



# **Singapore Myocardial Infarction Registry Annual Report 2021**

**National Registry of Diseases Office**  
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## Acknowledgement

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# Contents

<b>CONTENTS</b> .....	<b>3</b>
<b>1. GLOSSARY</b> .....	<b>5</b>
<b>2. EXECUTIVE SUMMARY</b> .....	<b>6</b>
<b>3. INTRODUCTION</b> .....	<b>7</b>
<b>4. METHODOLOGY</b> .....	<b>8</b>
<b>5. FINDINGS</b> .....	<b>11</b>
<b>5.1 INCIDENCE</b> .....	<b>11</b>
<i>Table 5.1.1: Incidence number and rate of AMI (per 100,000 population)</i> .....	11
<i>Figure 5.1.1: Incidence rate of AMI (per 100,000 population)</i> .....	11
<i>Table 5.1.2: Age distribution at onset of AMI</i> .....	12
<i>Figure 5.1.2: Age distribution at onset of AMI</i> .....	12
<i>Figure 5.1.3a: Age-specific incidence rate of AMI (per 100,000 population) across years</i> .....	13
<i>Figure 5.1.3b: Age-specific incidence rate of AMI (per 100,000 population) across age groups</i> .....	13
<i>Table 5.1.3: Age-specific incidence rate of AMI (per 100,000 population)</i> .....	14
<i>Table 5.1.4: Incidence number and rate of AMI (per 100,000 population) by gender</i> .....	15
<i>Figure 5.1.4: Incidence rate of AMI (per 100,000 population) by gender</i> .....	16
<i>Table 5.1.5a: Age distribution at onset of AMI among males</i> .....	16
<i>Figure 5.1.5a: Age distribution at onset of AMI among males</i> .....	17
<i>Table 5.1.5b: Age distribution at onset of AMI among females</i> .....	17
<i>Figure 5.1.5b: Age distribution at onset of AMI among females</i> .....	18
<i>Table 5.1.6: Incidence number and rate (per 100,000 population) of AMI by ethnicity</i> .....	19
<i>Figure 5.1.6: Incidence rate of AMI (per 100,000 population) by ethnicity</i> .....	20
<i>Table 5.1.7a: Age distribution at onset of AMI among Chinese</i> .....	20
<i>Figure 5.1.7a: Age distribution at onset of AMI among Chinese</i> .....	21
<i>Table 5.1.7b: Age distribution at onset of AMI among Malays</i> .....	21
<i>Figure 5.1.7b: Age distribution at onset of AMI among Malays</i> .....	22
<i>Table 5.1.7c: Age distribution at onset of AMI among Indians</i> .....	22
<i>Figure 5.1.7c: Age distribution at onset of AMI among Indians</i> .....	23
<i>Table 5.1.8: Incidence number and rate of AMI (per 100,000 population) by subtype</i> .....	24
<i>Figure 5.1.8: Incidence rate of AMI (per 100,000 population) by subtype</i> .....	24
<i>Table 5.1.9a: Age distribution at onset of STEMI</i> .....	25
<i>Figure 5.1.9a: Age distribution at onset of STEMI</i> .....	25
<i>Table 5.1.9b: Age distribution at onset of NSTEMI</i> .....	26
<i>Figure 5.1.9b: Age distribution at onset of NSTEMI</i> .....	27
<b>5.2 MORTALITY</b> .....	<b>28</b>
<i>Table 5.2.1: Mortality number and rate of AMI (per 100,000 population)</i> .....	28
<i>Figure 5.2.1: Mortality rate of AMI (per 100,000 population)</i> .....	28
<i>Table 5.2.2: Age distribution at death of AMI</i> .....	29
<i>Figure 5.2.2: Age distribution at death of AMI</i> .....	29
<i>Figure 5.2.3a: Age-specific mortality rate of AMI (per 100,000 population) across years</i> .....	30
<i>Figure 5.2.3b: Age-specific mortality rate of AMI (per 100,000 population) across age groups</i> .....	30
<i>Table 5.2.3: Age-specific mortality rate of AMI (per 100,000 population)</i> .....	31
<i>Table 5.2.4: Mortality number and rate of AMI (per 100,000 population) by gender</i> .....	32
<i>Figure 5.2.4: Mortality rate of AMI (per 100,000 population) by gender</i> .....	33
<i>Table 5.2.5a: Age distribution at death of AMI among males</i> .....	33
<i>Figure 5.2.5a: Age distribution at death of AMI among males</i> .....	34
<i>Table 5.2.5b: Age distribution at death of AMI among females</i> .....	34
<i>Figure 5.2.5b: Age distribution at death of AMI among females</i> .....	35
<i>Table 5.2.6: Mortality number and rate of AMI (per 100,000 population) by ethnicity</i> .....	35
<i>Figure 5.2.6: Mortality rate of AMI (per 100,000 population) by ethnicity</i> .....	36

Table 5.2.7a: Age distribution at death of AMI among Chinese .....	37
Figure 5.2.7a: Age distribution at death of AMI among Chinese .....	37
Table 5.2.7b: Age distribution at death of AMI among Malays .....	38
Figure 5.2.7b: Age distribution at death of AMI among Malays .....	39
Table 5.2.7c: Age distribution at death of AMI among Indians .....	39
Figure 5.2.7c: Age distribution at death of AMI among Indians .....	40
Table 5.2.8: Mortality number and rate of AMI (per 100,000 population) by subtype .....	40
Figure 5.2.8: Mortality rate of AMI (per 100,000 population) by subtype .....	41
Table 5.2.9a: Age distribution at death of STEMI .....	41
Figure 5.2.9a: Age distribution at death of STEMI .....	42
Table 5.2.9b: Age distribution at death of NSTEMI .....	42
Figure 5.2.9b: Age distribution at death of NSTEMI .....	43
<b>5.3 30-DAY CASE FATALITY .....</b>	<b>44</b>
Table 5.3.1: 30-day case fatality number and rate of AMI (%) .....	44
Figure 5.3.1: 30-day case fatality rate of AMI (%) .....	44
Table 5.3.2: 30-day case fatality number and rate of AMI (%) by gender .....	45
Figure 5.3.2: 30-day case fatality rate of AMI (%) by gender .....	46
Table 5.3.3: 30-day case fatality number and rate of AMI (%) by ethnicity .....	46
Figure 5.3.3: 30-day case fatality rate of AMI (%) by ethnicity .....	47
Table 5.3.4: 30-day case fatality number and rate of AMI (%) by subtype .....	48
Figure 5.3.4: 30-day case fatality rate of AMI (%) by subtype .....	49
<b>5.4 SYMPTOMS .....</b>	<b>50</b>
Figure 5.4.1: Type of symptoms (%) .....	50
Figure 5.4.2a: Type of symptoms (%) among STEMI .....	51
Figure 5.4.2b: Type of symptoms (%) among NSTEMI .....	51
Figure 5.4.3: Presenting symptoms (%) .....	52
Figure 5.4.4a: Presenting symptoms (%) among STEMI .....	53
Figure 5.4.4b: Presenting symptoms (%) among NSTEMI .....	53
<b>5.5 RISK FACTORS .....</b>	<b>54</b>
Figure 5.5.1: Risk factors (%) .....	54
Figure 5.5.2a: Risk factors (%) among STEMI .....	55
Figure 5.5.2b: Risk factors (%) among NSTEMI .....	55
<b>5.6 TIME FACTORS .....</b>	<b>56</b>
Figure 5.6.1: Mode of arrival (%) among STEMI .....	56
Figure 5.6.2: DTB time by mode of arrival among STEMI .....	58
<b>6. CONCLUSION .....</b>	<b>59</b>

## 1. GLOSSARY

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

## 2. EXECUTIVE SUMMARY

This annual report presents data on trends for incidence, mortality, 30-days case fatality, presenting symptoms, risk factors and time to treatment for Singapore residents with acute myocardial infarction (AMI) for the latest 10 years period, from 2011 to 2021.

The number of AMI episodes increased from 8,014 episodes in 2011 to 12,403 episodes in 2021. The age-standardised incidence rate (ASIR) increased slightly from 204.7 to 217.2 per 100,000 population during this period.

The number of AMI deaths was 1,000 in 2021, a slight increase compared to 907 in 2011. However, the age-standardised mortality rate (ASMR) declined significantly from 22.5 to 15.3 per 100,000 population during this period. A significant decrease in the 30-day case fatality rate (CFR) from 11.1% in 2011 to 8.3% in 2021 was also observed.

Overall, the proportion of AMI patients experiencing typical symptoms of AMI has declined over the years. While more than half of the ST-segment elevation myocardial infarction (STEMI) patients experienced typical symptoms, the majority of patients with non-ST-segment elevation myocardial infarction (NSTEMI) had no or non-typical symptoms. Between 2011 and 2021, the two most common presenting symptoms remained consistent for AMI patients: chest pain and breathlessness. The proportion of the AMI patients with chest pain hovered between 50.2% to 58.3% in the past 10 years, while the proportion with breathlessness ranged between 48.4% to 55.7% during this period.

With regard to risk factors for AMI, hypertension and hyperlipidemia were consistently the two most common risk factors among AMI patients between 2011 and 2021. Each year, about 75% of AMI patients had hypertension. From 2011 to 2021, the proportion with hyperlipidemia rose from 69.1% to 74.4%. Moderate-to-high risk BMI and diabetes were also prevalent among AMI patients, with more than half of them having these risk factors and upward trends were observed over the years. Smoking was also a common risk factor, observed among more than two-fifths of AMI patients during this period.

The median door-to-balloon (DTB) time improved from 66 minutes in 2011 to 55 minutes in 2021. The proportion of STEMI patients with DTB time of 90 minutes or less improved from 76.2% in 2011 to 96.8% in 2021. The median DTB time was consistently shorter for STEMI patients who arrived by Singapore Civil Defence Force (SCDF) ambulance (49 minutes in 2021) than those who relied on other modes of transport (63 minutes in 2021) 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 SCDF ambulance (98.3% in 2021) than those who arrived via other modes of transport (94.1% in 2021) across the years.

### 3. INTRODUCTION

Ischaemic heart disease was the second most common cause of death in 2021, accounting for 20.1% of all deaths in Singapore<sup>1</sup>. AMI, commonly known as heart attack, is a type of ischaemic heart disease.

The most common cause of AMI is atherosclerosis – the narrowing of the arteries due to the build-up of cholesterol deposits. An 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.

The common risk factors of AMI are hypertension, hyperlipidemia, diabetes, obesity, smoking and old age. The median age of Singapore residents rose from 38 years in 2011 to 41.8 years in 2021, and the proportion of residents aged 65 years and above rose from 9.3% in 2011 to 16.0% in 2021<sup>2</sup>. 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.

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<sup>1</sup> Principal Causes of Death. Ministry of Health, Singapore. [www.moh.gov.sg/resources-statistics/singapore-health-facts/principal-causes-of-death](http://www.moh.gov.sg/resources-statistics/singapore-health-facts/principal-causes-of-death) Accessed on 2 May 2023.

<sup>2</sup> Population Trends 2021. Department of Statistics, Singapore. [www.singstat.gov.sg/publications/population/population-trends](http://www.singstat.gov.sg/publications/population/population-trends) Accessed on 2 May 2023.

## 4. METHODOLOGY

The National Registry of Diseases Office (NRDO) collects and analyses epidemiological data to support health 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 9<sup>th</sup> Revision (ICD-9) Clinical Modification code 410 was used to identify AMI cases from 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 and/or abnormal electrocardiogram (ECG).

AMIs are broadly classified into STEMI and NSTEMI based on 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 recommendation by the American Heart Association<sup>3</sup>. For type 2 AMI, they were eventually combined with NSTEMI in this report as their clinical characteristics are similar<sup>4</sup>.

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<sup>3</sup> American College of Cardiology Foundation. Universal definition of myocardial infarction. *Journal of the American College of Cardiology* 2007; 50(22): 2173-2195.

<sup>4</sup> 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 2022 by matching the patients' NRIC number with the death information from 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<sup>5</sup>. The Segi World population estimates used for age standardisation are available on the World Health Organization website<sup>6</sup>.

### 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 patients in the same year. This indicator reflects the severity of AMI, the timeliness of healthcare delivery and the effectiveness of AMI treatment.

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<sup>5</sup> 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](http://tablebuilder.singstat.gov.sg/publicfacing/mainMenu.action). Accessed on 23 April 2023.

<sup>6</sup> Omar BA et al. Age standardization of rates: a new WHO standard. GPE discussion paper series: no. 31. EIP.GPE/EBD World Health Organization 2001.

This report focuses on Singapore residents, aged 15 years and above, diagnosed with AMI in 2011 to 2021 as they stood on 24 March 2023. All findings in this report, except mortality and case fatality, were based on episodes.

## 5. FINDINGS

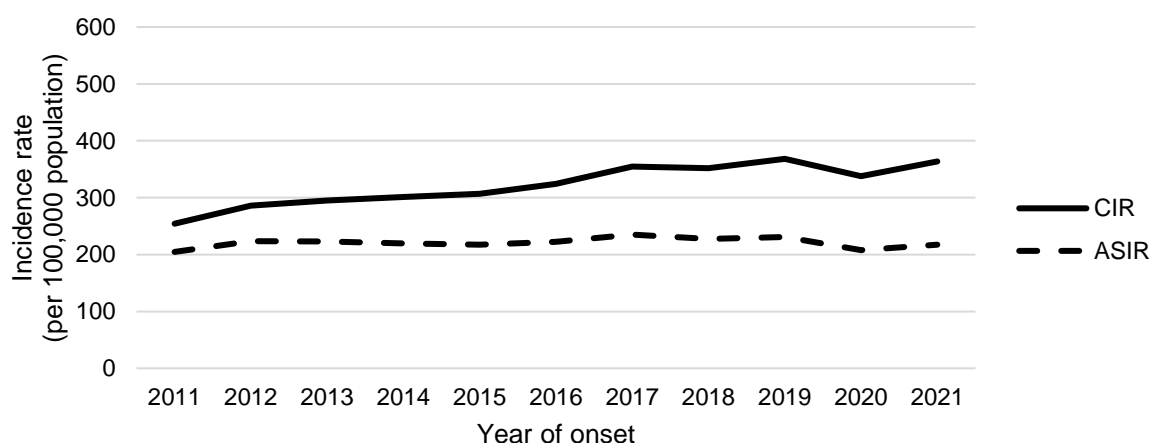
### 5.1 Incidence

The number of AMI episodes and the crude incidence rate (CIR) showed a general increasing trend between 2011 and 2021 (Table 5.1.1 and Figure 5.1.1). However, after accounting for Singapore's ageing population, the rise in ASIR was no longer significant ( $p=0.562$ ). Notably, there was a drop in incidence in 2020, which was likely due to the corollary effect of COVID-19 pandemic, as patients especially elderly with NSTEMI, avoided going to the hospitals<sup>7</sup>. Similarly, declines in hospital admissions for AMI during the peak of the pandemic were also noted in many other countries, such as in China, Italy, Spain, the United States, United Kingdom, France, Greece, and Sweden<sup>8</sup>. In 2021, however, the ASIR returned to be closer to that observed prior to the COVID-19 pandemic.

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

Year of onset	Number	CIR	95% CI	ASIR	95% CI
2011	8014	254.2	248.7-259.8	204.7	200.1-209.3
2012	9124	285.9	280.0-291.8	223.3	218.6-227.9
2013	9532	295.2	289.3-301.1	222.8	218.3-227.3
2014	9835	301.4	295.5-307.4	219.3	214.9-223.7
2015	10132	307.0	301.0-313.0	217.2	212.9-221.5
2016	10814	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	11983	352.1	345.8-358.4	227.5	223.3-231.6
2019	12650	368.3	361.8-374.7	230.8	226.7-235.0
2020	11679	337.9	331.8-344.1	207.9	204.0-211.8
2021	12403	363.8	357.4-370.2	217.2	213.3-221.2
<b>P for trend</b>	-	<0.001	-	0.562	-

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



<sup>7</sup> Tern P. et al. Impact of COVID-19 on Acute MI and Percutaneous Coronary Intervention Rates and Outcomes in Southeast Asia and the Middle East. Journal of Asia Pacific Society of Cardiology: 2022.

<sup>8</sup> Toscano et al. Acute Myocardial Infarction During the COVID-19 Pandemic: An Update on Clinical Characteristics and Outcomes. Front. Cardiovasc. Med. 2021; 8.

The median age at onset of AMI increased slightly from 69.1 years in 2011 to 70.2 years in 2021 (Table 5.1.2). About 76% of the patients were aged 60 years or above in 2021, a gradual increase from about 70% in 2011 (Figure 5.1.2).

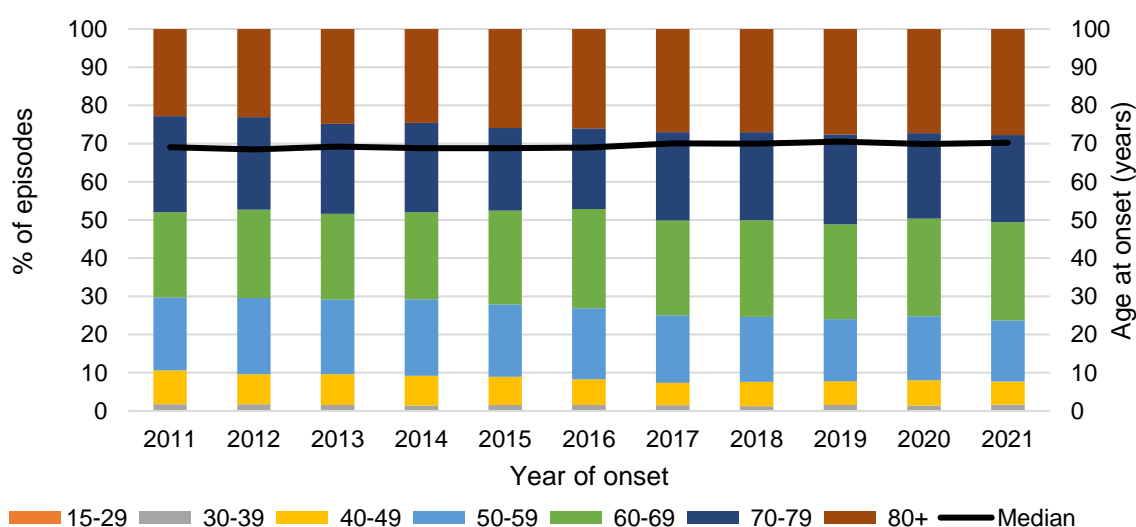
**Table 5.1.2: Age distribution at onset of AMI**

Year of onset	Overall		Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%	
2011	69.1	13	0.2	126	1.6	709	8.8	
2012	68.5	15	0.2	139	1.5	726	8.0	
2013	69.2	13	0.1	139	1.5	765	8.0	
2014	68.8	11	0.1	127	1.3	768	7.8	
2015	68.8	13	0.1	148	1.5	742	7.3	
2016	69.0	16	0.1	155	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	70.5	22	0.2	179	1.4	785	6.2	
2020	69.9	15	0.1	143	1.2	774	6.6	
2021	70.2	12	0.1	190	1.5	747	6.0	

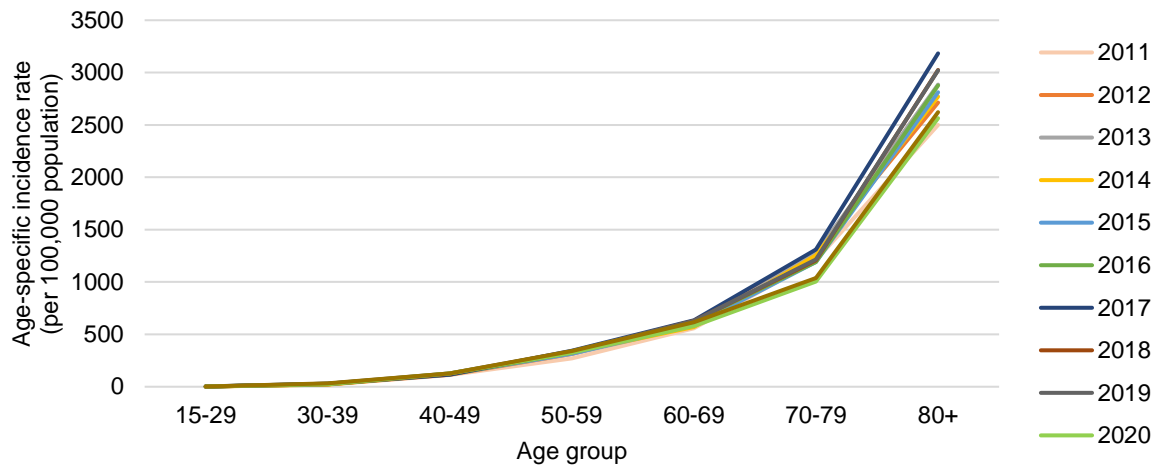
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2011	1536	19.2	1784	22.3	2016	25.2	1830	22.8
2012	1818	19.9	2107	23.1	2213	24.3	2106	23.1
2013	1859	19.5	2146	22.5	2241	23.5	2369	24.9
2014	1972	20.1	2241	22.8	2297	23.4	2419	24.6
2015	1923	19.0	2489	24.6	2189	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	2762	23.0	3233	27.0
2019	2056	16.3	3136	24.8	2978	23.5	3494	27.6
2020	1960	16.8	2984	25.6	2624	22.5	3179	27.2
2021	1988	16.0	3194	25.8	2829	22.8	3443	27.8

**Figure 5.1.2: Age distribution at onset of AMI**

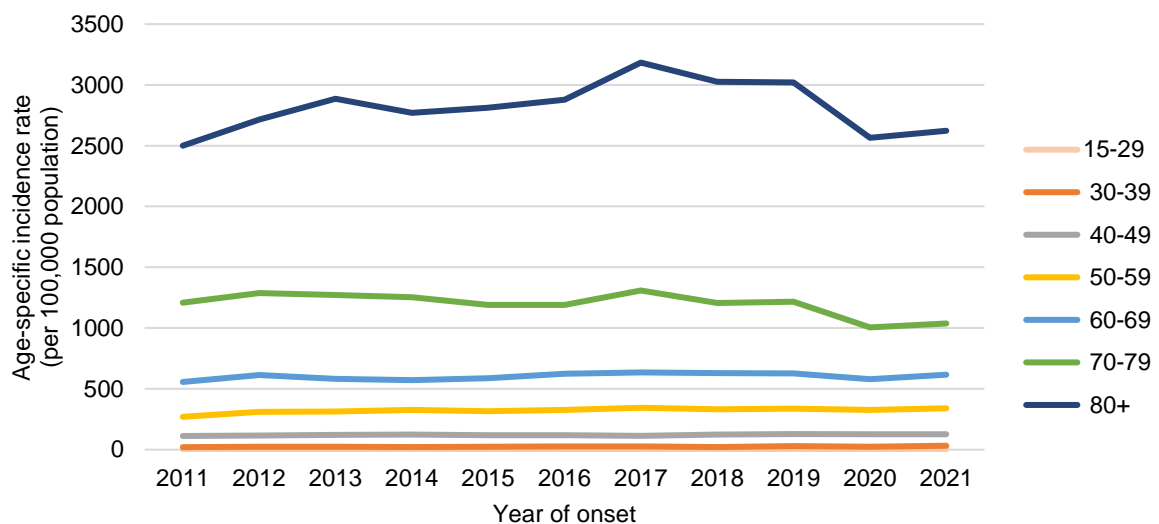


The age-specific incidence rate of AMI increased with age, with the oldest age group having the highest incidence rate (Figures 5.1.3a and 5.1.3b). Over the years, significant rises in age-specific AMI incidence rates were seen in those aged 30-59 years; while among those aged 70-79 years, there was a significant decline in age-specific incidence of AMI (Table 5.1.3).

**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**



**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
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	285.9	280.0-291.8	1.9	1.0-2.9	22.8	19.0-26.6	115.3	106.9-123.7
2013	295.2	289.3-301.1	1.7	0.8-2.6	23.1	19.2-26.9	121.7	113.0-130.3
2014	301.4	295.5-307.4	1.4	0.6-2.3	21.4	17.7-25.1	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	26.4	22.2-30.5	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	368.3	361.8-374.7	2.9	1.7-4.1	30.1	25.7-34.5	128.2	119.2-137.1
2020	337.9	331.8-344.1	2.0	1.0-3.0	23.9	20.0-27.9	126.7	117.7-135.6
2021	363.8	357.4-370.2	1.7	0.7-2.6	32.2	27.6-36.8	126.0	117.0-135.0
P for trend	<0.001	-	0.186	-	0.011	-	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
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	312.3	297.9-326.6	614.6	588.4-640.9	1286.6	1233.0-1340.2	2713.9	2598.0-2829.8
2013	313.0	298.8-327.2	583.0	558.3-607.7	1272.6	1219.9-1325.3	2885.5	2769.3-3001.7
2014	326.5	312.1-341.0	570.7	547.0-594.3	1254.4	1203.1-1305.7	2771.1	2660.7-2881.5
2015	315.2	301.1-329.3	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	1206.8	1161.8-1251.8	3024.9	2920.6-3129.2
2019	337.9	323.3-352.5	627.0	605.1-649.0	1216.9	1173.2-1260.6	3021.0	2920.8-3121.2
2020	325.6	311.2-340.1	580.5	559.7-601.3	1005.4	966.9-1043.8	2564.2	2475.1-2653.4
2021	340.3	325.3-355.3	616.6	595.2-638.0	1038.9	1000.6-1077.2	2622.0	2534.4-2709.6
P for trend	0.007	-	0.108	-	0.024	-	0.594	-

Although the gender distribution was almost equal in the general population, there were more males who had AMI than females over the years, with about twice as many males getting an AMI every year (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 327.8 per 100,000 population, while females had an ASIR of 115.7 per 100,000 population in 2021. While the CIRs had increased significantly for both genders, after accounting for population ageing, these changes were no longer significant.

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<sup>9</sup>. Furthermore, the prevalence of hypertension, hyperlipidemia, diabetes, high risk body mass index (BMI) and smoking, which are common risk factors of AMI, were higher among males than females in the general population based on the National Population Health Survey (NPHS) 2020 and 2021<sup>10,11</sup>.

**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
2011	5305	66.2	343.9	334.6-353.1	295.8	287.7-303.9
2012	5977	65.5	383.1	373.4-392.8	320.8	312.6-329.0
2013	6106	64.1	387.2	377.5-396.9	314.9	307.0-322.8
2014	6391	65.0	401.4	391.5-411.2	315.4	307.7-323.2
2015	6581	65.0	408.9	399.0-418.8	312.7	305.1-320.3
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	7990	66.7	483.0	472.4-493.6	339.3	331.8-346.8
2019	8270	65.4	495.8	485.1-506.5	338.3	330.9-345.6
2020	7811	66.9	465.6	455.3-476.0	312.0	305.0-319.0
2021	8329	67.2	502.4	491.6-513.1	327.8	320.6-335.0
P for trend	-	-	<0.001	-	0.067	-
Female						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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	35.0	210.0	203.1-216.9	127.7	123.3-132.1
2016	3710	34.3	216.8	209.8-223.7	128.7	124.3-133.0
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	4380	34.6	247.9	240.5-255.2	132.2	128.0-136.3
2020	3868	33.1	217.5	210.6-224.3	112.5	108.8-116.3
2021	4074	32.8	232.6	225.4-239.7	115.7	111.9-119.4

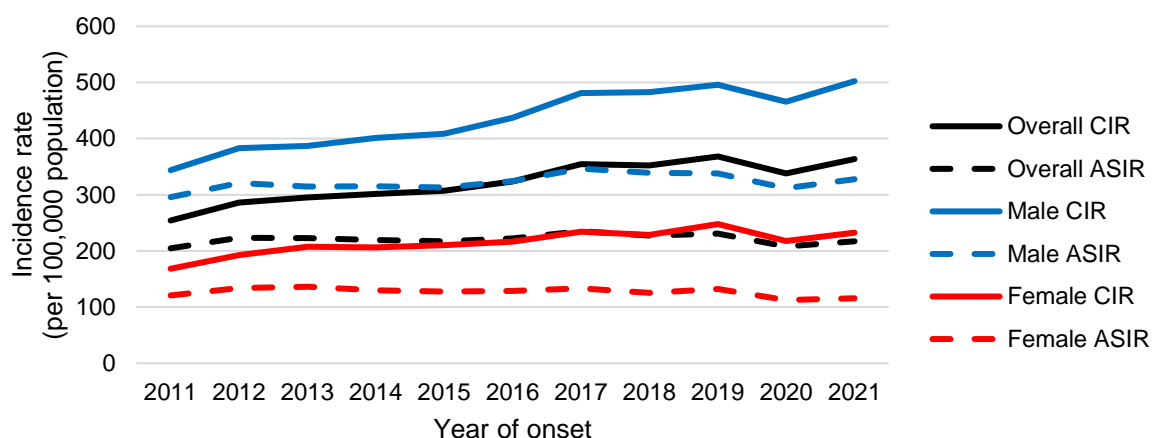
<sup>9</sup> Mehta LS et al. Acute myocardial infarction in women. *Circulation* 2016; 133.

<sup>10</sup> National Population Health Survey 2020 (Household Interview and Health Examination). Ministry of Health, Singapore. <https://www.moh.gov.sg/docs/librariesprovider5/default-document-library/nphs-2020-survey-report.pdf> Accessed on 27 April 2023.

<sup>11</sup> National Population Health Survey 2021 (Household Interview). Ministry of Health, Singapore. <https://www.moh.gov.sg/resources-statistics/reports/nphs-2020-21> Accessed on 27 April 2023.

<b>P for trend</b>	-	-	0.001	-	0.120	-
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**Figure 5.1.4: Incidence rate of AMI (per 100,000 population) by gender**



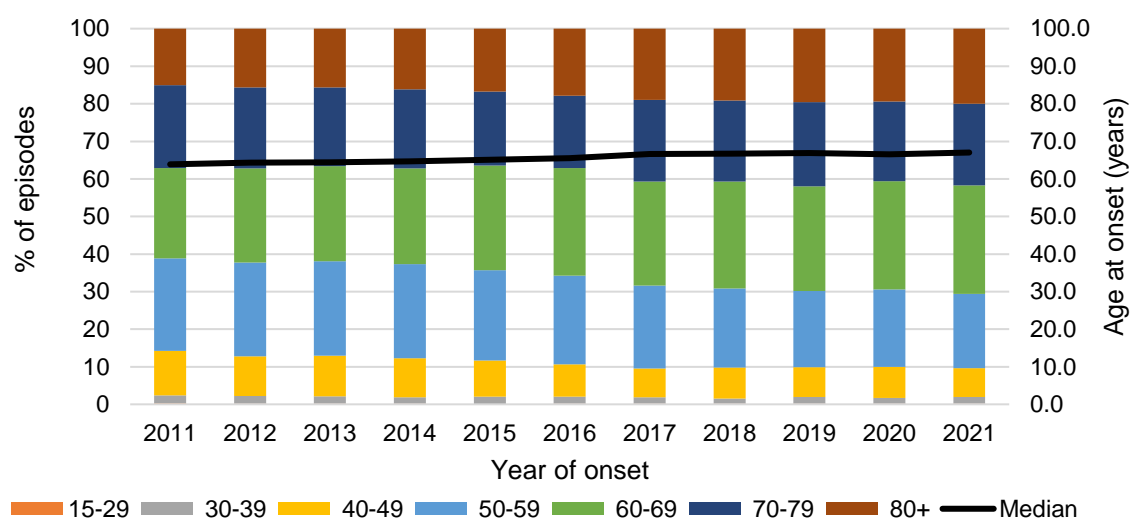
The median age at onset of AMI among males increased slightly from 63.9 years in 2011 to 67.0 years in 2021 (Table 5.1.5a). The highest proportion of male AMI patients in 2021 was among those aged 60-69 years (28.9%); this was the case throughout the years from 2012 onwards (Figure 5.1.5a).

**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	%
2011	63.9		12	0.2	116	2.2	627	11.8
2012	64.3		11	0.2	120	2.0	633	10.6
2013	64.4		10	0.2	121	2.0	661	10.8
2014	64.7		10	0.2	111	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	66.9		16	0.2	144	1.7	660	8.0
2020	66.5		14	0.2	118	1.5	646	8.3
2021	67.0		11	0.1	154	1.8	637	7.6
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2011	1306	24.6	1273	24.0	1174	22.1	797	15.0
2012	1491	24.9	1500	25.1	1286	21.5	936	15.7
2013	1534	25.1	1547	25.3	1277	20.9	956	15.7
2014	1599	25.0	1632	25.5	1342	21.0	1033	16.2
2015	1576	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	1725	21.6	1527	19.1
2019	1678	20.3	2301	27.8	1856	22.4	1615	19.5
2020	1610	20.6	2254	28.9	1656	21.2	1513	19.4
2021	1644	19.7	2406	28.9	1811	21.7	1666	20.0



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



The median age at onset of AMI among females increased slightly from 76.3 years in 2011 to 77.4 years in 2021 (Table 5.1.5b), about 10 years older than the median age at onset among males (Table 5.1.5a). In contrast to males, the highest proportion of female AMI patients in 2021 was among those aged 80 years or above (43.6%); a pattern that had been consistent since 2011 (Figure 5.1.5b).

Worldwide, the pattern of females having AMI onset 9-10 years later than males persists across all regions, primarily because younger males had higher levels of risk factors than females of the same age, especially lipid abnormalities and smoking<sup>12,13</sup>. The same risk profile has been observed in Singapore in the NPHS 2021<sup>14</sup>, whereby self-reported hyperlipidaemia and smoking were substantially more common among males aged 30-59 years compared to females of the same ages.

**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	%
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	22	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	125	2.9
2020	77.6	1	0.0	25	0.6	128	3.3
2021	77.4	1	0.0	36	0.9	110	2.7
Year of onset	Age 50-59	Age 60-69	Age 70-79	Age 80+			

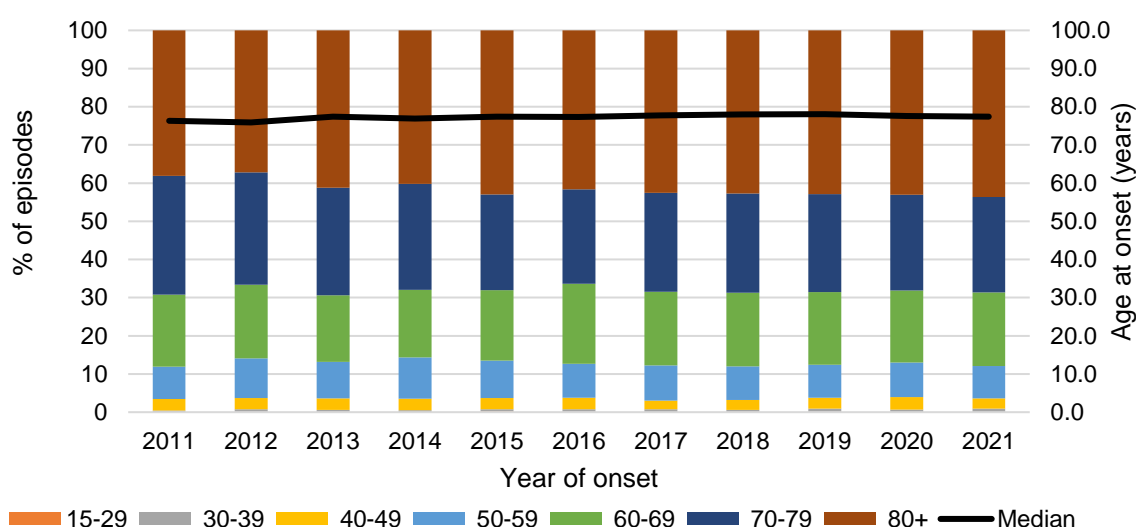
<sup>12</sup> Yusuf, S et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet*. 2004;364:937-952.

<sup>13</sup> Campbell, D. J. Why do men and women differ in their risk of myocardial infarction? *European Heart Journal*. 2008;29:835-835.

<sup>14</sup> National Population Health Survey 2021 (Household Interview). Ministry of Health, Singapore. <https://www.moh.gov.sg/resources-statistics/reports/nphs-2020-21> Accessed on 27 April 2023.

	Number	%	Number	%	Number	%	Number	%
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	378	8.6	835	19.1	1122	25.6	1879	42.9
2020	350	9.0	730	18.9	968	25.0	1666	43.1
2021	344	8.4	788	19.3	1018	25.0	1777	43.6

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



Comparing the ethnic distribution of the AMI population with the general population, the proportion of Chinese were lower among the AMI population (Table 5.1.6). Chinese also consistently had the lowest ASIR across the years (Figure 5.1.6). The ASIRs were 168.5, 432.4 and 431.8 per 100,000 population for the Chinese, Malays, and Indians respectively in 2021. The rise in ASIR over the years was not significant for all the three ethnic groups.

The prevalence of diabetes and high-risk BMI, 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 2020 and 2021<sup>15,16</sup>. Furthermore, Indians have ethnic-specific risk for coronary artery disease<sup>17</sup>. The high prevalence of AMI risk factors among Malays and the combination of AMI risk factors

<sup>15</sup> National Population Health Survey 2020 (Household Interview and Health Examination). Ministry of Health, Singapore. <https://www.moh.gov.sg/docs/librariesprovider5/default-document-library/nphs-2020-survey-report.pdf> Accessed on 27 April 2023.

<sup>16</sup> National Population Health Survey 2021 (Household Interview). Ministry of Health, Singapore. <https://www.moh.gov.sg/resources-statistics/reports/nphs-2020-21> Accessed on 27 April 2023.

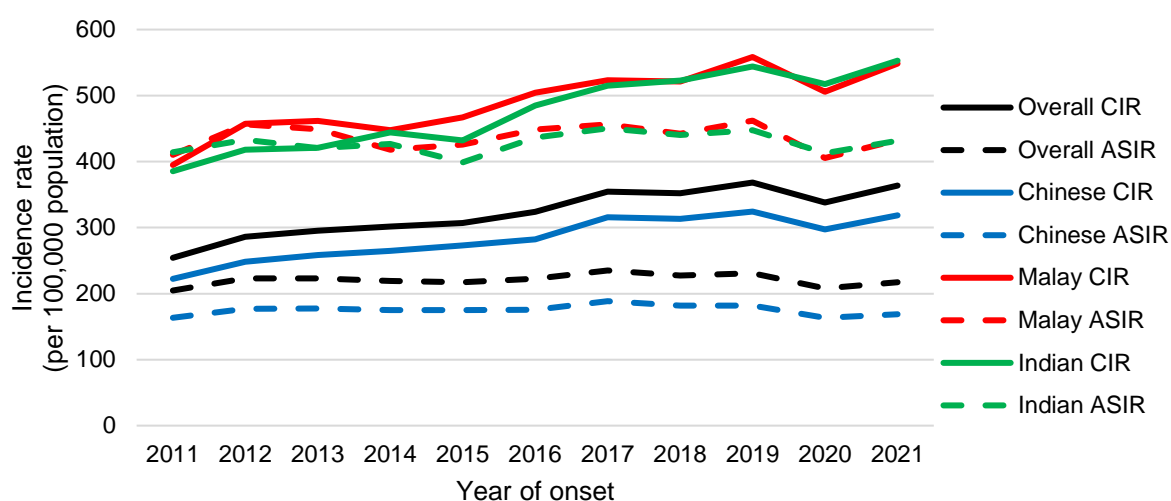
<sup>17</sup> Zheng H et al. Ethnic differences and trends in ST-segment elevation myocardial infarction incidence and mortality in a multi-ethnic population. *Annals Academy of Medicine Singapore*. 2019; 48: 75-85.

in the backdrop of genetic predisposition to coronary artery disease among Indians were likely the reasons for their higher ASIRs, relative to Chinese.

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

<b>Chinese</b>						
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CIR</b>	<b>95% CI</b>	<b>ASIR</b>	<b>95% CI</b>
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	6309	66.2	258.6	252.2-265.0	177.5	173.1-182.0
2014	6521	66.3	264.7	258.2-271.1	175.0	170.7-179.4
2015	6802	67.1	272.9	266.4-279.3	175.0	170.8-179.3
2016	7119	65.8	282.4	275.9-289.0	175.7	171.5-179.9
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	8409	66.5	324.3	317.4-331.2	181.9	177.9-186.0
2020	7757	66.4	297.4	290.8-304.0	163.6	159.8-167.4
2021	8196	66.1	318.8	311.9-325.7	168.5	164.7-172.4
<b>P for trend</b>	-	-	<0.001	-	0.894	-
<b>Malay</b>						
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CIR</b>	<b>95% CI</b>	<b>ASIR</b>	<b>95% CI</b>
2011	1568	19.6	394.9	375.3-414.4	410.4	389.3-431.5
2012	1843	20.2	457.3	436.4-478.2	456.3	434.9-477.7
2013	1888	19.8	461.8	441.0-482.7	449.1	428.4-469.8
2014	1856	18.9	447.7	427.4-468.1	418.1	398.6-437.5
2015	1962	19.4	467.0	446.4-487.7	425.9	406.7-445.2
2016	2148	19.9	504.4	483.1-525.8	448.4	429.1-467.8
2017	2255	18.9	523.4	501.8-545.0	456.3	437.1-475.4
2018	2268	18.9	521.0	499.6-542.5	442.3	423.9-460.7
2019	2452	19.4	558.4	536.3-580.5	462.0	443.6-480.5
2020	2237	19.2	505.8	484.8-526.7	405.4	388.4-422.5
2021	2416	19.5	548.5	526.7-570.4	432.4	414.9-450.0
<b>P for trend</b>	-	-	<0.001	-	0.916	-
<b>Indian</b>						
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CIR</b>	<b>95% CI</b>	<b>ASIR</b>	<b>95% CI</b>
2011	1063	13.3	385.4	362.3-408.6	414.3	388.5-440.1
2012	1166	12.8	418.1	394.1-442.1	433.1	407.6-458.6
2013	1183	12.4	420.7	396.7-444.7	420.4	395.9-444.8
2014	1261	12.8	444.3	419.8-468.9	426.7	402.8-450.7
2015	1236	12.2	432.1	408.0-456.1	398.7	376.1-421.4
2016	1399	12.9	485.0	459.6-510.4	436.4	413.2-459.6
2017	1500	12.6	514.9	488.9-541.0	450.4	427.4-473.3
2018	1537	12.8	522.6	496.5-548.8	440.4	418.3-462.4
2019	1619	12.8	544.3	517.8-570.8	447.5	425.7-469.3
2020	1546	13.2	517.2	491.4-542.9	412.6	392.1-433.2
2021	1623	13.1	552.9	526.0-579.8	431.8	410.8-452.7
<b>P for trend</b>	-	-	<0.001	-	0.348	-

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



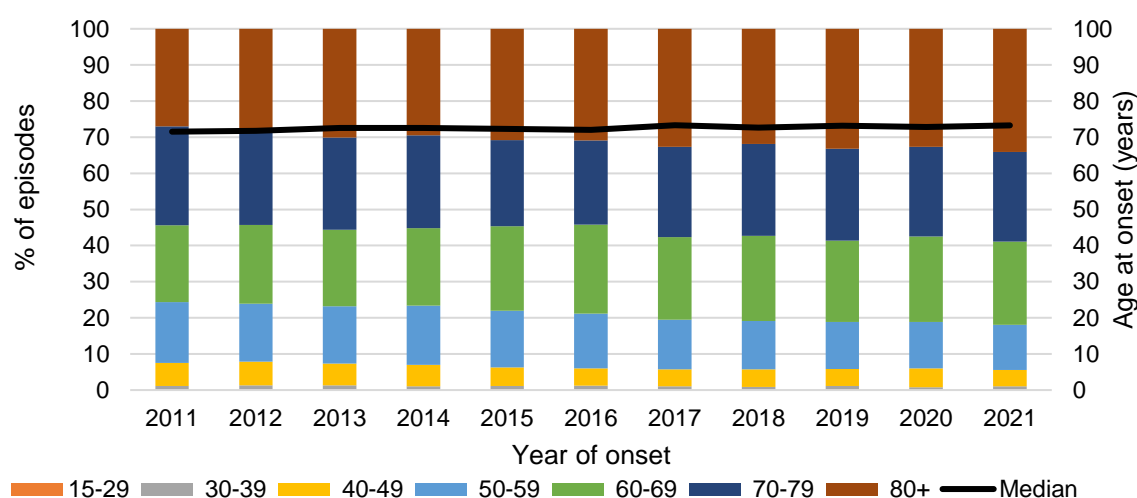
The Chinese had the oldest median age at onset of AMI, which increased slightly from 71.5 years in 2011 to 73.3 years in 2021 (Table 5.1.7a). Since 2012, those aged 80 years and above accounted for the largest proportion of AMI cases among the Chinese, ranging from 27.0%-34.1% (Figure 5.1.7a).

**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	%
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	60	0.9	389	6.0
2015	72.3		9	0.1	66	1.0	353	5.2
2016	72.0		4	0.1	81	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	73.2		10	0.1	87	1.0	392	4.7
2020	72.8		7	0.1	56	0.7	404	5.2
2021	73.3		7	0.1	82	1.0	369	4.5
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1335	21.2	1610	25.5	1898	30.1
2014	1072	16.4	1398	21.4	1674	25.7	1922	29.5
2015	1067	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	1095	13.0	1898	22.6	2137	25.4	2790	33.2

<b>2020</b>	999	12.9	1829	23.6	1925	24.8	2537	32.7
<b>2021</b>	1020	12.4	1893	23.1	2034	24.8	2791	34.1

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



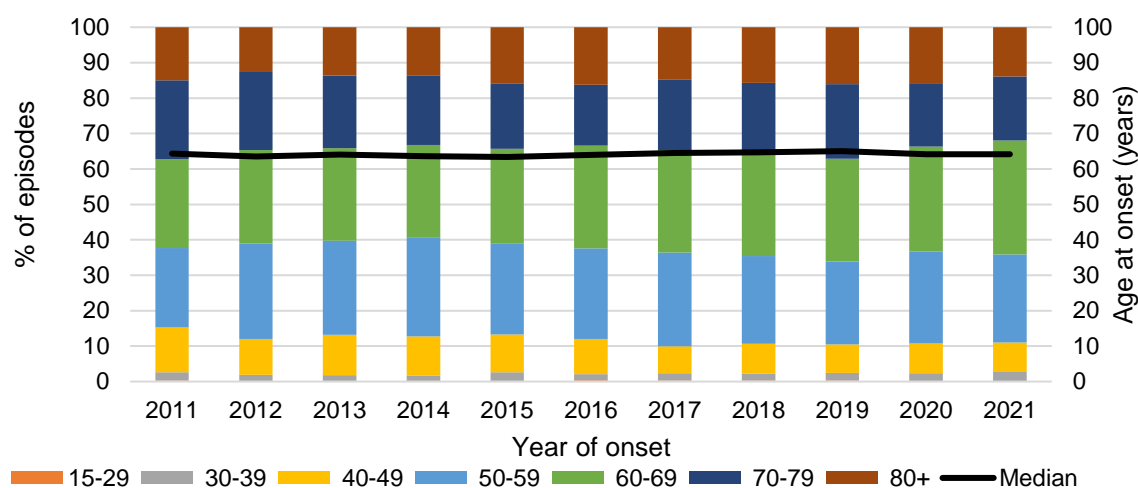
The median age at onset of AMI among the Malays was earlier than that among the Chinese and remained similar at 64.3 years in 2011 and 64.1 years in 2021 (Table 5.1.7b). The highest proportion of Malay AMI patients in 2021 was among those aged 60-69 years (32.2%) (Figure 5.1.7b).

**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	%
<b>2011</b>	64.3		4	0.3	37	2.4	199	12.7
<b>2012</b>	63.6		3	0.2	32	1.7	186	10.1
<b>2013</b>	64.0		3	0.2	32	1.7	214	11.3
<b>2014</b>	63.6		3	0.2	28	1.5	206	11.1
<b>2015</b>	63.4		4	0.2	48	2.4	208	10.6
<b>2016</b>	64.0		7	0.3	37	1.7	215	10.0
<b>2017</b>	64.5		7	0.3	46	2.0	171	7.6
<b>2018</b>	64.7		6	0.3	45	2.0	190	8.4
<b>2019</b>	65.0		7	0.3	54	2.2	195	8.0
<b>2020</b>	64.1		5	0.2	48	2.1	188	8.4
<b>2021</b>	64.1		3	0.1	66	2.7	197	8.2
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
<b>2011</b>	351	22.4	393	25.1	349	22.3	235	15.0
<b>2012</b>	497	27.0	486	26.4	407	22.1	232	12.6
<b>2013</b>	502	26.6	493	26.1	387	20.5	257	13.6
<b>2014</b>	516	27.8	486	26.2	362	19.5	255	13.7
<b>2015</b>	505	25.7	524	26.7	359	18.3	314	16.0
<b>2016</b>	549	25.6	622	29.0	370	17.2	348	16.2
<b>2017</b>	597	26.5	653	29.0	450	20.0	331	14.7
<b>2018</b>	563	24.8	659	29.1	449	19.8	356	15.7

<b>2019</b>	574	23.4	713	29.1	515	21.0	394	16.1
<b>2020</b>	580	25.9	663	29.6	400	17.9	353	15.8
<b>2021</b>	600	24.8	778	32.2	437	18.1	335	13.9

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



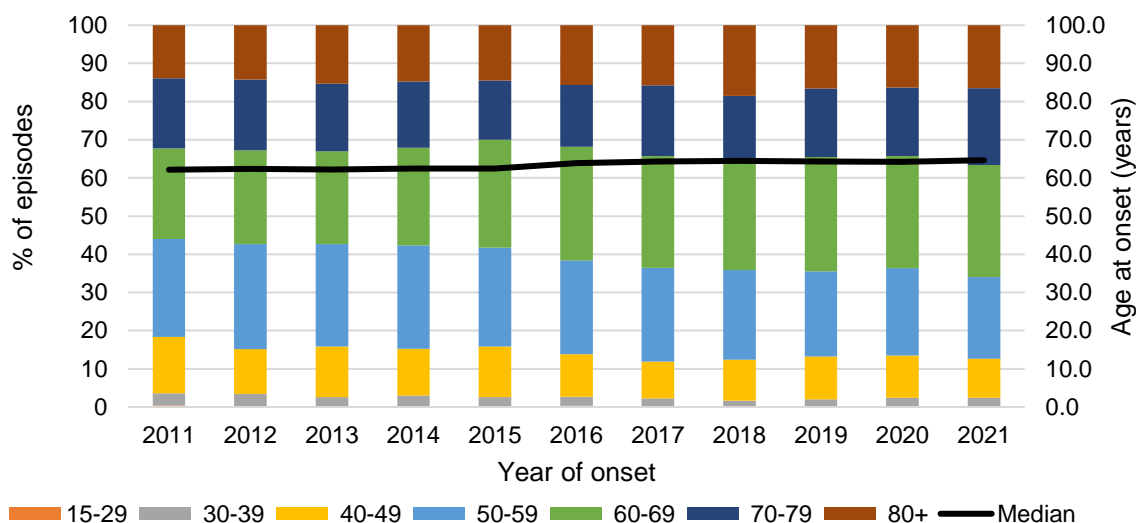
The median age at onset of AMI among the Indians increased slightly from 62.2 years in 2011 to 64.6 years in 2021 (Table 5.1.7c). Like the Malays, the highest proportion of Indian AMI patients in 2021 was among those aged 60-69 years (29.3%) (Figure 5.1.7c).

**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	%
<b>2011</b>	62.2		4	0.4	34	3.2	157	14.8
<b>2012</b>	62.4		2	0.2	38	3.3	137	11.7
<b>2013</b>	62.2		2	0.2	29	2.5	156	13.2
<b>2014</b>	62.4		2	0.2	36	2.9	154	12.2
<b>2015</b>	62.5		0	0.0	32	2.6	164	13.3
<b>2016</b>	63.9		5	0.4	33	2.4	155	11.1
<b>2017</b>	64.3		2	0.1	32	2.1	144	9.6
<b>2018</b>	64.5		3	0.2	22	1.4	165	10.7
<b>2019</b>	64.3		2	0.1	31	1.9	182	11.2
<b>2020</b>	64.2		2	0.1	35	2.3	171	11.1
<b>2021</b>	64.6		2	0.1	37	2.3	167	10.3
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
<b>2011</b>	273	25.7	252	23.7	195	18.3	148	13.9
<b>2012</b>	321	27.5	286	24.5	216	18.5	166	14.2
<b>2013</b>	318	26.9	287	24.3	210	17.8	181	15.3
<b>2014</b>	342	27.1	322	25.5	219	17.4	186	14.8
<b>2015</b>	320	25.9	349	28.2	192	15.5	179	14.5
<b>2016</b>	344	24.6	416	29.7	227	16.2	219	15.7
<b>2017</b>	369	24.6	439	29.3	278	18.5	236	15.7

<b>2018</b>	362	23.6	448	29.1	253	16.5	284	18.5
<b>2019</b>	361	22.3	484	29.9	290	17.9	269	16.6
<b>2020</b>	355	23.0	453	29.3	277	17.9	253	16.4
<b>2021</b>	346	21.3	476	29.3	327	20.1	268	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<sup>18</sup>.

A dip was observed in overall AMI incidence in 2020, possibly attributable to the COVID-19 pandemic. As STEMI is more severe with a higher likelihood of fatality if intervention was not provided promptly, the number of STEMI continued to rise in 2020 and the ASIR remained unaffected, as the likelihood of these patients avoiding hospital visits due to the ongoing COVID-19 pandemic was lower. However, the number of NSTEMI dropped in 2020 as it was possible that these patients, especially the elderly, could have avoided going to hospitals due to COVID-19 concerns. The ASIR for STEMI generally remained stable at between 52.8 and 57.3 per 100,000 population over the past decade ( $p=0.517$ ). Although the ASIR for NSTEMI had risen from 132.7 per 100,000 population in 2011 to 153.3 per 100,000 population in 2021, this change was not significant ( $p=0.300$ ).

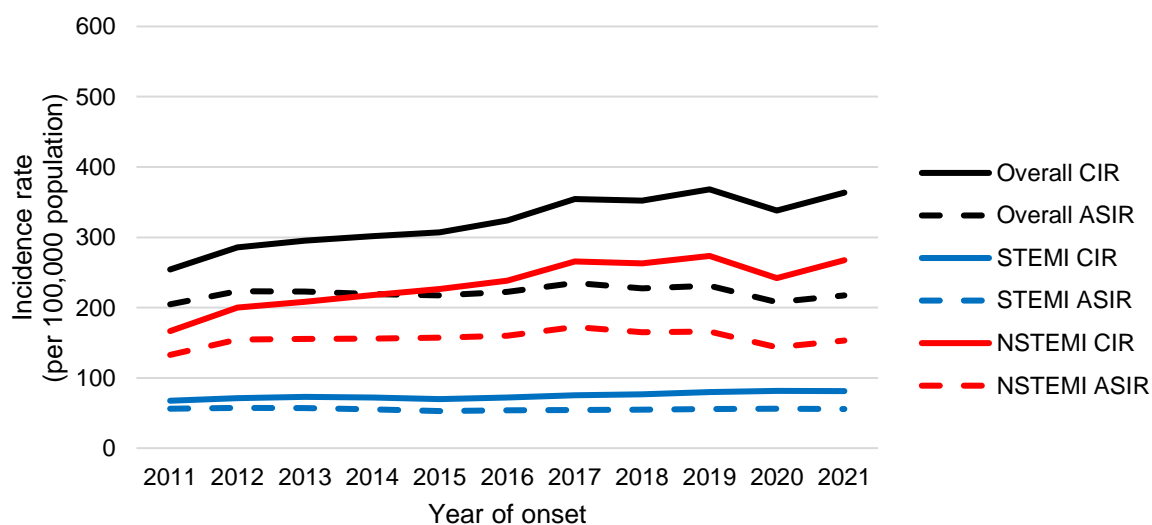
As the percentages in Table 5.1.8 are among all AMI and patients without documentation of STEMI or NSTEMI are not shown, the sum of the percentages for STEMI and NSTEMI are less than 100% for each year. Figures for overall CIR and ASIR include cases of unknown etiology.

<sup>18</sup>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
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	2345	23.8	71.9	69.0-74.8	55.1	52.9-57.4
2015	2308	22.8	69.9	67.1-72.8	52.8	50.6-55.0
2016	2406	22.2	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	2609	21.8	76.7	73.7-79.6	54.8	52.7-57.0
2019	2736	21.6	79.6	76.7-82.6	55.9	53.7-58.0
2020	2815	24.1	81.5	78.4-84.5	56.0	53.9-58.1
2021	2766	22.3	81.1	78.1-84.1	55.5	53.4-57.7
P for trend	-	-	<0.001	-	0.517	-
NSTEMI						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
2011	5251	65.5	166.6	162.1-171.1	132.7	129.0-136.4
2012	6379	69.9	199.9	195.0-204.8	154.6	150.8-158.5
2013	6731	70.6	208.4	203.5-213.4	155.6	151.8-159.4
2014	7109	72.3	217.9	212.8-222.9	156.0	152.3-159.7
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	9395	74.3	273.5	268.0-279.0	166.0	162.6-169.5
2020	8363	71.6	242.0	236.8-247.2	143.4	140.2-146.6
2021	9121	73.5	267.5	262.0-273.0	153.3	150.0-156.5
P for trend	-	-	<0.001	-	0.300	-

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



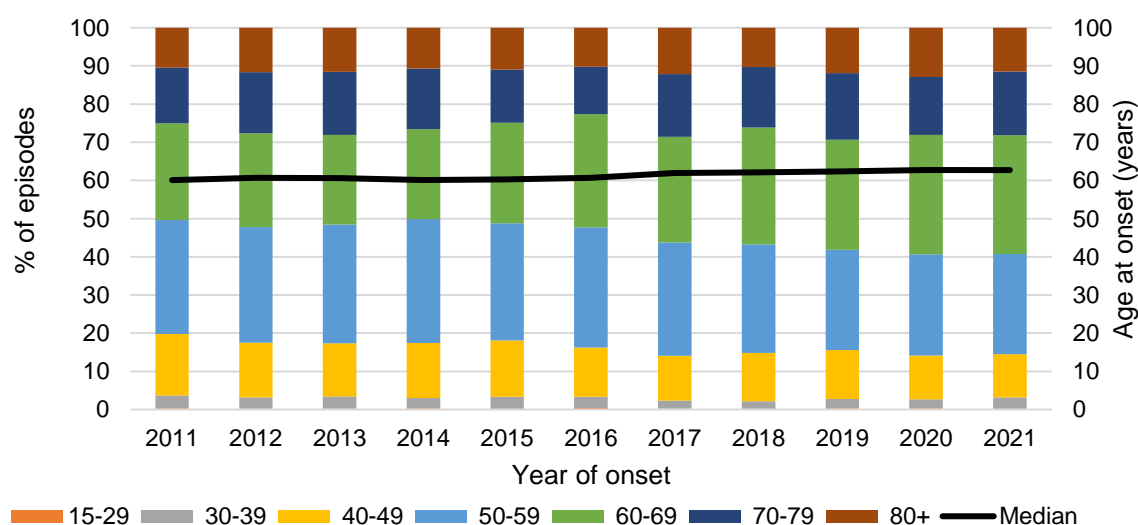


The median age at onset of STEMI increased slightly from 60.1 years in 2011 to 62.7 years in 2021 (Table 5.1.9a). The largest proportion of STEMI patients in 2021 was among those aged 60-69 years (31.1%) (Figure 5.1.9a).

**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	%
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	63	2.7	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	62.4		9	0.3	67	2.4	351	12.8
2020	62.7		9	0.3	67	2.4	323	11.5
2021	62.7		5	0.2	84	3.0	312	11.3
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	30.5	415	15.9	268	10.3
2019	718	26.2	789	28.8	477	17.4	325	11.9
2020	745	26.5	882	31.3	427	15.2	362	12.9
2021	727	26.3	860	31.1	461	16.7	317	11.5

**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), which was about 10 years older than the median age at onset of STEMI (Table 5.1.9a). Unlike NSTEMI, the highest proportion of NSTEMI patients in 2021 was among those aged 80 years or above (32.2%) (Figure 5.1.9b). Data from the Global Registry of Acute Coronary Events (GRACE) and UK Myocardial Ischemia National Audit Project had also similarly demonstrated that older adults are more likely to present with NSTEMI than STEMI<sup>19</sup>. This trend of NSTEMI patients being older is generally consistent internationally<sup>20</sup>.

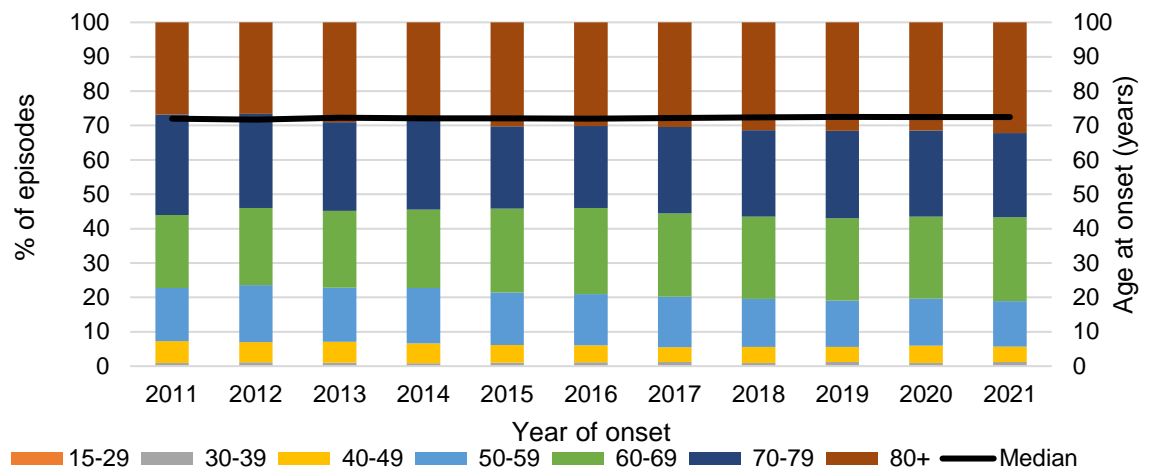
**Table 5.1.9b: Age distribution at onset of NSTEMI**

Year of onset	Overall		Age 15-29		Age 30-39		Age 40-49	
	Median age		Number	%	Number	%	Number	%
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	72.5		11	0.1	106	1.1	409	4.4
2020	72.4		6	0.1	70	0.8	424	5.1
2021	72.5		6	0.1	102	1.1	412	4.5
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2011	812	15.5	1115	21.2	1536	29.3	1406	26.8
2012	1060	16.6	1431	22.4	1749	27.4	1695	26.6
2013	1061	15.8	1503	22.3	1738	25.8	1954	29.0
2014	1141	16.1	1621	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	1272	13.5	2245	23.9	2388	25.4	2964	31.5
2020	1146	13.7	1995	23.9	2088	25.0	2634	31.5
2021	1206	13.2	2224	24.4	2234	24.5	2937	32.2

<sup>19</sup> Dai X et al. Acute coronary syndrome in older adults. *Journal of Geriatric Cardiology*; 2016;13: 101-108.

<sup>20</sup> McManus D. V. et al. Recent Trends in the Incidence, Treatment, and Outcomes of Patients with ST and Non-ST-Segment Acute Myocardial Infarction. *Am J Med* 2011; 124(1): 40-47.

**Figure 5.1.9b: Age distribution at onset of NSTEMI**



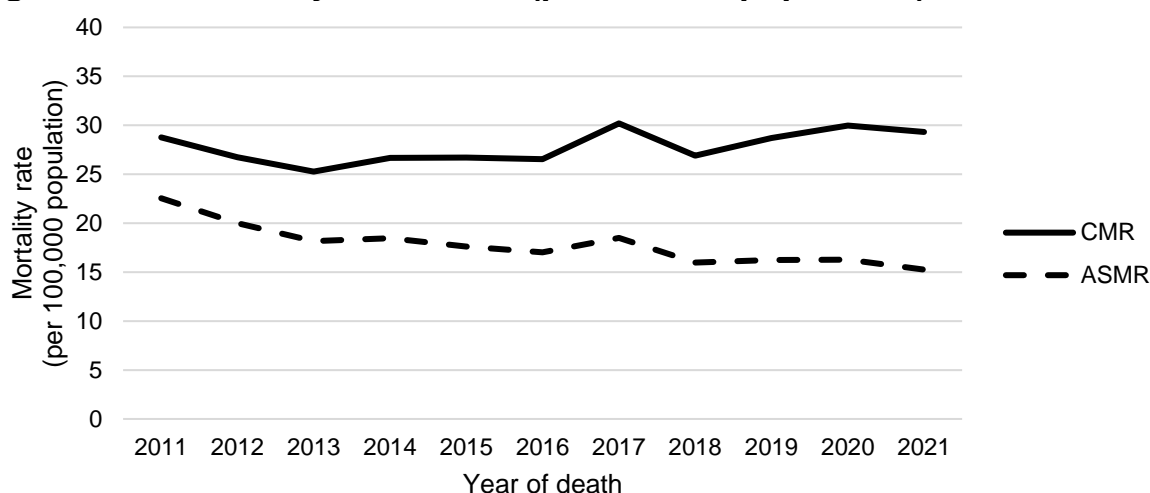
## 5.2 Mortality

The number of AMI deaths was 1,000 in 2021, a slight rise compared to 907 in 2011 (Table 5.2.1), despite a substantial rise in the number of AMI episodes from 8,014 to 12,403 during the same period (Table 5.1.1). Overall, the crude mortality rate (CMR) remained relatively similar at 28.8 per 100,000 population in 2011 and 29.3 per 100,000 population in 2021 (Figure 5.2.1). Accounting for Singapore's ageing population, the drop in ASMR from 22.5 per 100,000 population in 2011 to 15.3 per 100,000 population in 2021 was significant ( $p < 0.001$ ). This decreasing trend in ASMR was likely due to the higher rates of revascularisation and pharmacotherapy over the years<sup>21,22,23</sup>, as well as a decrease in elapsed time between AMI onset and the administration of treatment.

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

Year of death	Number	CMR	95% CI	ASMR	95% CI
2011	907	28.8	26.9-30.6	22.5	21.0-24.0
2012	853	26.7	24.9-28.5	20.0	18.6-21.4
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	881	26.7	24.9-28.5	17.6	16.4-18.8
2016	886	26.5	24.8-28.3	17.0	15.9-18.2
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	986	28.7	26.9-30.5	16.2	15.2-17.3
2020	1036	30.0	28.2-31.8	16.3	15.3-17.3
2021	1000	29.3	27.5-31.1	15.3	14.3-16.2
<b>P for trend</b>	-	0.082	-	<0.001	-

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



<sup>21</sup> Aronow, H.D and Bavashi, C. Mechanical Complications in Acute Myocardial Infarction. JACC Cardiovascular Interventions; 2019;12(18).

<sup>22</sup> Takeji Y. et al. Differences in mortality and causes of death between STEMI and NSTEMI in the early and late phases after acute myocardial infarction. PLoS ONE 2021; 16(11).

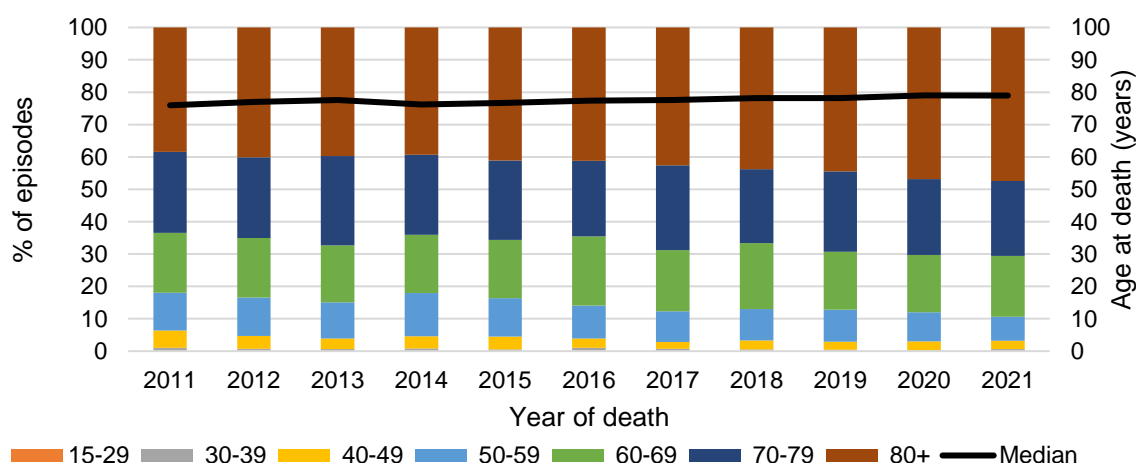
<sup>23</sup> McManus D. V. et al. Recent Trends in the Incidence, Treatment, and Outcomes of Patients with ST and Non-ST-Segment Acute Myocardial Infarction. Am J Med 2011; 124(1): 40-47.

The median age at death increased slightly from 76.0 years in 2011 to 79.0 years in 2021 (Table 5.2.2). The proportion of those in the oldest age group amongst AMI deaths had increased over the years – almost half of the patients who died of AMI in 2021 were aged 80 years and above (47.4%), compared to 38.5% in 2011 (Figure 5.2.2). Those aged 80 years and above comprised a substantially larger proportion of AMI deaths vis-à-vis AMI incidence (about 23%-28%) (Table 5.1.2).

**Table 5.2.2: Age distribution at death of AMI**

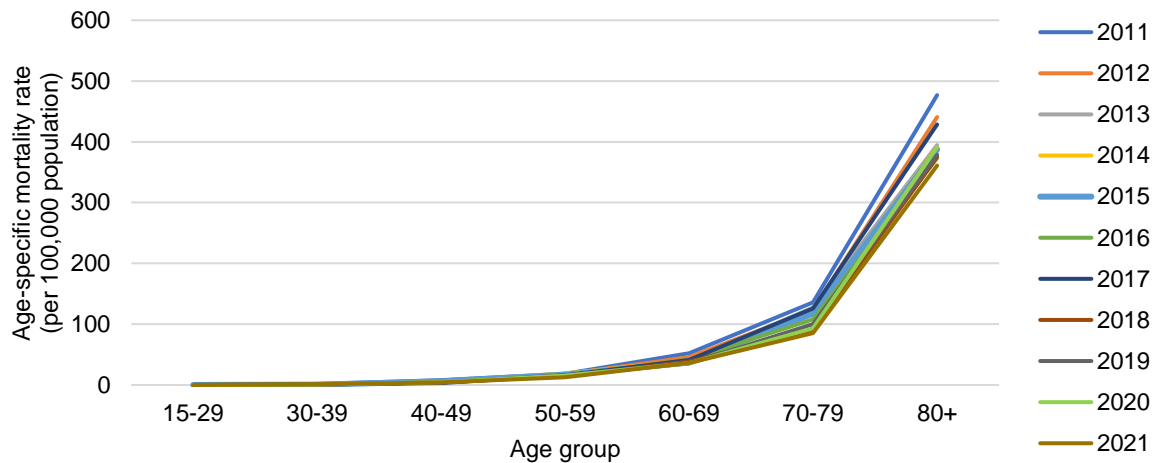
Year of death	Overall		Age 15-29		Age 30-39		Age 40-49	
	Median age		Number	%	Number	%	Number	%
2011	76.0		0	0.0	9	1.0	49	5.4
2012	76.9		1	0.1	5	0.6	34	4.0
2013	77.5		0	0.0	5	0.6	27	3.3
2014	76.2		1	0.1	6	0.7	33	3.8
2015	76.7		0	0.0	5	0.6	35	4.0
2016	77.4		2	0.2	7	0.8	26	2.9
2017	77.6		1	0.1	7	0.7	21	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
2020	79.0		0	0.0	3	0.3	28	2.7
2021	79.0		0	0.0	6	0.6	26	2.6
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2011	106	11.7	167	18.4	227	25.0	349	38.5
2012	101	11.8	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	104	11.8	159	18.0	216	24.5	362	41.1
2016	90	10.2	189	21.3	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	9.8	177	18.0	245	24.8	438	44.4
2020	93	9.0	184	17.8	243	23.5	485	46.8
2021	74	7.4	188	18.8	232	23.2	474	47.4

**Figure 5.2.2: Age distribution at death of AMI**

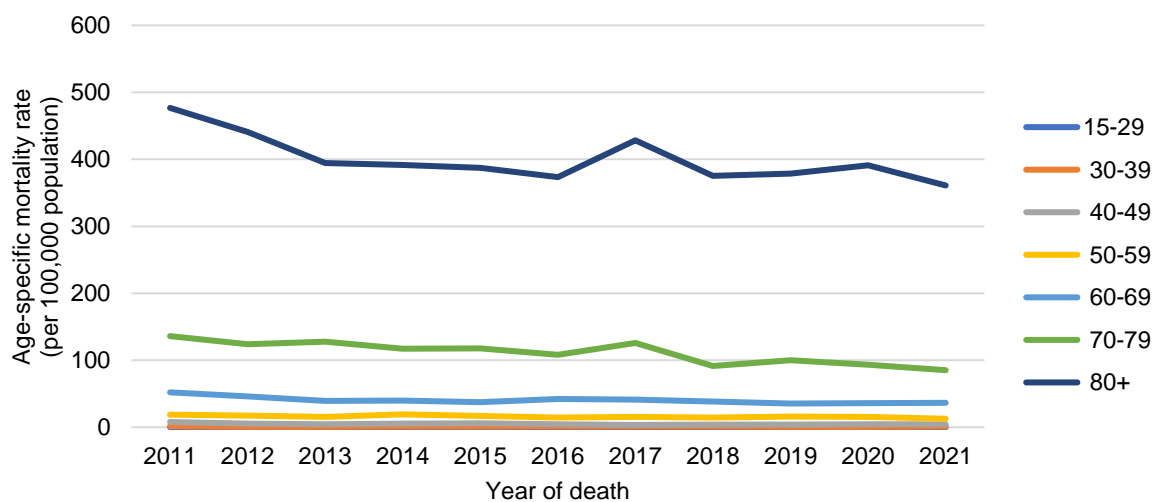


The age-specific mortality rate of AMI increased with age, with the oldest age group consistently having the highest mortality rate each year, but also the largest decrease in mortality rate over the years (Figures 5.2.3a and 5.2.3b). Significant drops in mortality rates were seen in all the age groups aged 40 years or above (Table 5.2.3).

**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**



**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
2011	28.8	26.9-30.6	0.0	0.0-0.0	1.5	0.5-2.4	7.8	5.6-9.9
2012	26.7	24.9-28.5	0.1	0.0-0.4	0.8	0.1-1.5	5.4	3.6-7.2
2013	25.3	23.5-27.0	0.0	0.0-0.0	0.8	0.1-1.6	4.3	2.7-5.9
2014	26.7	24.9-28.4	0.1	0.0-0.4	1.0	0.2-1.8	5.3	3.5-7.1
2015	26.7	24.9-28.5	0.0	0.0-0.0	0.8	0.1-1.6	5.6	3.8-7.5
2016	26.5	24.8-28.3	0.3	0.0-0.6	1.2	0.3-2.1	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	26.9	25.1-28.6	0.0	0.0-0.0	0.9	0.1-1.6	4.1	2.5-5.7
2019	28.7	26.9-30.5	0.0	0.0-0.0	0.7	0.0-1.3	4.1	2.5-5.7
2020	30.0	28.2-31.8	0.0	0.0-0.0	0.5	0.0-1.1	4.6	2.9-6.3
2021	29.3	27.5-31.1	0.0	0.0-0.0	1.0	0.2-1.8	4.4	2.7-6.1
P for trend	0.082	-	-	-	0.206	-	0.036	-
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
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	17.0	13.8-20.3	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	35.4	30.2-40.6	100.1	87.6-112.6	378.7	343.2-414.2
2020	15.5	12.3-18.6	35.8	30.6-41.0	93.1	81.4-104.8	391.2	356.4-426.0
2021	12.7	9.8-15.6	36.3	31.1-41.5	85.2	74.2-96.2	361.0	328.5-393.5
P for trend	0.010	-	0.003	-	<0.001	-	0.013	-

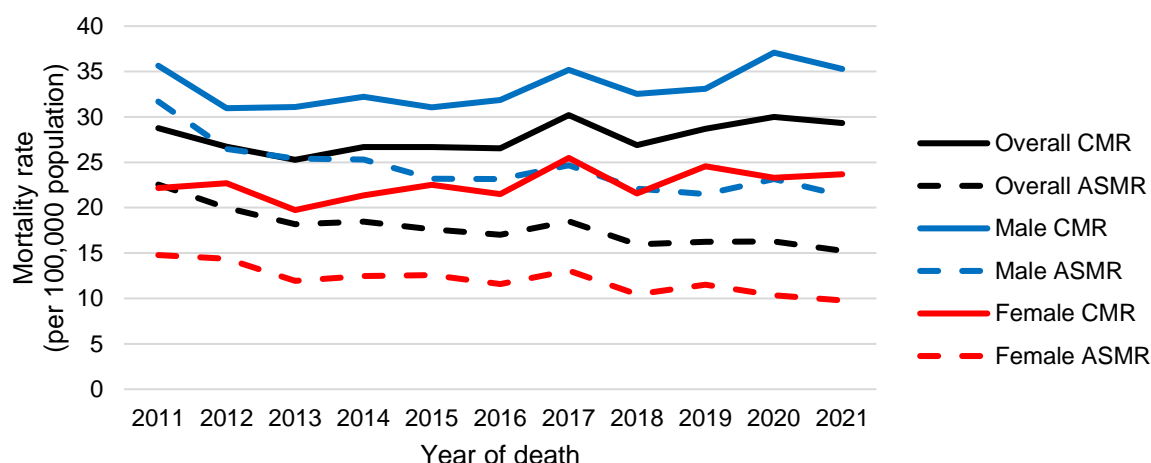
As with incidence trends (Table 5.1.4), males also accounted for a greater proportion of AMI deaths than females – about 60% each year (Table 5.2.4). The ASMRs of AMI were also consistently higher among males. In 2021, the ASMR of AMI in males was 21.3 per 100,000 population, while females had an ASMR of 9.8 per 100,000 population. The ASMR had dropped significantly over the years for both genders ( $p=0.001$ ) (Figure 5.2.4).

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

<b>Male</b>						
<b>Year of death</b>	<b>Number</b>	<b>%</b>	<b>CMR</b>	<b>95% CI</b>	<b>ASMR</b>	<b>95% CI</b>
<b>2011</b>	550	60.6	35.7	32.7-38.6	31.7	29.0-34.4
<b>2012</b>	483	56.6	31.0	28.2-33.7	26.5	24.1-28.9
<b>2013</b>	490	60.0	31.1	28.3-33.8	25.4	23.1-27.7
<b>2014</b>	513	59.0	32.2	29.4-35.0	25.3	23.1-27.5
<b>2015</b>	500	56.8	31.1	28.3-33.8	23.2	21.1-25.2
<b>2016</b>	518	58.5	31.9	29.1-34.6	23.2	21.1-25.2
<b>2017</b>	577	56.7	35.2	32.3-38.0	24.7	22.6-26.7
<b>2018</b>	538	58.8	32.5	29.8-35.3	22.1	20.2-24.0
<b>2019</b>	552	56.0	33.1	30.3-35.9	21.5	19.7-23.3
<b>2020</b>	622	60.0	37.1	34.2-40.0	23.2	21.3-25.0
<b>2021</b>	585	58.5	35.3	32.4-38.1	21.3	19.6-23.1
<b>P for trend</b>	-	-	0.148	-	0.001	-
<b>Female</b>						
<b>Year of death</b>	<b>Number</b>	<b>%</b>	<b>CMR</b>	<b>95% CI</b>	<b>ASMR</b>	<b>95% CI</b>
<b>2011</b>	357	39.4	22.2	19.9-24.5	14.8	13.2-16.4
<b>2012</b>	370	43.4	22.7	20.4-25.0	14.4	12.8-15.9
<b>2013</b>	326	40.0	19.7	17.6-21.9	11.9	10.6-13.3
<b>2014</b>	357	41.0	21.4	19.2-23.6	12.5	11.1-13.8
<b>2015</b>	381	43.2	22.5	20.3-24.8	12.6	11.2-13.9
<b>2016</b>	368	41.5	21.5	19.3-23.7	11.6	10.3-12.8
<b>2017</b>	441	43.3	25.5	23.1-27.9	13.1	11.8-14.3
<b>2018</b>	377	41.2	21.6	19.4-23.7	10.5	9.4-11.6
<b>2019</b>	434	44.0	24.6	22.2-26.9	11.5	10.4-12.6
<b>2020</b>	414	40.0	23.3	21.0-25.5	10.4	9.3-11.4
<b>2021</b>	415	41.5	23.7	21.4-26.0	9.8	8.8-10.8
<b>P for trend</b>	-	-	0.100	-	0.001	-



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

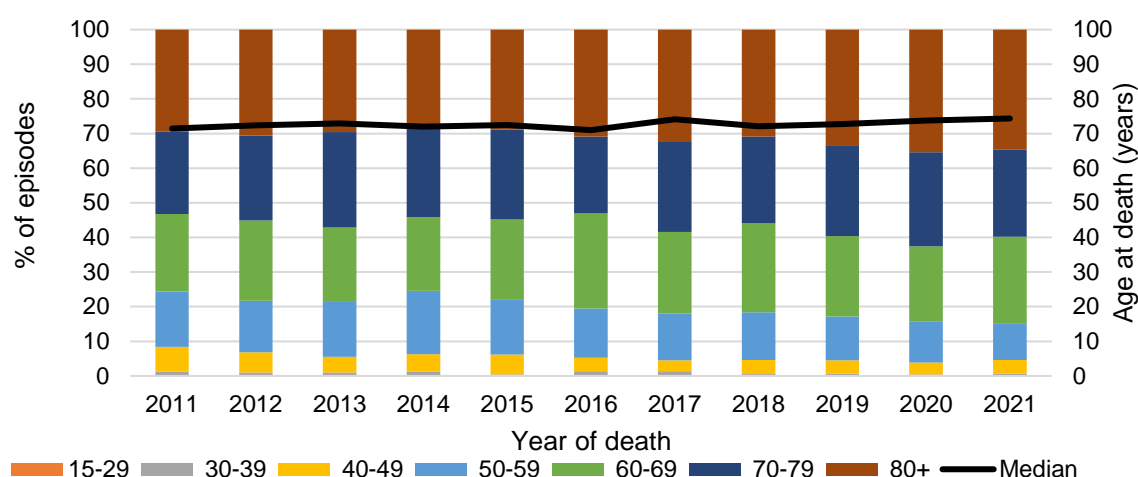


The median age at death among male AMI patients ranged between 71.0 and 74.3 years in the past decade (Table 5.2.5a). The highest proportion of males who died of AMI in 2021 was among those aged 80 years or above (34.5%) (Figure 5.2.5a).

**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	%
2011	71.4		0	0.0	7	1.3	39	7.1
2012	72.4		1	0.2	4	0.8	28	5.8
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
2020	73.7		0	0.0	3	0.5	21	3.4
2021	74.3		0	0.0	4	0.7	23	3.9
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2011	88	16.0	123	22.4	131	23.8	162	29.5
2012	72	14.9	112	23.2	118	24.4	148	30.6
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	80	16.0	115	23.0	130	26.0	144	28.8
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	12.7	128	23.2	145	26.3	184	33.3
2020	74	11.9	135	21.7	169	27.2	220	35.4
2021	62	10.6	146	25.0	148	25.3	202	34.5

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

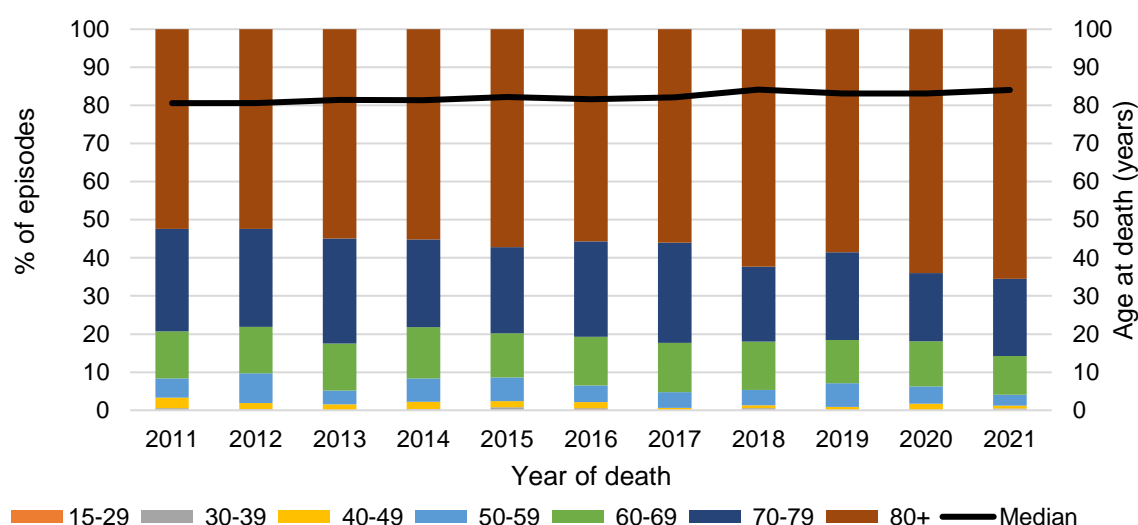


Like the median age at onset of AMI (Tables 5.1.5a and 5.1.5b), females had an older median age at death than males, which increased from 80.6 years in 2011 to 84.1 years in 2021 (Table 5.2.5b). As with males, those aged 80 years and above comprised the largest proportion of AMI deaths (65.5%), though the corresponding proportion each year was nearly twice that among males (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	%
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	81.6		1	0.3	1	0.3	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
2020	83.1		0	0.0	0	0.0	7	1.7
2021	84.1		0	0.0	2	0.5	3	0.7
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	4.3	47	12.8	92	25.0	205	55.7
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	23.0	254	58.5
2020	19	4.6	49	11.8	74	17.9	265	64.0
2021	12	2.9	42	10.1	84	20.2	272	65.5

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



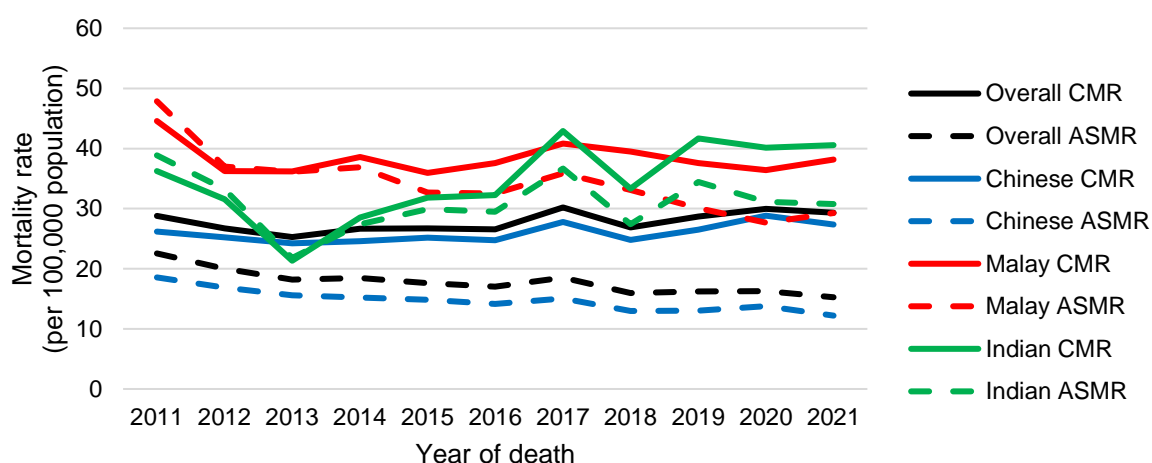
The Chinese consistently had the lowest ASIR of AMI across the years (Table 5.1.6); likewise, they consistently had the lowest ASMR (Table 5.2.6). The ASMR among the Chinese (12.2 per 100,000 population) was lower than the ASMR among Malays (29.3 per 100,000 population) and Indians (30.8 per 100,000 population) in 2021. The ASMR showed a significant downward trend over the years for Chinese ( $p < 0.001$ ) and Malays ( $p = 0.001$ ) but not for Indians ( $p = 0.927$ ) (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
2011	623	68.7	26.2	24.1-28.2	18.6	17.1-20.1
2012	608	71.3	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	627	71.2	25.2	23.2-27.1	14.8	13.6-16.0
2016	623	70.3	24.7	22.8-26.7	14.1	13.0-15.3
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	687	69.7	26.5	24.5-28.5	13.1	12.0-14.1
2020	752	72.6	28.8	26.8-30.9	13.8	12.7-14.8
2021	703	70.3	27.3	25.3-29.4	12.2	11.3-13.2
<b>P for trend</b>	-	-	0.054	-	<0.001	-

Malay						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
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	17.1	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	165	16.7	37.6	31.8-43.3	30.1	25.4-34.8
2020	161	15.5	36.4	30.8-42.0	27.7	23.3-32.0
2021	168	16.8	38.1	32.4-43.9	29.3	24.8-33.8
P for trend	-	-	0.511	-	0.001	-
Indian						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
2011	100	11.0	36.3	29.2-43.4	38.9	30.9-46.8
2012	88	10.3	31.6	25.0-38.1	33.2	26.1-40.3
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
2020	120	11.6	40.1	33.0-47.3	31.2	25.5-36.8
2021	119	11.9	40.5	33.3-47.8	30.8	25.2-36.3
P for trend	-	-	0.048	-	0.927	-

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



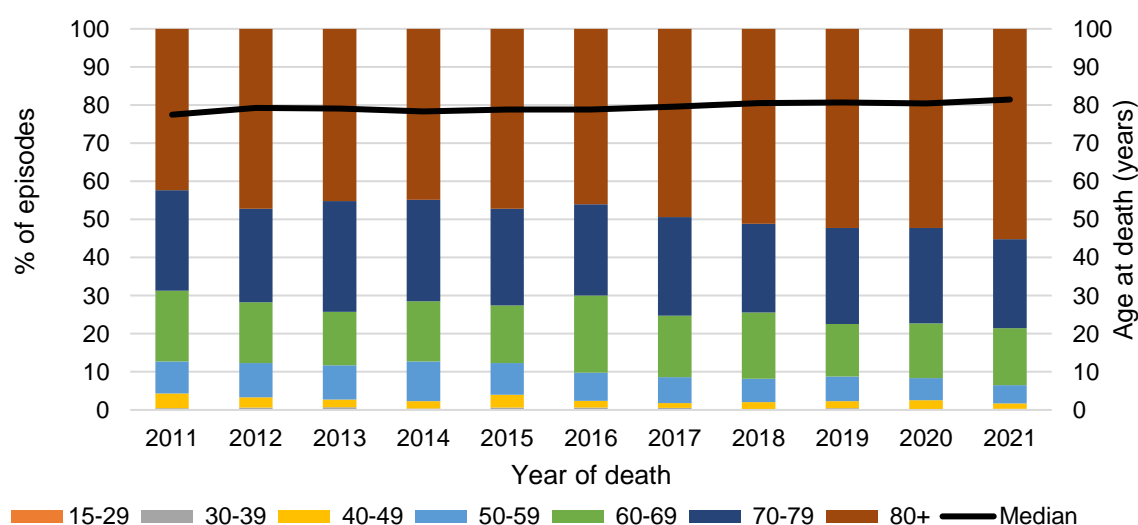
Similar to the median age at onset of AMI (Tables 5.1.7a to 5.1.7c), the Chinese had the oldest median age at death, which increased from 77.5 years in 2011 to 81.4 years in 2021 (Table 5.2.7a). Those aged 80 years and above made up the highest

proportion of AMI deaths among the Chinese, increasing from 42.4% in 2011 to 55.2% in 2021 (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	%
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	3.3
2016	78.9		0	0.0	4	0.6	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
2020	80.4		0	0.0	1	0.1	18	2.4
2021	81.4		0	0.0	2	0.3	10	1.4
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	52	8.3	95	15.2	159	25.4	296	47.2
2016	46	7.4	126	20.2	149	23.9	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	13.8	173	25.2	359	52.3
2020	44	5.9	108	14.4	188	25.0	393	52.3
2021	34	4.8	105	14.9	164	23.3	388	55.2

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

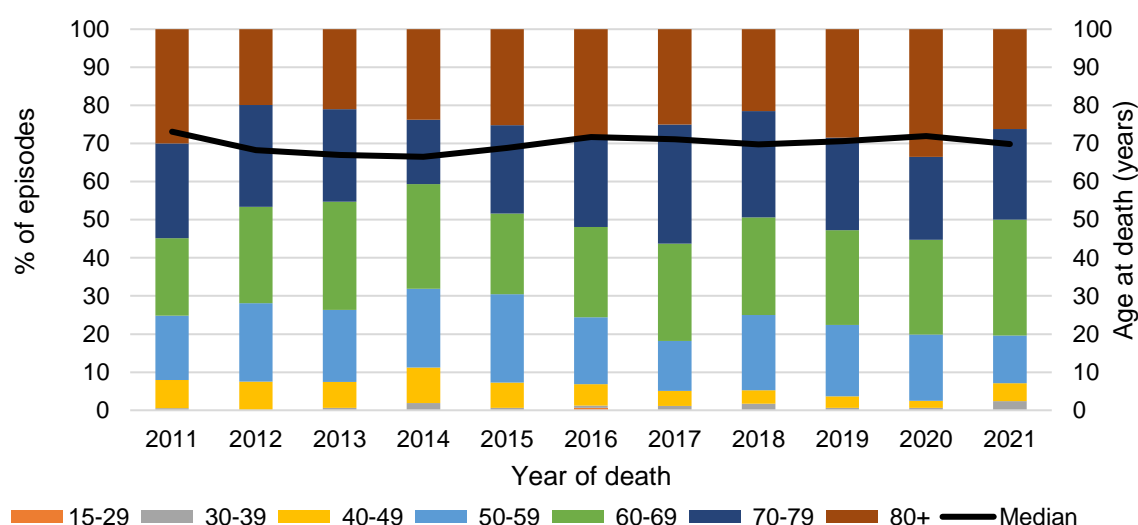


The median age at death among Malay AMI patients was younger than that for the Chinese, ranging between 66.5 and 73.1 years in the past decade (Table 5.2.7b). The highest proportion of Malays who died of AMI in 2021 was among those aged 60-69 years (30.4%) (Figure 5.2.7b).

**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	%
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	70.6		0	0.0	1	0.6	5	3.0
2020	72.0		0	0.0	1	0.6	3	1.9
2021	69.9		0	0.0	4	2.4	8	4.8
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	18.8	41	24.8	40	24.2	47	28.5
2020	28	17.4	40	24.8	35	21.7	54	33.5
2021	21	12.5	51	30.4	40	23.8	44	26.2

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

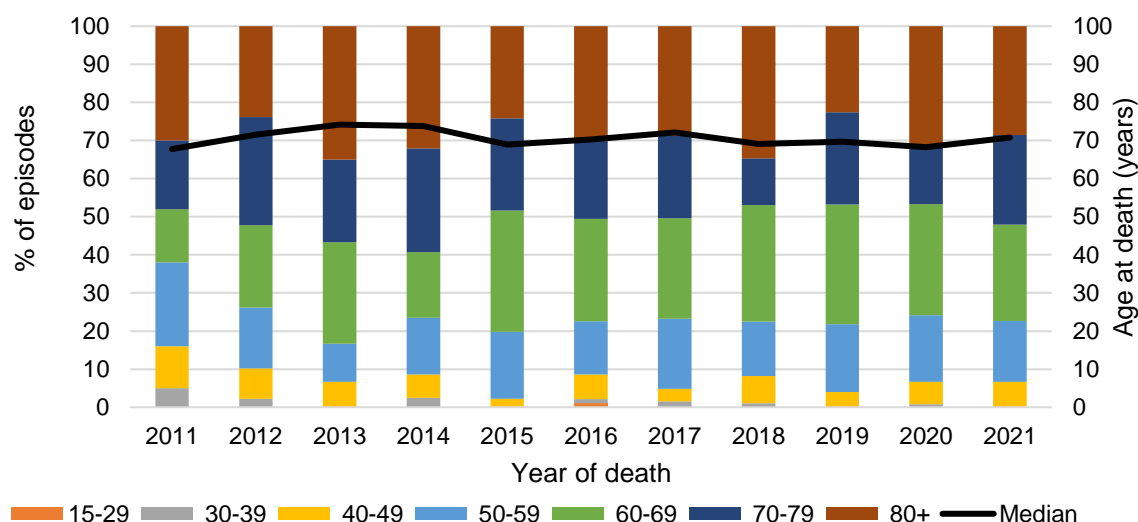


The median age at death among Indian AMI patients ranged between 67.8 and 74.2 years in the past decade (Table 5.2.7c). The highest proportion of Indians who died of AMI in 2021 was among those aged 80 years or above (28.6%) (Figure 5.2.7c).

**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	%
2011	67.8		0	0.0	5	5.0	11	11.0
2012	71.5		0	0.0	2	2.3	7	8.0
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
2020	68.2		0	0.0	1	0.8	7	5.8
2021	70.8		0	0.0	0	0.0	8	6.7
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2011	22	22.0	14	14.0	18	18.0	30	30.0
2012	14	15.9	19	21.6	25	28.4	21	23.9
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
2020	21	17.5	35	29.2	18	15.0	38	31.7
2021	19	16.0	30	25.2	28	23.5	34	28.6

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



The incidence numbers and ASIRs of NSTEMI were consistently higher than STEMI across the years (Table 5.1.8); likewise, the mortality numbers and ASMRs of NSTEMI were 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 8.7 per 100,000 population in 2011 to 5.2 per 100,000 population in 2021 ( $p=0.002$ ), while the ASMR for STEMI dipped slightly from 5.5 per 100,000 population in 2011 to 4.6 per 100,000 population in 2021 ( $p=0.130$ ). The older age of NSTEMI patients was likely a contributing factor as advanced age has been shown to be a strong predictor for poorer health outcomes (including mortality) following AMI, compounded by a greater prevalence of comorbidities<sup>24</sup>.

As the percentages in Table 5.2.8 are among all AMI and patients without documentation of STEMI or NSTEMI are not shown, the sum of the percentages for STEMI and NSTEMI are less than 100% for each year. Figures for overall CMR and ASMR include cases of unknown etiology.

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

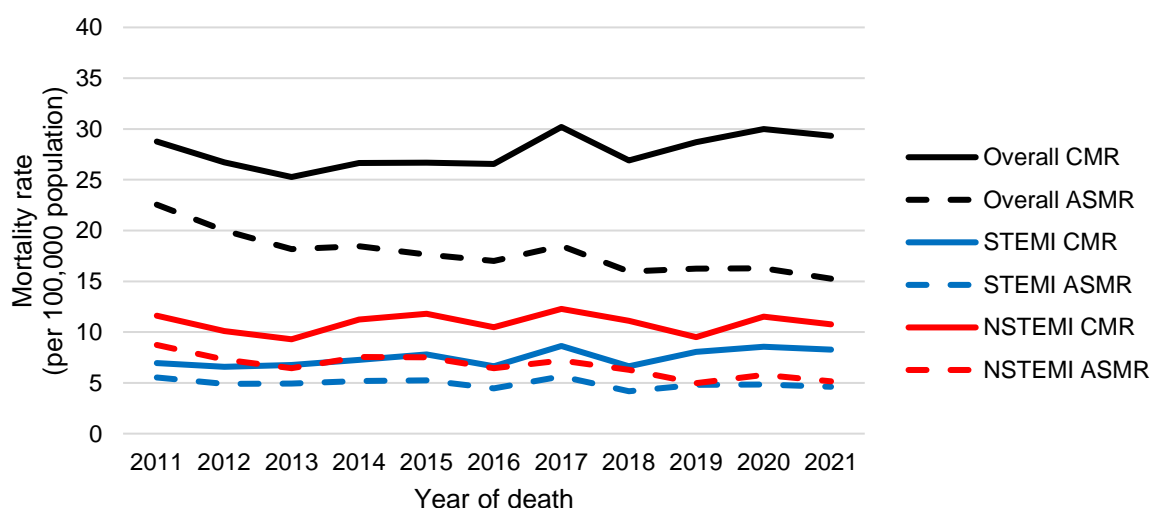
Year of death	STEMI					
	Number	%	CMR	95% CI	ASMR	95% CI
2011	219	24.1	6.9	6.0-7.9	5.5	4.8-6.3
2012	210	24.6	6.6	5.7-7.5	4.9	4.2-5.6
2013	218	26.7	6.8	5.9-7.6	4.9	4.3-5.6
2014	237	27.2	7.3	6.3-8.2	5.2	4.5-5.9
2015	257	29.2	7.8	6.8-8.7	5.3	4.6-5.9
2016	221	24.9	6.6	5.7-7.5	4.5	3.9-5.1
2017	291	28.6	8.6	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

<sup>24</sup> Dai X et al. Acute coronary syndrome in older adults. *Journal of Geriatric Cardiology*; 2016;13. 101-108.



<b>2019</b>	277	28.1	8.1	7.1-9.0	4.8	4.2-5.4
<b>2020</b>	296	28.6	8.6	7.6-9.5	4.8	4.3-5.4
<b>2021</b>	282	28.2	8.3	7.3-9.2	4.6	4.1-5.2
<b>P for trend</b>	-	-	0.027	-	0.130	-
<b>NSTEMI</b>						
<b>Year of death</b>	<b>Number</b>	<b>%</b>	<b>CMR</b>	<b>95% CI</b>	<b>ASMR</b>	<b>95% CI</b>
<b>2011</b>	366	40.4	11.6	10.4-12.8	8.7	7.8-9.6
<b>2012</b>	322	37.7	10.1	9.0-11.2	7.3	6.5-8.1
<b>2013</b>	300	36.8	9.3	8.2-10.3	6.4	5.7-7.2
<b>2014</b>	367	42.2	11.2	10.1-12.4	7.5	6.8-8.3
<b>2015</b>	390	44.3	11.8	10.6-13.0	7.5	6.8-8.3
<b>2016</b>	350	39.5	10.5	9.4-11.6	6.4	5.7-7.1
<b>2017</b>	414	40.7	12.3	11.1-13.5	7.2	6.5-7.9
<b>2018</b>	378	41.3	11.1	10.0-12.2	6.3	5.6-6.9
<b>2019</b>	326	33.1	9.5	8.5-10.5	5.0	4.4-5.5
<b>2020</b>	398	38.4	11.5	10.4-12.6	5.8	5.2-6.4
<b>2021</b>	367	36.7	10.8	9.7-11.9	5.2	4.6-5.7
<b>P for trend</b>	-	-	0.806	-	0.002	-

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



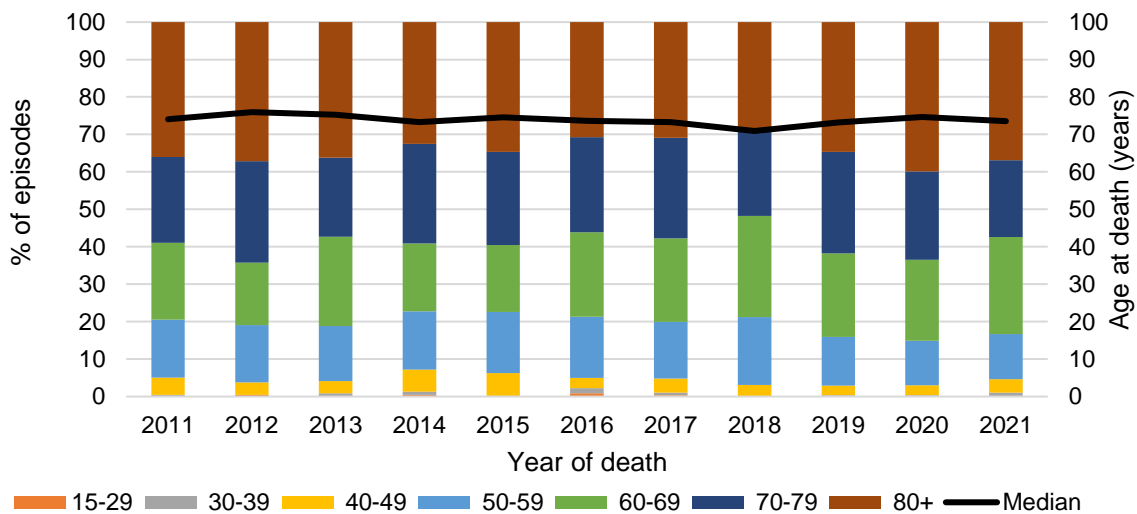
The median age at death among STEMI patients ranged between 70.9 and 76.0 years in the past decade (Table 5.2.9a). The highest proportion of STEMI patients who died of AMI in 2021 was among those aged 80 years or above (36.9%) – this pattern had been consistent since 2011 (Figure 5.2.9a).

**Table 5.2.9a: Age distribution at death of STEMI**

<b>Year of death</b>	<b>Overall</b>	<b>Age 15-29</b>		<b>Age 30-39</b>		<b>Age 40-49</b>	
	<b>Median age</b>	<b>Number</b>	<b>%</b>	<b>Number</b>	<b>%</b>	<b>Number</b>	<b>%</b>
<b>2011</b>	74.0	0	0.0	1	0.5	10	4.6
<b>2012</b>	76.0	1	0.5	0	0.0	7	3.3
<b>2013</b>	75.2	0	0.0	2	0.9	7	3.2
<b>2014</b>	73.3	1	0.4	2	0.8	14	5.9
<b>2015</b>	74.6	0	0.0	0	0.0	16	6.2

<b>2016</b>	73.6	2	0.9	3	1.4	6	2.7	
<b>2017</b>	73.3	1	0.3	2	0.7	11	3.8	
<b>2018</b>	70.9	0	0.0	0	0.0	7	3.1	
<b>2019</b>	73.2	0	0.0	1	0.4	7	2.5	
<b>2020</b>	74.6	0	0.0	1	0.3	8	2.7	
<b>2021</b>	73.5	0	0.0	3	1.1	10	3.5	
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
<b>2011</b>	34	15.5	45	20.5	50	22.8	79	36.1
<b>2012</b>	32	15.2	35	16.7	57	27.1	78	37.1
<b>2013</b>	32	14.7	52	23.9	46	21.1	79	36.2
<b>2014</b>	37	15.6	43	18.1	63	26.6	77	32.5
<b>2015</b>	42	16.3	46	17.9	64	24.9	89	34.6
<b>2016</b>	36	16.3	50	22.6	56	25.3	68	30.8
<b>2017</b>	44	15.1	65	22.3	78	26.8	90	30.9
<b>2018</b>	41	18.1	61	27.0	52	23.0	65	28.8
<b>2019</b>	36	13.0	62	22.4	75	27.1	96	34.7
<b>2020</b>	35	11.8	64	21.6	70	23.6	118	39.9
<b>2021</b>	34	12.1	73	25.9	58	20.6	104	36.9

**Figure 5.2.9a: Age distribution at death of STEMI**



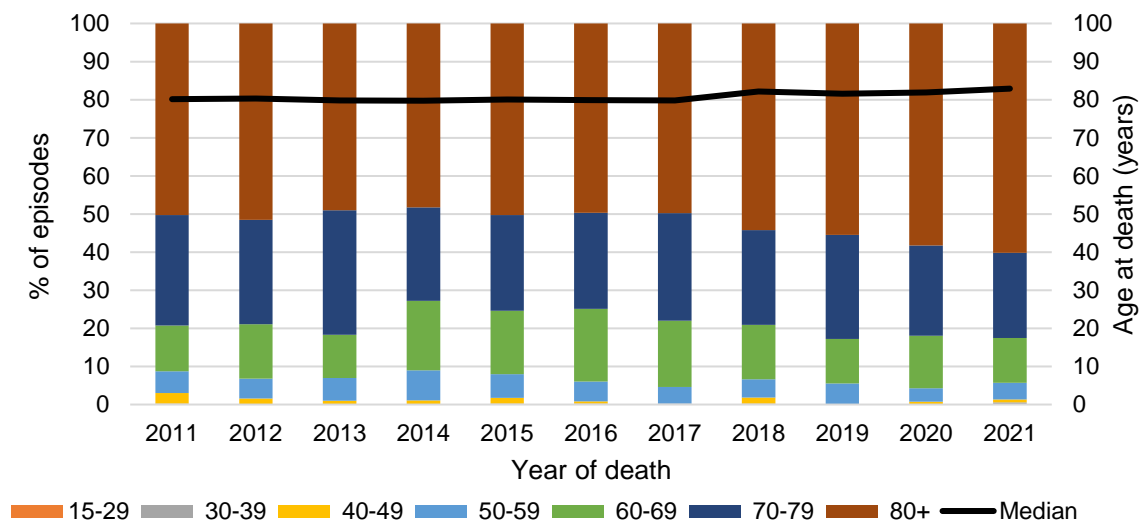
Like the median age at onset (Tables 5.1.9a and 5.1.9b), NSTEMI patients had an older median age at death than STEMI patients, ranging between 79.7 to 82.9 years in the past decade (Table 5.2.9b). Those aged 80 years and above made up the largest proportion of NSTEMI deaths in 2021 (60.2%) (Figure 5.2.9b).

**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	%
<b>2011</b>	80.1	0	0.0	1	0.3	10	2.7
<b>2012</b>	80.3	0	0.0	0	0.0	5	1.6
<b>2013</b>	79.8	0	0.0	0	0.0	3	1.0
<b>2014</b>	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	
2020	81.9	0	0.0	0	0.0	3	0.8	
2021	82.9	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	%
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	11.7	89	27.3	181	55.5
2020	14	3.5	55	13.8	94	23.6	232	58.3
2021	16	4.4	43	11.7	82	22.3	221	60.2

Figure 5.2.9b: Age distribution at death of NSTEMI



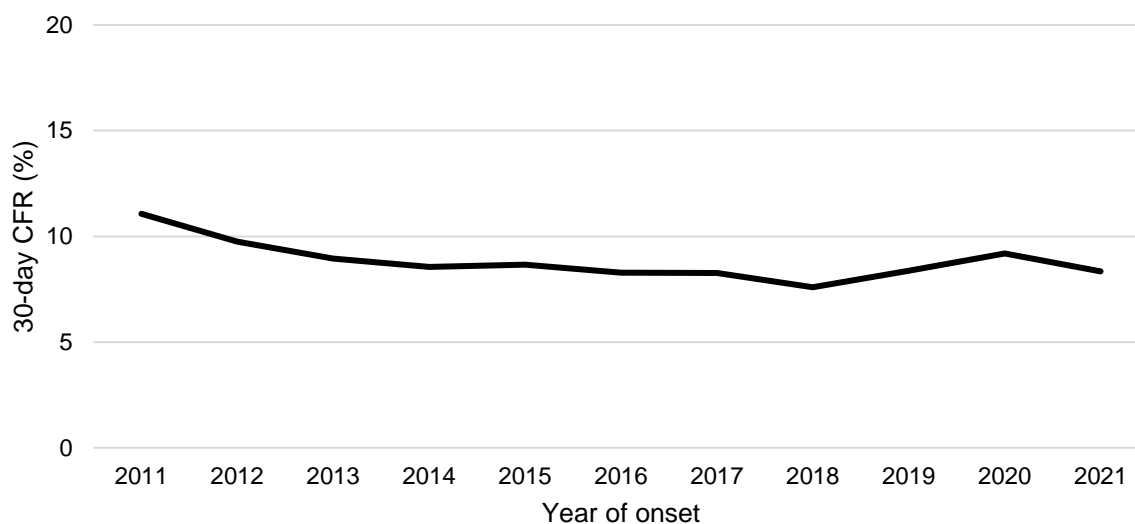
### 5.3 30-day Case Fatality

The number of AMI deaths within 30 days (Table 5.3.1) did not increase as much as the number of AMI episodes over the years (Table 5.1.1). While the 30-day CFR decreased significantly from 11.1% in 2011 to 8.3% in 2021 ( $p=0.031$ ), it showed a slight increasing trend in recent years (Figure 5.3.1). This increasing trend in CFR could be due to the rising prevalence of co-morbidities while the time to treatment and rates of revascularisation and pharmacotherapy plateaued in recent years.

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

Year of onset	Number	CFR	95% CI
2011	832	11.1	10.3-11.8
2012	826	9.8	9.1-10.4
2013	788	8.9	8.3-9.6
2014	785	8.6	8.0-9.2
2015	821	8.7	8.1-9.3
2016	837	8.3	7.7-8.8
2017	923	8.3	7.7-8.8
2018	849	7.6	7.1-8.1
2019	971	8.4	7.8-8.9
2020	997	9.2	8.6-9.8
2021	959	8.3	7.8-8.9
<b>P for trend</b>	-	0.031	-

**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 7.3% for males and 10.5% for females in 2021. 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 of revascularisation. Lower rate of revascularisation of the blocked arteries could have led to the higher CFR among females<sup>25</sup>. Other possible reasons include delayed treatment seeking in females due to more atypical presentation of symptoms<sup>26</sup>. The CFR fell significantly over the years for males ( $p=0.030$ ), but the decline was not significant for females ( $p=0.107$ ) (Figure 5.3.2).

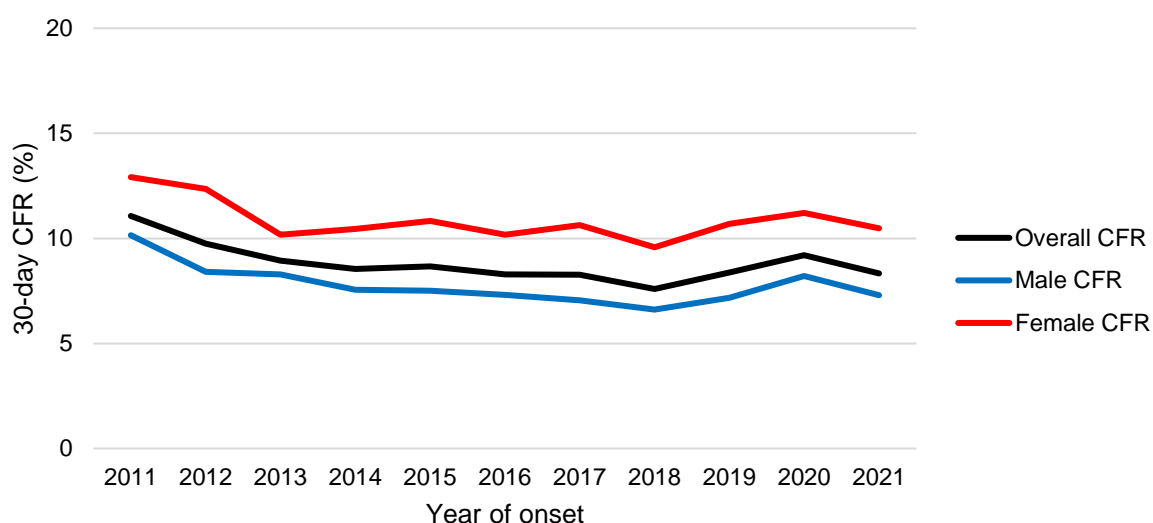
**Table 5.3.2: 30-day case fatality number and rate of AMI (%) by gender**

<b>Male</b>				
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CFR</b>	<b>95% CI</b>
<b>2011</b>	510	61.3	10.2	9.3-11.0
<b>2012</b>	469	56.8	8.4	7.6-9.2
<b>2013</b>	474	60.2	8.3	7.5-9.0
<b>2014</b>	455	58.0	7.6	6.9-8.3
<b>2015</b>	465	56.6	7.5	6.8-8.2
<b>2016</b>	488	58.3	7.3	6.7-8.0
<b>2017</b>	521	56.4	7.1	6.4-7.7
<b>2018</b>	495	58.3	6.6	6.0-7.2
<b>2019</b>	548	56.4	7.2	6.6-7.8
<b>2020</b>	598	60.0	8.2	7.6-8.9
<b>2021</b>	565	58.9	7.3	6.7-7.9
<b>P for trend</b>	-	-	0.030	-
<b>Female</b>				
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CFR</b>	<b>95% CI</b>
<b>2011</b>	322	38.7	12.9	11.5-14.3
<b>2012</b>	357	43.2	12.4	11.1-13.6
<b>2013</b>	314	39.8	10.2	9.0-11.3
<b>2014</b>	330	42.0	10.4	9.3-11.6
<b>2015</b>	356	43.4	10.8	9.7-12.0
<b>2016</b>	349	41.7	10.2	9.1-11.2
<b>2017</b>	402	43.6	10.6	9.6-11.7
<b>2018</b>	354	41.7	9.6	8.6-10.6
<b>2019</b>	423	43.6	10.7	9.7-11.7
<b>2020</b>	399	40.0	11.2	10.1-12.3
<b>2021</b>	394	41.1	10.5	9.4-11.5
<b>P for trend</b>	-	-	0.107	-

<sup>25</sup> Berger JS et al. Sex differences in mortality following acute coronary syndromes. JAMA 2009; 302(8): 874-882.

<sup>26</sup> Stehli et al. Sex differences in Time to Presentation, Revascularization, and Mortality in Myocardial Infarction Treated with Percutaneous Coronary Intervention. JAHA. 2019;8

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



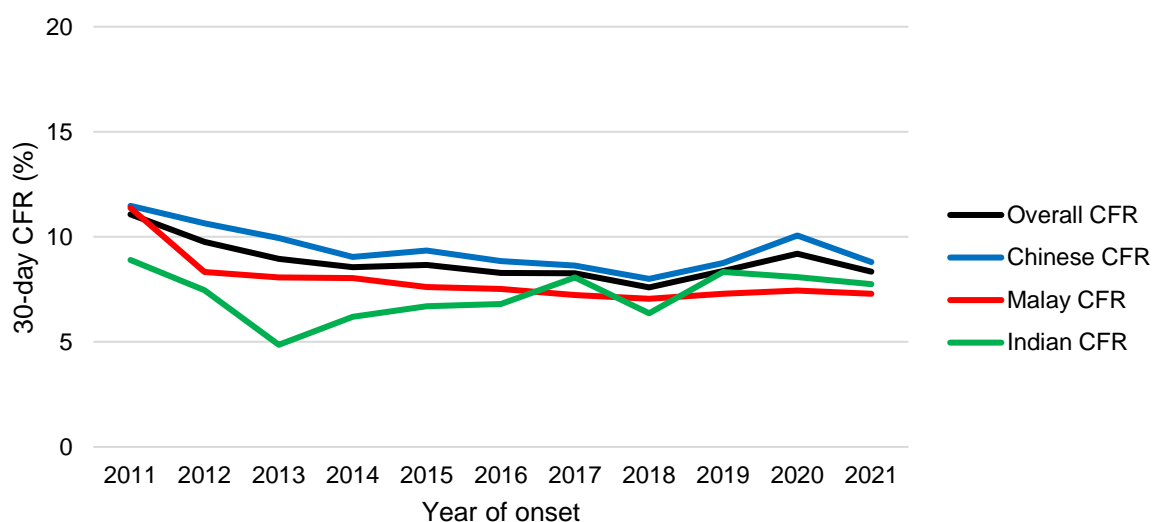
Although Chinese generally had the lowest ASMR (Table 5.2.6), they had the highest 30-day CFR across the years (Table 5.3.3). The CFRs were 8.8%, 7.3% and 7.8% for Chinese, Malays, and Indians respectively in 2021. This was likely due to Chinese being oldest at the onset of AMI (Tables 5.1.7a to 5.1.7c). The CFR fell significantly over the years for Chinese ( $p=0.039$ ) and Malays ( $p=0.009$ ) but not for Indians ( $p=0.438$ ) (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
2011	571	68.6	11.5	10.5-12.4
2012	593	71.8	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	594	72.4	9.3	8.6-10.1
2016	589	70.4	8.8	8.1-9.6
2017	651	70.5	8.6	8.0-9.3
2018	602	70.9	8.0	7.4-8.6
2019	678	69.8	8.8	8.1-9.4
2020	724	72.6	10.1	9.3-10.8
2021	671	70.0	8.8	8.1-9.5
<b>P for trend</b>	-	-	0.039	-

Malay				
Year of onset	Number	%	CFR	95% CI
2011	167	20.1	11.4	9.7-13.1
2012	140	16.9	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	18.0	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	161	16.6	7.3	6.2-8.4
2020	155	15.5	7.4	6.3-8.6
2021	163	17.0	7.3	6.2-8.4
P for trend	-	-	0.009	-
Indian				
Year of onset	Number	%	CFR	95% CI
2011	88	10.6	8.9	7.0-10.8
2012	81	9.8	7.5	5.8-9.1
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	123	12.7	8.3	6.9-9.8
2020	116	11.6	8.1	6.6-9.6
2021	115	12.0	7.8	6.3-9.2
P for trend	-	-	0.438	-

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



Although STEMI patients 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 4.0% for STEMI and NSTEMI patients respectively in 2021. A plausible reason was that STEMI was more severe with a higher likelihood of fatality if intervention was not provided promptly. Complications associated with high short-term fatality rates also tend to be more frequently described among STEMI compared to NSTEMI cases<sup>27</sup>. While the CFR for STEMI patients fluctuated over the years ( $p=0.507$ ), it fell significantly for NSTEMI patients ( $p=0.009$ ) (Figure 5.3.4).

As the percentages in Table 5.3.4 are among all AMI and patients without documentation of STEMI or NSTEMI are not shown, the sum of the percentages for STEMI and NSTEMI are less than 100% for each year. Figures for overall CFR include cases of unknown etiology.

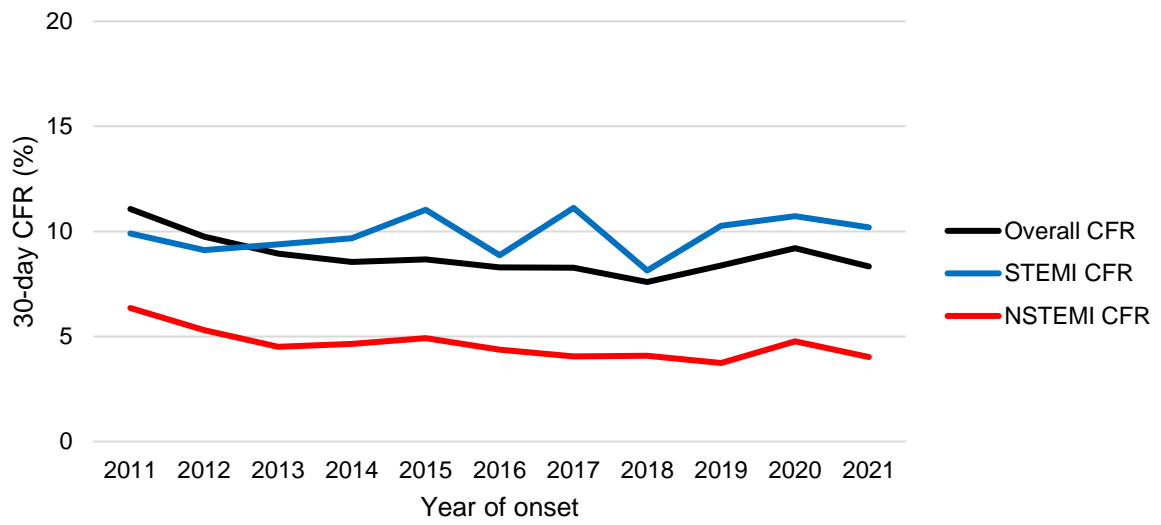
**Table 5.3.4: 30-day case fatality number and rate of AMI (%) by subtype**

STEMI				
Year of onset	Number	%	CFR	95% CI
2011	205	24.6	9.9	8.5-11.3
2012	201	24.3	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	30.3	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	272	28.0	10.3	9.0-11.5
2020	294	29.5	10.7	9.5-12.0
2021	275	28.7	10.2	9.0-11.4
P for trend	-	-	0.507	-
NSTEMI				
Year of onset	Number	%	CFR	95% CI
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	38.1	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	315	32.4	3.7	3.3-4.1
2020	362	36.3	4.8	4.3-5.3
2021	333	34.7	4.0	3.6-4.4
P for trend	-	-	0.009	-

<sup>27</sup> Bouisset F. et al. Comparison of Short- and Long-Term Prognosis between ST-Elevation and Non-ST Elevation Myocardial Infarction. J. Clin. Med. 2023; 10(180)



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

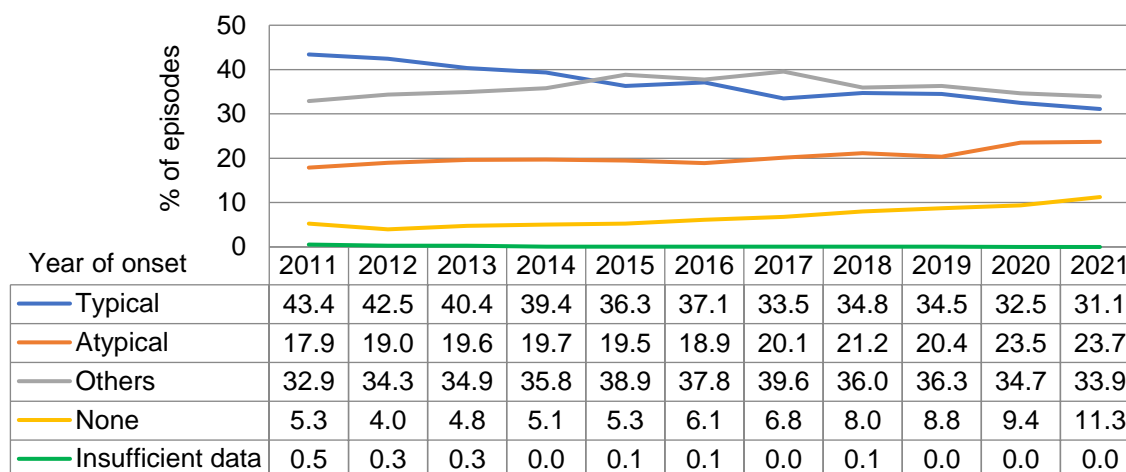


## 5.4 Symptoms

Clinical presentation has consequences on patient recognition of symptoms, triage categorisation, prescription of diagnostic tests, and disease management<sup>28</sup>. 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 less than 20 minutes, or if pain was experienced at unusual sites such as 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 lacked details on the description and duration of symptoms.

The proportion of AMI patients experiencing typical symptoms of AMI were higher in earlier years, declining over time (Figure 5.4.1). Conversely, the proportion of patients experiencing symptoms that were non-typical rose over the years. The proportion of patients with typical symptoms dropped from 43.4% in 2011 to 31.1% in 2021. The proportion of patients with atypical symptoms rose from 17.9% in 2011 to 23.7% in 2021. Similarly, those with no symptom increased from 5.3% to 11.3% in the same period. The proportion of patients with symptoms that were neither typical nor atypical remained largely similar in the past decade, ranging from 32.9% to 39.6%.

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



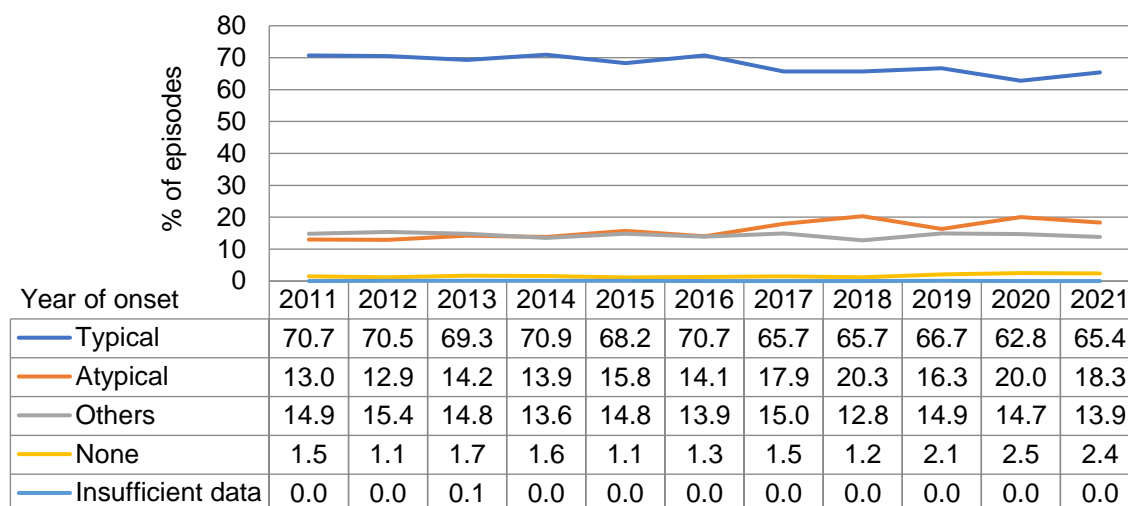
Among STEMI patients, about two-thirds (65.4%) of them experienced typical symptoms in 2021 (Figure 5.4.2a). Unlike STEMI patients, only about a fifth (21.5%) of NSTEMI patients experienced typical symptoms in 2021 (Figure 5.4.2b). This observation could be attributed to the smaller infarct size from NSTEMI, and the infarct did not involve the full thickness of the myocardium and epicardium<sup>29</sup>. The proportion

<sup>28</sup> Kim Soo-Joong. Global Awareness of Myocardial Infarction Symptoms in General Population. Korean Circulation Journal 2021;51(12): 997-1000.

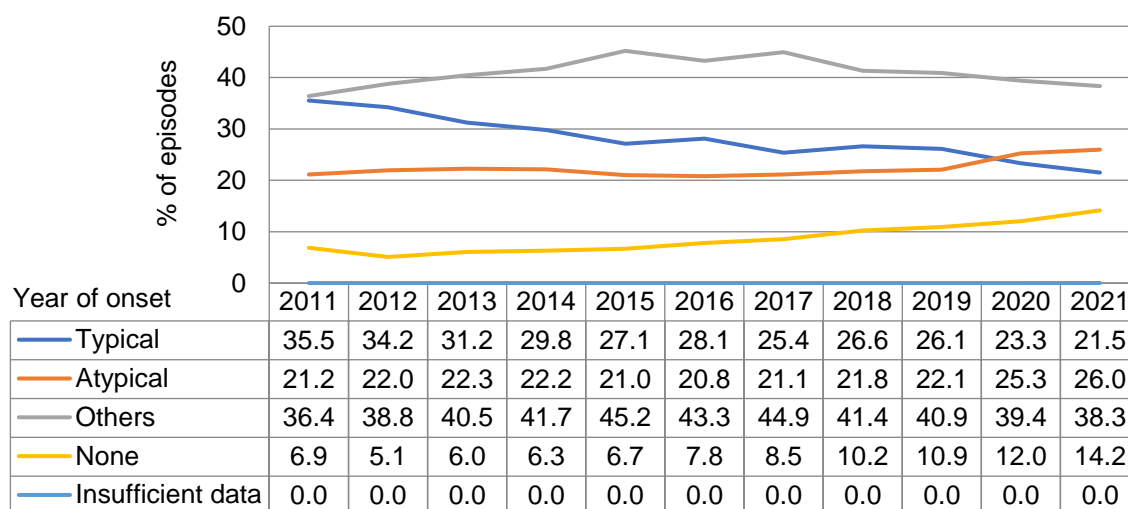
<sup>29</sup> Brieger D et al. Acute coronary syndromes without chest pain, an underdiagnosed and undertreated high-risk group: insights from the global registry of acute coronary events. Chest 2004; 126: 461-469.

of both STEMI and NSTEMI patients with typical symptoms dropped and that for atypical symptoms rose over the years. By 2020, the proportion of NSTEMI patients experiencing atypical symptoms had exceeded that of patients with typical symptoms.

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



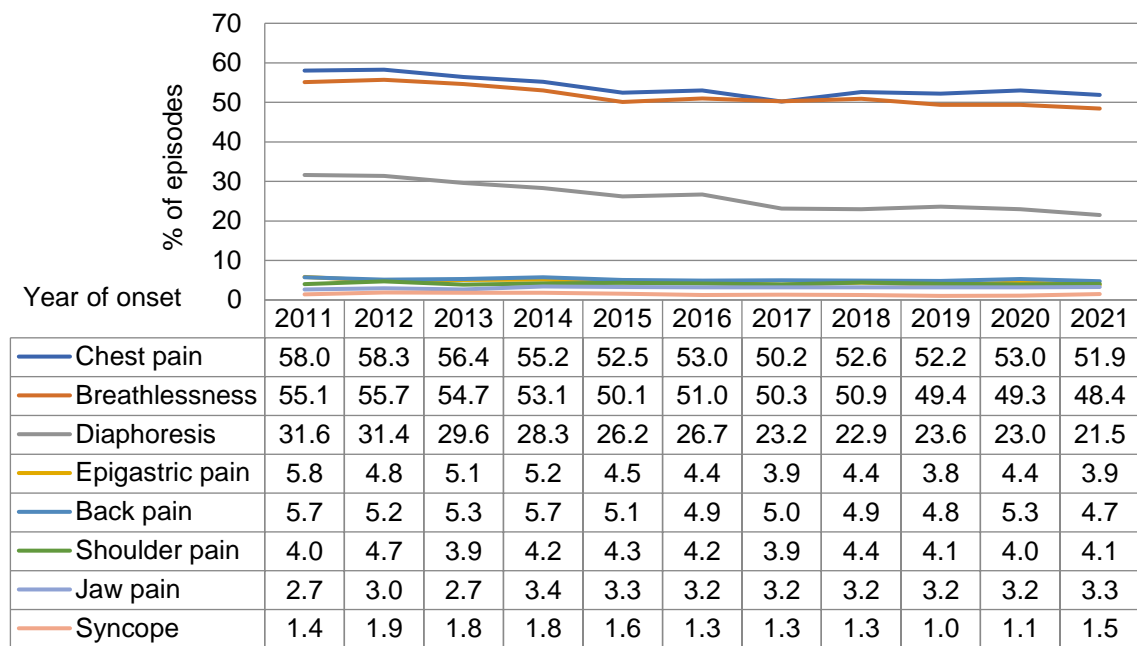
**Figure 5.4.2b: Type of symptoms (%) among NSTEMI**



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: 51.9%, breathlessness: 48.4%) in 2021 (Figure 5.4.3). About a fifth (21.5%) of the patients had diaphoresis (abnormal sweating) in 2021, while other symptoms like epigastric pain, back pain, shoulder pain, jaw pain and syncope (loss of consciousness) were less common, with fewer than 5% of the patients experiencing them. Clear downward trends were observed for chest pain, breathlessness, and diaphoresis over the past decade.

As a patient could have multiple symptoms, the percentages in Figures 5.4.3, 5.4.4a and 5.4.4b will not add up to 100% for each year.

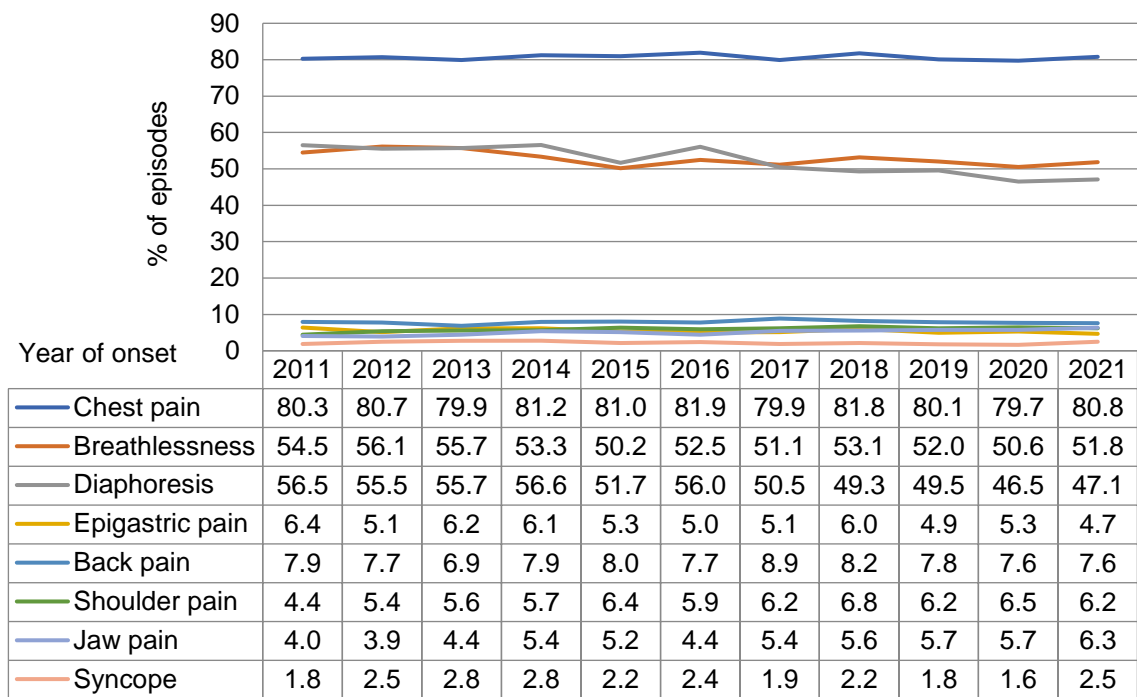
**Figure 5.4.3: Presenting symptoms (%)**



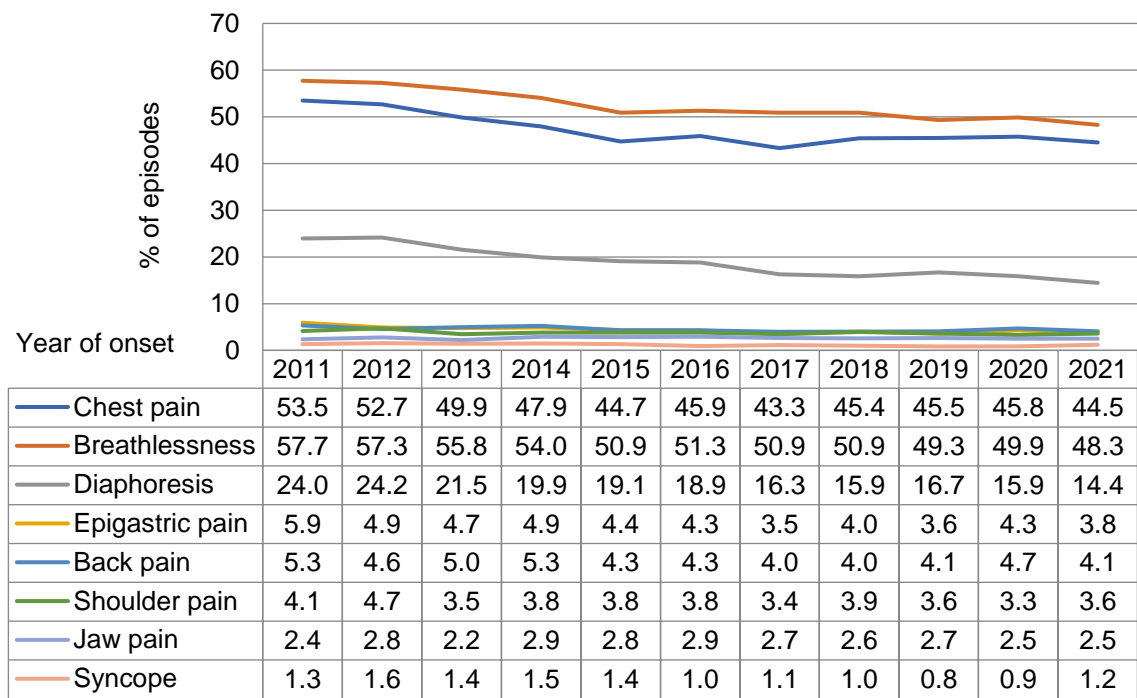
Chest pain was the most common presenting symptom of STEMI, with about 4 in 5 STEMI patients having this symptom every year (Figure 5.4.4a). Unlike STEMI, breathlessness was the most common presenting symptom of NSTEMI, with about half of the patients having this symptom in 2021 (Figure 5.4.4b). While the proportion of STEMI patients with chest pain remained stable over the years, the proportion of NSTEMI patients with chest pain dropped. The proportion who experienced breathlessness dropped for both STEMI and NSTEMI patients over the years. This might indicate a rise in silent AMI among NSTEMI patients, whereby mild and brief symptoms are experienced by individuals, leading to delays in seeking medical attention<sup>30</sup>.

<sup>30</sup> The danger of “silent” heart attacks. Harvard Health Publishing, Harvard Medical School. <https://www.health.harvard.edu/heart-health/the-danger-of-silent-heart-attacks> Accessed on 5 May 2023.

**Figure 5.4.4a: Presenting symptoms (%) among STEMI**



**Figure 5.4.4b: Presenting symptoms (%) among NSTEMI**

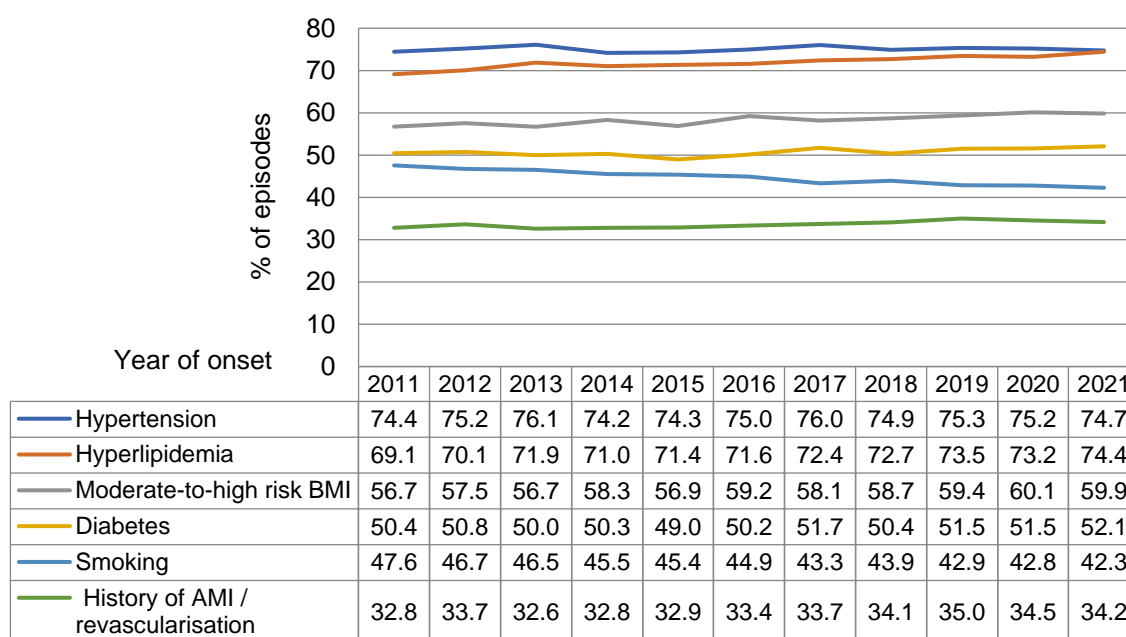


## 5.5 Risk Factors

Hypertension, hyperlipidemia, diabetes, high-BMI, and smoking are well established modifiable risk factors of AMI<sup>31</sup>. Hypertension, hyperlipidemia and diabetes were defined as present if there was history of the condition or if it was newly diagnosed during the index admission. Moderate-to-high risk BMI refers to BMI 23 kg/m<sup>2</sup> or above, whereby the risk for cardiovascular disease and diabetes is increased among Asian populations<sup>32</sup>. Smoking refers to former or current smokers. 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 the two most common risk factors among AMI patients across the years (Figure 5.5.1). In 2021, 74.7% of AMI patients had hypertension, while 74.4% had hyperlipidemia. Moderate-to-high risk BMI and diabetes were also prevalent among AMI patients, with more than half of them having these risk factors (moderate-to-high risk BMI: 59.9%, diabetes: 52.1%) in 2021. Upward trends were observed for all risk factors, except smoking, which dropped over the years.

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

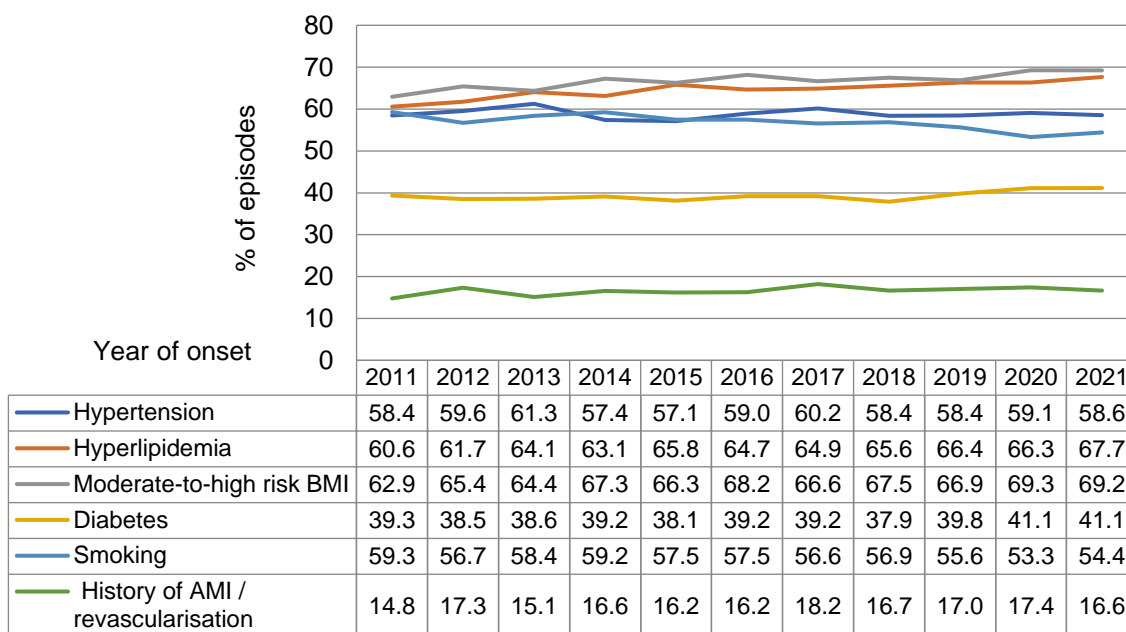


More than half of the STEMI patients had hypertension, hyperlipidemia, moderate-to-high risk BMI and smoked (Figure 5.5.2a). Compared to STEMI patients, the proportions of NSTEMI patients with hypertension, hyperlipidemia, diabetes, and history of AMI / revascularisation were higher (Figure 5.5.2b) as they tended to be older (Tables 5.1.9a and 5.1.9b). However, NSTEMI patients were also less likely to have moderate-to-high risk BMI or smoke.

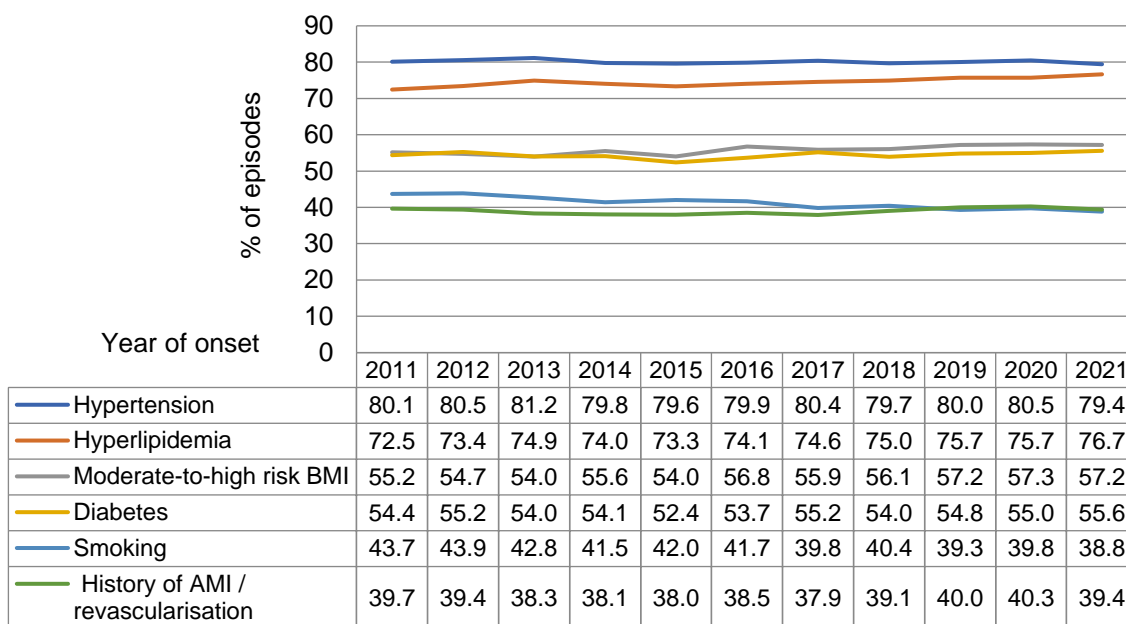
<sup>31</sup> Yusof, S et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet*. 2004;364:937-952.

<sup>32</sup> WHO expert consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004; 363: 157-163.

**Figure 5.5.2a: Risk factors (%) among STEMI**



**Figure 5.5.2b: Risk factors (%) among NSTEMI**



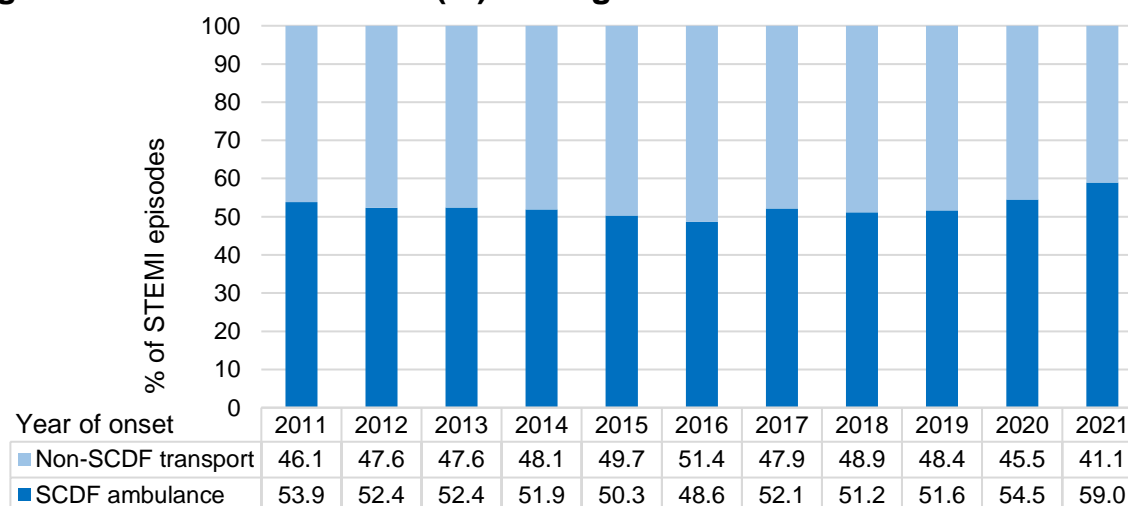
## 5.6 Time Factors

**Door-to-balloon (DTB) time:** DTB time refers to the time from first medical contact to 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 start 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<sup>33</sup>.

Studies have shown that direct ambulance admission to the catheterisation laboratory significantly reduces DTB time<sup>34</sup>. There are two main types of ambulance in Singapore: SCDF public emergency ambulance and non-SCDF private ambulance, which are mainly non-emergency medical transport services. Non-SCDF transport include non-SCDF private ambulance, public transport, personal private transport and walk-in.

The utilisation of SCDF ambulance among STEMI patients ranged between 48.6% to 59.0% from 2011 to 2021 (Figure 5.6.1).

**Figure 5.6.1: Mode of arrival (%) among STEMI**



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<sup>35</sup>, were excluded from the calculation of DTB time.

<sup>33</sup> Antman EM et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee to revise the 1999 guidelines for the management of patients with acute myocardial infarction). *Journal of American College of Cardiology* 2004; 94: 722-774.

<sup>34</sup> 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.

<sup>35</sup> 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.



These exclusion criteria were applied as the DTB time would be abnormally short or long under such scenarios.

The median DTB time improved from 66 (IQR 52-89) minutes in 2011 to 55 (IQR 42 – 69) minutes in 2021 among STEMI patients (Figure 5.6.2). The proportion of STEMI patients with DTB time of 90 minutes or less improved from 76.2% in 2011 to 96.8% in 2021. This improvement was driven by the efficiency in the healthcare delivery system comprising the early response teams and hospitals.

The median DTB time was consistently shorter for STEMI patients who arrived by SCDF ambulance (49 minutes in 2021) compared to those who relied on other modes of transport (63 minutes in 2021) across the years. A comparable difference was found by a single-centre retrospective cohort study in Singapore, where arrival via emergency ambulance was similarly associated with DTB times approximately 15 minutes shorter than arrival via other modes of transport<sup>36</sup>. This difference was largely attributable to decreased door-to-ECG and door-to-catheterisation laboratory times.

Similarly, the proportion of STEMI patients with DTB time within 90 minutes was consistently higher among those who arrived at the hospital via SCDF ambulance than those who arrived via other modes of transport (98.3% versus 94.1% respectively in 2021) across the years. When a STEMI diagnosis is determined in the pre-hospital setting through the SCDF Emergency Medical Services and the patient is triaged for a primary PCI, he/she will be conveyed to a PCI centre. The receiving hospital's Emergency Department (ED) is notified by the SCDF in advance to be put on standby, and the patient's ECG is transmitted to the ED before the ambulance's arrival<sup>37</sup>. This allows the hospital to confirm the diagnosis and activate the catheterisation laboratory, thereby shortening DTB time, which translates to reduction in mortality<sup>38</sup>. Worldwide, interventions such as pre-hospital ECG transmission and activation of catheterisation laboratories have been shown to reduce DTB times, and these are only available to patients conveyed via emergency ambulance services<sup>39</sup>.

In 2021, a platform jointly developed by the SCDF and Ministry of Health (MOH) called Operational Medical Networks Informatics Integrator (OMNII) was launched, allowing stakeholders in pre-hospital emergency care (such as the SCDF) and hospitals to view, document and share patient data with each other, resulting in speedier patient management and improving chances of survival<sup>40</sup>. With OMNII, SCDF paramedics could also pre-register the patient prior to their arrival at the ED, potentially further improving the DTB time for STEMI patients who arrive by SCDF ambulance.

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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.

<sup>36</sup> Liu et al. Improved door-to-balloon time for primary percutaneous coronary intervention for patients conveyed via emergency ambulance service. *Ann Acad Med Singapore* 2021;50:671-678.

<sup>37</sup> Chia YW and Chia M. Reducing the total ischaemic time in ST-segment elevation myocardial infarction: Every step matters. *Ann Acad Med Singapore* 2021;50:662-665.

<sup>38</sup> Nallamotheu 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.

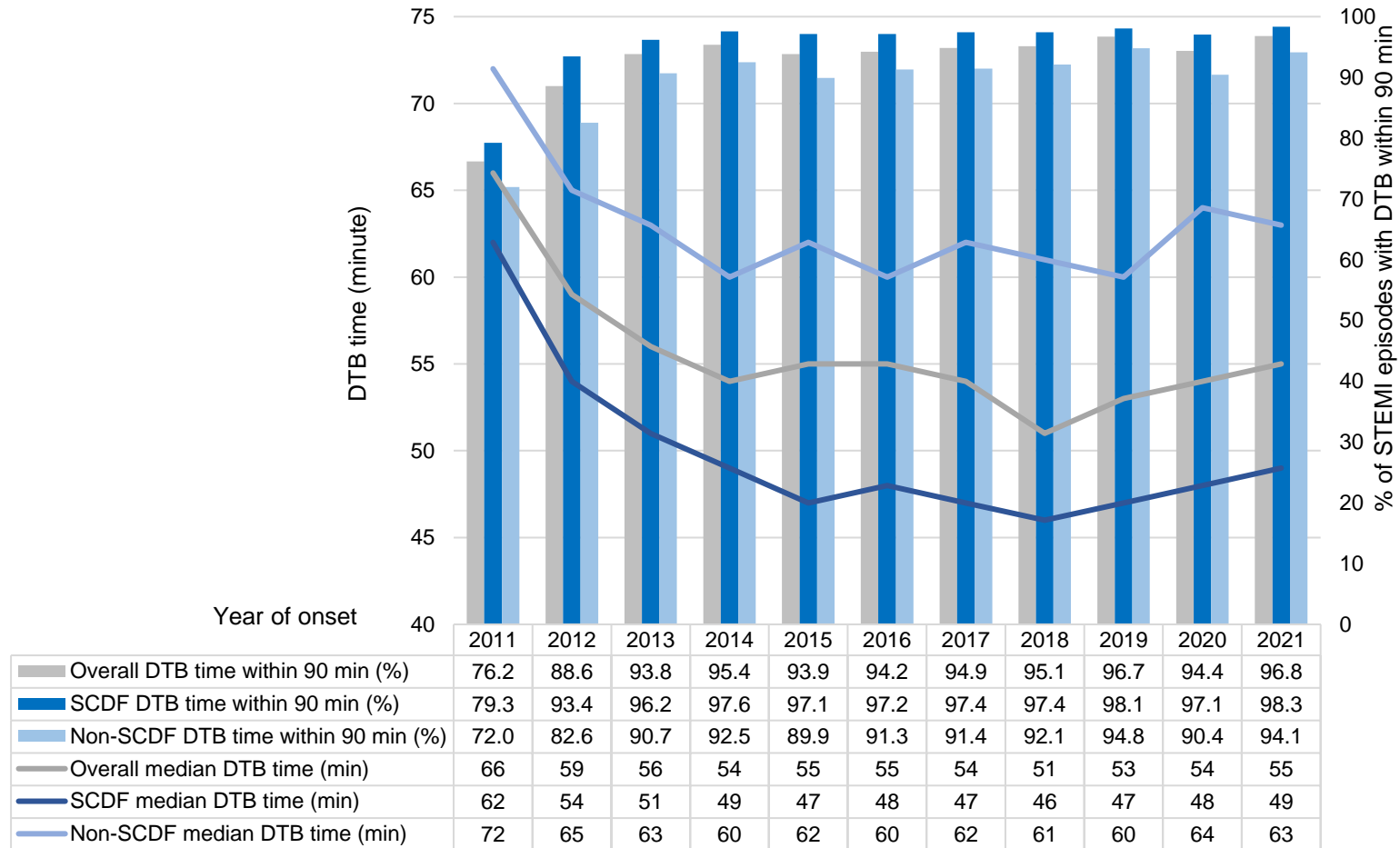
<sup>39</sup> Liu et al. Improved door-to-balloon time for primary percutaneous coronary intervention for patients conveyed via emergency ambulance service. *Ann Acad Med Singapore* 2021;50:671-678.

<sup>40</sup> New digital platform for paramedics and hospitals to share patient data in real time. Yeoh G.

<https://www.channelnewsasia.com/singapore/digital-platform-scdf-moh-hospitals-patients-omnii-2132121>

Accessed on 10 May 2023.

**Figure 5.6.2: DTB time by mode of arrival among STEMI**



## 6. CONCLUSION

Cardiovascular diseases were the third highest contributor to the combined burden of early death and disability in Singapore, accounting for 13.9% of all disability-adjusted life years (DALYs) in 2019<sup>41</sup>. It is important for individuals with high risk of AMI to take preventive action. Hypertension, hyperlipidemia, smoking, diabetes, abdominal obesity, diet, and failure to engage in regular physical activity are all significantly associated with increased risk of AMI onset regardless of gender and age, and this is observed across all regions of the world. Collectively, these account for a vast majority of the attributable risk of AMI and are all modifiable through lifestyle changes<sup>42</sup>.

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<sup>43</sup>. Individual awareness of the typical and atypical symptoms of AMI can shorten the time from onset to treatment, thereby improving outcomes, reducing overall mortality and the chances of reinfarction<sup>44</sup>. 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.

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<sup>41</sup> Global Burden of Disease 2019 study findings. Ministry of Health, Singapore. <https://www.moh.gov.sg/news-highlights/details/global-burden-of-disease-2019-study-findings/> Accessed on 5 May 2023.

<sup>42</sup> Yusuf, S et al. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet*. 2004;364:937-952.

<sup>43</sup> Ibid.

<sup>44</sup> Kim Soo-Joong. Global Awareness of Myocardial Infarction Symptoms in General Population. *Korean Circulation Journal* 2021;51(12): 997-1000.