Singapore Myocardial Infarction Registry Annual Report 2022

National Registry of Diseases Office
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Acknowledgement

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1. GLOSSARY

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

2. EXECUTIVE SUMMARY

This annual report presents data on trends for incidence, mortality, 30-day case fatality, presenting symptoms, risk factors, time to treatment and length of hospitalisation for Singapore residents with acute myocardial infarction (AMI) for the latest 10 years period, from 2012 to 2022.

The number of AMI episodes increased by about 44% from 9,124 episodes in 2012 to 13,137 episodes in 2022. The age-standardised incidence rate (ASIR) remained relatively unchanged at 223.3 and 217.9 per 100,000 population respectively.

The number of AMI deaths was 1,073 in 2022, an increase of about 26% from 853 in 2012. However, the age-standardised mortality rate (ASMR) declined significantly from 20.0 to 15.5 per 100,000 population during this period. There was little overall change in the 30-day case fatality rate (CFR), at 9.8% in 2012 and 8.5% in 2022.

The proportion of AMI patients experiencing typical symptoms of AMI dropped over the years. Each year, about 60-70% of ST-segment elevation myocardial infarction (STEMI) patients had typical symptoms, while the majority of the non-ST-segment elevation myocardial infarction (NSTEMI) patients had no or non-typical symptoms. Between 2012 and 2022, the two most common presenting symptoms remained consistent for AMI patients: chest pain and breathlessness. Approximately 50-60% of AMI patients experienced chest pain every year in the past 10 years, while about 48-55% experienced breathlessness.

Relating to risk factors for AMI, between 2012 and 2022, hypertension and hyperlipidaemia were consistently the two most common risk factors among AMI patients. Every year from 2012 to 2022, about 75% (3 in 4) of AMI patients had hypertension, while the proportion with hyperlipidaemia rose from 70.1% in 2012 to 74.4% in 2022. Moderate-to-high 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 about two in five AMI patients during this period.

The median door-to-balloon (DTB) time remained relatively unchanged at 59 minutes in 2012 and 57 minutes in 2022. The proportion of STEMI patients with DTB time of 90 minutes or less improved from 88.6% in 2012 to 95.6% in 2022. The median DTB time was consistently shorter for STEMI patients who arrived by Singapore Civil Defence Force (SCDF) ambulance (51 minutes in 2022) than those who relied on other modes of transport (65 minutes in 2022) across the years. The proportion of STEMI patients with DTB time of 90 minutes or less was consistently higher among those who were conveyed via SCDF ambulance (97.5% in 2022) than those who arrived via other modes of transport (92.4% in 2022) across the years.

Between 2012 and 2022, the average length of hospitalisation for AMI remained largely similar, ranging between 7.6 and 8.1 days every year.

3. INTRODUCTION

Ischaemic heart disease was the third most common cause of death in Singapore in 2022, accounting for 19.7% of all deaths in Singapore[1]. AMI, commonly known as heart attack, is a type of ischaemic heart disease.

The most common cause of AMI is atherosclerosis – the narrowing of the arteries due to the build-up of cholesterol deposits in the arterial walls, forming plaques that narrow the arteries and restrict blood flow. 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 with a higher 30-day case fatality rate, while NSTEMI is more prevalent, accounting for about 80% of AMI episodes each year.

The common risk factors of AMI are hypertension, hyperlipidaemia, diabetes, obesity, smoking and old age. The proportion of Singapore residents aged 65 years and above rose from about 10% (1 in 10) in 2012 to 16.6% (1 in 6) in 2022[2]. This figure has been projected to rise to about 24.1% (1 in 4) in 2030[3]. With Singapore's rapidly ageing population, the incidence of AMI is expected to rise. To mitigate the impact of AMI, preventive measures that reduce cardiovascular risk, as well as post-AMI interventions that improve prognosis and reduce recurrence risk, are essential.

[1] Principal Causes of Death. Ministry of Health, Singapore. www.moh.gov.sg/resources-statistics/singapore-health-facts/principal-causes-of-death Accessed on 8 May 2024.
[2] SingStat Table Builder, Population and Population Structure, Annual Population, Singapore Residents by age group, ethnic group and sex. Department of Statistics, Singapore. https://tablebuilder.singstat.gov.sg/table/TS/M810011. Accessed on 23 April 2024.
[3] Population Trends – Overview. National Population and Talent Division, Prime Minister's Office, Singapore. https://www.population.gov.sg/our-population/population-trends/overview/. Accessed 18 June 2024.

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 9th 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[4]. For type 2 AMI, they were

[4] American College of Cardiology Foundation. Universal definition of myocardial infarction. Journal of the American College of Cardiology 2007; 50(22): 2173-2195.

eventually combined with NSTEMI in this report as their clinical characteristics are similar[5].

Cases that were transferred 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 September 2023 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[6]. The Segi World population estimates used for age standardisation are available on the World Health Organization website[7].

Incidence rate

The incidence rate in each year was calculated by taking the number of AMI episodes that occurred in a year among Singapore residents, 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 among Singapore residents, 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

[5] Stein YG et al. Type-II myocardial infarction – patient characteristics, management and outcomes. PLoS One 2014; 9(1): e84285.
[6] SingStat Table Builder, Population and Population Structure, Annual Population, Singapore Residents by age group, ethnic group and sex. Department of Statistics, Singapore. https://tablebuilder.singstat.gov.sg/table/TS/M810011. Accessed on 23 April 2024.
[7] 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.

severity of AMI, the timeliness of healthcare delivery and the effectiveness of AMI treatment.

This report focuses on Singapore residents, aged 15 years and above, diagnosed with AMI in 2012 to 2022 as they stood on 27 March 2024. All findings in this report, except mortality and case fatality, were based on AMI episodes.

5. FINDINGS

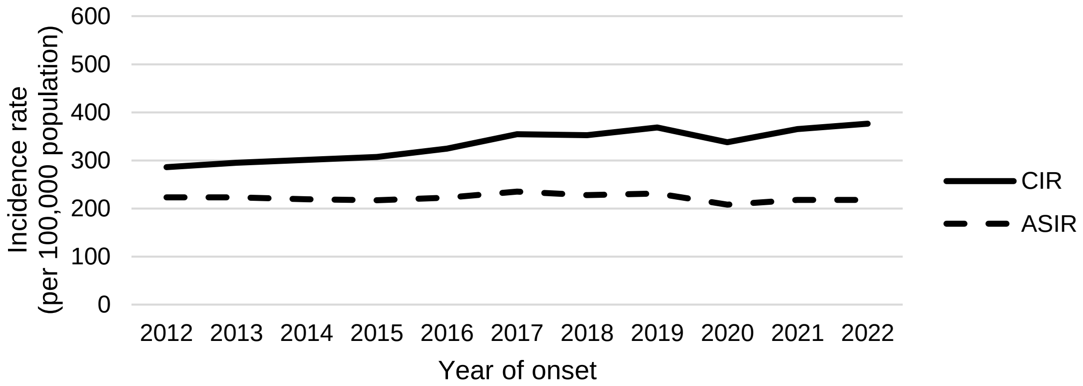
5.1 Incidence

The number of AMI episodes increased by about 44% from 9,124 in 2012 to 13,137 in 2022, with the corresponding crude incidence rates (CIR) increasing significantly from 285.9 to 376.3 per 100,000 population (Table 5.1.1 and Figure 5.1.1). However, after accounting for Singapore's ageing population, there was little overall change in ASIR (p=0.544). Notably, there was a drop in the AMI incidence number and rate in 2020, which was likely due to the corollary effect of COVID-19 pandemic, as patients avoided going to the hospitals, especially elderly with NSTEMI[8]. 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, United States, United Kingdom, France, Greece, and Sweden[9]. In 2021 and 2022, 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
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	10815	324.1	317.9-330.2	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	12651	368.3	361.9-374.7	230.9	226.7-235.0
2020	11680	338.0	331.8-344.1	207.9	204.0-211.8
2021	12447	365.1	358.6-371.5	217.9	213.9-221.9
2022	13137	376.3	369.8-382.7	217.9	214.0-221.8
P for trend	-	<0.001**	-	0.544	-

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



[8] 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.
[9] 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 from 68.5 years in 2012 to 71.4 years in 2022 ($p<0.001$) (Table 5.1.2). Nearly 80% of AMI patients were aged 60 years and above at onset in 2022, a gradual increase from about 70% in 2012; and about 53% were aged 70 years and above (Figure 5.1.2). In comparison, the American Heart Association (AHA) reported in 2023 that 30-40% of Americans hospitalised for acute coronary syndrome were aged 75 years and above[10].

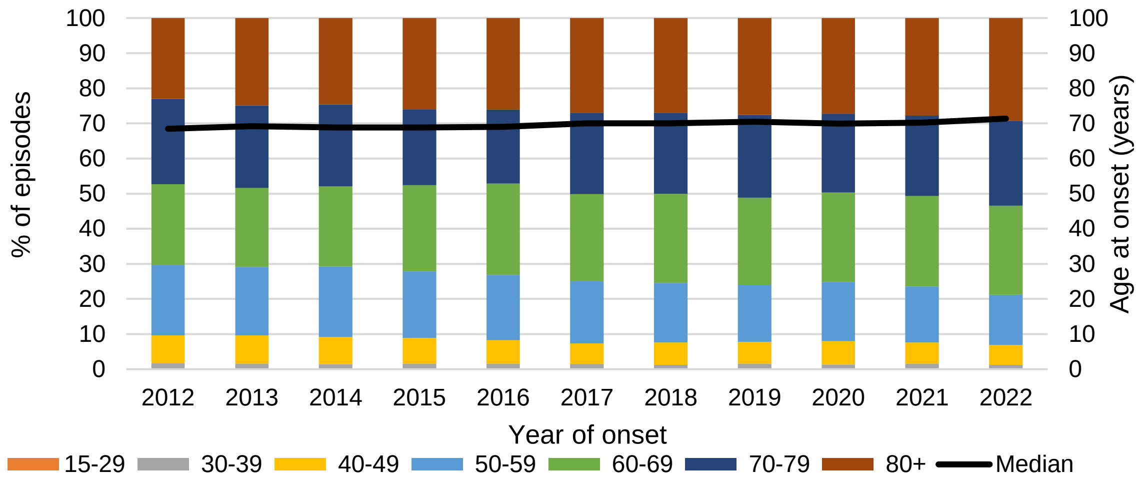
Table 5.1.2: Age distribution at onset of AMI

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
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	70.3	12	0.1	190	1.5	747	6.0
2022	71.4	10	0.1	158	1.2	733	5.6

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	2285	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	2057	16.3	3136	24.8	2978	23.5	3494	27.6
2020	1960	16.8	2984	25.5	2624	22.5	3180	27.2
2021	1988	16.0	3203	25.7	2848	22.9	3459	27.8
2022	1889	14.4	3335	25.4	3176	24.2	3836	29.2

[10] Damluji et al. Management of Acute Coronary Syndrome in the Older Adult Population: A Scientific Statement From the American Heart Association. Circulation. 2023;147:e32–e62

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 (80 years and above) having the highest incidence rate – about 4.5 and 2.5 times that of those aged 60-69 and 70-79 years respectively (Figures 5.1.3a and 5.1.3b). Over the years, only those aged 70-79 years exhibited a significant decline in age-specific incidence of AMI, while the trends in the remaining age groups were not statistically significant (Table 5.1.3).

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

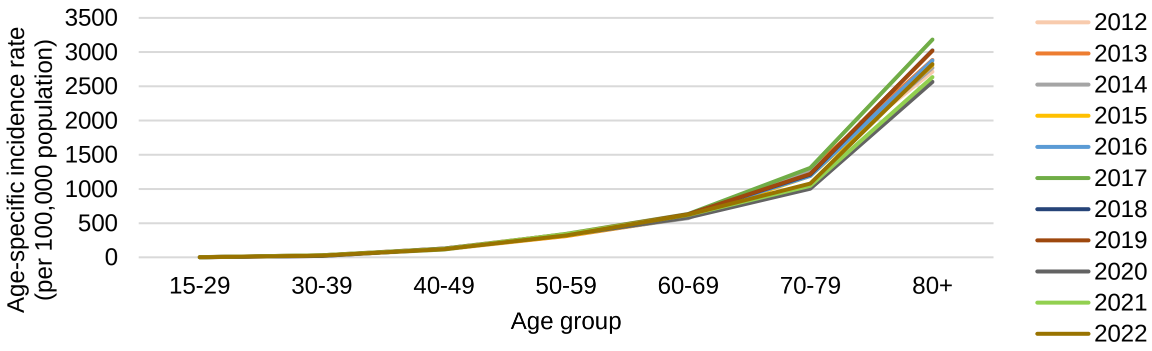


Figure 5.1.3b: Age-specific incidence rate of AMI (per 100,000 population) across age groups

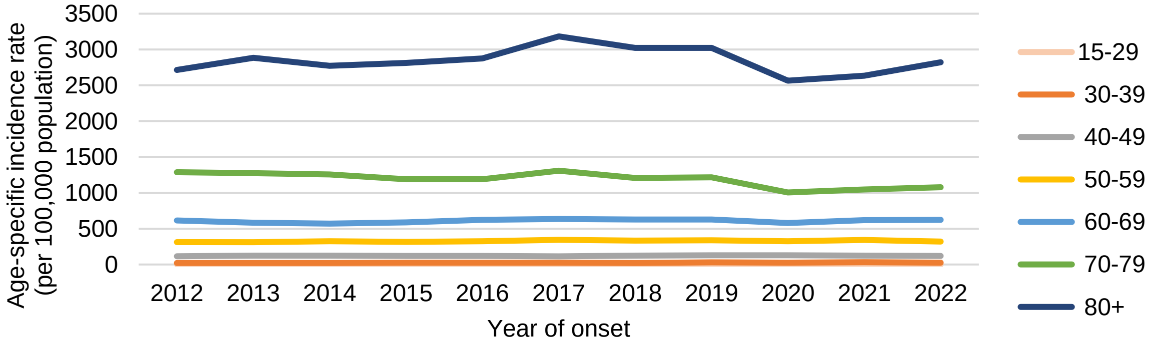


Table 5.1.3: Age-specific incidence rate of AMI (per 100,000 population)

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
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	324.1	317.9-330.2	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	361.9-374.7	2.9	1.7-4.1	30.1	25.7-34.5	128.2	119.2-137.1
2020	338.0	331.8-344.1	2.0	1.0-3.0	23.9	20.0-27.9	126.7	117.7-135.6
2021	365.1	358.6-371.5	1.7	0.7-2.6	32.2	27.6-36.8	126.0	117.0-135.0
2022	376.3	369.8-382.7	1.4	0.5-2.2	26.0	21.9-30.0	121.3	112.5-130.1
P for trend	<0.001**	-	0.805	-	0.052	-	0.096	-

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
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	1191.6	1142.8-1240.5	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	338.1	323.5-352.7	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	2565.1	2475.9-2654.2
2021	340.3	325.3-355.3	618.3	596.9-639.8	1045.9	1007.5-1084.3	2634.2	2546.4-2721.9
2022	318.6	304.3-333.0	622.3	601.2-643.4	1078.9	1041.4-1116.4	2824.2	2734.8-2913.6
P for trend	0.103	-	0.252	-	0.005**	-	0.776	-

Although the sex distribution was almost equal in the general population, there were about twice as many males getting an AMI every year (Table 5.1.4). The ASIRs for males were consistently higher than females (Figure 5.1.4). In 2022, males had an ASIR of 326.7 per 100,000 population, while females had an ASIR of 118.2 per 100,000 population. While the CIRs had increased significantly for both sexes, after accounting for population ageing, the change in ASIR of AMI among males was not significant (p=0.274), while that for females had decreased significantly (p=0.004).

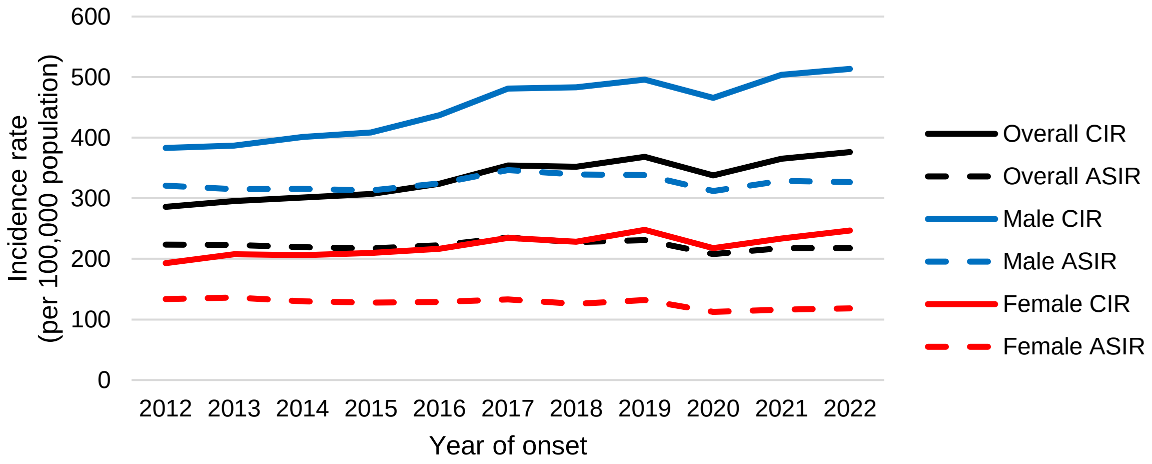
Males were known to have a higher risk of AMI than females. The underlying causes were multifactorial and related to the pathophysiological sex differences in AMI[11]. Furthermore, the prevalence of hypertension, hyperlipidaemia, diabetes, high body mass index (BMI) and smoking, which are common risk factors of AMI, were higher among males than females in the general population based on the National Population Health Survey (NPHS) 2022 [12].

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

Male						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
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	7105	65.7	437.0	426.8-447.2	324.3	316.7-331.9
2017	7890	66.0	480.9	470.3-491.5	346.6	338.9-354.3
2018	7991	66.7	483.1	472.5-493.6	339.3	331.8-346.8
2019	8271	65.4	495.9	485.2-506.5	338.3	330.9-345.7
2020	7812	66.9	465.7	455.4-476.0	312.0	305.0-319.1
2021	8355	67.1	503.9	493.1-514.7	328.7	321.5-336.0
2022	8695	66.2	513.6	502.8-524.4	326.7	319.6-333.7
P for trend	-	-	<0.001**	-	0.274	-
Female						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
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	3992	33.3	228.3	221.2-235.3	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	4092	32.9	233.6	226.4-240.8	116.1	112.3-119.9
2022	4442	33.8	247.0	239.7-254.3	118.2	114.5-121.9
P for trend	-	-	0.001**	-	0.004**	-

[11] Mehta LS et al. Acute myocardial infarction in women. Circulation 2016; 133.
[12] National Population Health Survey 2022 (Household Interview and Health Examination). Ministry of Health, Singapore. https://www.moh.gov.sg/resources-statistics/reports/national-population-health-survey-2022. Accessed 18 June 2024.

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



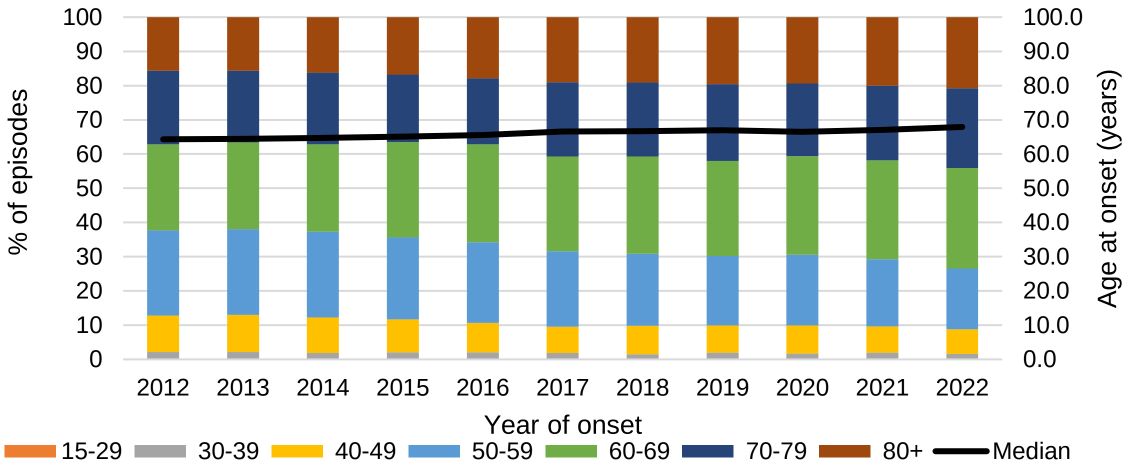
The median age at onset of AMI among males increased from 64.3 years in 2012 to 67.9 years in 2022 ($p<0.001$) (Table 5.1.5a). The highest proportion of male AMI patients in 2022 was among those aged 60-69 years (29.3%); this was the case throughout the years from 2012 onwards (Figure 5.1.5a).

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	%
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	67.1	11	0.1	154	1.8	637	7.6
2022	67.9	4	0.0	137	1.6	622	7.2

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1366	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	1528	19.1
2019	1679	20.3	2301	27.8	1856	22.4	1615	19.5
2020	1610	20.6	2254	28.9	1656	21.2	1514	19.4
2021	1644	19.7	2413	28.9	1823	21.8	1673	20.0
2022	1550	17.8	2550	29.3	2026	23.3	1806	20.8

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



The median age at onset of AMI among females increased from 75.9 years in 2012 to 78.4 years in 2022 (p=0.008) (Table 5.1.5b), about 10 years older than the median age at onset among males (Table 5.1.5a). In contrast to males, amongst whom those aged 60-69 years formed the biggest age group (29.3%), those aged 80 years and above formed the largest proportion of female AMI patients every year (45.7%) in 2022 (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 prevalence of risk factors than females of the same age, especially lipid abnormalities and smoking[13,14]. The same risk profile had been observed in Singapore in the NPHS 2022[15], whereby the prevalence of hyperlipidaemia and smoking were substantially higher among males aged 30-59 years compared to females of the same age.

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

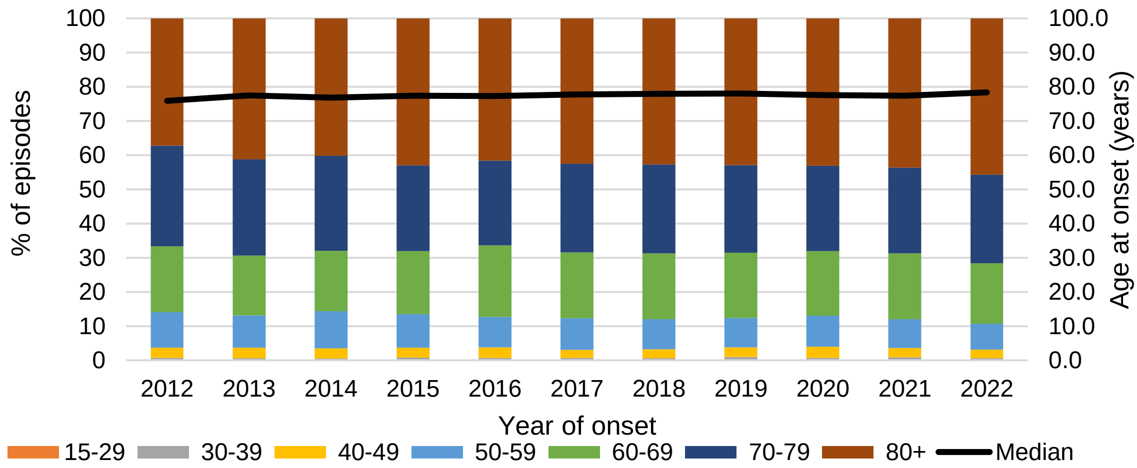
Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2012	75.9	4	0.1	19	0.6	93	3.0
2013	77.4	3	0.1	18	0.5	104	3.0
2014	76.9	1	0.0	16	0.5	104	3.0
2015	77.4	5	0.1	22	0.6	105	3.0
2016	77.3	5	0.1	22	0.6	114	3.1
2017	77.8	2	0.0	28	0.7	93	2.3
2018	78.0	3	0.1	20	0.5	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

[13] 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.
[14] Campbell, D. J. Why do men and women differ in their risk of myocardial infarction? European Heart Journal. 2008;29:835-835.
[15] National Population Health Survey 2022 (Household Interview and Health Examination). Ministry of Health, Singapore. https://www.moh.gov.sg/resources-statistics/reports/national-population-health-survey-2022. Accessed 18 June 2024.

2022	78.4	6	0.1	21	0.5	111	2.5

Year of onset	**Age 50-59**		**Age 60-69**		**Age 70-79**		**Age 80+**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
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	1705	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	790	19.3	1025	25.0	1786	43.6
2022	339	7.6	785	17.7	1150	25.9	2030	45.7

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 was lower among the AMI population (Table 5.1.6). Chinese also consistently had the lowest ASIR across the years – consistently less than half that of the Malays and Indians (Figure 5.1.6). In 2022, the ASIR of AMI in the Chinese, Malays and Indians were 172.9, 421.3 and 418.3 per 100,000 population respectively. The changes in ASIR over the years were not significant for all the three ethnic groups.

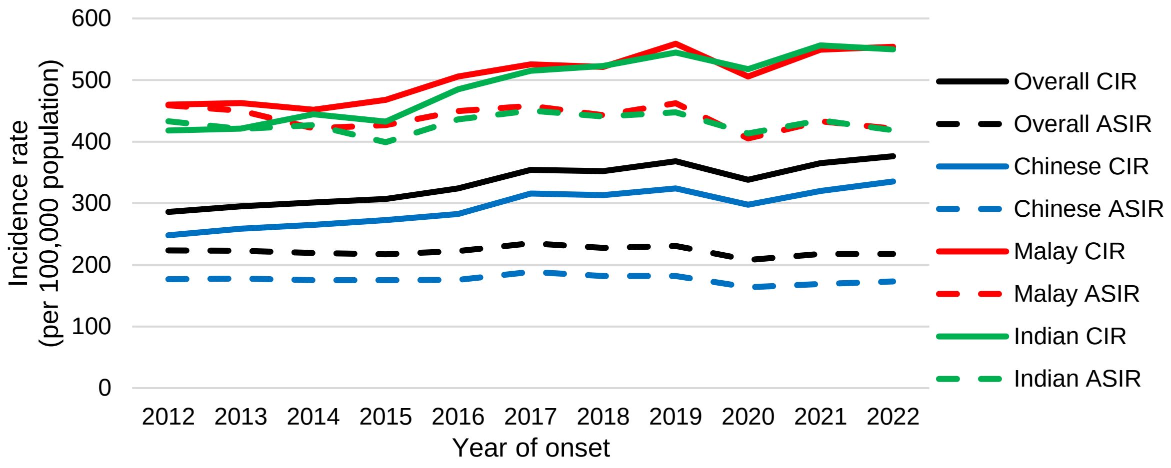
A possible reason for the comparatively higher incidence of AMI in the Malays and Indians could be that diabetes and high BMI, which are common risk factors of AMI, were more prevalent among Malays and Indians than Chinese in the general population based on the NPHS 2022[16]. Smoking, another significant risk factor of AMI, is also more prevalent among Malays than the other ethnic groups[16]. Furthermore, Indians have ethnic-specific risk for coronary artery disease[17].

[16] National Population Health Survey 2022 (Household Interview and Health Examination). Ministry of Health, Singapore. https://www.moh.gov.sg/resources-statistics/reports/national-population-health-survey-2022. Accessed 18 June 2024.
[17] Zheng H et al. Ethnic differences and trends in ST-segment elevation myocardial infarction incidence and mortality in a multi-ethnic population. Annuals Academy of Medicine Singapore. 2019; 48: 75-85.

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

Chinese						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
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	6801	67.1	272.8	266.3-279.3	175.0	170.8-179.3
2016	7119	65.8	282.4	275.9-289.0	175.7	171.5-179.9
2017	8035	67.2	315.6	308.7-322.5	188.5	184.3-192.8
2018	8046	67.1	313.2	306.3-320.0	182.0	177.9-186.1
2019	8410	66.5	324.3	317.4-331.3	181.9	177.9-186.0
2020	7756	66.4	297.4	290.7-304.0	163.6	159.8-167.4
2021	8230	66.1	320.1	313.2-327.0	169.1	165.2-173.0
2022	8809	67.1	335.3	328.3-342.3	172.9	169.0-176.7
P for trend	-	-	<0.001**	-	0.343	-
Malay						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2012	1854	20.3	460.0	439.1-481.0	458.8	437.4-480.3
2013	1892	19.8	462.8	442.0-483.7	450.0	429.3-470.7
2014	1873	19.0	451.8	431.4-472.3	421.7	402.2-441.2
2015	1965	19.4	467.7	447.1-488.4	426.6	407.3-445.9
2016	2154	19.9	505.8	484.5-527.2	449.6	430.2-469.0
2017	2263	18.9	525.2	503.6-546.9	458.1	438.9-477.2
2018	2270	18.9	521.5	500.0-542.9	442.7	424.3-461.2
2019	2454	19.4	558.9	536.8-581.0	462.4	443.9-480.9
2020	2236	19.1	505.6	484.6-526.5	405.2	388.1-422.2
2021	2419	19.4	549.2	527.3-571.1	432.8	415.3-450.3
2022	2480	18.9	554.0	532.2-575.8	421.3	404.5-438.1
P for trend	-	-	<0.001**	-	0.235	-
Indian						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2012	1166	12.8	418.1	394.1-442.1	433.1	407.6-458.6
2013	1184	12.4	421.1	397.1-445.0	420.7	396.3-445.2
2014	1261	12.8	444.3	419.8-468.9	426.7	402.8-450.7
2015	1237	12.2	432.4	408.3-456.5	399.0	376.4-421.6
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	1538	12.8	523.0	496.8-549.1	440.6	418.6-462.7
2019	1620	12.8	544.6	518.1-571.1	447.8	426.0-469.6
2020	1548	13.3	517.8	492.0-543.6	413.1	392.6-433.7
2021	1633	13.1	556.3	529.3-583.3	434.5	413.4-455.5
2022	1680	12.8	549.7	523.4-576.0	418.3	398.3-438.3
P for trend	-	-	<0.001**	-	0.811	-

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



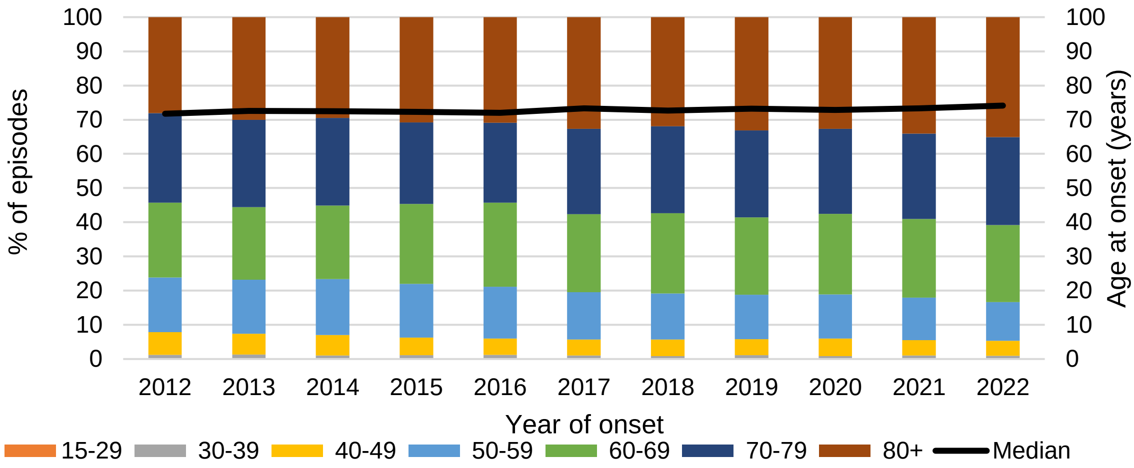
The Chinese had the oldest median age at onset of AMI, which increased from 71.7 years in 2012 to 74.1 years in 2022 (p=0.002) (Table 5.1.7a). Since 2012, those aged 80 years and above accounted for the largest proportion of AMI cases among the Chinese, ranging from 28.0%-35.1% (Figure 5.1.7a).

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	%
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
2022	74.1	5	0.1	78	0.9	391	4.4

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	2097	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	2622	32.6
2018	1079	13.4	1895	23.6	2045	25.4	2566	31.9
2019	1096	13.0	1898	22.6	2137	25.4	2790	33.2
2020	999	12.9	1829	23.6	1925	24.8	2536	32.7
2021	1018	12.4	1899	23.1	2050	24.9	2805	34.1
2022	997	11.3	1985	22.5	2265	25.7	3088	35.1

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



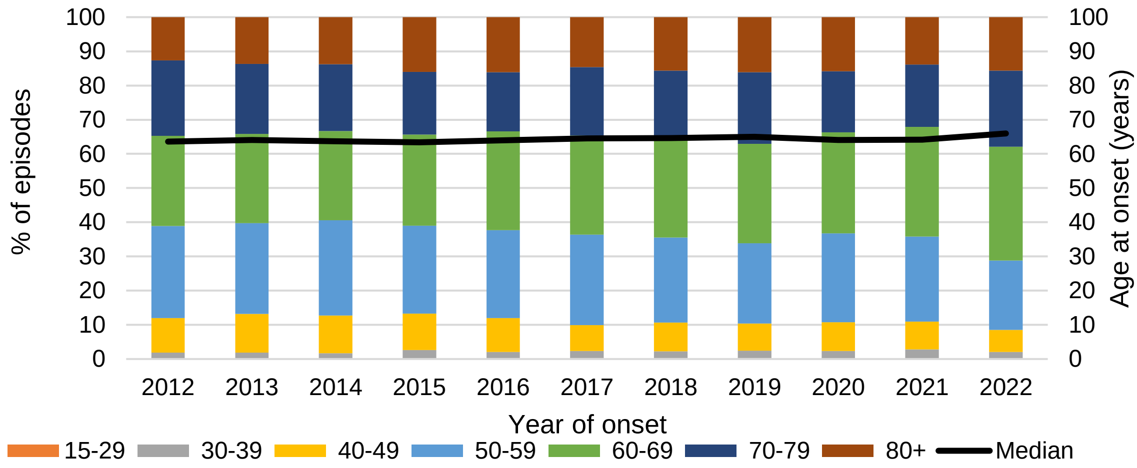
The median age at onset of AMI among the Malays was earlier than that among the Chinese, increasing from 63.6 years in 2012 to 66.0 years in 2022 (p=0.014) (Table 5.1.7b). Across all years, those aged 60-69 years made up the largest proportion of Malay AMI patients (33.3% in 2022) (Figure 5.1.7b).

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	%
2012	63.6	3	0.2	32	1.7	187	10.1
2013	64.0	3	0.2	32	1.7	214	11.3
2014	63.7	3	0.2	28	1.5	208	11.1
2015	63.4	4	0.2	48	2.4	209	10.6
2016	64.0	7	0.3	37	1.7	215	10.0
2017	64.5	7	0.3	46	2.0	172	7.6
2018	64.7	6	0.3	45	2.0	191	8.4
2019	65.0	7	0.3	54	2.2	195	7.9
2020	64.1	5	0.2	48	2.1	187	8.4
2021	64.1	3	0.1	66	2.7	196	8.1
2022	66.0	3	0.1	49	2.0	159	6.4

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2012	499	26.9	490	26.4	409	22.1	234	12.6
2013	504	26.6	493	26.1	388	20.5	258	13.6
2014	521	27.8	489	26.1	366	19.5	258	13.8
2015	505	25.7	524	26.7	361	18.4	314	16.0
2016	552	25.6	624	29.0	371	17.2	348	16.2
2017	598	26.4	657	29.0	452	20.0	331	14.6
2018	564	24.8	659	29.0	449	19.8	356	15.7
2019	574	23.4	714	29.1	515	21.0	395	16.1
2020	581	26.0	662	29.6	400	17.9	353	15.8
2021	601	24.8	777	32.1	440	18.2	336	13.9
2022	503	20.3	826	33.3	551	22.2	389	15.7

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



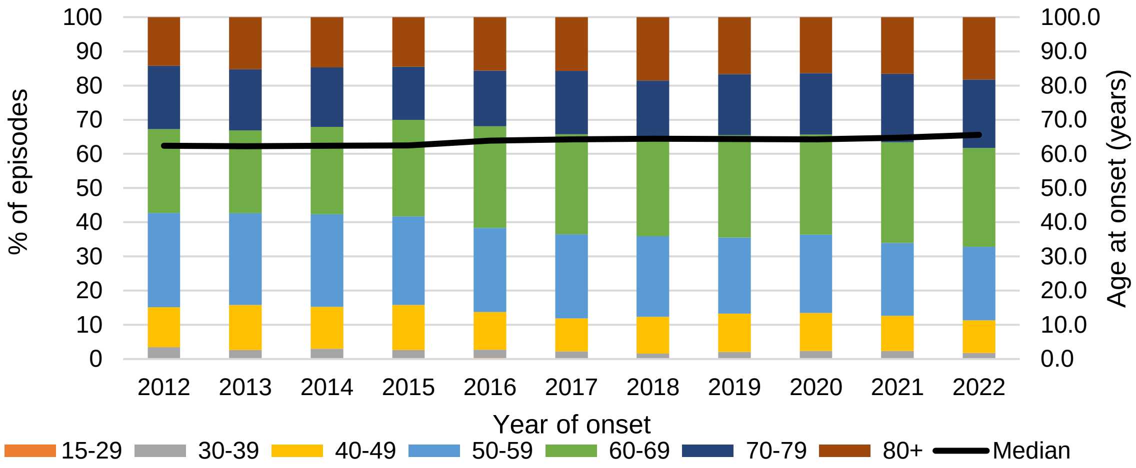
The median age at onset of AMI among the Indians increased from 62.4 years in 2012 to 65.6 years in 2022 ($p<0.001$) (Table 5.1.7c). From 2015 onwards, those aged 60-69 years made up the largest proportion of Indian AMI patients (28.9% in 2022) (Figure 5.1.7c).

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	%
2012	62.4	2	0.2	38	3.3	137	11.7
2013	62.2	2	0.2	29	2.4	156	13.2
2014	62.4	2	0.2	36	2.9	154	12.2
2015	62.5	0	0.0	32	2.6	164	13.3
2016	63.9	5	0.4	33	2.4	155	11.1
2017	64.3	2	0.1	32	2.1	144	9.6
2018	64.5	3	0.2	22	1.4	165	10.7
2019	64.3	2	0.1	31	1.9	182	11.2
2020	64.2	2	0.1	35	2.3	171	11.0
2021	64.7	2	0.1	37	2.3	168	10.3
2022	65.6	2	0.1	28	1.7	160	9.5

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2012	321	27.5	286	24.5	216	18.5	166	14.2
2013	318	26.9	287	24.2	211	17.8	181	15.3
2014	342	27.1	322	25.5	219	17.4	186	14.8
2015	320	25.9	349	28.2	192	15.5	180	14.6
2016	344	24.6	416	29.7	227	16.2	219	15.7
2017	369	24.6	439	29.3	278	18.5	236	15.7
2018	362	23.5	448	29.1	253	16.4	285	18.5
2019	361	22.3	484	29.9	290	17.9	270	16.7
2020	355	22.9	454	29.3	277	17.9	254	16.4
2021	347	21.2	481	29.5	328	20.1	270	16.5
2022	361	21.5	486	28.9	337	20.1	306	18.2

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



NSTEMI occurred more frequently than STEMI (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[18].

A dip was observed in overall AMI incidence in 2020, possibly attributable to the COVID-19 pandemic. A STEMI is more severe with a higher likelihood of fatality if intervention is not provided promptly. Thus, the number of STEMIs continued to rise in 2020 and the ASIR remained unaffected, as these patients were less likely to avoid hospital visits due to the ongoing COVID-19 pandemic. However, the number of NSTEMIs dropped in 2020, as 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=0.708), as was that for NSTEMI (range: 143.4 to 172.4 per 100,000 population, p=0.739).

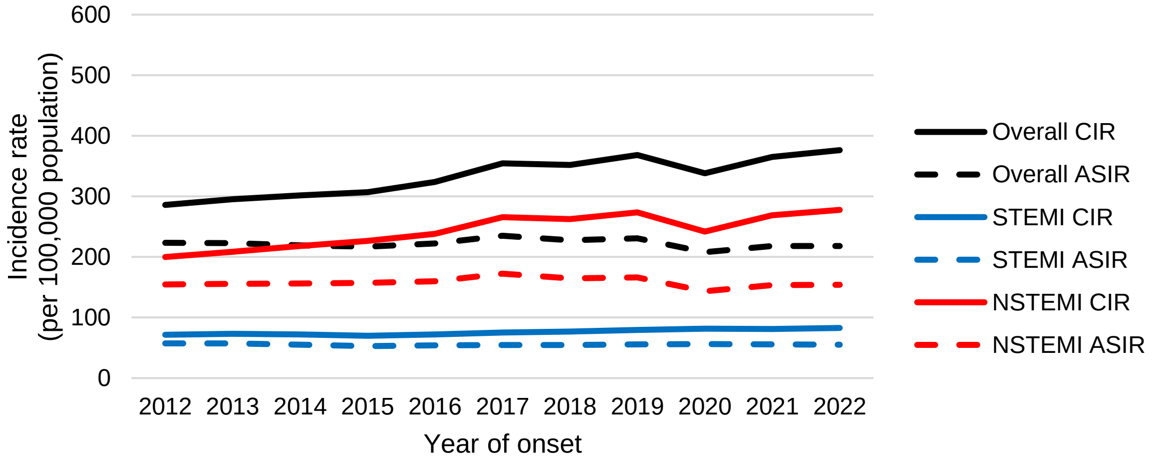
As the percentages in Table 5.1.8 are among all AMI and patients without documentation of STEMI or NSTEMI are not shown, the sum of the percentages for STEMI and NSTEMI are less than 100% for each year. Figures for overall CIR and ASIR include cases of unknown etiology.

[18]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**
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	2773	22.3	81.3	78.3-84.4	55.6	53.5-57.8
2022	2891	22.0	82.8	79.8-85.8	55.4	53.3-57.5
P for trend	-	-	<0.001**	-	0.708	-
NSTEMI						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
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	7953	73.5	238.3	233.1-243.5	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	9396	74.3	273.5	268.0-279.1	166.0	162.6-169.5
2020	8364	71.6	242.0	236.8-247.2	143.4	140.3-146.6
2021	9158	73.6	268.6	263.1-274.1	153.8	150.5-157.1
2022	9697	73.8	277.7	272.2-283.3	153.9	150.7-157.1
P for trend	-	-	<0.001**	-	0.739	-

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



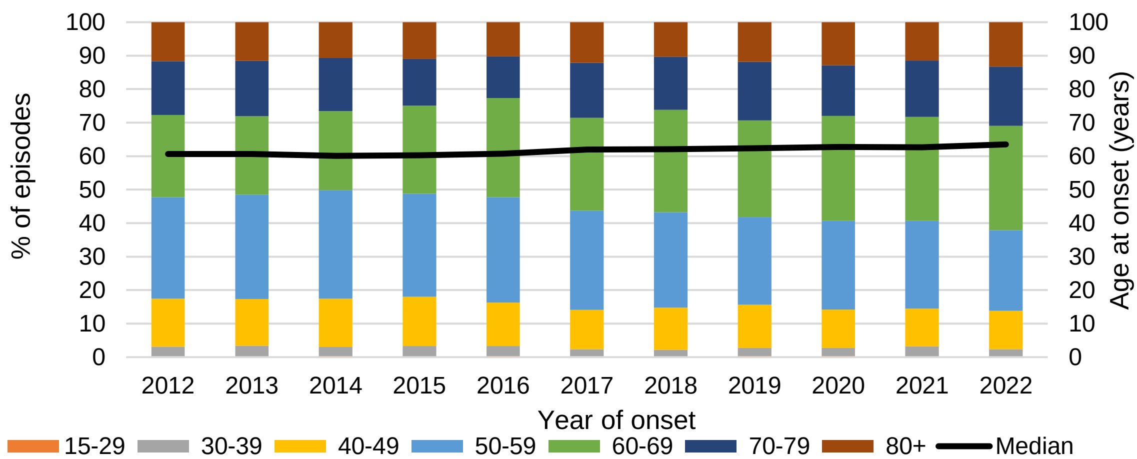
The median age at onset of STEMI increased from 60.7 years in 2012 to 63.5 years in 2022 (p<0.001) (Table 5.1.9a). Every year, more than half of STEMI patients were aged 50-69 years at onset (55.2% in 2022) (Figure 5.1.9a); the percentage of STEMI patients aged 60 years and above had also increased from about 52% in 2012 to 62% in 2022.

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	%
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
2022	63.5	3	0.1	64	2.2	333	11.5

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	26.2	862	31.1	465	16.8	318	11.5
2022	697	24.1	900	31.1	510	17.6	384	13.3

Figure 5.1.9a: Age distribution at onset of STEMI



The median age at onset of NSTEMI increased from 71.7 years in 2012 to 73.5 years in 2022 (p=0.004) (Table 5.1.9b), about 10 years older than the median age at onset of STEMI (Table 5.1.9a). Unlike STEMI, the highest proportion of NSTEMI patients in 2022 was among those aged 80 years and above (33.4%) (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 were more likely to present with NSTEMI than STEMI[19]. This trend of NSTEMI patients being older is generally consistent internationally[20].

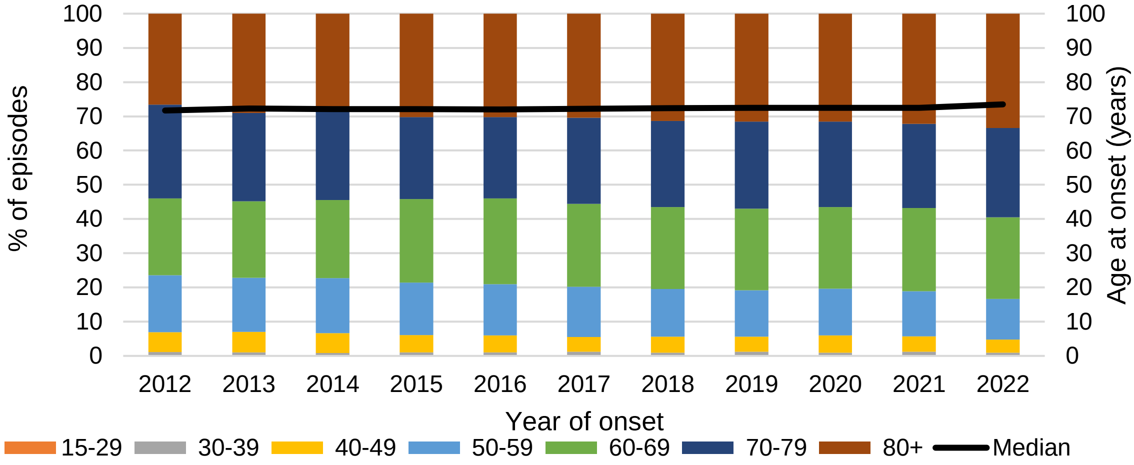
Table 5.1.9b: Age distribution at onset of NSTEMI

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
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
2022	73.5	6	0.1	84	0.9	375	3.9

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1891	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	1273	13.5	2245	23.9	2388	25.4	2964	31.5
2020	1146	13.7	1995	23.9	2088	25.0	2635	31.5
2021	1207	13.2	2231	24.4	2248	24.5	2952	32.2
2022	1147	11.8	2315	23.9	2534	26.1	3236	33.4

[19] Dai X et al. Acute coronary syndrome in older adults. Journal of Geriatric Cardiology; 2016:13. 101-108.
[20] 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



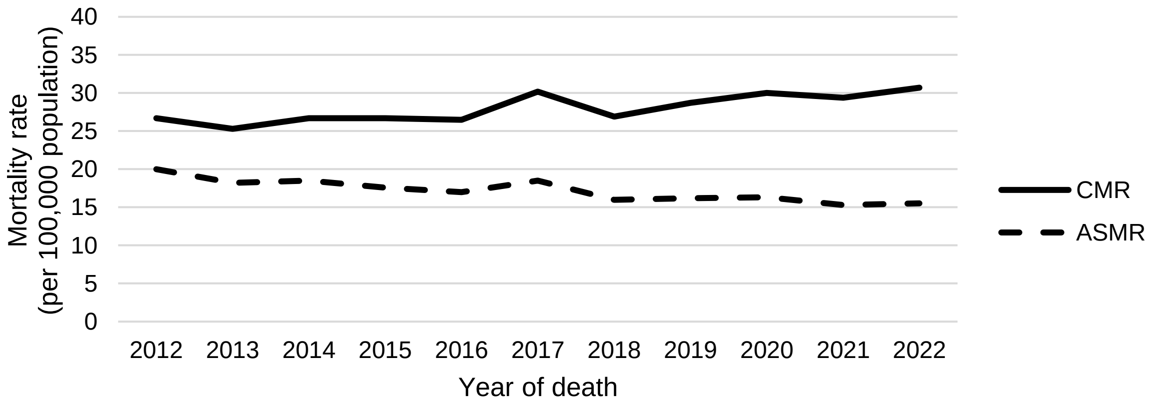
5.2 Mortality

The number of AMI deaths increased by about 25% from 853 in 2012 to 1,073 in 2022 (Table 5.2.1), a comparatively less drastic rise than the number of AMI episodes from 9,124 to 13,137 during the same period (Table 5.1.1). Overall, the crude mortality rate (CMR) increased from 26.7 to 30.7 per 100,000 population in the past decade (Figure 5.2.1). However, the increase in CMR is due in part to population ageing, as there was a significant drop in ASMR from 20.0 per 100,000 population in 2012 to 15.5 per 100,000 population in 2022 ($p<0.001$). This decreasing trend in ASMR was likely due to the higher rates of revascularisation and pharmacotherapy over the years[21,22,23,24].

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

Year of death	Number	CMR	95% CI	ASMR	95% CI
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	1002	29.4	27.6-31.2	15.3	14.3-16.3
2022	1073	30.7	28.9-32.6	15.5	14.5-16.4
P for trend	-	0.002**	-	<0.001**	-

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



[21] Aronow, H.D and Bavashi, C. Mechanical Complications in Acute Myocardial Infarction. JACC Cardiovascular Interventions; 2019:12(18).
[22] 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).
[23] 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.
[24] Laforgia PL et al. The Reduction of Mortality in Acute Myocardial Infarction: From Bed Rest to Future Directions. International Journal of Preventive Medicine 2022.

The median age at death increased from 76.9 years in 2012 to 79.2 years in 2022 ($p<0.001$) (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 2022 were aged 80 years and above (47.7%), compared to 40.1% in 2012 (Figure 5.2.2). As older persons are less likely to survive an AMI compared to those who are younger[25], individuals aged 80 years and above comprised a substantially larger proportion of AMI deaths vis-à-vis AMI incidence (about 23%-29%) (Table 5.1.2). Other possible reasons for poorer outcomes among older AMI patients include delayed treatment seeking due to atypical presenting symptoms, and preclusion from coronary reperfusion therapy due to a greater prevalence of comorbidities related to advanced age[26,27].

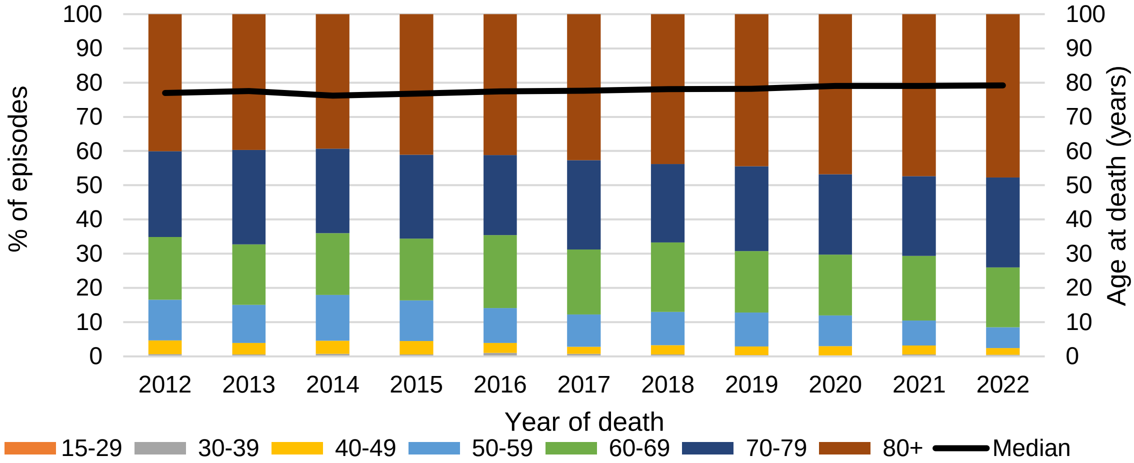
Table 5.2.2: Age distribution at death of AMI

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
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
2022	79.2	1	0.1	4	0.4	21	2.0

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	73	7.3	189	18.9	234	23.4	474	47.3
2022	65	6.1	188	17.5	282	26.3	512	47.7

[25] Mangion K et al. Survival in the elderly after acute myocardial infarction: room for more improvement. Age and Ageing 2014; 43: 739–740.
[26] Ibid.
[27] Carro A, Kaski JC. Myocardial Infarction in the Elderly. Aging and Disease. 2011;2(1): 116-137

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 (Figures 5.2.3a and 5.2.3b). Significant drops in mortality rates were seen in those aged 50-79 years (Table 5.2.3).

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

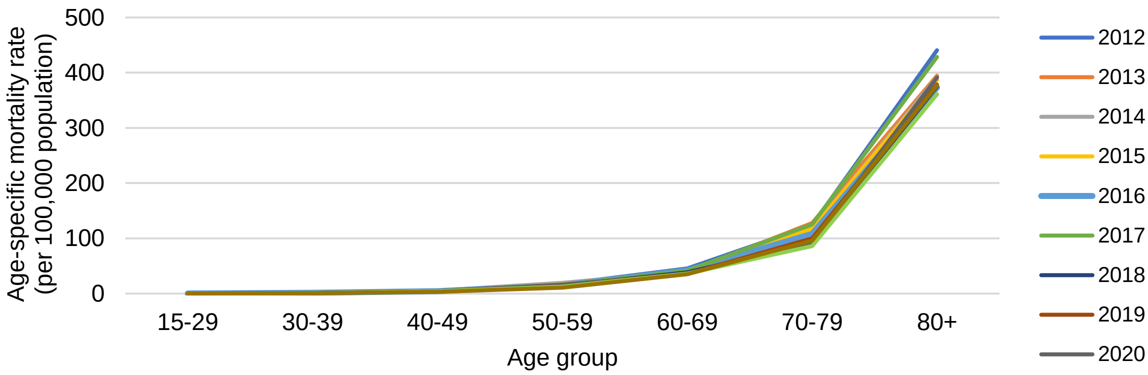


Figure 5.2.3b: Age-specific mortality rate of AMI (per 100,000 population) across age groups

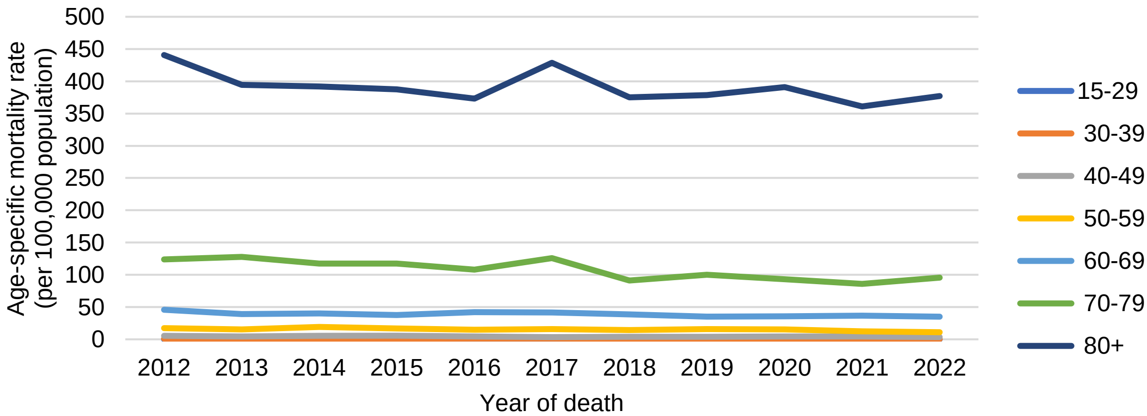


Table 5.2.3: Age-specific mortality rate of AMI (per 100,000 population)

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
2012	26.7	24.9-28.5	0.1	0.1-0.4	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	0.1-0.4	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	0.1-0.6	1.2	0.3-2.1	4.2	2.6-5.9
2017	30.2	28.3-32.1	0.1	0.1-0.4	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	0.1-1.1	4.6	2.9-6.3
2021	29.4	27.6-31.2	0.0	0.0-0.0	1.0	0.2-1.8	4.4	2.7-6.1
2022	30.7	28.9-32.6	0.1	0.1-0.4	0.7	0.0-1.3	3.5	2.0-5.0
P for trend	0.002**	-	0.962	-	0.400	-	0.062	-

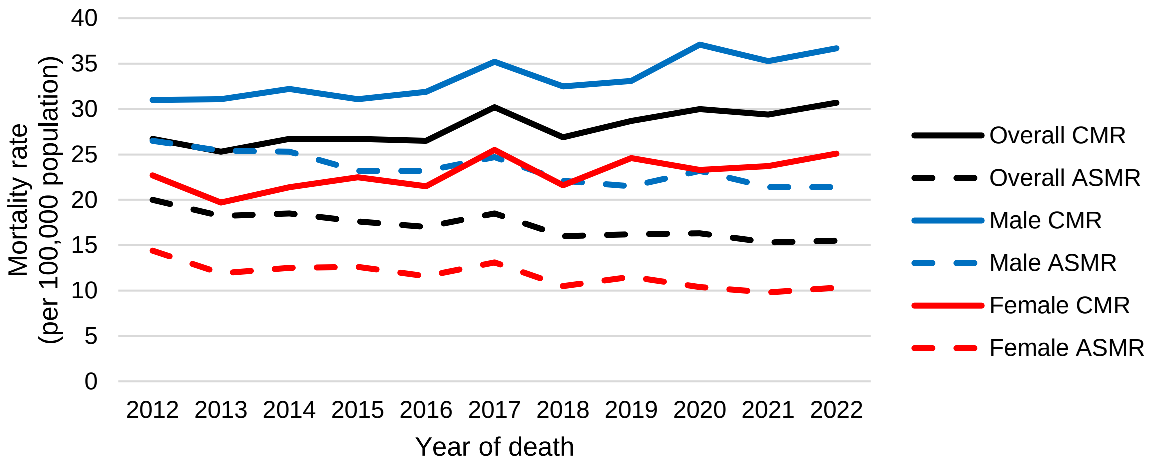
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2012	17.3	14.0-20.7	45.8	38.6-53.0	123.8	107.2-140.5	440.7	394.0-487.4
2013	15.3	12.2-18.5	39.1	32.7-45.5	127.8	111.1-144.5	394.6	351.7-437.6
2014	19.2	15.7-22.7	40.0	33.7-46.2	117.4	101.7-133.1	391.8	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	12.5	9.6-15.4	36.5	31.3-41.7	85.9	74.9-96.9	361.0	328.5-393.5
2022	11.0	8.3-13.6	35.1	30.1-40.1	95.8	84.6-107.0	376.9	344.3-409.6
P for trend	0.007**	-	0.004**	-	0.001**	-	0.052	-

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 2022, the ASMR of AMI in males was 21.4 per 100,000 population, while females had an ASMR of 10.3 per 100,000 population. The ASMR had dropped significantly over the years for both males and females ($p<0.001$, $p=0.001$) (Figure 5.2.4).

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

Male						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2012	483	56.6	31.0	28.2-33.7	26.5	24.1-28.9
2013	490	60.0	31.1	28.3-33.8	25.4	23.1-27.7
2014	513	59.0	32.2	29.4-35.0	25.3	23.1-27.5
2015	500	56.8	31.1	28.3-33.8	23.2	21.1-25.2
2016	518	58.5	31.9	29.1-34.6	23.2	21.1-25.2
2017	577	56.7	35.2	32.3-38.0	24.7	22.6-26.7
2018	538	58.8	32.5	29.8-35.3	22.1	20.2-24.0
2019	552	56.0	33.1	30.3-35.9	21.5	19.7-23.3
2020	622	60.0	37.1	34.2-40.0	23.2	21.3-25.0
2021	586	58.5	35.3	32.5-38.2	21.4	19.6-23.1
2022	622	58.0	36.7	33.9-39.6	21.4	19.7-23.2
P for trend	-	-	0.001**	-	<0.001**	-
Female						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2012	370	43.4	22.7	20.4-25.0	14.4	12.8-15.9
2013	326	40.0	19.7	17.6-21.9	11.9	10.6-13.3
2014	357	41.0	21.4	19.2-23.6	12.5	11.1-13.8
2015	381	43.2	22.5	20.3-24.8	12.6	11.2-13.9
2016	368	41.5	21.5	19.3-23.7	11.6	10.3-12.8
2017	441	43.3	25.5	23.1-27.9	13.1	11.8-14.3
2018	377	41.2	21.6	19.4-23.7	10.5	9.4-11.6
2019	434	44.0	24.6	22.2-26.9	11.5	10.4-12.6
2020	414	40.0	23.3	21.0-25.5	10.4	9.3-11.4
2021	416	41.5	23.7	21.5-26.0	9.8	8.8-10.8
2022	451	42.0	25.1	22.8-27.4	10.3	9.3-11.3
P for trend	-	-	0.032*	-	0.001**	-

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



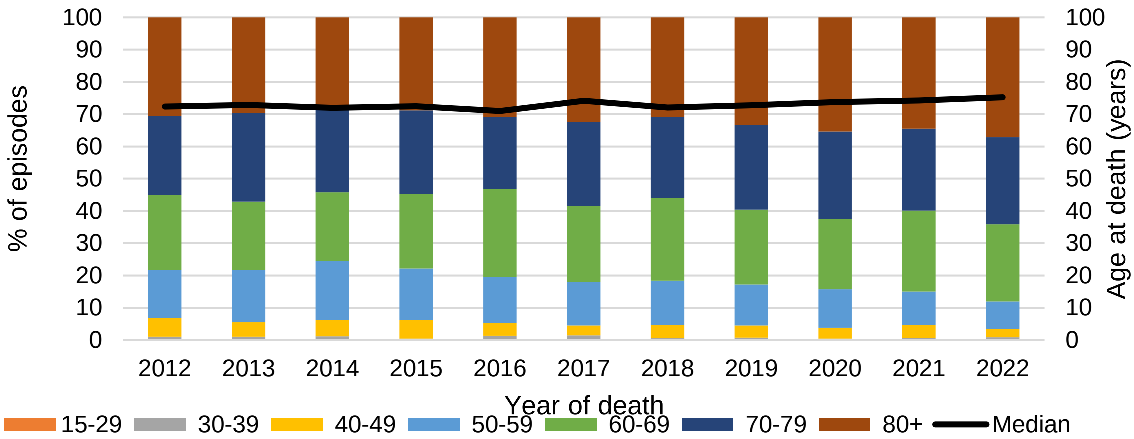
There was an overall increase in the median age at AMI death among males from 72.4 years in 2012 to 75.2 years in 2022 (p=0.03) (Table 5.2.5a). In 2022, those aged 80 years and above accounted for the highest percentage of male AMI deaths at 37.1% (or nearly 2 in 5), compared to 30.6% in 2012 (Figure 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	%
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
2022	75.2	1	0.2	4	0.6	16	2.6
Year of death	**Age 50-59**		**Age 60-69**		**Age 70-79**		**Age 80+**
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	61	10.4	147	25.1	149	25.4	202	34.5
2022	53	8.5	149	24.0	168	27.0	231	37.1

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



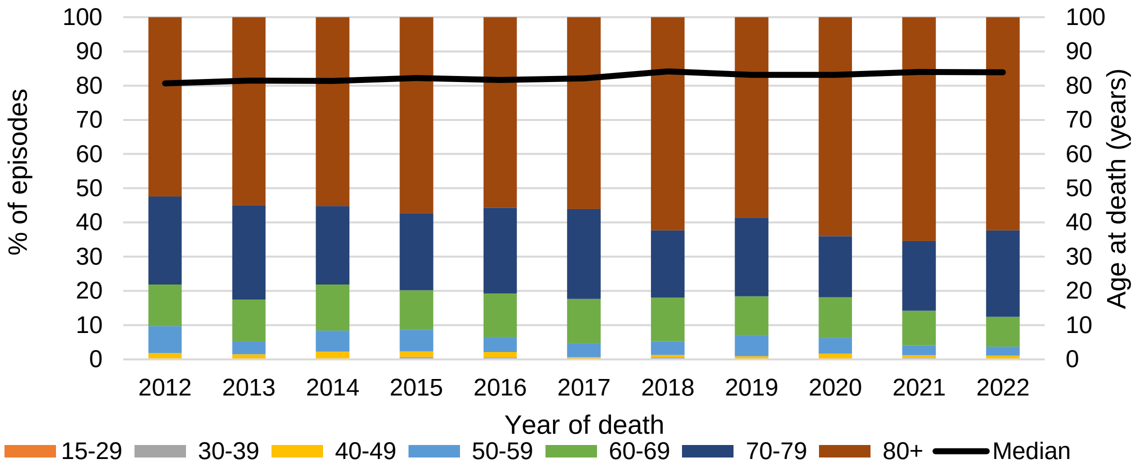
Like the median age at onset of AMI (Tables 5.1.5a and 5.1.5b), females had an older median age at death than males, increasing from 80.6 years in 2012 to 83.9 years in 2022 ($p<0.001$) (Table 5.2.5b). As with males, those aged 80 years and above comprised the largest proportion of female AMI deaths (62.3%), and the corresponding proportion each year was nearly twice that among males in the oldest age band (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	%
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	84.0	0	0.0	2	0.5	3	0.7
2022	83.9	0	0.0	0	0.0	5	1.1

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	85	20.4	272	65.4
2022	12	2.7	39	8.6	114	25.3	281	62.3

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



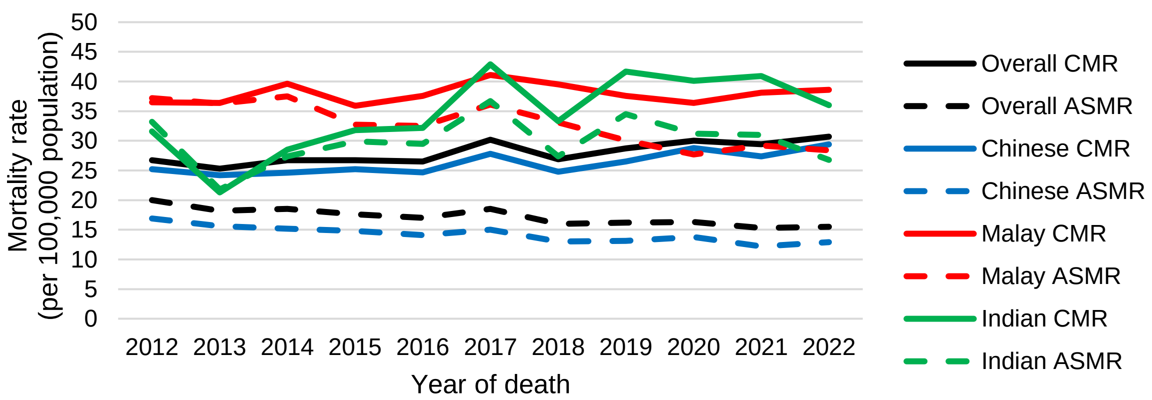
The Chinese consistently had the lowest ASIR of AMI among the different ethnic groups across the years (Table 5.1.6); likewise, they consistently had the lowest ASMR (Table 5.2.6). The ASMR among the Chinese (12.9 per 100,000 population) was lower than the ASMR among Malays (28.4 per 100,000 population) and Indians (26.8 per 100,000 population) in 2022. The ASMR showed a significant downward trend over the years for Chinese ($p<0.001$) and Malays ($p<0.001$) but not for Indians ($p=0.558$) (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**
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	705	70.4	27.4	25.4-29.4	12.2	11.3-13.2
2022	773	72.0	29.4	27.3-31.5	12.9	12.0-13.9
P for trend	-	-	0.003**	-	<0.001**	-

Malay						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2012	147	17.2	36.5	30.6-42.4	37.2	31.0-43.5
2013	149	18.3	36.4	30.6-42.3	36.3	30.3-42.3
2014	164	18.9	39.6	33.5-45.6	37.5	31.6-43.4
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	177	17.4	41.1	35.0-47.1	36.1	30.7-41.5
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	29.2	24.7-33.7
2022	173	16.1	38.6	32.9-44.4	28.4	24.1-32.7
P for trend	-	-	0.463	-	<0.001**	-
Indian						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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	120	12.0	40.9	33.6-48.2	31.0	25.4-36.6
2022	110	10.3	36.0	29.3-42.7	26.8	21.8-31.8
P for trend	-	-	0.014*	-	0.558	-

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



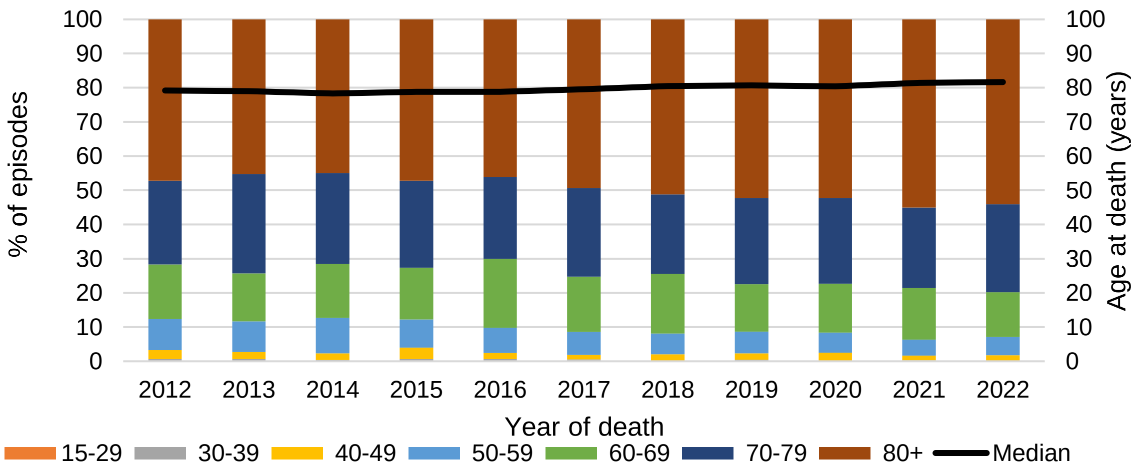
Similar to the median age at onset of AMI (Tables 5.1.7a to 5.1.7c), the Chinese had the oldest median age at death, which increased from 79.2 years in 2012 to 81.7 years in 2022 ($p<0.001$) (Table 5.2.7a). Those aged 80 years and above made up the highest proportion of AMI deaths among the Chinese, increasing from 47.2% in 2012 to 54.1% in 2022 (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	%
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
2022	81.7	1	0.1	0	0.0	13	1.7

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	33	4.7	106	15.0	166	23.5	388	55.0
2022	41	5.3	101	13.1	199	25.7	418	54.1

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

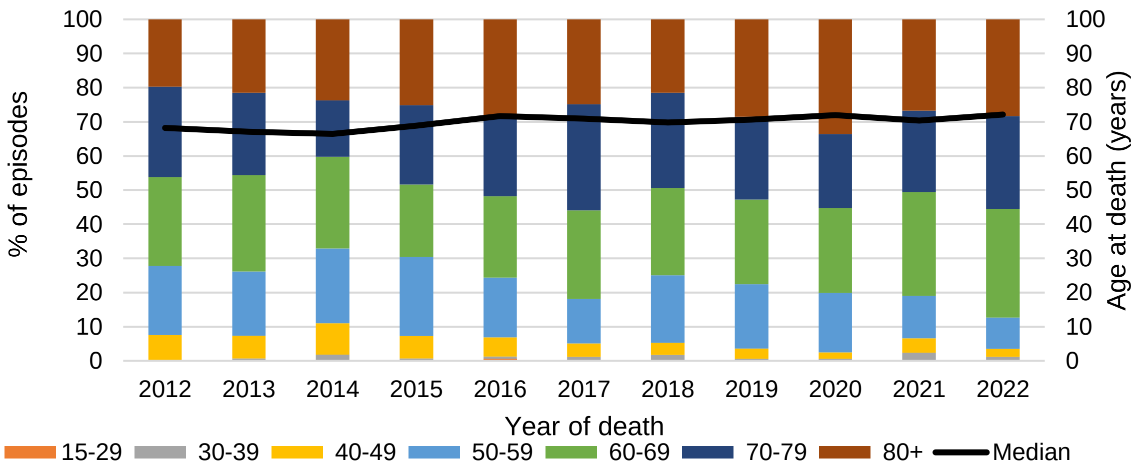


The median age at death among Malay AMI patients was about 10 years younger than that for the Chinese, increasing from 68.2 years to 72.1 years over the past decade (p=0.004) (Table 5.2.7b). The highest proportion of Malays who died of AMI in 2022 was among those aged 60-69 years (31.8%) (Figure 5.2.7b).

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	%
2012	68.2	0	0.0	0	0.0	11	7.5
2013	67.0	0	0.0	1	0.7	10	6.7
2014	66.5	0	0.0	3	1.8	15	9.1
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	70.9	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	70.3	0	0.0	4	2.4	7	4.2
2022	72.1	0	0.0	2	1.2	4	2.3
Year of death	**Age 50-59**		**Age 60-69**		**Age 70-79**		**Age 80+**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
2012	30	20.4	38	25.9	39	26.5	29	19.7
2013	28	18.8	42	28.2	36	24.2	32	21.5
2014	36	22.0	44	26.8	27	16.5	39	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	13.0	46	26.0	55	31.1	44	24.9
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	45	26.8
2022	16	9.2	55	31.8	47	27.2	49	28.3

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



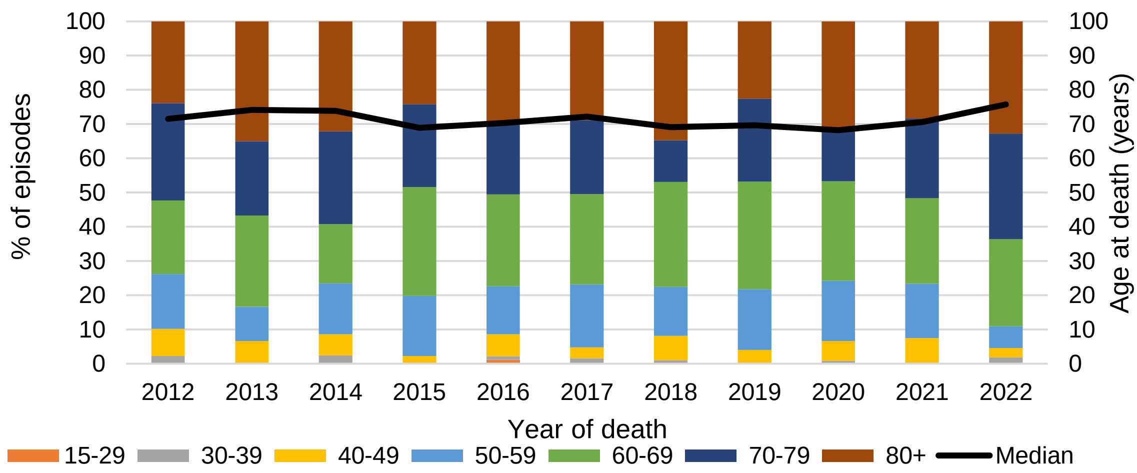
The median age at death among Indian AMI patients ranged between 68.2 and 75.8 years in the past decade (p=0.737) (Table 5.2.7c). Those aged 80 years and above comprised the largest group of AMI deaths among Indians in 2022 (32.7%) (Figure 5.2.7c).

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	%
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	70.6	0	0.0	0	0.0	9	7.5
2022	75.8	0	0.0	2	1.8	3	2.7

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	15.8	30	25.0	28	23.3	34	28.3
2022	7	6.4	28	25.5	34	30.9	36	32.7

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



The incidence numbers and ASIRs of NSTEMI were consistently higher than those of 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 NSTEMI dropped significantly from 7.3 in 2012 to 5.5 per 100,000 population in 2022 (p=0.004), while the ASMR for STEMI remained relatively unchanged at 4.9 per 100,000 population in 2012 and 4.6 per 100,000 population in 2022 (p=0.223). 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[28].

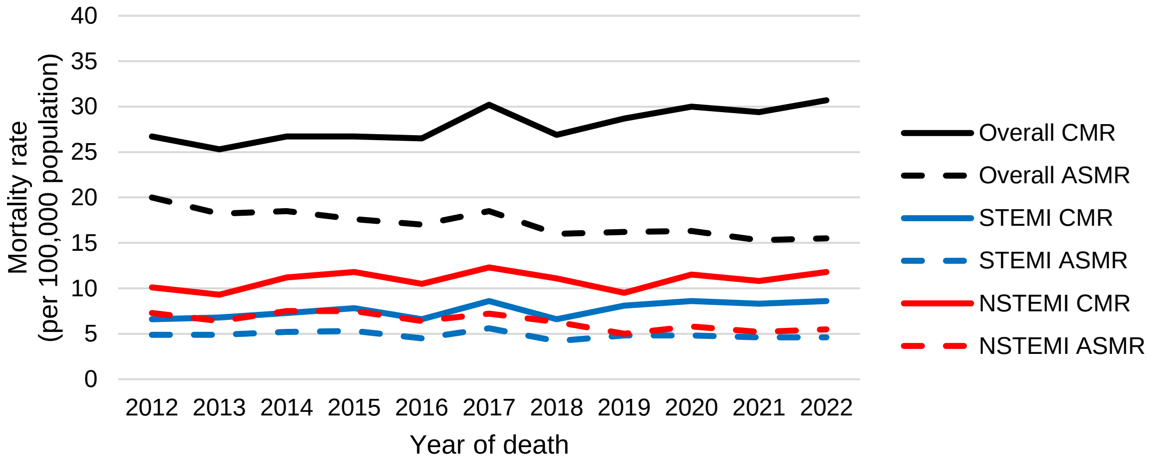
As the percentages in Table 5.2.8 are among all AMI and patients without documentation of STEMI or NSTEMI are not shown, the sum of the percentages for STEMI and NSTEMI are less than 100% for each year. Figures for overall CMR and ASMR include cases of unknown etiology.

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

STEMI						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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
2019	277	28.1	8.1	7.1-9.0	4.8	4.2-5.4
2020	296	28.6	8.6	7.6-9.5	4.8	4.3-5.4
2021	282	28.1	8.3	7.3-9.2	4.6	4.1-5.2
2022	301	28.1	8.6	7.6-9.6	4.6	4.1-5.2
P for trend	-	-	0.015*	-	0.223	-
NSTEMI						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2012	322	37.7	10.1	9.0-11.2	7.3	6.5-8.1
2013	300	36.8	9.3	8.2-10.3	6.4	5.7-7.2
2014	367	42.2	11.2	10.1-12.4	7.5	6.8-8.3
2015	390	44.3	11.8	10.6-13.0	7.5	6.8-8.3
2016	350	39.5	10.5	9.4-11.6	6.4	5.7-7.1
2017	414	40.7	12.3	11.1-13.5	7.2	6.5-7.9
2018	378	41.3	11.1	10.0-12.2	6.3	5.6-6.9
2019	326	33.1	9.5	8.5-10.5	5.0	4.4-5.5
2020	398	38.4	11.5	10.4-12.6	5.8	5.2-6.4
2021	369	36.8	10.8	9.7-11.9	5.2	4.6-5.7
2022	411	38.3	11.8	10.6-12.9	5.5	5.0-6.1
P for trend	-	-	0.280	-	0.004**	-

[28] Dai X et al. Acute coronary syndrome in older adults. Journal of Geriatric Cardiology; 2016:13. 101-108.

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

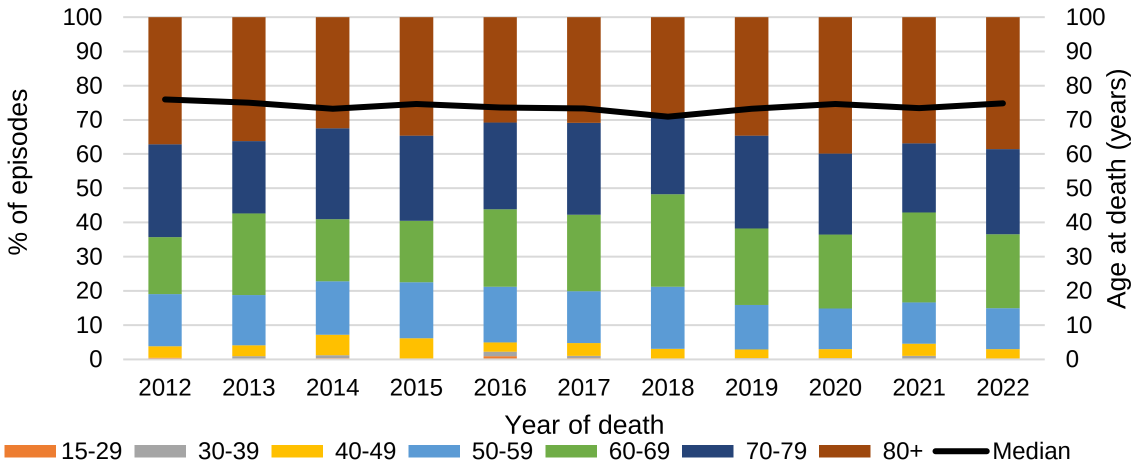


The median age at death among STEMI patients ranged between 70.9 and 76.0 years in the past decade (p=0.345) (Table 5.2.9a). The highest proportion of STEMI patients who died of AMI in 2022 was among those aged 80 years and above (38.5%) – this pattern had been consistent since 2012 (Figure 5.2.9a).

Table 5.2.9a: Age distribution at death of STEMI

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2012	76.0	1	0.5	0	0.0	7	3.3
2013	75.0	0	0.0	2	0.9	7	3.2
2014	73.3	1	0.4	2	0.8	14	5.9
2015	74.6	0	0.0	0	0.0	16	6.2
2016	73.6	2	0.9	3	1.4	6	2.7
2017	73.3	1	0.3	2	0.7	11	3.8
2018	70.9	0	0.0	0	0.0	7	3.1
2019	73.2	0	0.0	1	0.4	7	2.5
2020	74.6	0	0.0	1	0.3	8	2.7
2021	73.4	0	0.0	3	1.1	10	3.5
2022	74.8	0	0.0	0	0.0	9	3.0
Year of death	**Age 50-59**		**Age 60-69**		**Age 70-79**		**Age 80+**	
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
2012	32	15.2	35	16.7	57	27.1	78	37.1
2013	32	14.7	52	23.9	46	21.1	79	36.2
2014	37	15.6	43	18.1	63	26.6	77	32.5
2015	42	16.3	46	17.9	64	24.9	89	34.6
2016	36	16.3	50	22.6	56	25.3	68	30.8
2017	44	15.1	65	22.3	78	26.8	90	30.9
2018	41	18.1	61	27.0	52	23.0	65	28.8
2019	36	13.0	62	22.4	75	27.1	96	34.7
2020	35	11.8	64	21.6	70	23.6	118	39.9
2021	34	12.1	74	26.2	57	20.2	104	36.9
2022	36	12.0	65	21.6	75	24.9	116	38.5

Figure 5.2.9a: Age distribution at death of STEMI



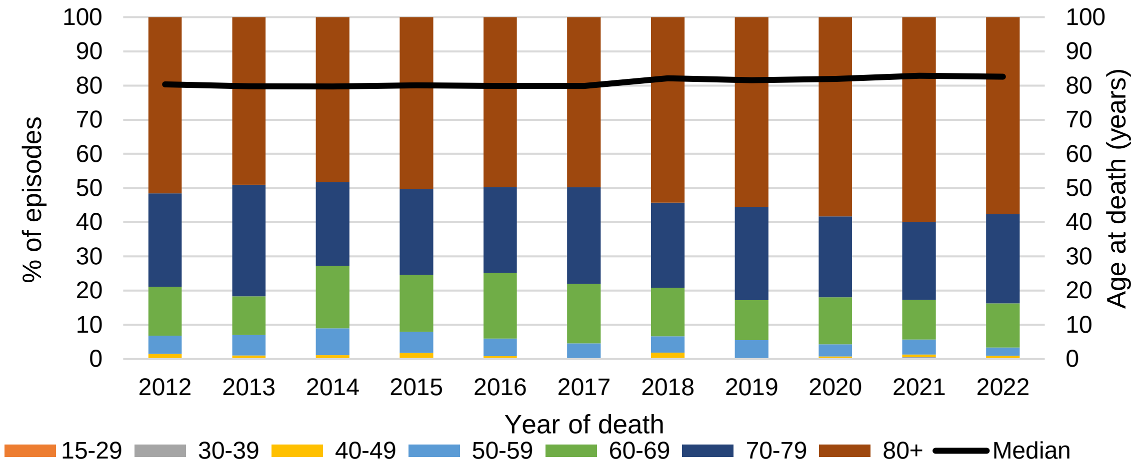
Like the median age at onset (Tables 5.1.9a and 5.1.9b), NSTEMI patients had an older median age at death than STEMI patients, increasing from 80.3 years to 82.5 years in the past decade (Table 5.2.9b). Those aged 80 years and above made up the largest proportion of NSTEMI deaths in 2022 (57.7%) (Figure 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	%
2012	80.3	0	0.0	0	0.0	5	1.6
2013	79.8	0	0.0	0	0.0	3	1.0
2014	79.7	0	0.0	0	0.0	4	1.1
2015	80.0	0	0.0	1	0.3	6	1.5
2016	79.9	0	0.0	1	0.3	2	0.6
2017	79.8	0	0.0	1	0.2	0	0.0
2018	82.1	0	0.0	1	0.3	6	1.6
2019	81.6	0	0.0	0	0.0	0	0.0
2020	81.9	0	0.0	0	0.0	3	0.8
2021	82.9	0	0.0	2	0.5	3	0.8
2022	82.5	0	0.0	0	0.0	4	1.0

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	4.3	43	11.7	84	22.8	221	59.9
2022	10	2.4	53	12.9	107	26.0	237	57.7

Figure 5.2.9b: Age distribution at death of NSTEMI



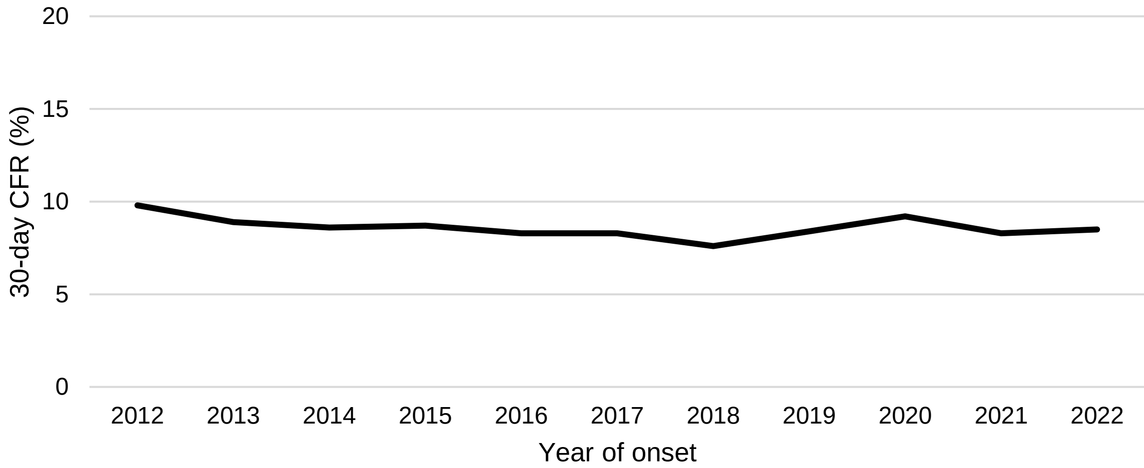
5.3 30-day Case Fatality

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). The CFR remained similar over the years, at 9.8% in 2012 and 8.5% in 2022 (p=0.179) (Figure 5.3.1).

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

Year of onset	Number	CFR	95% CI
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	998	9.2	8.6-9.8
2021	963	8.3	7.8-8.9
2022	1029	8.5	8.0-9.0
P for trend	-	0.179	-

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



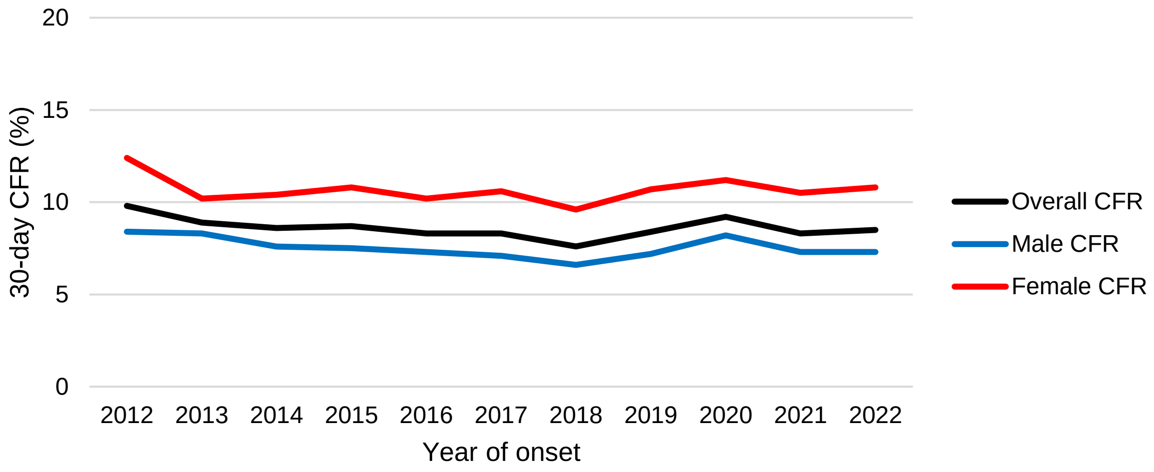
Although the ASMRs of AMI for males were consistently higher than females across the years (Table 5.2.4), the 30-day CFRs for males were consistently lower than females (Table 5.3.2). In 2022, the CFR was 7.3% for males, and about 1.5 times higher at 10.8% for females. As females tended to have AMI at an older age than males (Tables 5.1.5a and 5.1.5b), they were likely to have more co-morbidities at AMI onset, 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[29]. Other possible reasons include delayed treatment seeking in females due to more atypical presentation of symptoms[30]. The decline in CFR was not significant for both males and females over the years (p=0.137, p=0.551) (Figure 5.3.2).

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

Male				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2012	469	56.8	8.4	7.6-9.2
2013	474	60.2	8.3	7.5-9.0
2014	455	58.0	7.6	6.9-8.3
2015	465	56.6	7.5	6.8-8.2
2016	488	58.3	7.3	6.7-8.0
2017	521	56.4	7.1	6.4-7.7
2018	495	58.3	6.6	6.0-7.2
2019	548	56.4	7.2	6.6-7.8
2020	599	60.0	8.2	7.6-8.9
2021	568	59.0	7.3	6.7-7.9
2022	593	57.6	7.3	6.7-7.9
P for trend	-	-	0.137	-
Female				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2012	357	43.2	12.4	11.1-13.6
2013	314	39.8	10.2	9.0-11.3
2014	330	42.0	10.4	9.3-11.6
2015	356	43.4	10.8	9.7-12.0
2016	349	41.7	10.2	9.1-11.2
2017	402	43.6	10.6	9.6-11.7
2018	354	41.7	9.6	8.6-10.6
2019	423	43.6	10.7	9.7-11.7
2020	399	40.0	11.2	10.1-12.3
2021	395	41.0	10.5	9.4-11.5
2022	436	42.4	10.8	9.8-11.8
P for trend	-	-	0.551	-

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



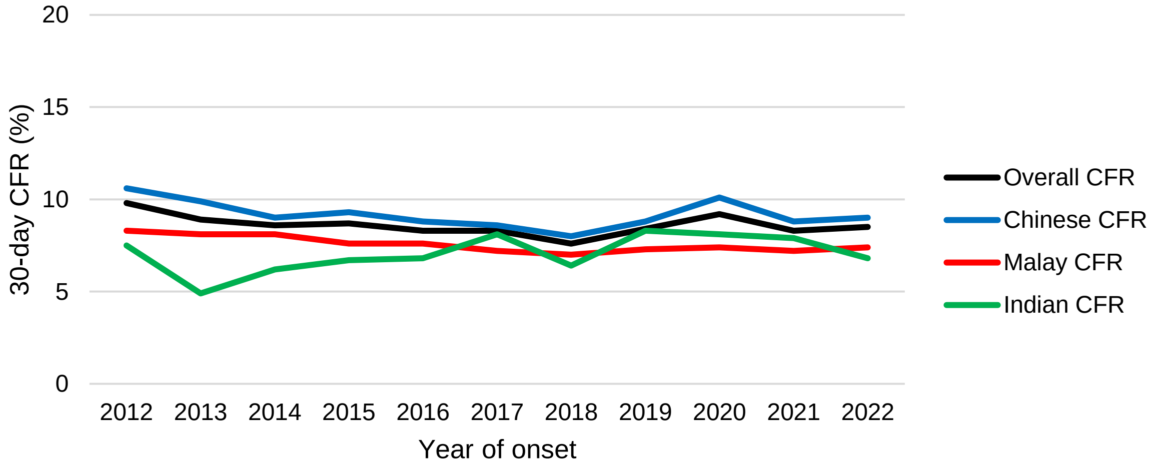
Although Chinese generally had the lowest ASMR (Table 5.2.6), they had the highest 30-day CFR across the years (Table 5.3.3). The CFRs were 9.0%, 7.4% and 6.8% for Chinese, Malays, and Indians respectively in 2022. This was likely due to Chinese being oldest at the onset of AMI (Tables 5.1.7a to 5.1.7c). The CFR fell significantly over the years for Malays (p=0.003), but not the Chinese (p=0.187) and Indians (p=0.118) (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**
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	725	72.6	10.1	9.3-10.8
2021	675	70.1	8.8	8.1-9.5
2022	740	71.9	9.0	8.4-9.7
P for trend	-	-	0.187	-

Malay				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2012	141	17.1	8.3	7.0-9.7
2013	140	17.8	8.1	6.8-9.4
2014	143	18.2	8.1	6.8-9.5
2015	140	17.1	7.6	6.3-8.8
2016	152	18.2	7.6	6.4-8.8
2017	150	16.3	7.2	6.0-8.3
2018	149	17.6	7.0	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	162	16.8	7.2	6.1-8.4
2022	169	16.4	7.4	6.3-8.6
P for trend	-	-	0.003**	-
Indian				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
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	6.6-9.5
2021	117	12.1	7.9	6.4-9.3
2022	104	10.1	6.8	5.5-8.1
P for trend	-	-	0.118	-

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 10.5% and 4.2% for STEMI and NSTEMI patients respectively in 2022. 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[31]. While the CFR for STEMI patients fluctuated over the years (p=0.308), it fell significantly for NSTEMI patients (p=0.041) (Figure 5.3.4).

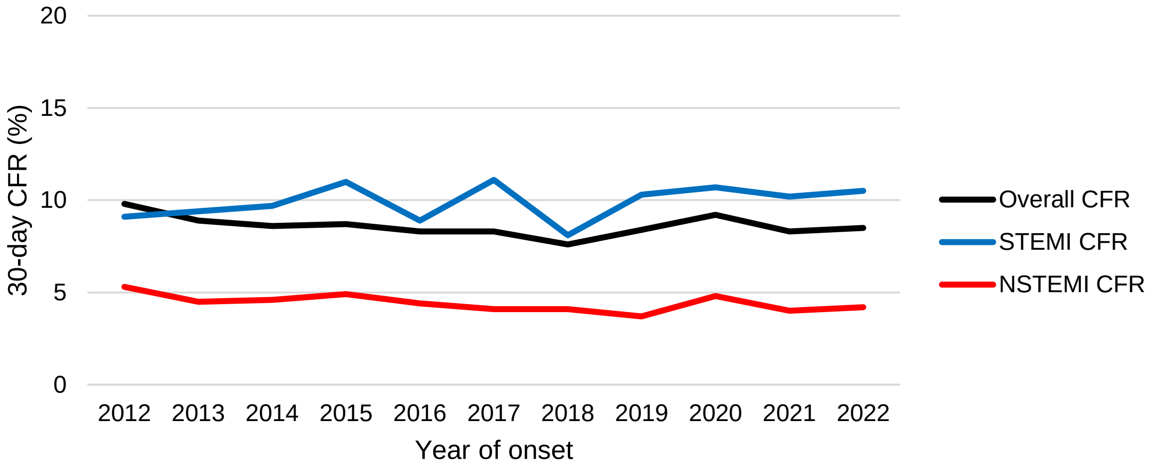
As the percentages in Table 5.3.4 are among all AMI and patients without documentation of STEMI or NSTEMI are not shown, the sum of the percentages for STEMI and NSTEMI are less than 100% for each year. Figures for overall CFR include cases of unknown etiology.

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

STEMI				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
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	276	28.7	10.2	9.0-11.4
2022	295	28.7	10.5	9.3-11.7
P for trend	-	-	0.308	-
NSTEMI				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
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	363	36.4	4.8	4.3-5.3
2021	336	34.9	4.0	3.6-4.5
2022	370	36.0	4.2	3.8-4.6
P for trend	-	-	0.041*	-

[31] 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

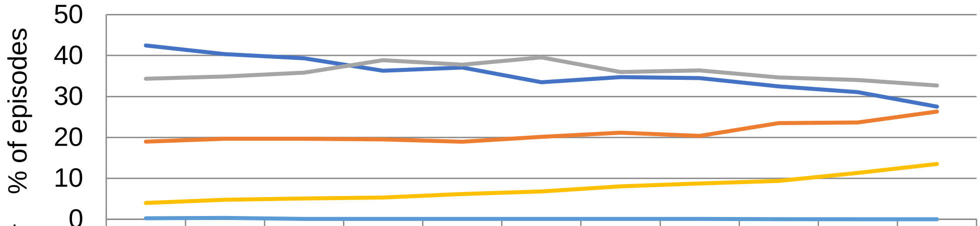


5.4 Symptoms

Clinical presentation has consequences on patient recognition of symptoms, triage categorisation, prescription of diagnostic tests, and disease management[32]. 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, or cases of collapse/unresponsiveness. 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 from 42.5% in 2012 to 27.5% in 2022 (Figure 5.4.1). Conversely, the proportion of patients experiencing symptoms that were non-typical increased by about 40% over the years, from 19.0% in 2012 to 26.3% in 2022. Similarly, those with no symptom increased from 4.0% to 13.5% 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 32.7% to 39.6%.

Figure 5.4.1: Type of symptoms (%)



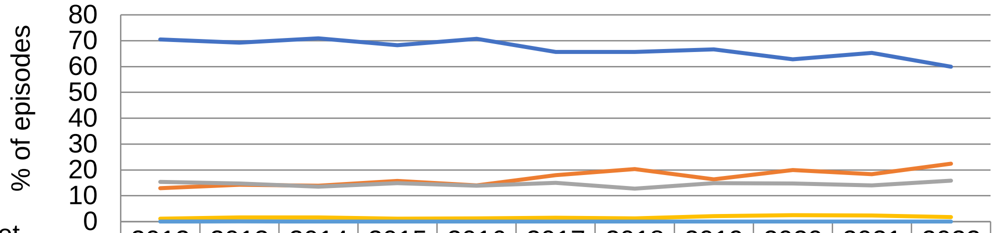
Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Typical	42.5	40.4	39.4	36.3	37.1	33.5	34.8	34.5	32.5	31.0	27.5
Atypical	19.0	19.6	19.7	19.5	18.9	20.1	21.2	20.4	23.5	23.7	26.3
Others	34.3	34.9	35.8	38.9	37.8	39.6	36.0	36.3	34.7	34.0	32.7
None	4.0	4.8	5.1	5.3	6.1	6.8	8.0	8.8	9.4	11.3	13.5
Insufficient data	0.3	0.3	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.0	0.0

Among STEMI patients, about 60% experienced typical symptoms in 2022 (Figure 5.4.2a). Unlike STEMI patients, less than a fifth (18.5%) of NSTEMI patients experienced typical symptoms in 2022 (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[33]. Additionally, as NSTEMI patients tended to be older, diminished chest pain sensation and cognitive impairment could

[32] Kim Soo-Joong. Global Awareness of Myocardial Infarction Symptoms in General Population. Korean Circulation Journal 2021;51(12): 997-1000.
[33] 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.

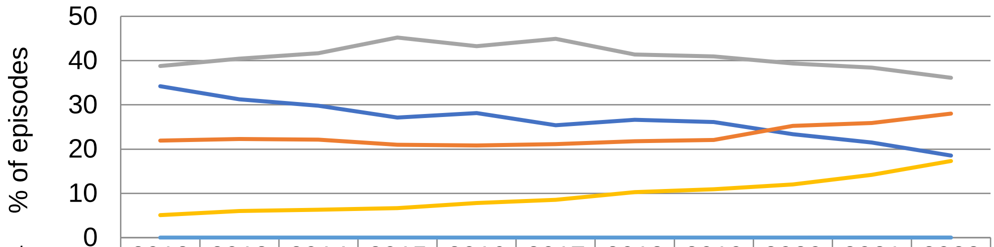
also affect symptom perception, leading to a greater likelihood of presenting with atypical symptoms[34]. The proportion of both STEMI and NSTEMI patients with typical symptoms dropped and that for atypical symptoms rose over the years. STEMI patients were consistently more likely to experience typical symptoms of AMI. Up till 2019, NSTEMI patients were more likely to experience typical AMI symptoms, but the proportion of NSTEMI patients experiencing atypical symptoms exceeded that of patients with typical symptoms from 2020 onwards.

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



Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Typical	70.5	69.3	70.9	68.2	70.7	65.7	65.7	66.7	62.8	65.3	59.9
Atypical	12.9	14.2	13.9	15.8	14.1	17.9	20.3	16.3	20.0	18.3	22.4
Others	15.4	14.8	13.6	14.8	13.9	15.0	12.8	14.9	14.7	14.0	15.8
None	1.1	1.7	1.6	1.1	1.3	1.5	1.2	2.1	2.5	2.4	1.8
Insufficient data	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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



Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Typical	34.2	31.2	29.8	27.1	28.1	25.4	26.6	26.1	23.3	21.5	18.5
Atypical	22.0	22.3	22.2	21.0	20.8	21.1	21.8	22.1	25.3	25.9	28.0
Others	38.8	40.5	41.7	45.2	43.2	44.9	41.4	40.9	39.4	38.4	36.1
None	5.1	6.0	6.3	6.7	7.8	8.5	10.2	10.9	12.0	14.2	17.3
Insufficient data	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

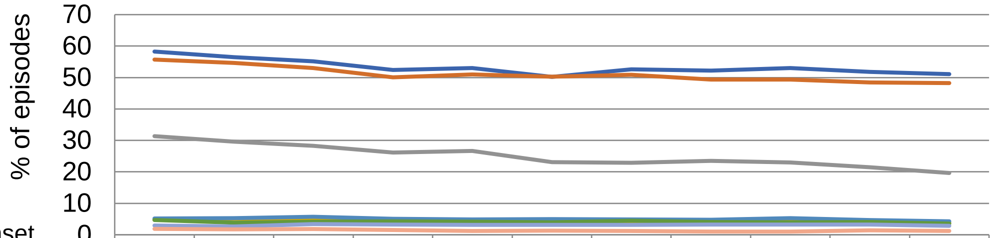
Consistently across the years, the two most common presenting symptoms of AMI were chest pain and breathlessness, with about half of the patients having these symptoms (chest pain: 51.1%, breathlessness: 48.2%) in 2022 (Figure 5.4.3). About a fifth (19.7%) of the patients had diaphoresis (abnormal sweating) in 2022, 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

[34] Carro A, Kaski JC. Myocardial Infarction in the Elderly. Aging and Disease. 2011;2(1): 116-137

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 (%)

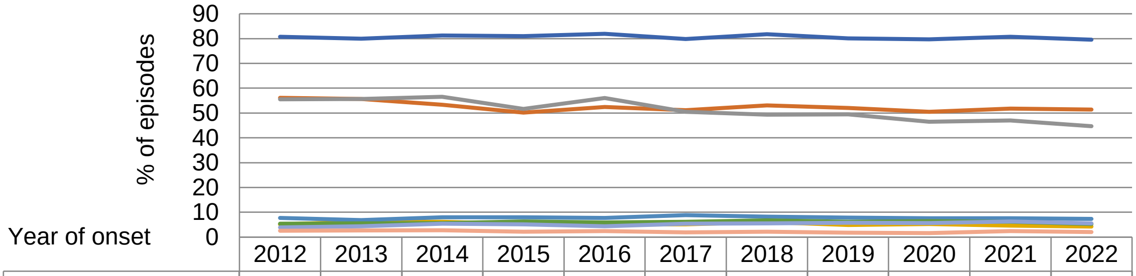


Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Chest pain	58.3	56.4	55.2	52.5	53.0	50.2	52.6	52.2	53.0	51.8	51.1
Breathlessness	55.7	54.7	53.1	50.1	51.0	50.3	50.9	49.4	49.3	48.4	48.2
Diaphoresis	31.4	29.6	28.3	26.2	26.7	23.2	22.9	23.6	23.0	21.4	19.7
Epigastric pain	4.8	5.1	5.2	4.5	4.4	3.9	4.4	3.8	4.4	3.9	3.8
Back pain	5.2	5.3	5.7	5.1	4.9	5.0	4.9	4.8	5.3	4.7	4.3
Shoulder pain	4.7	3.9	4.2	4.3	4.2	3.9	4.4	4.1	4.0	4.1	3.6
Jaw pain	3.0	2.7	3.4	3.3	3.2	3.2	3.2	3.2	3.2	3.3	2.9
Syncope	1.9	1.8	1.8	1.6	1.3	1.3	1.3	1.0	1.1	1.5	1.3

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 2022 (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 from 52.7% in 2012 to 43.8% in 2022. 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[35].

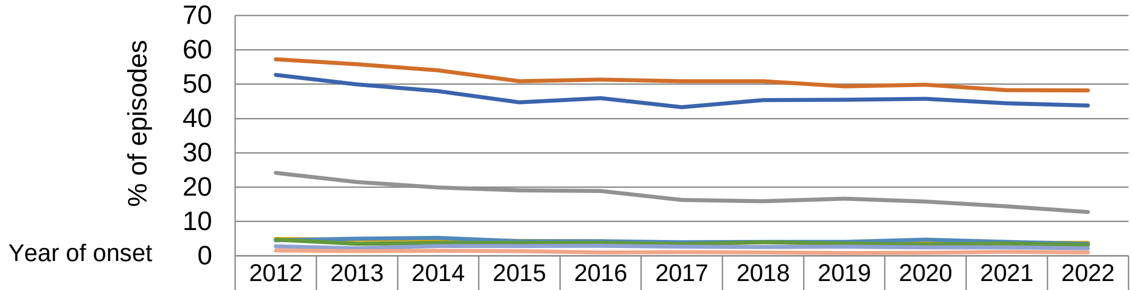
[35] The danger of "silent" heart attacks. Harvard Health Publishing, Harvard Medical School. https://www.health.harvard.edu/heart-health/the-danger-of-silent-heart-attacks Accessed on 5 May 2023.

Figure 5.4.4a: Presenting symptoms (%) among STEMI



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Chest pain	80.7	79.9	81.2	81.0	81.9	79.9	81.8	80.1	79.7	80.7	79.6
Breathlessness	56.1	55.7	53.3	50.2	52.5	51.1	53.1	52.0	50.6	51.8	51.4
Diaphoresis	55.5	55.7	56.6	51.7	56.0	50.5	49.3	49.5	46.5	47.0	44.7
Epigastric pain	5.1	6.2	6.1	5.3	5.0	5.1	6.0	4.9	5.3	4.7	4.3
Back pain	7.7	6.9	7.9	8.0	7.7	8.9	8.2	7.8	7.6	7.6	7.3
Shoulder pain	5.4	5.6	5.7	6.4	5.9	6.2	6.8	6.2	6.5	6.2	5.3
Jaw pain	3.9	4.4	5.4	5.2	4.4	5.4	5.6	5.7	5.7	6.3	5.5
Syncope	2.5	2.8	2.8	2.2	2.4	1.9	2.2	1.8	1.6	2.5	2.0

Figure 5.4.4b: Presenting symptoms (%) among NSTEMI



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Chest pain	52.7	49.9	47.9	44.7	45.9	43.3	45.4	45.5	45.8	44.4	43.8
Breathlessness	57.3	55.8	54.0	50.9	51.3	50.9	50.9	49.3	49.9	48.2	48.2
Diaphoresis	24.2	21.5	19.9	19.1	18.9	16.3	15.9	16.7	15.9	14.4	12.8
Epigastric pain	4.9	4.7	4.9	4.4	4.3	3.5	4.0	3.6	4.3	3.8	3.8
Back pain	4.6	5.0	5.3	4.3	4.3	4.0	4.0	4.1	4.7	4.1	3.5
Shoulder pain	4.7	3.5	3.8	3.8	3.8	3.4	3.9	3.6	3.3	3.6	3.2
Jaw pain	2.8	2.2	2.9	2.8	2.9	2.7	2.6	2.7	2.5	2.5	2.2
Syncope	1.6	1.4	1.5	1.4	1.0	1.1	1.0	0.8	0.9	1.2	1.0

5.5 Risk Factors

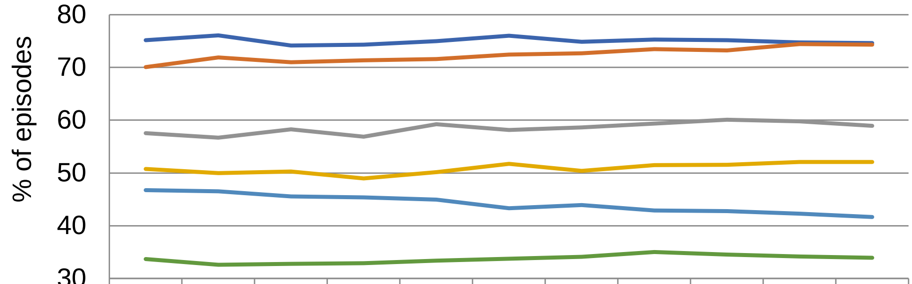
Hypertension, hyperlipidaemia, Type 2 diabetes, obesity, and smoking have been identified as the five main modifiable risk factors of cardiovascular diseases (CVD), including AMI. The increasing prevalence of hypertension, high blood cholesterol, and high BMI could partly explain the rise in crude incidence of AMI[36]. In 2019, CVD accounted for about 80% of the total societal costs (in the form of healthcare costs and productivity losses) attributed to the trio of metabolic risk factors (high blood pressure, high blood glucose, high cholesterol)[37]. It has also been found that the risk factors for CVD tend to cluster – for example, high blood pressure often co-exists with high cholesterol, resulting in a synergistic effect and presenting a greater likelihood of developing disease (including CVD) compared to an individual risk factor alone[38].

In this report, hypertension, hyperlipidaemia and diabetes were considered to be present if there was history of the condition or if it was newly diagnosed during the index admission. Moderate-to-high BMI refers to BMI 23 kg/m^2 and above, whereby the risk for cardiovascular disease and diabetes is increased among Asian populations[39]. Smoking includes 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 hyperlipidaemia were consistently the two most common risk factors among AMI patients across the years (Figure 5.5.1). In 2022, 74.6% of AMI patients had hypertension, while 74.4% had hyperlipidaemia. Moderate-to-high BMI and diabetes were also prevalent among AMI patients, with more than half of them having these risk factors (moderate-to-high BMI: 59.0%, diabetes: 52.1%) in 2022. While the proportions of AMI patients with hypertension and a history of AMI/revascularisation were fairly consistent at approximately 3 in 4 and 1 in 3 respectively every year, slight upward trends were observed for hyperlipidaemia, moderate-to-high BMI, and diabetes. However, there was a drop in the percentage of AMI patients who were current or former smokers.

[36] Tan J. et al. Strategies to prevent cardiovascular disease in Singapore: A call to action from Singapore Heart Foundation, Singapore Cardiac Society, and Chapter of Cardiologists of the Academy of Medicine, Singapore. Ann Acad Med Singap 2024;53: 23-33
[37] Tan V., Lim J., Katika A., Chow WL., Ma S., Chen C. The societal cost of modifiable risk factors in Singapore. BMC Public Health 2023; 23:1285
[38] Ibid.
[39] WHO expert consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. Lancet 2004; 363: 157-163.

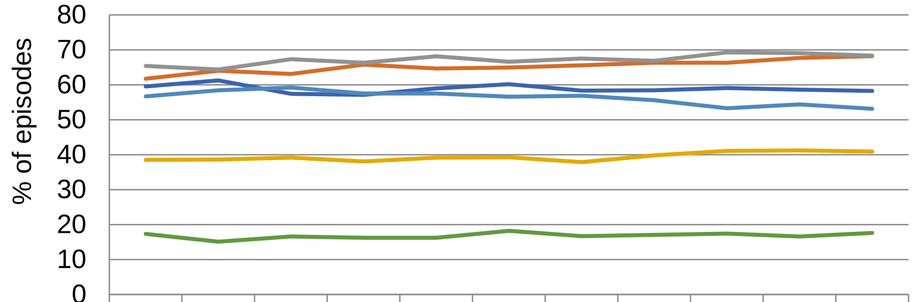
Figure 5.5.1: Risk factors (%)



Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Hypertension	75.2	76.1	74.2	74.3	75.0	76.0	74.9	75.3	75.2	74.8	74.6
Hyperlipidemia	70.1	71.9	71.0	71.4	71.6	72.4	72.7	73.5	73.2	74.4	74.4
Moderate-to-high BMI	57.5	56.7	58.3	56.9	59.3	58.1	58.7	59.4	60.1	59.8	59.0
Diabetes	50.8	50.0	50.3	49.0	50.2	51.7	50.4	51.5	51.5	52.1	52.1
Smoking	46.7	46.5	45.5	45.4	45.0	43.3	43.9	42.9	42.8	42.3	41.7
History of AMI / revascularisation	33.7	32.6	32.8	32.9	33.4	33.7	34.1	35.0	34.5	34.2	33.9

More than half of the STEMI patients had hypertension, hyperlipidaemia, moderate-to-high BMI or smoked (Figure 5.5.2a). Compared to STEMI patients, the proportions of NSTEMI patients with hypertension, hyperlipidaemia, 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), which is associated with an increased burden of cardiovascular risk factors[40]. However, NSTEMI patients were also less likely to have moderate-to-high BMI or smoke.

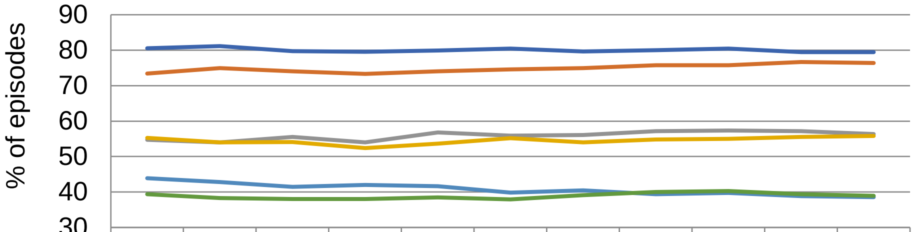
Figure 5.5.2a: Risk factors (%) among STEMI



Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Hypertension	59.6	61.3	57.4	57.1	59.0	60.2	58.4	58.4	59.1	58.6	58.2
Hyperlipidemia	61.7	64.1	63.1	65.8	64.7	64.9	65.6	66.4	66.3	67.7	68.2
Moderate-to-high BMI	65.4	64.4	67.3	66.3	68.2	66.6	67.5	66.9	69.3	69.1	68.3
Diabetes	38.5	38.6	39.2	38.1	39.2	39.2	37.9	39.8	41.1	41.2	40.9
Smoking	56.7	58.4	59.2	57.5	57.5	56.6	56.9	55.6	53.3	54.4	53.1
History of AMI / revascularisation	17.3	15.1	16.6	16.2	16.2	18.2	16.7	17.0	17.4	16.6	17.6

[40] Zuhdi A et al. Acute coronary syndrome in the elderly: the Malaysian National Cardiovascular Disease Database-Acute Coronary Syndrome registry. Singapore Med J 2016; 57(4): 191-197.

Figure 5.5.2b: Risk factors (%) among NSTEMI



Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Hypertension	80.5	81.2	79.8	79.6	79.9	80.4	79.7	80.0	80.5	79.5	79.5
Hyperlipidemia	73.4	74.9	74.0	73.3	74.0	74.6	75.0	75.7	75.7	76.7	76.4
Moderate-to-high BMI	54.7	54.0	55.6	54.0	56.8	55.9	56.1	57.2	57.3	57.1	56.4
Diabetes	55.2	54.0	54.1	52.4	53.7	55.2	54.0	54.8	55.0	55.6	55.8
Smoking	43.9	42.8	41.5	42.0	41.7	39.8	40.5	39.4	39.8	38.8	38.6
History of AMI / revascularisation	39.4	38.3	38.1	38.0	38.5	37.9	39.1	40.1	40.3	39.4	38.9

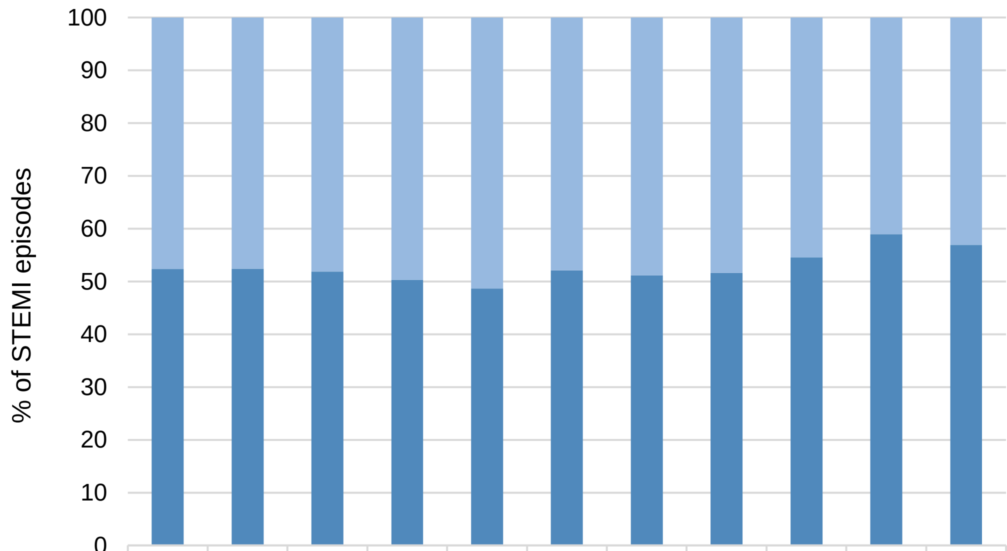
5.6 Time Factors

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[41].

Studies have shown that direct ambulance admission to the catheterisation laboratory significantly reduces DTB time[42]. The Singapore Civil Defence Force (SCDF) is the main provider of emergency ambulance services in Singapore. 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 from about 50%-60% from 2012 to 2022 (Figure 5.6.1). In 2022, 3 in 5 cases of STEMI arrived by SCDF ambulance.

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



Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Non-SCDF transport	47.6	47.6	48.1	49.7	51.4	47.9	48.9	48.4	45.5	41.1	43.1
SCDF ambulance	52.4	52.4	51.9	50.3	48.6	52.1	51.2	51.6	54.5	59.0	56.9

[41] 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.
[42] Dorsch MF et al. Direct ambulance admission to the cardiac catheterization laboratory significantly reduces door-to-balloon times in primary percutaneous coronary intervention. American Heart Journal 2008; 155(6): 1054-1058.

Patients who were admitted for a non-AMI condition but developed AMI during hospitalisation, patients who were transferred from another hospital, and patients who experienced non-system delays[43], were excluded from the calculation of DTB time. These exclusion criteria were applied as the DTB time would be abnormally short or long under such scenarios.

The median DTB time remained relatively unchanged at 59 (IQR 48-75) minutes in 2012 and 57 (IQR 45-71) minutes in 2022 among STEMI patients (Figure 5.6.2). The proportion of STEMI patients with DTB time of 90 minutes or less improved from 88.6% in 2012 to 95.6% in 2022. 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 (51 minutes in 2022) compared to those who relied on other modes of transport (65 minutes in 2022) across the years. SCDF paramedics are trained to recognise STEMI changes in the ECG. Individuals assessed by SCDF paramedics to be in need of immediate intervention can bypass triage upon arrival at the receiving hospital's emergency department (ED), resulting in shorter times to initiation of primary PCI.[44] 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[45]. 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 (97.5% versus 92.4% respectively in 2022) 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 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[46]. This allows the hospital to confirm the diagnosis, prepare the resuscitation bay and controlled drugs if necessary, pre-order procedures and activate the catheterisation laboratory, thereby shortening DTB time, which translates to reduction in mortality[47,48]. Worldwide, interventions such

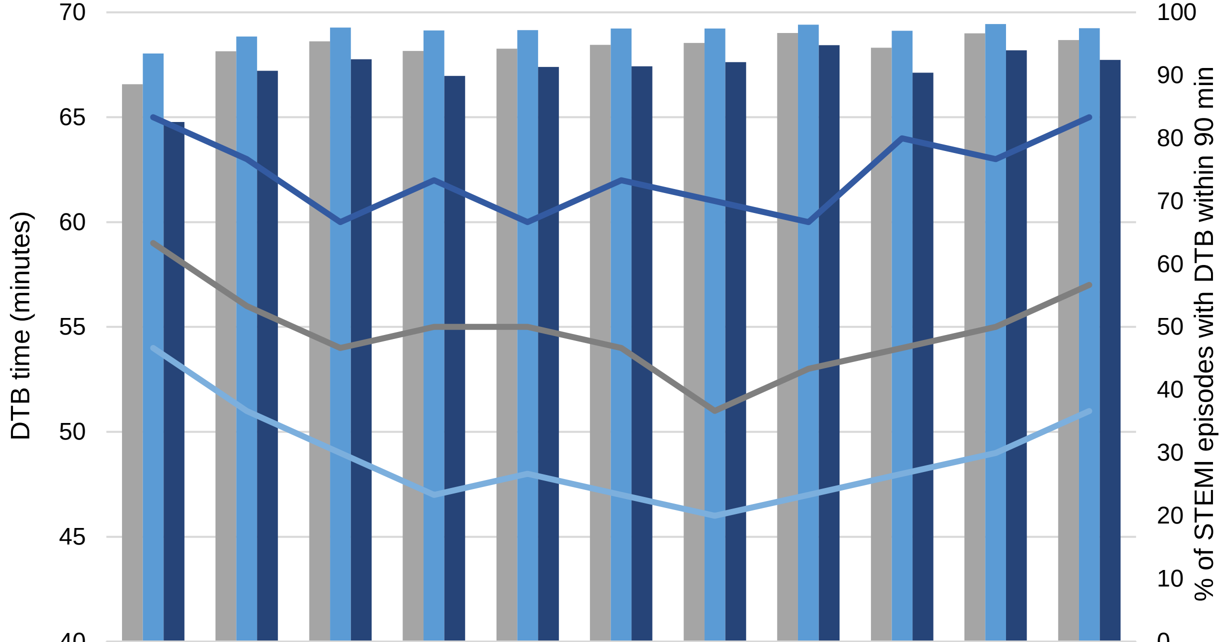
[43] The SMIR only started collecting this variable from 2012 onwards.
Non-system delay refers to delay in primary PCI due to patient's condition. It includes: unfit for primary PCI at the point of hospital arrival (indicated by cardiopulmonary resuscitation, direct current shock, cardiogenic shock, deterioration before or during primary PCI), requirement for other procedure or test prior to primary PCI, equivocal ECG, evolved AMI, delayed consent.
System delay refers to delay in primary PCI due to hospital's system. It includes: delayed process leading to the start of primary PCI, catheterisation laboratory being occupied, procedure difficulty, uptriaged, missed diagnosis, unknown reason.
[44] CNA Insider. On Call With Singapore's Emergency Medical Services: When Minutes Can Mean Life Or Death. https://www.youtube.com/watch?v=9PjWLStxWCc Accessed on 8 May 2024.
[45] 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.
[46] 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.
[47] Nallamothu BK et al. Relation between door-to-balloon times and mortality after primary percutaneous coronary intervention over time: a retrospective study. Lancet 2015; 385(9973): 1114-1122.
[48] CNA Insider. On Call With Singapore's Emergency Medical Services: When Minutes Can Mean Life Or Death. https://www.youtube.com/watch?v=9PjWLStxWCc Accessed on 8 May 2024.

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[49].

In August 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 (including vital signs) with each other, resulting in speedier patient management and improving chances of survival[50],[51]. 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.

[49] 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.
[50] 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.
[51] Home Team Science and Technology Agency (HTX). Embracing innovation and technology to save lives with OMNII. https://www.htx.gov.sg/news/featured-news-embracing-innovation-and-technology-to-save-lives-with-omnii Accessed 8 May 2024.

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



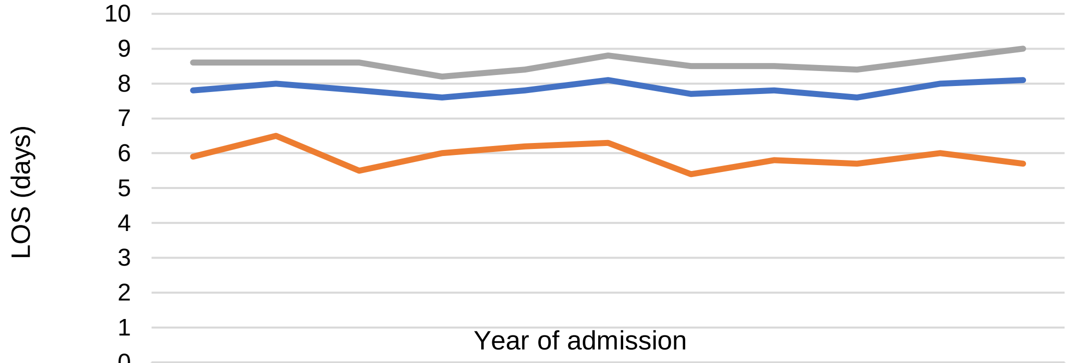
Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Overall DTB time within 90 min (%)	88.6	93.8	95.4	93.9	94.2	94.9	95.1	96.7	94.4	96.7	95.6
SCDF DTB time within 90 min (%)	93.4	96.2	97.6	97.1	97.2	97.4	97.4	98.1	97.1	98.1	97.5
Non-SCDF DTB time within 90 min (%)	82.6	90.7	92.5	89.9	91.3	91.4	92.1	94.8	90.4	94.0	92.4
Overall median DTB time (min)	59	56	54	55	55	54	51	53	54	55	57
SCDF median DTB time (min)	54	51	49	47	48	47	46	47	48	49	51
Non-SCDF median DTB time (min)	65	63	60	62	60	62	61	60	64	63	65

5.7 Length of Hospitalisation

Patients who died during hospitalisation, patients who were discharged against medical advice, patients who were transferred from another hospital, and patients who were admitted for a non-AMI condition but developed AMI during hospitalisation, were excluded from the calculation of length of hospital stay (LOS). These exclusion criteria were applied as the LOS would be abnormally short or long under such scenarios.

The average LOS ranged between 7.6 and 8.1 days from 2012 to 2022 (Figure 5.7.1). The average LOS was consistently longer among NSTEMI than STEMI patients by about 2 to 3 days. This could be due to their older age at onset and therefore higher prevalence of co-morbidities; and coupled with their greater tendency for complications, necessitating more extensive monitoring[52,53].

Figure 5.7.1: Length of hospitalisation (days)



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Overall	7.8	8.0	7.8	7.6	7.8	8.1	7.7	7.8	7.6	8.0	8.1
STEMI	5.9	6.5	5.5	6.0	6.2	6.3	5.4	5.8	5.7	6.0	5.7
NSTEMI	8.6	8.6	8.6	8.2	8.4	8.8	8.5	8.5	8.4	8.7	9.0

[52] Bhat A. G. et al. Hospitalisation Duration of Acute Myocardial Infarction: A Temporal Analysis of 18-Year United States Data. Medicina 2022; 58:
[53] Dai X et al. Acute coronary syndrome in older adults. Journal of Geriatric Cardiology; 2016:13. 101-108.

6. CONCLUSION

Driven partly by population ageing, the crude incidence of AMI had risen over the past decade. In 2021, cardiovascular diseases were the third highest contributor to the combined burden of early death and disability in Singapore, accounting for 13.3% of all disability-adjusted life years (DALYs)[54]. It is important for individuals with high risk of AMI to take preventive action. Hypertension, hyperlipidaemia, smoking, diabetes, obesity, unhealthy diet, and a lack of regular physical activity are all significantly associated with increased risk of AMI onset regardless of sex 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 interventions such as dietary changes and regular exercise[55,56].

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 food options, exercising and maintaining a healthy weight, avoiding smoking, going for health screening and follow-ups, and controlling blood pressure, cholesterol and glucose levels well[57]. 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[58]. 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.

[54] Global Burden of Disease study 2021 (GBD 2021). Accessed on 10 October 2024.
[55] 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.
[56] Tan J. et al. Strategies to prevent cardiovascular disease in Singapore: A call to action from Singapore Heart Foundation, Singapore Cardiac Society, and Chapter of Cardiologists of the Academy of Medicine, Singapore. Ann Acad Med Singap 2024;53: 23-33
[57] Ibid.
[58] Kim Soo-Joong. Global Awareness of Myocardial Infarction Symptoms in General Population. Korean Circulation Journal 2021;51(12): 997-1000.