010	80.6	1	0.2	0	0.0	7	1.6
2011	80.6	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	84.2	0	0.0	2	0.5	3	0.8
2019	83.1	0	0.0	0	0.0	4	0.9

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	12.7	74	19.6	235	62.3
2019	27	6.2	49	11.3	100	23.1	253	58.4

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

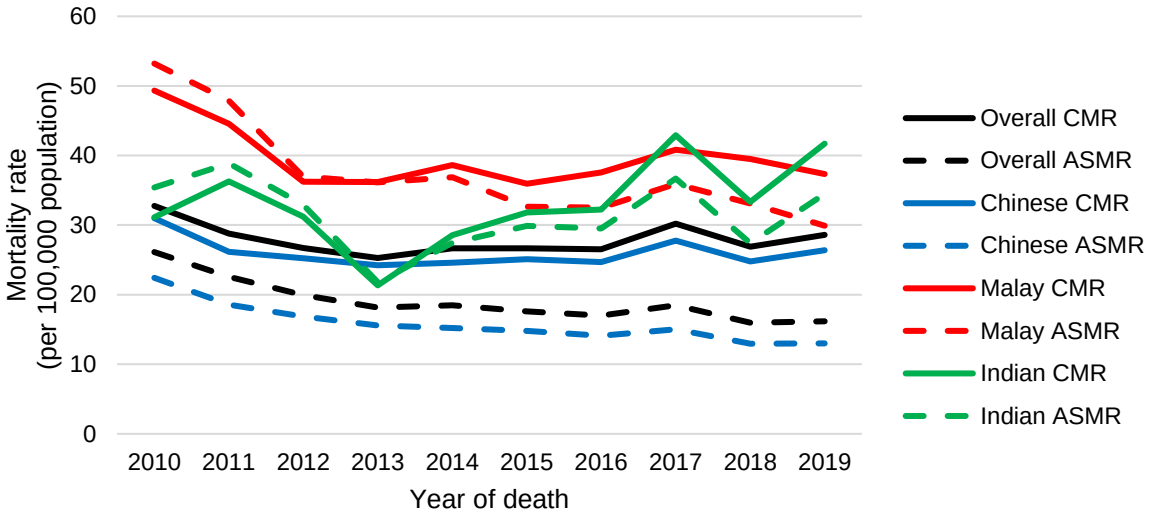


As Chinese consistently had the lowest ASIR across the years (Table 5.1.6), they also consistently had the lowest ASMR (Table 5.2.6). The ASMR of 13.0 per 100,000 population among Chinese was lower than the ASMR for Malays (29.9 per 100,000 population) and Indians (34.5 per 100,000 population) in 2019. The ASMR showed a significant downward trend over the years for Chinese ($p<0.001$) and Malays ($p=0.002$) but not for Indians ($p=0.739$) (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**
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	637	69.6	24.8	22.9-26.7	13.0	11.9-14.0
2019	684	69.7	26.4	24.4-28.4	13.0	12.0-14.0
P for trend	-	-	0.389	-	<0.001	-
Malay						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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	172	18.8	39.5	33.6-45.4	33.1	28.1-38.1
2019	164	16.7	37.3	31.6-43.1	29.9	25.3-34.6
P for trend	-	-	0.156	-	0.002	-
Indian						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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	98	10.7	33.3	26.7-39.9	27.4	21.9-32.9
2019	124	12.6	41.7	34.3-49.0	34.5	28.3-40.6
P for trend	-	-	0.179	-	0.739	-

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



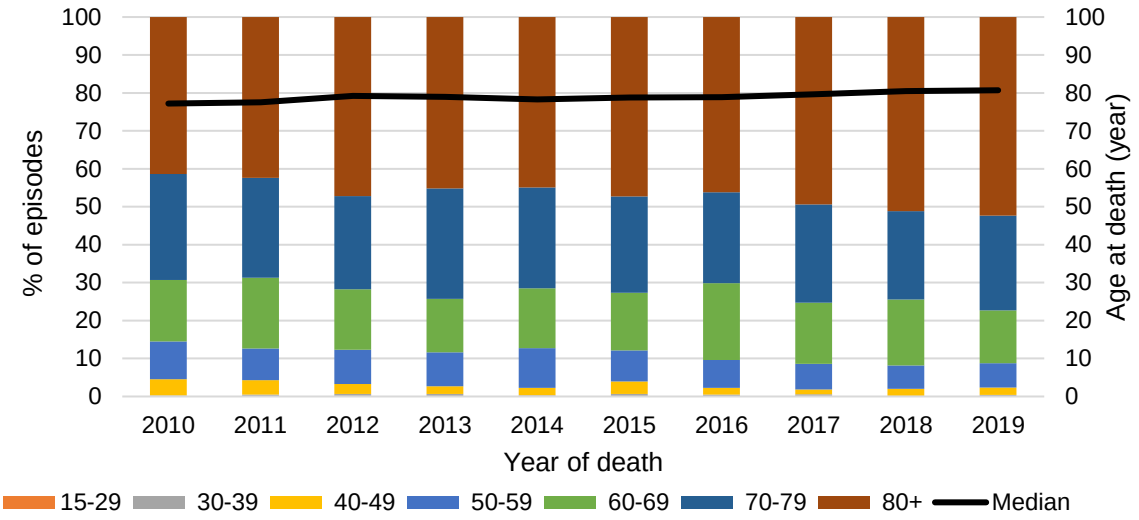
Similar to the median age at onset of AMI (Tables 5.1.7a to 5.1.7c), Chinese had the oldest median age at death, which increased slightly from 77.2 years in 2010 to 80.7 years in 2019 (Table 5.2.7a). The highest proportion of Chinese who died of AMI in 2019 was among those aged 80 years or above (52.3%) (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	%
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	78.8	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	80.5	0	0.0	1	0.2	12	1.9
2019	80.7	0	0.0	3	0.4	13	1.9

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	6.1	111	17.4	148	23.2	326	51.2
2019	44	6.4	95	13.9	171	25.0	358	52.3

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



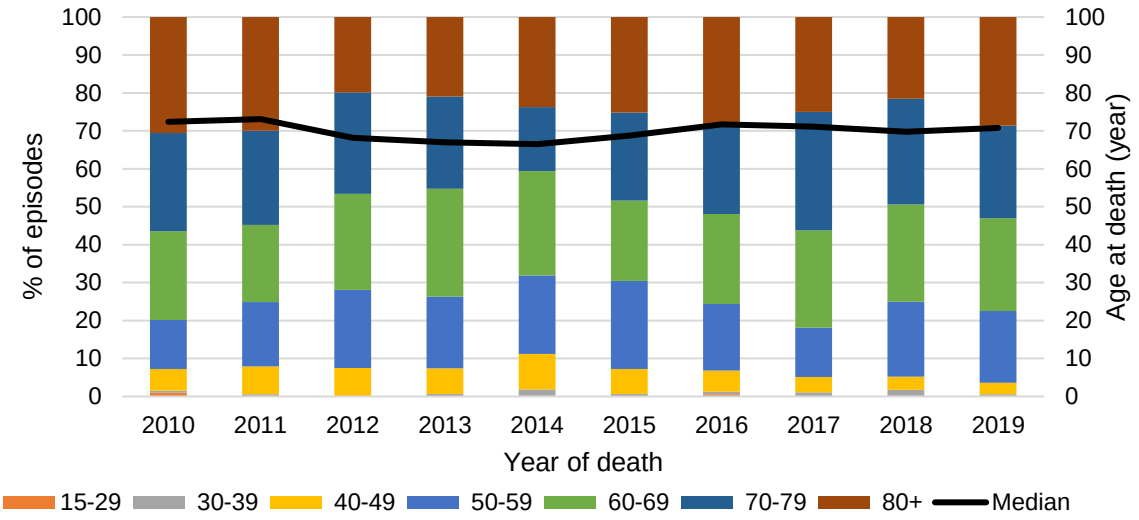
The median age at death among Malay AMI patients fluctuated between 66.5 and 73.1 years in the past decade (Table 5.2.7b). The highest proportion of Malays who died of AMI in 2019 was among those aged 80 years or above (28.7%) (Figure 5.2.7b).

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	%
2010	72.4	2	1.0	1	0.5	11	5.7
2011	73.1	0	0.0	1	0.6	13	7.3
2012	68.2	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	69.8	0	0.0	3	1.7	6	3.5
2019	70.8	0	0.0	1	0.6	5	3.0

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	19.8	44	25.6	48	27.9	37	21.5
2019	31	18.9	40	24.4	40	24.4	47	28.7

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



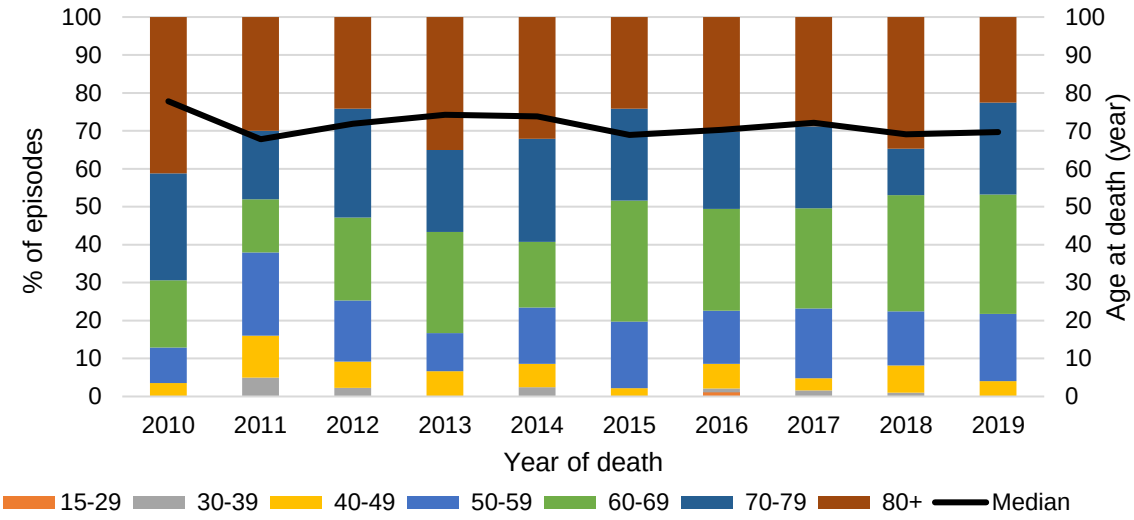
The median age at death among Indian AMI patients fluctuated between 67.8 and 77.8 years in the past decade (Table 5.2.7c). The highest proportion of Indians who died of AMI in 2019 was among those aged 60-69 years (31.5%) (Figure 5.2.7c).

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	%
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	74.2	0	0.0	0	0.0	4	6.7
2014	73.8	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	7.1
2019	69.7	0	0.0	0	0.0	5	4.0

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	18.4	33	26.4	27	21.6	36	28.8
2018	14	14.3	30	30.6	12	12.2	34	34.7
2019	22	17.7	39	31.5	30	24.2	28	22.6

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



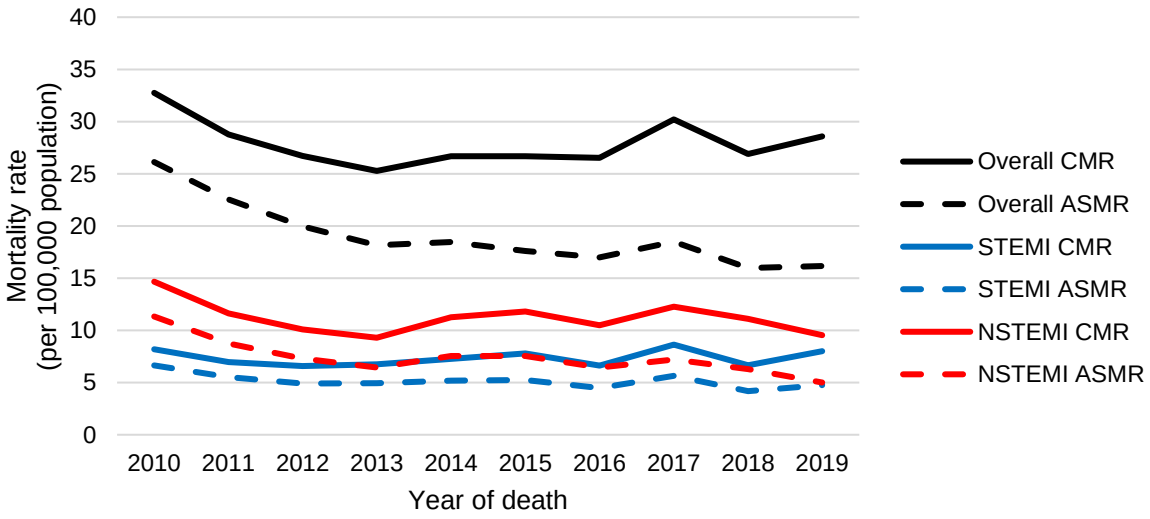
As the ASIRs of NSTEMI were consistently higher than STEMI across the years (Table 5.1.8), the ASMRs of NSTEMI were also consistently higher (Table 5.2.8). The ASMR of both STEMI and NSTEMI dropped over the years, with a larger drop for NSTEMI, where it dropped significantly from 11.3 per 100,000 population in 2010 to 5.0 per 100,000 population in 2019 (p=0.004), while the ASMR for STEMI dropped from 6.6 per 100,000 population in 2010 to 4.8 per 100,000 population in 2019 (p=0.051).

As patients without documentation of STEMI or NSTEMI were excluded from Table 5.2.8, the sum of the percentages for STEMI and NSTEMI will be less than 100% for each year.

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**
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	24.7	6.6	5.8-7.5	4.2	3.6-4.7
2019	275	28.0	8.0	7.1-9.0	4.8	4.2-5.3
P for trend	-	-	0.701	-	0.051	-
NSTEMI						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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	11.1-13.5	7.2	6.5-7.9
2018	378	41.3	11.1	10.0-12.2	6.3	5.6-6.9
2019	328	33.4	9.5	8.5-10.6	5.0	4.5-5.6
P for trend	-	-	0.269	-	0.004	-

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



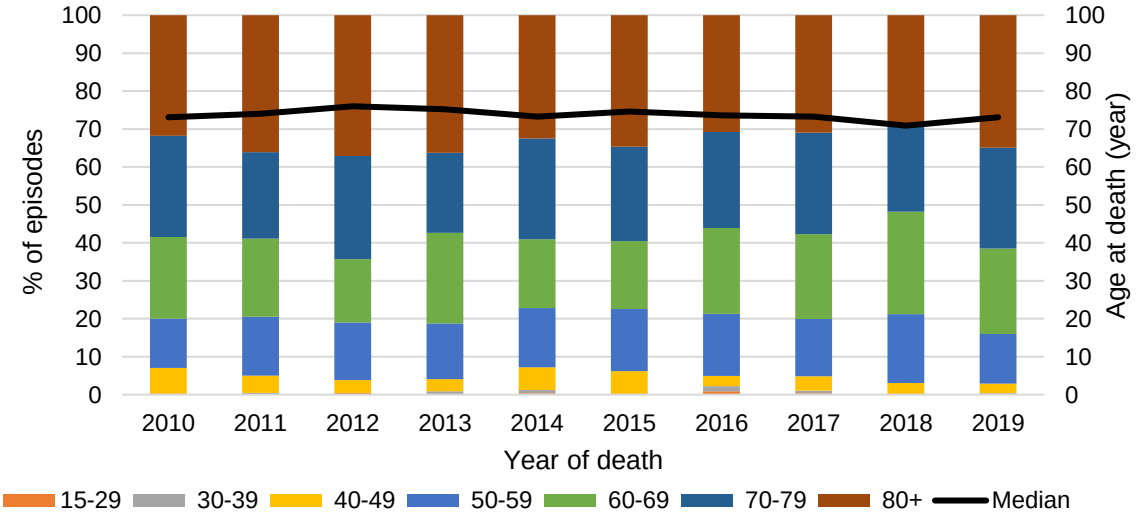
The median age at death among STEMI patients fluctuated between 70.9 and 76.0 years in the past decade (Table 5.2.9a). The highest proportion of STEMI patients who died of AMI in 2019 was among those aged 80 years or above (34.9%) (Figure 5.2.9a).

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	%
2010	73.1	0	0.0	0	0.0	18	7.1
2011	74.0	0	0.0	1	0.5	10	4.6
2012	76.0	1	0.5	0	0.0	7	3.3
2013	75.2	0	0.0	2	0.9	7	3.2
2014	73.3	1	0.4	2	0.8	14	5.9
2015	74.6	0	0.0	0	0.0	16	6.2
2016	73.6	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
2019	73.1	0	0.0	1	0.4	7	2.5

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2019	36	13.1	62	22.5	73	26.5	96	34.9

Figure 5.2.9a: Age distribution at death of STEMI



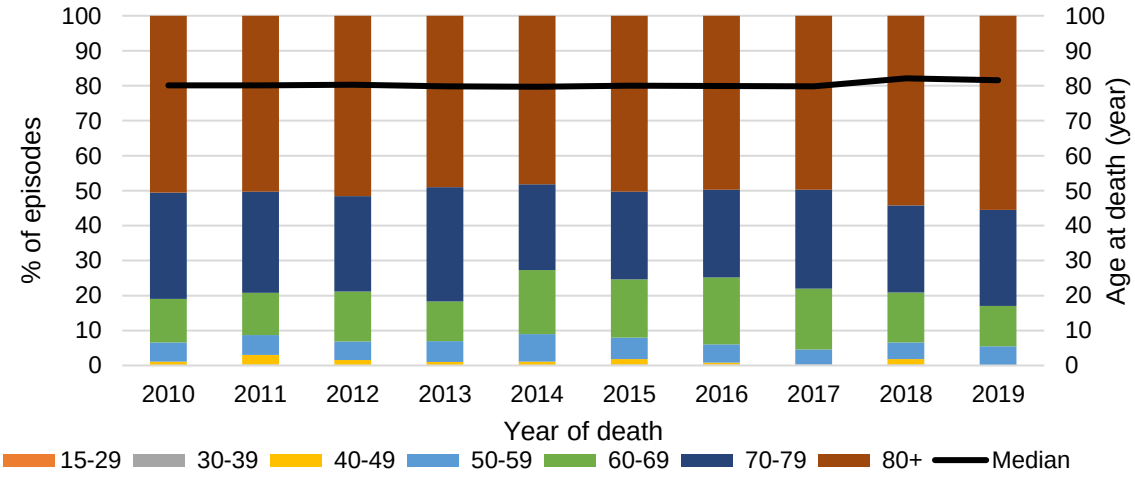
Similar to the median age at onset (Tables 5.1.9a and 5.1.9b), NSTEMI patients had an older median age at death than STEMI patients, which remained stable at between 79.7 to 82.1 years in the past decade (Table 5.2.9b). The highest proportion of NSTEMI patients who died of AMI in 2019 was among those aged 80 years or above (55.5%) (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	%
2010	80.1	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	79.9	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
2019	81.6	0	0.0	0	0.0	0	0.0

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	14.3	94	24.9	205	54.2
2019	18	5.5	38	11.6	90	27.4	182	55.5

Figure 5.2.9b: Age distribution at death of NSTEMI



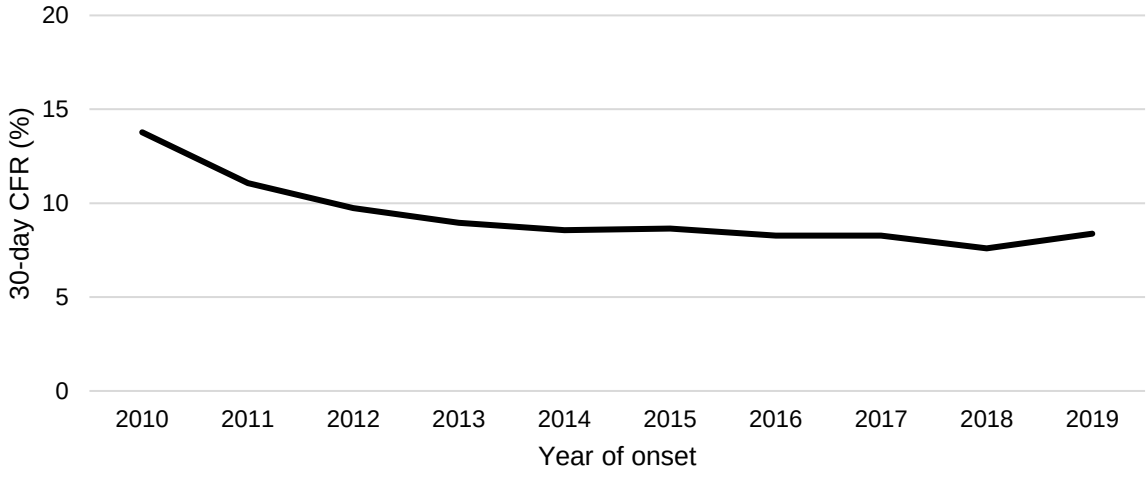
5.3 30-day Case Fatality

As the number of AMI deaths within 30 days (Table 5.3.1) did not increase with the number of AMI episodes (Table 5.1.1), the 30-day CFR decreased significantly from 13.8% in 2010 to 8.4% in 2019 (p=0.002) (Figure 5.3.1).

Table 5.3.1: 30-day case fatality number and rate of AMI (%)

Year of onset	Number	CFR	95% CI
2010	952	13.8	12.9-14.7
2011	832	11.1	10.3-11.8
2012	825	9.7	9.1-10.4
2013	788	8.9	8.3-9.6
2014	785	8.6	8.0-9.2
2015	820	8.7	8.1-9.2
2016	836	8.3	7.7-8.8
2017	923	8.3	7.7-8.8
2018	849	7.6	7.1-8.1
2019	963	8.4	7.8-8.9
P for trend	-	0.002	-

Figure 5.3.1: 30-day case fatality rate of AMI (%)



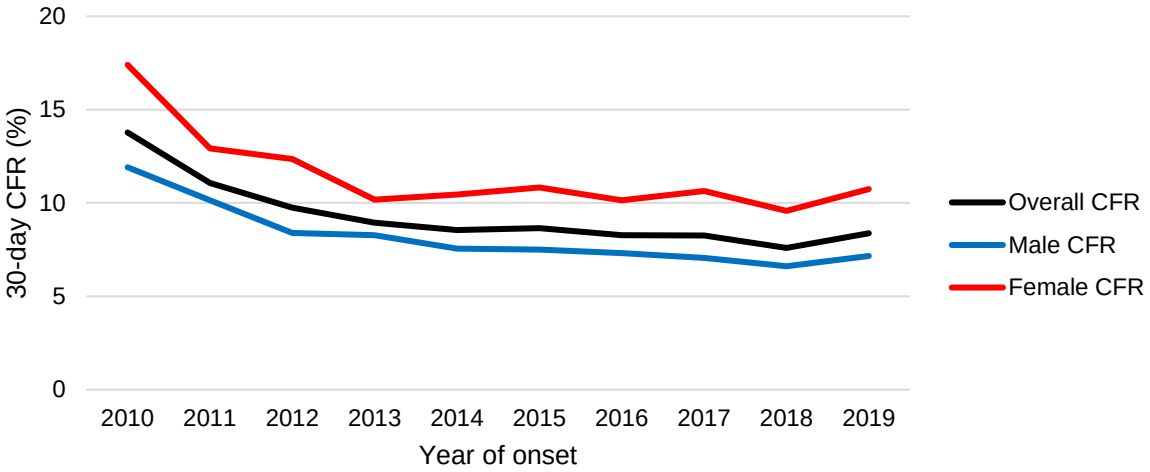
Although the ASMRs for males were consistently higher than females across the years (Table 5.2.4), the 30-day CFRs for males were consistently lower than females (Table 5.3.2). The CFR was 7.2% for males and 10.7% for females in 2019. As females tended to have AMI at an older age than males (Tables 5.1.5a 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 decline revascularisation. Lower rate of revascularisation of the blocked arteries could have led to the higher CFR among females[12]. The CFR fell significantly over the years for both genders (males: p=0.001, females: p=0.012) (Figure 5.3.2).

Table 5.3.2: 30-day case fatality number and rate of AMI (%) by gender

Male				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	544	57.1	11.9	10.9-12.9
2011	510	61.3	10.2	9.3-11.0
2012	468	56.7	8.4	7.6-9.2
2013	474	60.2	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	488	58.4	7.3	6.7-8.0
2017	521	56.4	7.1	6.4-7.7
2018	495	58.3	6.6	6.0-7.2
2019	542	56.3	7.2	6.6-7.8
P for trend	-	-	0.001	-
Female				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	408	42.9	17.4	15.7-19.1
2011	322	38.7	12.9	11.5-14.3
2012	357	43.3	12.4	11.1-13.6
2013	314	39.8	10.2	9.0-11.3
2014	330	42.0	10.4	9.3-11.6
2015	356	43.4	10.8	9.7-12.0
2016	348	41.6	10.1	9.1-11.2
2017	402	43.6	10.6	9.6-11.7
2018	354	41.7	9.6	8.6-10.6
2019	421	43.7	10.7	9.7-11.8
P for trend	-	-	0.012	-

[12] Berger JS et al. Sex differences in mortality following acute coronary syndromes. JAMA 2009; 302(8): 874-882.

Figure 5.3.2: 30-day case fatality rate of AMI (%) by gender

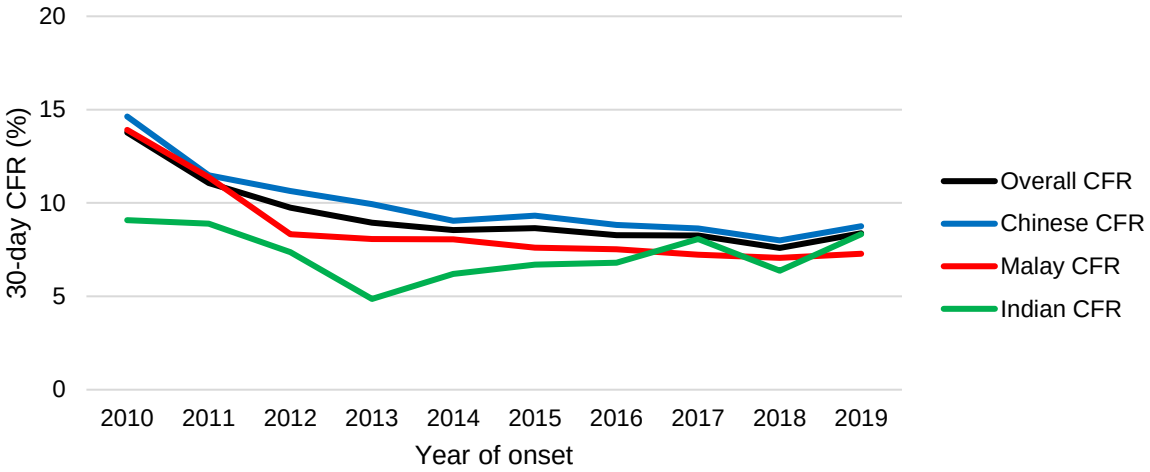


Although Chinese generally had the lowest ASMR (Table 5.2.6), they generally had the highest 30-day CFR across the years (Table 5.3.3). The CFRs were 8.8%, 7.3% and 8.3% for Chinese, Malays and Indians respectively in 2019. This was likely due to Chinese being oldest at the onset of AMI (Tables 5.1.7a to 5.1.7c). The CFR fell significantly over the years for Chinese (p=0.001) and Malays (p=0.003) but not for Indians (p=0.666) (Figure 5.3.3).

Table 5.3.3: 30-day case fatality number and rate of AMI (%) by ethnicity

Chinese				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	677	71.1	14.6	13.5-15.7
2011	571	68.6	11.5	10.5-12.4
2012	593	71.9	10.6	9.8-11.5
2013	580	73.6	9.9	9.1-10.8
2014	550	70.1	9.0	8.3-9.8
2015	593	72.3	9.3	8.6-10.1
2016	588	70.3	8.8	8.1-9.5
2017	651	70.5	8.6	8.0-9.3
2018	602	70.9	8.0	7.4-8.6
2019	672	69.8	8.8	8.1-9.4
P for trend	-	-	0.001	-
Malay				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	183	19.2	13.9	11.9-15.9
2011	167	20.1	11.4	9.7-13.1
2012	140	17.0	8.3	6.9-9.7
2013	139	17.6	8.1	6.7-9.4
2014	140	17.8	8.0	6.7-9.4
2015	140	17.1	7.6	6.3-8.9
2016	151	18.1	7.5	6.3-8.7
2017	150	16.3	7.2	6.1-8.4
2018	149	17.6	7.1	5.9-8.2
2019	160	16.6	7.3	6.2-8.4
P for trend	-	-	0.003	-
Indian				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
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	10.5	6.8	5.4-8.2
2017	113	12.2	8.1	6.6-9.6
2018	90	10.6	6.4	5.0-7.7
2019	122	12.7	8.3	6.9-9.8
P for trend	-	-	0.666	-

Figure 5.3.3: 30-day case fatality rate of AMI (%) by ethnicity



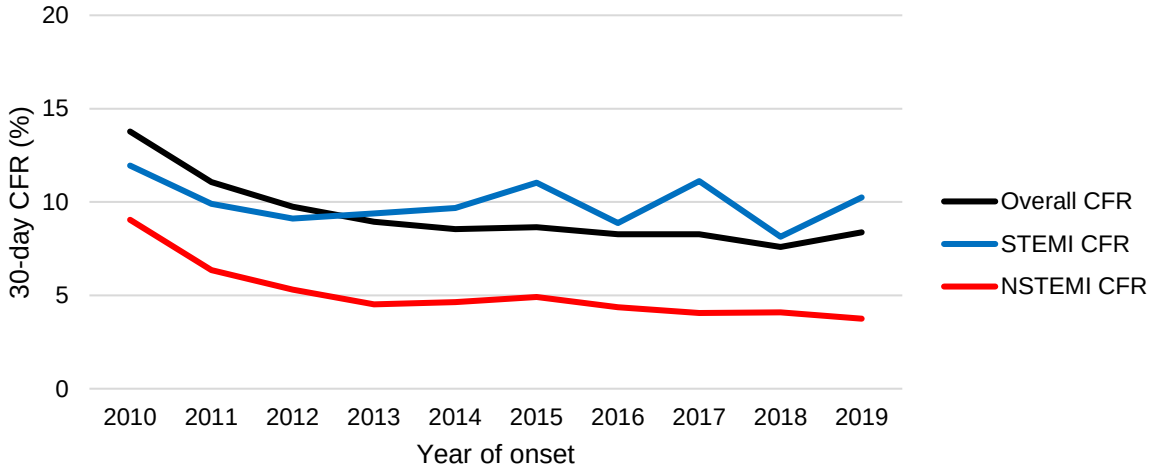
Although STEMI patients consistently had lower ASMRs than NSTEMI patients across the years (Table 5.2.8), the 30-day CFRs among STEMI patients were consistently higher than NSTEMI patients (Table 5.3.4). The CFRs were 10.2% and 3.7% for STEMI and NSTEMI patients respectively in 2019. A plausible reason was that STEMI was more severe with a higher likelihood of fatality if intervention was not provided promptly. While the CFR for STEMI patients fluctuated over the years (p=0.401), it fell significantly for NSTEMI patients (p=0.001) (Figure 5.3.4).

As patients without documentation of STEMI or NSTEMI were excluded from Table 5.3.4, the sum of the percentages for STEMI and NSTEMI will be less than 100% for each year.

Table 5.3.4: 30-day case fatality number and rate of AMI (%) by subtype

STEMI				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	245	25.7	12.0	10.5-13.4
2011	205	24.6	9.9	8.5-11.3
2012	201	24.4	9.1	7.9-10.4
2013	214	27.2	9.4	8.1-10.6
2014	220	28.0	9.7	8.4-11.0
2015	249	30.4	11.0	9.7-12.4
2016	208	24.9	8.9	7.7-10.1
2017	274	29.7	11.1	9.8-12.4
2018	207	24.4	8.1	7.0-9.2
2019	270	28.0	10.2	9.0-11.5
P for trend	-	-	0.401	-
NSTEMI				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	400	42.0	9.0	8.2-9.9
2011	307	36.9	6.4	5.6-7.1
2012	307	37.2	5.3	4.7-5.9
2013	275	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	319	38.2	4.4	3.9-4.8
2017	335	36.3	4.1	3.6-4.5
2018	335	39.5	4.1	3.6-4.5
2019	313	32.5	3.7	3.3-4.2
P for trend	-	-	0.001	-

Figure 5.3.4: 30-day case fatality rate of AMI (%) by subtype

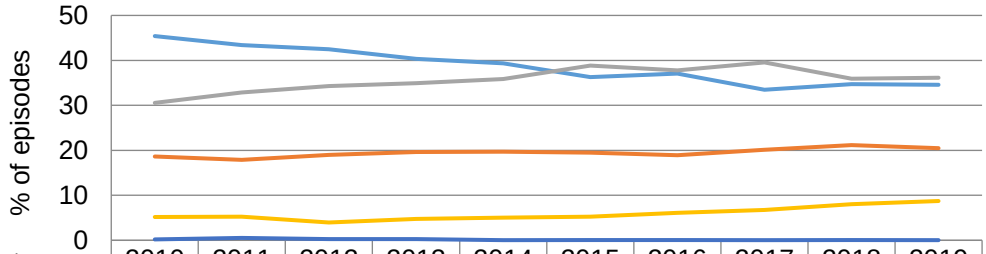


5.4 Symptoms

Clinical presentation has consequences on triage categorisation, diagnostic tests prescription and disease management. Symptoms of AMI were defined as typical when there was continuous chest pain of at least 20 minutes. Symptoms would be deemed as atypical if the chest pain was of short duration and/or intermittent with each bout lasting for less than 20 minutes, or if pain was experienced at unusual sites such as the upper abdomen, arm, jaw and neck. For well-described symptoms that did not satisfy the criteria for typical or atypical, they were classified as others. These 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 medical records or lacking in details on the description and duration of symptoms.

The proportions of patients experiencing typical symptoms of AMI were higher in the earlier years (Figure 5.4.1). However, the proportions of patients experiencing symptoms that were neither typical nor atypical became more common in later years. The proportion of patients with typical symptoms dropped from 45.4% in 2010 to 34.6% in 2019. The proportion of patients with other symptoms that were neither typical nor atypical, rose from 30.6% in 2010 to 36.1% in 2019. Similarly, the proportion of patients with atypical symptoms and those with no symptoms increased slightly over the years.

Figure 5.4.1: Type of symptoms (%)

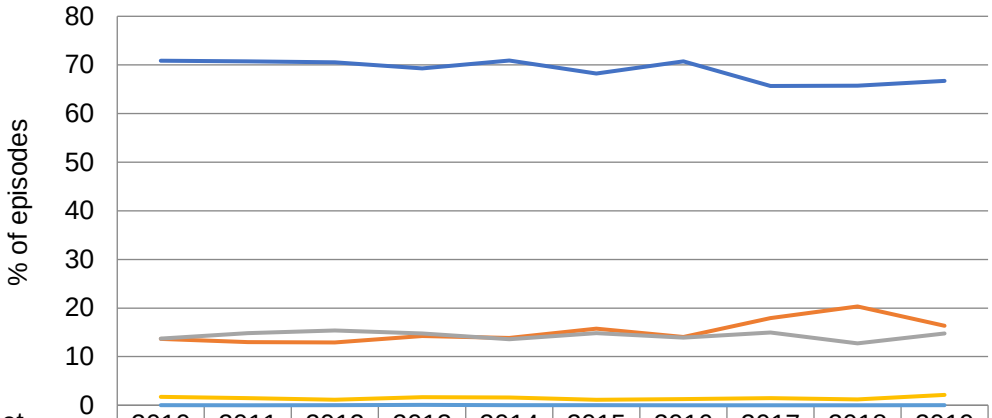


Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Typical	45.4	43.4	42.5	40.4	39.4	36.3	37.1	33.5	34.8	34.6
Atypical	18.6	17.9	19.0	19.6	19.7	19.5	18.9	20.1	21.2	20.5
Others	30.6	32.9	34.3	34.9	35.8	38.9	37.8	39.6	36.0	36.1
None	5.2	5.3	4.0	4.8	5.1	5.3	6.1	6.8	8.0	8.7
Insufficient data	0.2	0.5	0.3	0.3	0.0	0.1	0.1	0.0	0.1	0.0

Among STEMI patients, two-thirds of them experienced typical symptoms in 2019 (Figure 5.4.2a). The proportion of STEMI patients with typical symptoms dropped slightly in recent years. Unlike STEMI patients, only a quarter of NSTEMI patients experienced typical symptoms in 2019 (Figure 5.4.2b). This observation could be attributed to smaller infarct size from NSTEMI and that the infarct did not involve the full thickness of the myocardium and epicardium[13]. The proportion of NSTEMI patients with typical symptoms dropped steadily over the years.

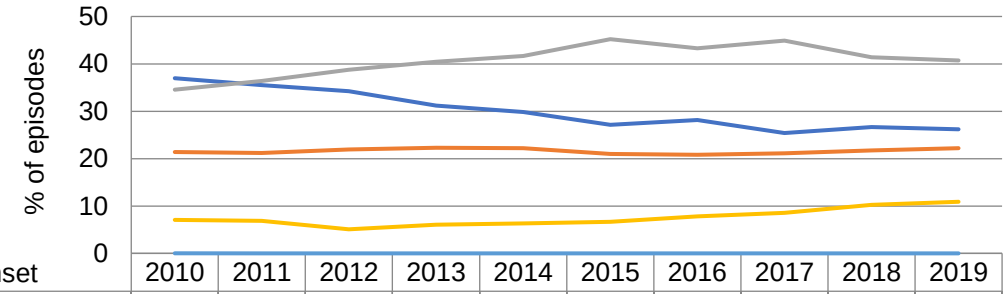
[13] Brieger D et al. Acute coronary syndromes without chest pain, an underdiagnosed and undertreated high-risk group: insights from the global registry of acute coronary events. Chest 2004; 126: 461-469.

Figure 5.4.2a: Type of symptoms (%) among STEMI



Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Typical	70.9	70.7	70.5	69.3	70.9	68.2	70.7	65.7	65.7	66.7
Atypical	13.6	13.0	12.9	14.2	13.9	15.8	14.1	17.9	20.3	16.3
Others	13.7	14.9	15.4	14.8	13.6	14.8	13.9	15.0	12.7	14.8
None	1.7	1.5	1.1	1.7	1.6	1.1	1.3	1.5	1.2	2.1
Insufficient data	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0

Figure 5.4.2b: Type of symptoms (%) among NSTEMI

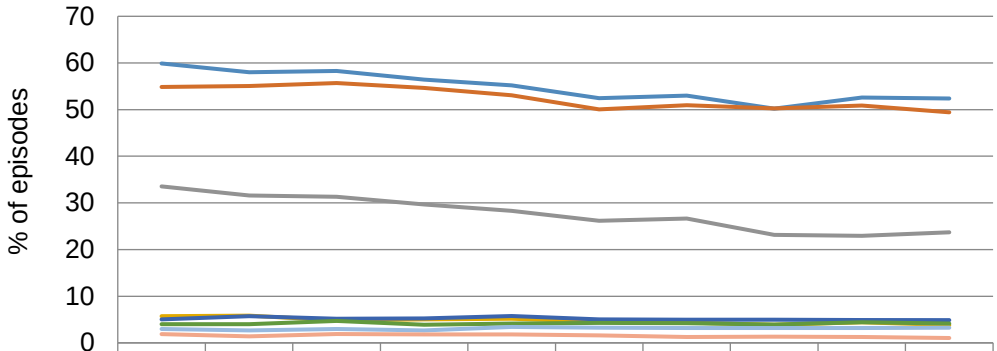


Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Typical	37.0	35.5	34.2	31.2	29.8	27.1	28.1	25.4	26.6	26.2
Atypical	21.4	21.2	22.0	22.3	22.2	21.0	20.8	21.1	21.8	22.2
Others	34.6	36.4	38.8	40.5	41.7	45.2	43.3	44.9	41.4	40.7
None	7.1	6.9	5.1	6.0	6.3	6.7	7.8	8.5	10.2	10.9
Insufficient data	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Consistently across the years, the two most common presenting symptoms of AMI were chest pain and breathlessness, with about half of the patients having these symptoms (chest pain: 52.4%, breathlessness: 49.4%) in 2019 (Figure 5.4.3). About a quarter of the patients (23.7%) had diaphoresis in 2019, while other symptoms like epigastric pain, back pain, shoulder pain, jaw pain and syncope were less common with fewer than 5% of the patients having it. Downward trends were observed for all symptoms except back pain, shoulder pain and jaw pain.

As a patient could have multiple symptoms, the percentages in Figure 5.4.3 will not add up to 100% for each year.

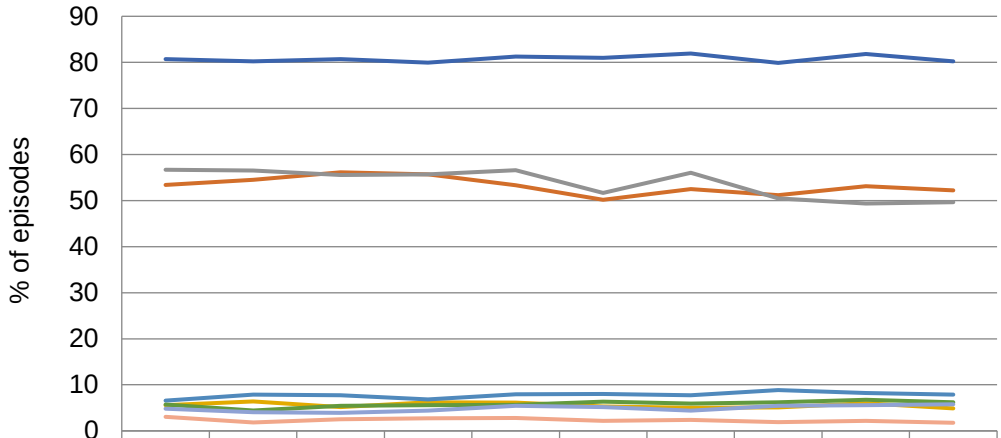
Figure 5.4.3: Presenting symptoms (%)



Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Chest pain	59.9	58.0	58.3	56.4	55.2	52.5	53.0	50.2	52.6	52.4
Breathlessness	54.9	55.1	55.7	54.7	53.1	50.1	51.0	50.3	50.9	49.4
Diaphoresis	33.5	31.6	31.3	29.6	28.3	26.2	26.7	23.2	22.9	23.7
Epigastric pain	5.7	5.8	4.8	5.1	5.2	4.5	4.4	3.9	4.4	3.8
Back pain	5.0	5.7	5.2	5.3	5.8	5.1	4.9	5.0	4.9	4.9
Shoulder pain	4.0	4.0	4.7	3.9	4.2	4.3	4.2	3.9	4.4	4.1
Jaw pain	3.0	2.7	3.0	2.7	3.4	3.3	3.2	3.2	3.2	3.3
Syncope	1.9	1.4	1.9	1.8	1.8	1.6	1.3	1.3	1.3	1.0

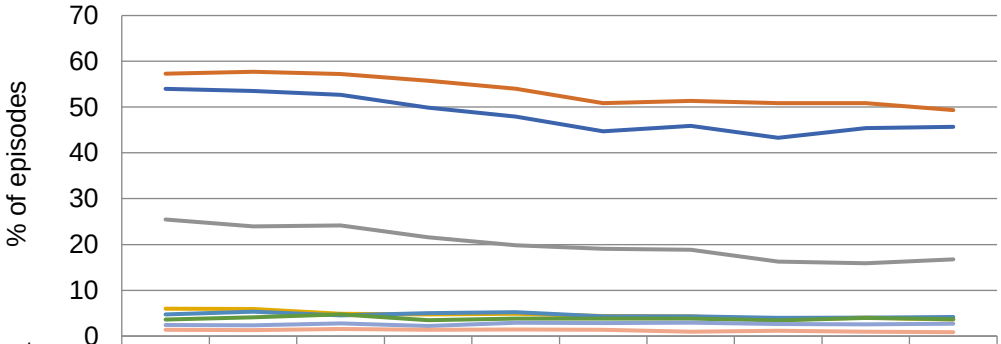
Chest pain was the most common presenting symptom of STEMI, with 4 in 5 STEMI patients having chest pain every year (Figure 5.4.4a). Unlike STEMI, breathlessness was the most common presenting symptom of NSTEMI (Figure 5.4.4b). The proportion of NSTEMI patients presenting with breathlessness dropped over the years, with about half of them feeling breathless in 2019. Notably, other common presenting symptoms of NSTEMI such as chest pain and diaphoresis also dropped over the years. This might indicate a rise in silent AMI among the NSTEMI patients.

Figure 5.4.4a: Presenting symptoms (%) among STEMI



Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Chest pain	80.7	80.3	80.7	79.9	81.2	81.0	81.9	79.9	81.8	80.2
Breathlessness	53.4	54.5	56.1	55.7	53.3	50.2	52.5	51.1	53.1	52.2
Diaphoresis	56.7	56.5	55.5	55.7	56.6	51.7	56.0	50.5	49.4	49.6
Epigastric pain	5.6	6.4	5.1	6.2	6.1	5.3	5.0	5.1	6.0	4.9
Back pain	6.6	7.9	7.7	6.9	7.9	8.0	7.7	8.9	8.2	7.9
Shoulder pain	5.7	4.4	5.4	5.6	5.7	6.4	5.9	6.2	6.8	6.2
Jaw pain	4.8	4.0	3.9	4.4	5.4	5.2	4.4	5.4	5.6	5.8
Syncope	3.1	1.8	2.5	2.8	2.8	2.2	2.4	1.9	2.2	1.8

Figure 5.4.4b: Presenting symptoms (%) among NSTEMI



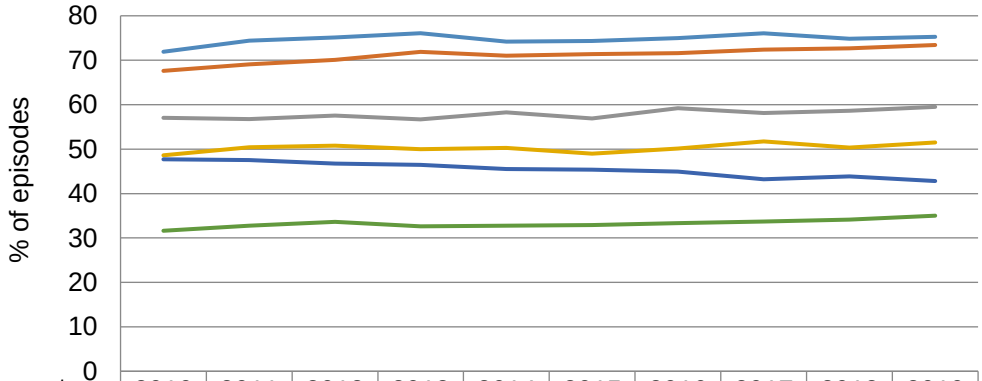
Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Chest pain	54.0	53.5	52.7	49.9	47.9	44.7	45.9	43.3	45.4	45.7
Breathlessness	57.3	57.7	57.2	55.8	54.0	50.9	51.3	50.9	50.9	49.4
Diaphoresis	25.5	24.0	24.2	21.6	19.9	19.1	18.9	16.3	15.9	16.8
Epigastric pain	6.0	5.9	4.9	4.7	4.9	4.4	4.3	3.5	4.0	3.6
Back pain	4.7	5.3	4.6	5.0	5.3	4.3	4.3	4.0	4.0	4.1
Shoulder pain	3.6	4.1	4.7	3.5	3.8	3.8	3.8	3.4	3.9	3.7
Jaw pain	2.4	2.4	2.8	2.2	2.9	2.8	2.9	2.7	2.6	2.7
Syncope	1.4	1.3	1.6	1.4	1.5	1.4	1.0	1.1	1.0	0.9

5.5 Risk Factors

Hypertension, hyperlipidemia, diabetes, being overweight and smoking are well established modifiable risk factors of AMI[14]. Hypertension, hyperlipidemia and diabetes were defined as positive if there was history of the condition or if it was newly diagnosed during index admission. Being overweight, which refers to having a body mass index (BMI) of 23 kg/m^2 or above, increases the risk for cardiovascular disease and diabetes among Asian populations[15]. Smoking included former or current smoking status of patients. As a patient could have multiple risk factors, the percentages in all Figures of this section will not add up to 100% for each year.

Hypertension and hyperlipidemia were consistently observed to be the two most common risk factors among AMI patients across the years (Figure 5.5.1). In 2019, 75.3% of AMI patients had hypertension while 73.4% had hyperlipidemia. In addition, diabetes, smoking and being overweight were also observed to be common risk factors among AMI patients, with about half of them having these risk factors (overweight: 59.5%, diabetes: 51.5%, smoking: 42.8%) in 2019. Upward trends were observed for the proportions of patients who were overweight and those with hypertension, hyperlipidemia, diabetes and history of AMI / revascularisation over the past decade, while the proportion of patients who smoked dropped during this period.

Figure 5.5.1: Risk factors (%)



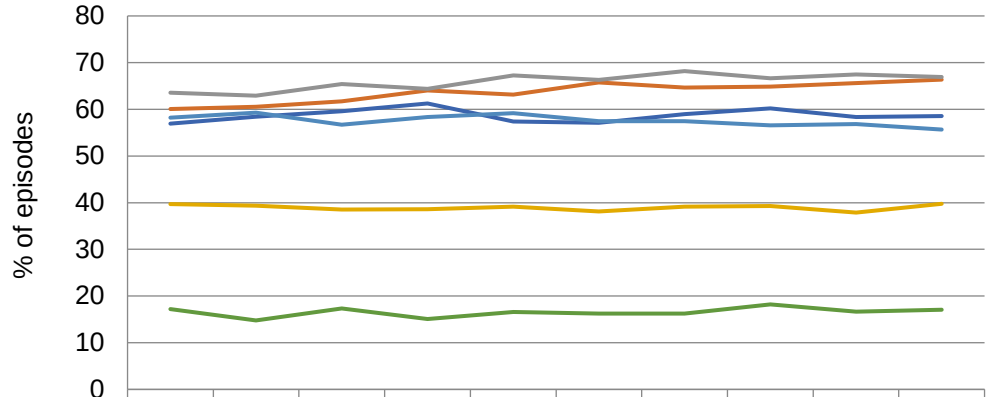
Year of AMI onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Hypertension	71.9	74.4	75.2	76.1	74.2	74.3	75.0	76.0	74.9	75.3
Hyperlipidemia	67.6	69.1	70.1	71.9	71.0	71.4	71.6	72.4	72.7	73.4
Overweight	57.0	56.7	57.5	56.7	58.3	56.9	59.2	58.1	58.6	59.5
Diabetes	48.6	50.4	50.8	50.0	50.3	49.0	50.2	51.7	50.4	51.5
Smoking	47.7	47.5	46.7	46.5	45.5	45.4	44.9	43.2	43.9	42.8
History of AMI / revascularisation	31.6	32.8	33.7	32.6	32.8	32.9	33.4	33.7	34.1	35.0

More than half of the STEMI patients had hypertension, hyperlipidemia, were overweight and smoked (Figure 5.5.2a). Compared to STEMI patients, the proportions of NSTEMI patients with hypertension, hyperlipidemia, diabetes and history of AMI /

[14] 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.
[15] WHO expert consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004; 363: 157-163.

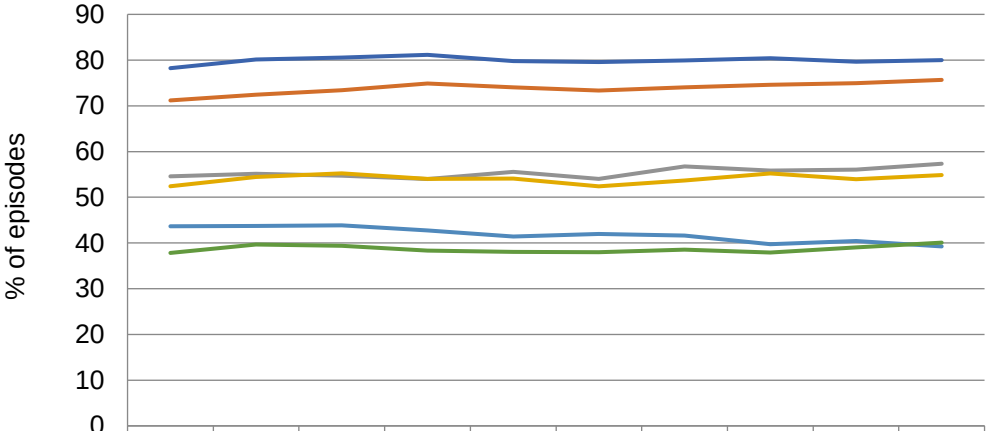
revascularisation were higher (Figure 5.5.2b) as they tended to be older (Tables 5.1.9a and 5.1.9b).

Figure 5.5.2a: Risk factors (%) among STEMI



Year of AMI onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Hypertension	56.9	58.4	59.6	61.3	57.4	57.1	59.0	60.2	58.3	58.5
Hyperlipidemia	60.1	60.6	61.7	64.1	63.1	65.8	64.7	64.9	65.6	66.4
Overweight	63.6	62.9	65.4	64.4	67.3	66.3	68.2	66.6	67.5	66.9
Diabetes	39.7	39.3	38.5	38.6	39.2	38.1	39.2	39.3	37.9	39.8
Smoking	58.2	59.3	56.7	58.4	59.2	57.5	57.5	56.6	56.8	55.7
History of AMI / revascularisation	17.2	14.8	17.3	15.1	16.6	16.2	16.2	18.2	16.7	17.1

Figure 5.5.2b: Risk factors (%) among NSTEMI



Year of AMI onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Hypertension	78.2	80.1	80.5	81.2	79.8	79.6	79.9	80.4	79.7	80.0
Hyperlipidemia	71.2	72.5	73.4	74.9	74.0	73.3	74.1	74.6	75.0	75.7
Overweight	54.6	55.2	54.7	54.0	55.6	54.0	56.8	55.9	56.1	57.3
Diabetes	52.4	54.4	55.2	54.0	54.1	52.4	53.7	55.2	54.0	54.9
Smoking	43.6	43.7	43.9	42.8	41.4	42.0	41.7	39.7	40.4	39.3
History of AMI / revascularisation	37.8	39.7	39.4	38.3	38.1	38.0	38.5	37.9	39.1	40.1

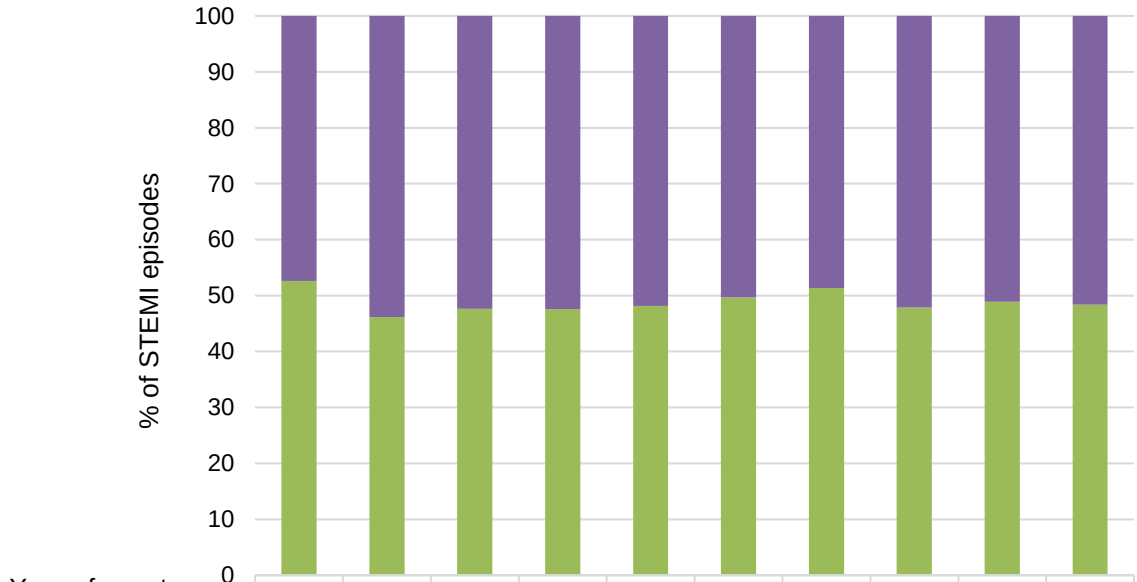
5.6 Time Factors

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[16].

Studies have shown that direct ambulance admission to the catheterisation laboratory significantly reduces DTB time[17]. There are two main types of ambulance in Singapore: SCDF public emergency ambulance and non-SCDF private non-emergency ambulance. Non-SCDF transport included non-SCDF private ambulance, public transport, personal private transport and walk-in.

The utilisation of SCDF ambulance among STEMI patients fluctuated around 50% in the past decade (Figure 5.6.1).

Figure 5.6.1: Mode of arrival (%) among STEMI



Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Non-SCDF transport	47.4	53.9	52.4	52.4	51.8	50.3	48.6	52.1	51.1	51.6
SCDF ambulance	52.6	46.1	47.6	47.6	48.2	49.7	51.4	47.9	48.9	48.4

[16] 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.

[17] 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.

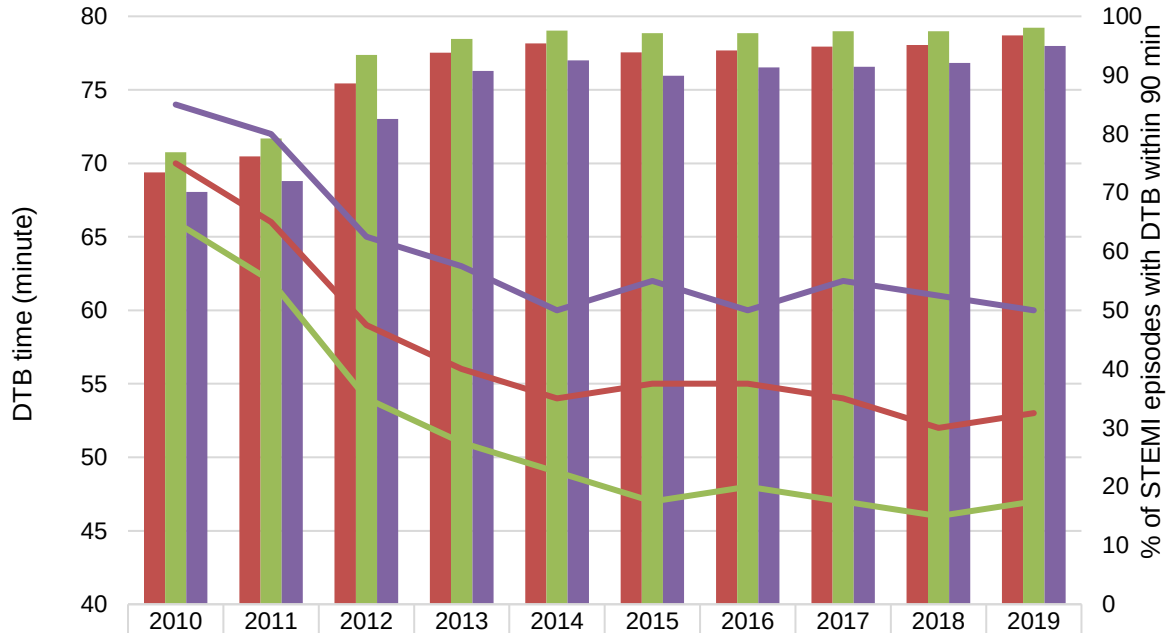
Patients who were admitted for a non-AMI condition but developed AMI during hospitalisation, patients who were transferred from another hospital, and patients who experienced non-system delays[18], were excluded from the calculation of DTB time. These exclusion criteria were applied as the DTB time would be abnormally short or long under such scenarios.

The median DTB time improved from 70 (IQR 54 – 92) minutes in 2010 to 53 (IQR 42 – 67) minutes in 2019 among STEMI patients (Figure 5.6.2). Similarly, the proportion of STEMI patients with DTB time of 90 minutes or less improved from 73.5% in 2010 to 96.8% in 2019. This improvement was driven by the efficiency in the healthcare delivery system comprising the early response teams and hospitals.

The median DTB time was observed to be consistently shorter for STEMI patients who utilised the SCDF ambulance (47 minutes in 2019) compared to those who relied on other modes of transport (60 minutes in 2019) 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 (98.1% in 2019) than those who arrived via other modes of transport (95.0% in 2019) 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 be conveyed to a PCI centre. The receiving hospital Emergency Department (ED) is notified by SCDF in advance, and the patient's ECG is transmitted to the ED before the ambulance's arrival. This allows the hospital to confirm the diagnosis and activate the catheterisation laboratory, thereby saving DTB time, which translates to reduction in mortality[19].

[18] 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, evolved AMI, delayed consent.
System delay refers to delay in primary PCI due to hospital's system. It includes: delayed process leading to the start of primary PCI, catheterisation laboratory being occupied, procedure difficulty, uptriaged, missed diagnosis, unknown reason.
[19] 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	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Overall DTB time within 90 min (%)	73.5	76.2	88.6	93.8	95.4	93.9	94.2	94.9	95.1	96.8
SCDF DTB time within 90 min (%)	76.9	79.3	93.4	96.2	97.6	97.1	97.2	97.4	97.4	98.1
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	95.0
Overall median DTB time (min)	70	66	59	56	54	55	55	54	52	53
SCDF median DTB time (min)	66	62	54	51	49	47	48	47	46	47
Non-SCDF median DTB time (min)	74	72	65	63	60	62	60	62	61	60

6 CONCLUSION

The top contributor to the combined burden of early death and disability in Singapore was cardiovascular diseases, accounting for 14.2% of the total disability-adjusted life years in 2017[20]. It is important for individuals with high risk of AMI to take preventive action. Individuals can reduce their chances of developing AMI by adopting a healthy lifestyle, such as having a balanced diet and opting for healthier options, exercising and maintaining a healthy weight, avoiding smoking, going for regular health screening and follow-ups, and controlling blood pressure, cholesterol and glucose levels well[21]. 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 maintaining a healthy lifestyle can reduce the risk of subsequent cardiovascular events and death.

[20] The Burden of Disease in Singapore, 1990-2017. Ministry of Health, Singapore. www.healthdata.org/sites/default/files/files/policy_report/2019/GDB_2017_Singapore_Report.pdf Accessed on 1 Mar 2021.

[21] 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.