Singapore Stroke Registry
Annual Report 2020

National Registry of Diseases Office

Acknowledgement

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

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1. GLOSSARY

AF	Atrial fibrillation/ flutter
ASIR	Age-standardised incidence rate
ASMR	Age-standardised mortality rate
CFR	Case fatality rate
CI	Confidence interval
CIR	Crude incidence rate
CMR	Crude mortality rate
HS	Haemorrhagic stroke
ICD	International Classification of Diseases
IS	Ischaemic stroke
MHA	Ministry of Home Affairs
MONICA	Monitoring Trends and Determinants in Cardiovascular Disease
NIHSS	National Institute of Health Stroke Scale
NRIC	National Registration Identity Card
SSR	Singapore Stroke Registry

2. EXECUTIVE SUMMARY

The number of stroke episodes increased from 5,890 episodes in 2010 to 8,846 episodes in 2020. The age-standardised incidence rate (ASIR) increased slightly from 158.0 to 159.5 per 100,000 population during this period.

The number of deaths due to stroke was 814 in 2020, a slight rise compared to 735 in 2010. However, in terms of age-standardised mortality rate (ASMR), there was a significant decline from 18.9 to 13.3 per 100,000 population during this period. A significant drop in 30-day case fatality rate (CFR) from 9.9% in 2010 to 7.9% in 2020 was also observed.

About 80% of stroke incidence each year were ischaemic strokes (IS), while 20% were haemorrhagic strokes (HS). As the age-standardised incidence rates of IS were consistently higher than HS across the years, the age-standardised mortality rates of IS were also generally higher. However, the 30-day case fatality rates among HS patients were consistently higher. This is likely due to HS generally being a more severe condition with a higher likelihood of fatality if not treated promptly.

Between 2010 and 2020, hyperlipidemia and hypertension were consistently the two most common risk factors among stroke patients. In 2020, 82.9% of the patients had hyperlipidemia and 81.5% had hypertension. Diabetes, smoking and atrial fibrillation/flutter were also prevalent among stroke patients, with 42.7%, 35.2% and 19.2% of them having these risk factors respectively in 2020. Aside from smoking whereby the proportion of patients who smoked dropped slightly, the proportion of stroke patients with the other risk factors remained stable over the years.

The proportion of IS patients who received thrombolytic agent increased from 2.6% in 2010 to 7.1% in 2020.

3. INTRODUCTION

Cerebrovascular disease was the fourth most common cause of death in 2020, accounting for 6.0% of all deaths in Singapore[1]. Stroke is a type of cerebrovascular disease.

There are two main types of stroke – ischaemic stroke (IS) and haemorrhagic stroke (HS). IS is more prevalent and it occurs due to blockage of blood vessel, which limits blood flow to the brain. HS is more severe and it occurs due to ruptured blood vessel that causes bleeding in the brain. IS is commonly treated with blood thinning drugs, such as anti-platelets and anti-coagulants, while HS is usually treated with surgery or endovascular therapy.

The common risk factors of stroke are hypertension, hyperlipidemia, diabetes, atrial fibrillation/flutter (AF), smoking and old age. The median age of Singapore residents rose from 37.4 years in 2010 to 41.5 years in 2020[2]. With Singapore's rapidly ageing population, the incidence of stroke is expected to rise. In order to mitigate the impact of stroke, preventive measures that reduce cerebrovascular risk, as well as post-stroke 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 17 May 2022.
[2] Population Trends 2021. Department of Statistics, Singapore. www.singstat.gov.sg/publications/population/population-trends Accessed on 1 Feb 2022.

4. METHODOLOGY

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

The Singapore Stroke Registry (SSR) was set up in 2002 as a joint effort championed by representatives from all public healthcare institutions. Data collection started with contributions from Tan Tock Seng Hospital and Singapore General Hospital. Since 2005, data was subsequently received from all public healthcare institutions.

Data sources

The SSR receives stroke case notifications from

1. All public healthcare institutions via the Hospital In-patient Discharge Summary,
2. Ministry of Health via the MediClaim 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 codes 430 to 437 (excluding 432.1 and 435) were used to identify stroke cases in the data sources prior to 2012, while the ICD-10 Australian Modification codes I60 to I68 (excluding I62.0 and I62.1) were used for stroke 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 stroke by viewing the patients' medical records, before extracting relevant detailed clinical information from there. All cases collected by the SSR were diagnosed as stroke by a certified doctor, accompanied by clinical signs of disturbance of cerebral function lasting more than 24 hours, and with no apparent cause other than a vascular origin.

The MONICA (Monitoring Trends and Determinants in Cardiovascular Disease) criterion was used for episode management, whereby a recurring stroke within 28 days of a preceding episode was merged with the preceding episode, while a recurring stroke after 28 days of a preceding episode was counted as another stroke episode[3].

The death status of all patients registered in the SSR were updated till 31 December 2021 by matching the patients' NRIC number with the death information from the MHA.

[3] Thorvaldsen P et al. Stroke trends in the MONICA project. Stroke 1997; 28(3): 500-506.

Population estimate

The Singapore population estimates used to calculate the incidence rates and mortality rates in this report were obtained from the Singapore Department of Statistics, which releases mid-year population estimates of Singapore residents (i.e. Singapore citizens and permanent residents) annually[4]. The Segi World population estimates used for age standardisation are available on the World Health Organisation website[5].

Incidence rate

The incidence rate in each year was calculated by taking the number of stroke episodes that occurred in a year, divided by the number of Singapore residents in the same year. Patients were categorised into 5-year age groups and age standardisation was done using the direct method with the Segi World population as the standardisation weights.

Mortality rate

The mortality rate in each year was calculated by taking the number of deaths with stroke as the primary cause of death occurring in a year, divided by the number of Singapore residents in the same year. Patients were categorised into 5-year age groups and age standardisation was done using the direct method with the Segi World population as the standardisation weights.

Case fatality rate

The case fatality rate in each year was calculated by taking the number of deaths with stroke as the primary cause of death that occurred within 30 days from onset of stroke, divided by the number of stroke patients in the same year. This indicator reflects the severity of stroke, the timeliness of healthcare delivery and the effectiveness of stroke treatment.

This report focuses on Singapore residents, aged 15 years or above, diagnosed with stroke and treated in public healthcare institutions in the past decade, from 2010 to 2020 as they stood on 15 June 2022. All findings in this report, except mortality and case fatality, were based on episodes. The registry started capturing onset date and time in 2014, but these information were often estimated or not available as the initial symptoms of stroke might be subtle. Hence, hospital arrival date and time were used for stroke that occurred out-of-hospital, while onset date and time were used for stroke that occurred in-hospital after patients were admitted due to a non-stroke condition. Hospital arrival date and time were also used if the onset date and time were not available.

[4] SingStat Table Builder, Population and Population Structure, Annual Population, Singapore Residents by age group, ethnic group and sex. Department of Statistics, Singapore. tablebuilder.singstat.gov.sg/publicfacing/mainMenu.action. Accessed on 1 Feb 2022.

[5] Omar BA et al. Age standardization of rates: a new WHO standard. GPE discussion paper series: no. 31. EIP.GPE/EBD World Health Organization 2001.

5. FINDINGS

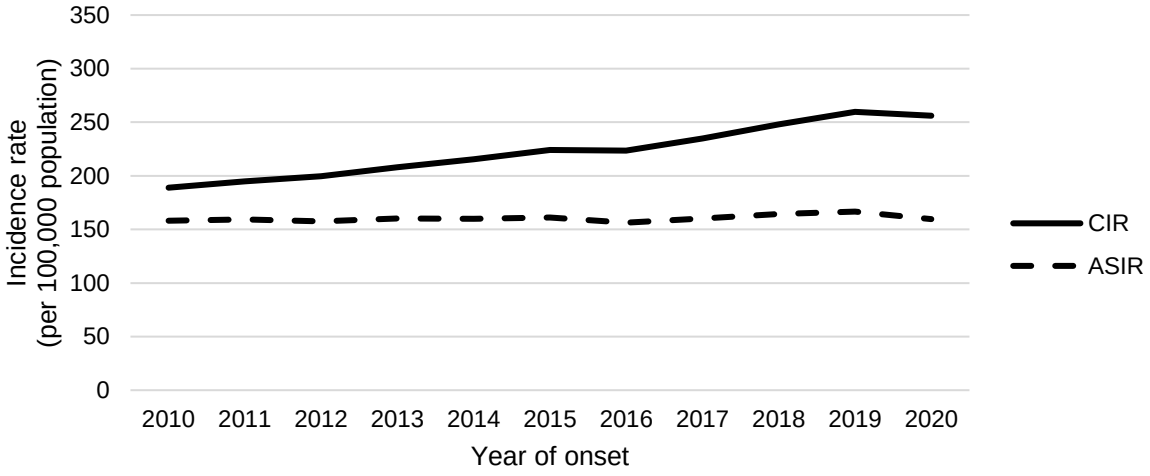
5.1 Incidence

The number of stroke episodes increased between 2010 and 2020 and there was a significant increase in the crude incidence rate (CIR) during this period (Table 5.1.1 and Figure 5.1.1). However, after accounting for Singapore's ageing population, the rise in age-standardised incidence rate (ASIR) from 158.0 to 159.5 per 100,000 population from 2010 to 2020 was no longer significant.

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

Year of onset	Number	CIR	95% CI	ASIR	95% CI
2010	5890	188.9	184.1-193.8	158.0	153.9-162.1
2011	6143	194.9	190.0-199.7	159.2	155.2-163.3
2012	6367	199.5	194.6-204.4	157.6	153.6-161.5
2013	6720	208.1	203.1-213.1	160.3	156.4-164.2
2014	7029	215.4	210.4-220.5	159.8	156.0-163.6
2015	7399	224.2	219.1-229.3	161.1	157.4-164.9
2016	7456	223.4	218.3-228.5	156.3	152.7-159.9
2017	7918	234.9	229.7-240.0	160.2	156.6-163.8
2018	8439	248.0	242.7-253.3	164.5	160.9-168.0
2019	8921	259.7	254.3-265.1	166.6	163.1-170.2
2020	8846	256.0	250.6-261.3	159.5	156.1-162.9
P for trend	-	<0.001	-	0.082	-

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



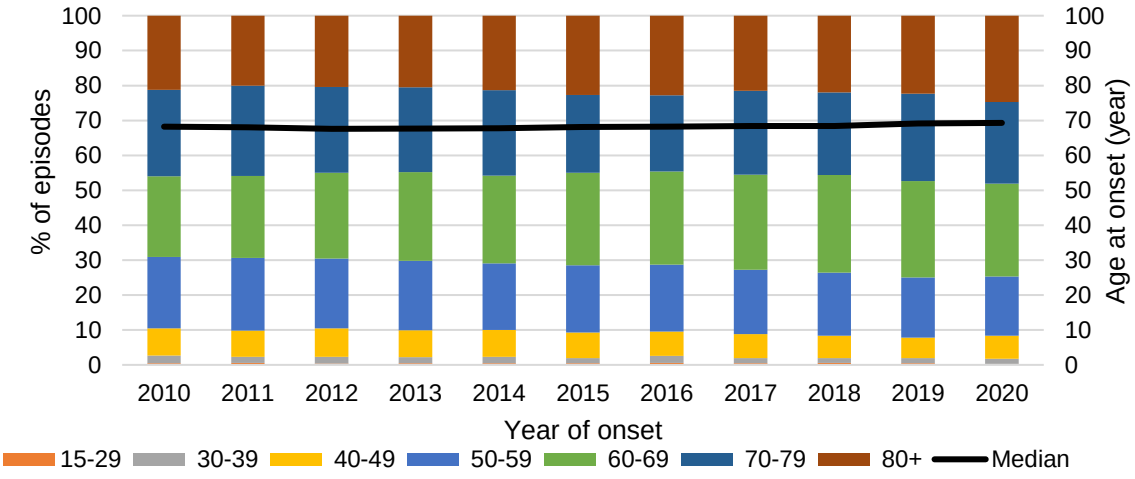
The median age at onset of stroke increased slightly from 68.2 years in 2010 to 69.3 years in 2020 (Table 5.1.2). About 3 in 4 patients were aged 60 years or above in 2020 (Figure 5.1.2).

Table 5.1.2: Age distribution at onset of stroke

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	68.2	30	0.5	129	2.2	455	7.7
2011	68.0	34	0.6	109	1.8	463	7.5
2012	67.6	24	0.4	123	1.9	518	8.1
2013	67.7	30	0.4	117	1.7	518	7.7
2014	67.8	31	0.4	128	1.8	542	7.7
2015	68.1	32	0.4	112	1.5	542	7.3
2016	68.2	42	0.6	149	2.0	521	7.0
2017	68.4	41	0.5	116	1.5	539	6.8
2018	68.4	44	0.5	120	1.4	538	6.4
2019	69.1	43	0.5	126	1.4	526	5.9
2020	69.3	27	0.3	126	1.4	587	6.6

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	1208	20.5	1362	23.1	1457	24.7	1249	21.2
2011	1274	20.7	1445	23.5	1589	25.9	1229	20.0
2012	1273	20.0	1567	24.6	1560	24.5	1302	20.4
2013	1338	19.9	1706	25.4	1631	24.3	1380	20.5
2014	1346	19.1	1761	25.1	1719	24.5	1502	21.4
2015	1426	19.3	1957	26.4	1653	22.3	1677	22.7
2016	1428	19.2	1991	26.7	1623	21.8	1702	22.8
2017	1458	18.4	2161	27.3	1903	24.0	1700	21.5
2018	1526	18.1	2363	28.0	1997	23.7	1851	21.9
2019	1541	17.3	2457	27.5	2234	25.0	1994	22.4
2020	1498	16.9	2354	26.6	2066	23.4	2188	24.7

Figure 5.1.2: Age distribution at onset of stroke



The age-specific incidence rate increased with age, with the oldest age group having the highest incidence rate (Figures 5.1.3a and 5.1.3b). Between 2010 and 2020, a significant rise in incidence rates were observed for those aged 40-49 years (p=0.001), 50-59 years (p<0.001) and 70-79 years (p=0.017) (Table 5.1.3).

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

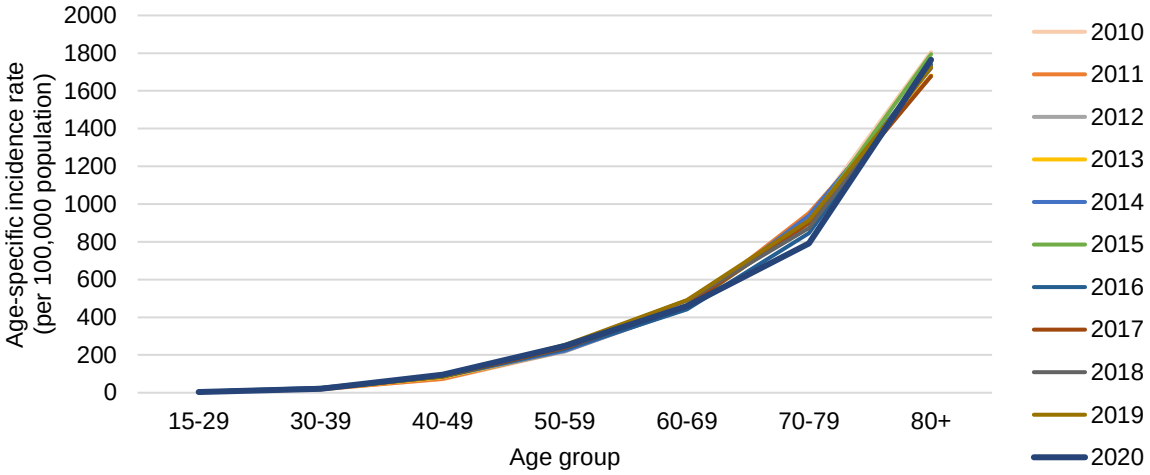


Figure 5.1.3b: Age-specific incidence rate of stroke (per 100,000 population) across years

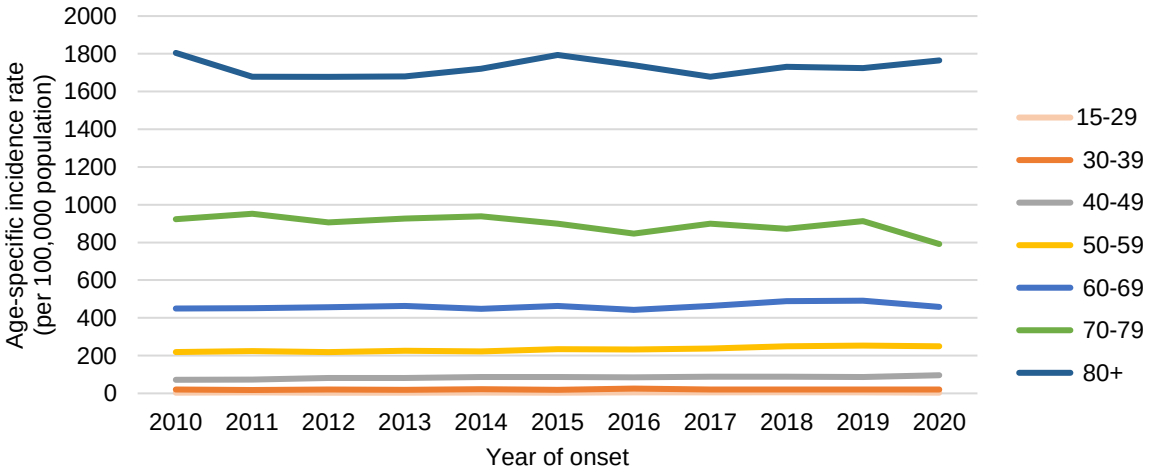


Table 5.1.3: Age-specific incidence rate of stroke (per 100,000 population)

Year of onset	Overall		Age 15-29		Age 30-39		Age 40-49	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2010	188.9	184.1-193.8	3.8	2.5-5.2	20.9	17.3-24.5	71.9	65.3-78.5
2011	194.9	190.0-199.7	4.4	2.9-5.8	17.8	14.4-21.1	73.4	66.7-80.1
2012	199.5	194.6-204.4	3.1	1.9-4.3	20.2	16.6-23.8	82.3	75.2-89.3
2013	208.1	203.1-213.1	3.9	2.5-5.2	19.4	15.9-22.9	82.4	75.3-89.5
2014	215.4	210.4-220.5	4.0	2.6-5.4	21.5	17.8-25.3	86.8	79.5-94.1
2015	224.2	219.1-229.3	4.1	2.7-5.5	18.9	15.4-22.4	87.4	80.0-94.8
2016	223.4	218.3-228.5	5.4	3.8-7.0	25.4	21.3-29.4	84.8	77.5-92.0
2017	234.9	229.7-240.0	5.2	3.6-6.8	20.0	16.4-23.6	87.7	80.3-95.1
2018	248.0	242.7-253.3	5.7	4.0-7.4	20.5	16.8-24.2	88.0	80.5-95.4
2019	259.7	254.3-265.1	5.7	4.0-7.4	21.2	17.5-24.9	85.9	78.5-93.2
2020	256.0	250.6-261.3	3.6	2.3-5.0	21.1	17.4-24.8	96.1	88.3-103.8
P for trend	<0.001	-	0.107	-	0.304	-	0.001	-
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2010	218.9	206.6-231.3	449.2	425.4-473.1	923.9	876.5-971.3	1804.9	1704.8-1905.0
2011	224.1	211.8-236.4	450.9	427.6-474.1	952.1	905.3-998.9	1679.0	1585.1-1772.8
2012	218.7	206.6-230.7	457.1	434.5-479.8	907.0	862.0-952.0	1677.8	1586.7-1769.0
2013	225.3	213.2-237.4	463.5	441.5-485.5	926.2	881.2-971.1	1680.9	1592.2-1769.6
2014	222.9	211.0-234.8	448.4	427.5-469.4	938.8	894.4-983.2	1720.6	1633.6-1807.6
2015	233.7	221.6-245.8	462.7	442.2-483.2	899.1	855.8-942.5	1794.6	1708.7-1880.5
2016	232.1	220.1-244.2	442.6	423.1-462.0	846.4	805.2-887.6	1740.3	1657.6-1823.0
2017	237.3	225.1-249.4	463.1	443.6-482.6	900.0	859.6-940.4	1678.6	1598.8-1758.4
2018	248.8	236.3-261.3	488.4	468.7-508.1	872.5	834.3-910.8	1731.8	1653.0-1810.7
2019	253.3	240.6-265.9	491.3	471.9-510.7	912.9	875.0-950.7	1724.1	1648.4-1799.7
2020	248.9	236.3-261.5	458.0	439.5-476.5	791.6	757.4-825.7	1764.9	1690.9-1838.8
P for trend	<0.001	-	0.071	-	0.017	-	0.747	-

Although the gender distribution was almost equal in the general population, there were more males suffering from stroke than females (Table 5.1.4). The ASIRs for males were consistently higher than females across the years (Figure 5.1.4). Males had an ASIR of 202.8 per 100,000 population, while females had an ASIR of 118.1 per 100,000 population in 2020. In addition, an upward trend in ASIR was observed for males (p=0.006) but not for females (p=0.102).

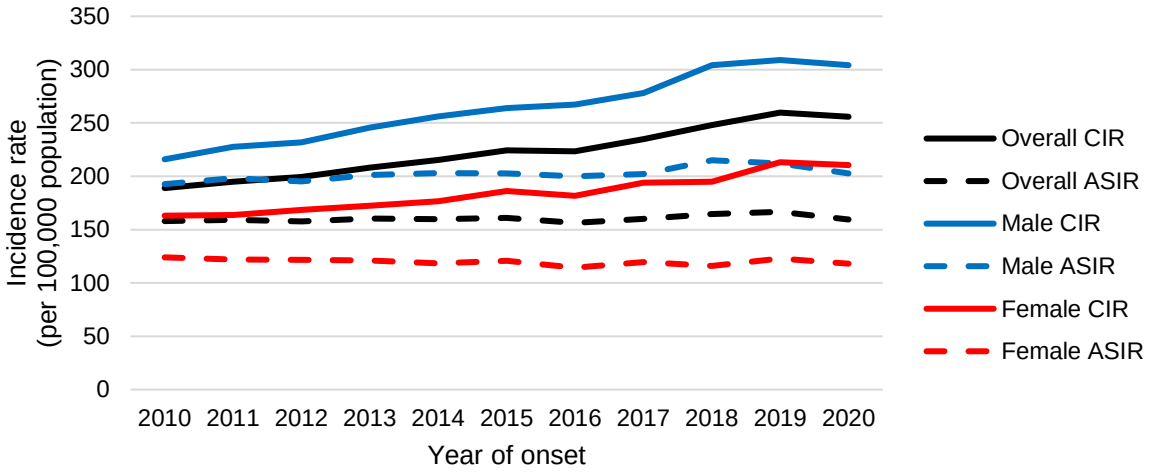
Males were known to have a higher risk of stroke compared to females. The underlying causes were multifactorial and related to the pathophysiological gender differences in stroke[6]. Furthermore, the prevalence of hypertension, hyperlipidemia, diabetes and smoking, which are common risk factors of stroke, were higher among males than females in the general population based on the National Population Health Survey 2020[7].

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

Male						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2010	3296	56.0	215.9	208.5-223.3	192.6	185.9-199.3
2011	3510	57.1	227.5	220.0-235.1	198.1	191.4-204.8
2012	3618	56.8	231.9	224.3-239.4	195.1	188.6-201.5
2013	3872	57.6	245.5	237.8-253.2	201.2	194.8-207.6
2014	4079	58.0	256.2	248.3-264.0	203.0	196.7-209.2
2015	4249	57.4	264.0	256.1-271.9	202.5	196.4-208.7
2016	4346	58.3	267.3	259.4-275.3	200.1	194.1-206.1
2017	4563	57.6	278.1	270.1-286.2	202.2	196.3-208.2
2018	5031	59.6	304.1	295.7-312.5	215.0	209.0-221.0
2019	5154	57.8	309.0	300.6-317.4	212.1	206.3-218.0
2020	5104	57.7	304.3	295.9-312.6	202.8	197.1-208.5
P for trend	-	-	<0.001	-	0.006	-
Female						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2010	2594	44.0	163.1	156.8-169.3	124.0	119.0-128.9
2011	2633	42.9	163.6	157.3-169.8	122.1	117.2-126.9
2012	2749	43.2	168.5	162.2-174.8	121.8	117.1-126.5
2013	2848	42.4	172.4	166.1-178.7	120.9	116.3-125.5
2014	2950	42.0	176.6	170.2-183.0	118.5	114.0-122.9
2015	3150	42.6	186.3	179.8-192.8	120.8	116.4-125.2
2016	3110	41.7	181.7	175.3-188.1	114.3	110.1-118.5
2017	3355	42.4	193.9	187.3-200.4	119.5	115.2-123.7
2018	3408	40.4	194.9	188.3-201.4	115.9	111.9-120.0
2019	3767	42.2	213.2	206.4-220.0	122.8	118.6-126.9
2020	3742	42.3	210.4	203.7-217.1	118.1	114.1-122.1
P for trend	-	-	<0.001	-	0.102	-

[6] Reeves MJ et al. Sex differences in stroke: epidemiology, clinical presentation, medical care, and outcomes. Lancet Neurology 2008; 7(10): 915-926.
[7] National Population Health Survey 2020 (Household Interview and Health Examination). Ministry of Health, Singapore. www.moh.gov.sg/resources-statistics/reports//national-survey-2019-20 Accessed on 1 Feb 2022.

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



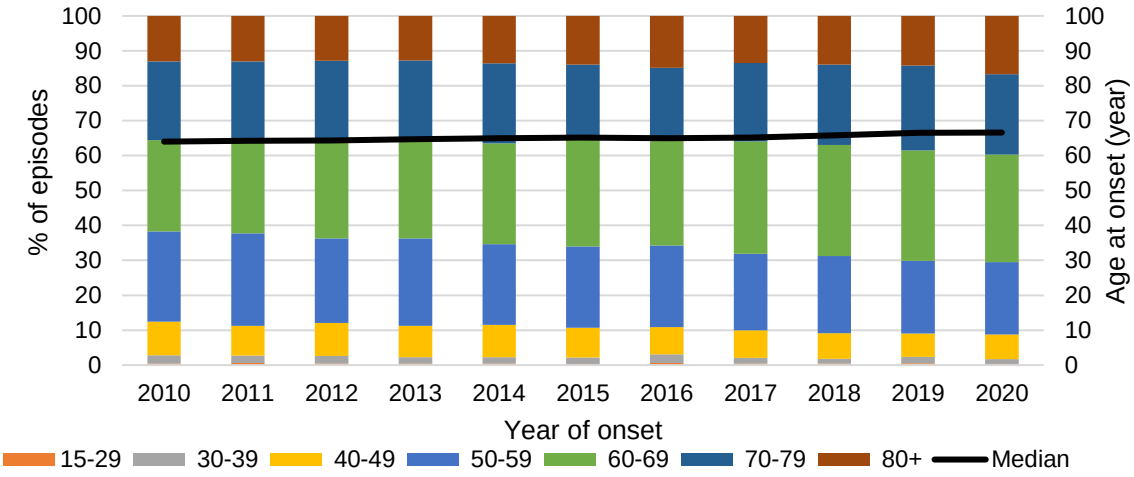
The median age at onset of stroke among males increased slightly from 64.0 years in 2010 to 66.6 years in 2020 (Table 5.1.5a). In 2020, those aged 60-69 years (30.8%) formed the highest proportion of male stroke patients (Figure 5.1.5a).

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

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	64.0	15	0.5	79	2.4	316	9.6
2011	64.2	20	0.6	75	2.1	301	8.6
2012	64.3	14	0.4	80	2.2	344	9.5
2013	64.7	16	0.4	72	1.9	349	9.0
2014	65.0	18	0.4	76	1.9	375	9.2
2015	65.2	15	0.4	77	1.8	362	8.5
2016	65.0	28	0.6	105	2.4	338	7.8
2017	65.2	19	0.4	74	1.6	361	7.9
2018	65.8	24	0.5	69	1.4	365	7.3
2019	66.5	29	0.6	94	1.8	345	6.7
2020	66.6	16	0.3	71	1.4	360	7.1

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	853	25.9	859	26.1	744	22.6	430	13.0
2011	929	26.5	923	26.3	806	23.0	456	13.0
2012	875	24.2	997	27.6	842	23.3	466	12.9
2013	969	25.0	1094	28.3	878	22.7	494	12.8
2014	942	23.1	1181	29.0	933	22.9	554	13.6
2015	989	23.3	1323	31.1	890	20.9	593	14.0
2016	1018	23.4	1352	31.1	861	19.8	644	14.8
2017	1000	21.9	1467	32.1	1026	22.5	616	13.5
2018	1112	22.1	1603	31.9	1157	23.0	701	13.9
2019	1069	20.7	1633	31.7	1250	24.3	734	14.2
2020	1057	20.7	1573	30.8	1174	23.0	853	16.7

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



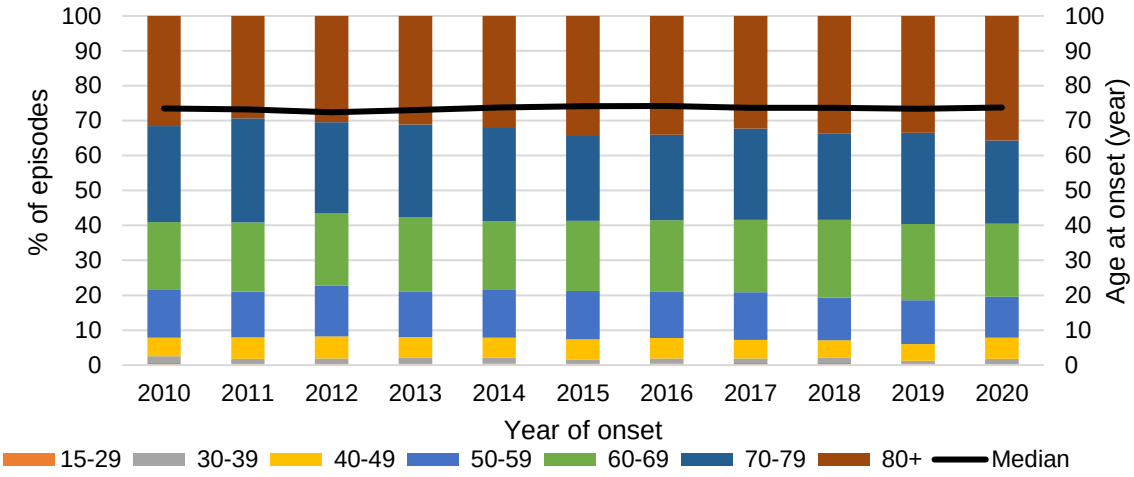
The median age at onset of stroke among females ranged between 72.4 and 74.2 years in the past decade (Table 5.1.5b), about 8 years older than the median age at onset among males (Table 5.1.5a). In 2020, those aged 80 years or above (35.7%) formed the highest proportion of female stroke patients (Figure 5.1.5b).

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

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	73.5	15	0.6	50	1.9	139	5.4
2011	73.2	14	0.5	34	1.3	162	6.2
2012	72.4	10	0.4	43	1.6	174	6.3
2013	73.0	14	0.5	45	1.6	169	5.9
2014	73.8	13	0.4	52	1.8	167	5.7
2015	74.1	17	0.5	35	1.1	180	5.7
2016	74.2	14	0.5	44	1.4	183	5.9
2017	73.7	22	0.7	42	1.3	178	5.3
2018	73.7	20	0.6	51	1.5	173	5.1
2019	73.4	14	0.4	32	0.8	181	4.8
2020	73.8	11	0.3	55	1.5	227	6.1

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	355	13.7	503	19.4	713	27.5	819	31.6
2011	345	13.1	522	19.8	783	29.7	773	29.4
2012	398	14.5	570	20.7	718	26.1	836	30.4
2013	369	13.0	612	21.5	753	26.4	886	31.1
2014	404	13.7	580	19.7	786	26.6	948	32.1
2015	437	13.9	634	20.1	763	24.2	1084	34.4
2016	410	13.2	639	20.5	762	24.5	1058	34.0
2017	458	13.7	694	20.7	877	26.1	1084	32.3
2018	414	12.1	760	22.3	840	24.6	1150	33.7
2019	472	12.5	824	21.9	984	26.1	1260	33.4
2020	441	11.8	781	20.9	892	23.8	1335	35.7

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



Although the ethnic distribution of the stroke patients was similar to the ethnic distribution of the general population (Table 5.1.6), Malays consistently had the highest ASIRs across the years (Figure 5.1.6). The ASIRs were 143.0, 247.3 and 177.7 per 100,000 population for Chinese, Malays and Indians respectively in 2020.

The prevalence of hypertension, hyperlipidemia, diabetes and smoking, which are common risk factors of stroke, were highest among Malays in the general population based on the National Population Health Survey 2020[8]. The high prevalence of stroke risk factors among Malays were likely the reason for their higher ASIRs, relative to Chinese and Indians.

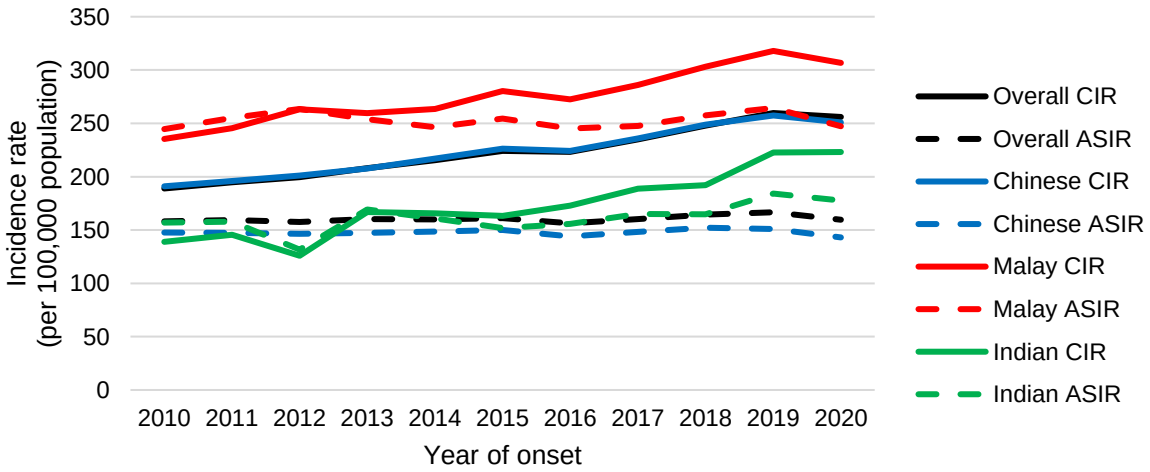
Table 5.1.6: Incidence number and rate (per 100,000 population) of stroke by ethnicity

Chinese						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2010	4499	76.4	191.0	185.4-196.6	147.5	143.1-151.9
2011	4664	75.9	195.8	190.2-201.5	147.3	143.0-151.6
2012	4849	76.2	201.1	195.4-206.8	146.5	142.3-150.7
2013	5066	75.4	207.7	202.0-213.4	147.4	143.3-151.5
2014	5342	76.0	216.8	211.0-222.6	148.5	144.4-152.6
2015	5637	76.2	226.1	220.2-232.0	150.1	146.1-154.2
2016	5649	75.8	224.1	218.3-230.0	144.1	140.2-148.0
2017	6006	75.9	235.9	230.0-241.9	148.1	144.2-151.9
2018	6393	75.8	248.8	242.7-254.9	152.1	148.3-156.0
2019	6674	74.8	257.4	251.2-263.6	151.0	147.2-154.7
2020	6540	73.9	250.7	244.7-256.8	143.0	139.4-146.7
P for trend	-	-	<0.001	-	0.862	-

[8] National Population Health Survey 2020 (Household Interview and Health Examination). Ministry of Health, Singapore. www.moh.gov.sg/resources-statistics/reports//national-survey-2019-20 Accessed on 1 Feb 2022.

Malay						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2010	921	15.6	235.4	220.2-250.6	244.6	228.1-261.1
2011	975	15.9	245.5	230.1-260.9	255.2	238.4-271.9
2012	1061	16.7	263.3	247.4-279.1	263.4	247.1-279.7
2013	1061	15.8	259.5	243.9-275.2	254.0	238.3-269.6
2014	1092	15.5	263.4	247.8-279.1	246.3	231.4-261.3
2015	1177	15.9	280.2	264.2-296.2	254.4	239.5-269.3
2016	1160	15.6	272.4	256.7-288.1	245.3	230.8-259.8
2017	1232	15.6	285.9	270.0-301.9	247.6	233.5-261.7
2018	1319	15.6	303.0	286.7-319.4	257.4	243.3-271.5
2019	1396	15.6	317.9	301.2-334.6	264.4	250.3-278.5
2020	1357	15.3	306.8	290.5-323.1	247.3	233.9-260.7
P for trend	-	-	<0.001	-	0.819	-
Indian						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2010	379	6.4	138.8	124.8-152.7	157.0	140.6-173.4
2011	401	6.5	145.4	131.2-159.6	157.9	141.8-174.0
2012	351	5.5	125.9	112.7-139.0	131.6	117.4-145.8
2013	469	7.0	166.8	151.7-181.9	169.1	153.4-184.8
2014	470	6.7	165.6	150.6-180.6	160.9	146.0-175.8
2015	467	6.3	163.2	148.4-178.1	151.8	137.7-165.9
2016	499	6.7	173.0	157.8-188.2	155.6	141.6-169.6
2017	550	6.9	188.8	173.0-204.6	165.1	151.1-179.1
2018	565	6.7	192.1	176.3-208.0	164.7	151.0-178.4
2019	662	7.4	222.6	205.6-239.5	184.1	170.0-198.3
2020	667	7.5	223.1	206.2-240.1	177.7	164.1-191.2
P for trend	-	-	<0.001	-	0.040	-

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



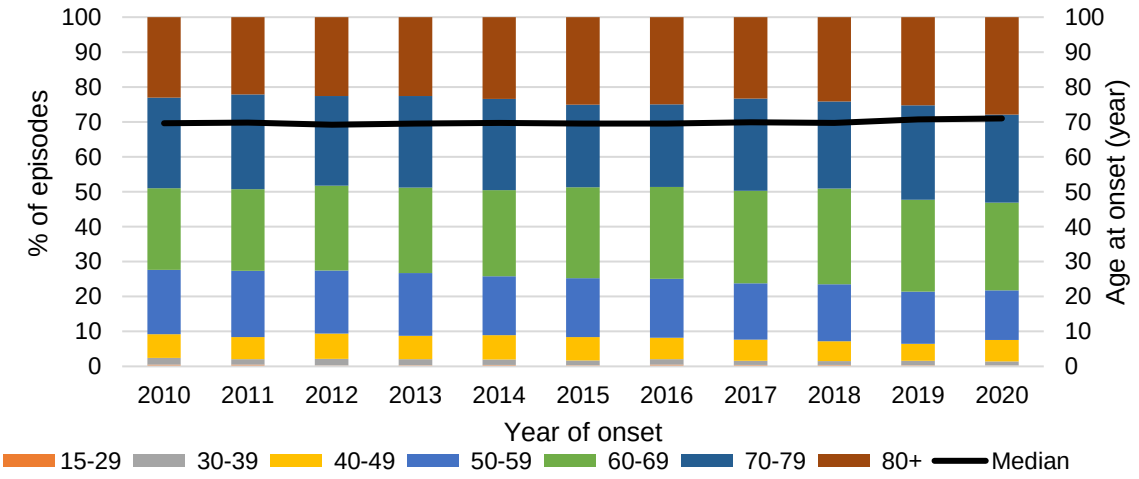
Among the ethnic groups, Chinese had the oldest median age at onset of stroke, which increased slightly from 69.6 years in 2010 to 71.0 years in 2020 (Table 5.1.7a). In 2020, those aged 80 years or above (27.9%) formed the highest proportion of Chinese stroke patients (Figure 5.1.7a).

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

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	69.6	22	0.5	89	2.0	302	6.7
2011	69.8	23	0.5	74	1.6	294	6.3
2012	69.2	13	0.3	93	1.9	348	7.2
2013	69.5	18	0.4	85	1.7	339	6.7
2014	69.7	22	0.4	83	1.6	370	6.9
2015	69.5	20	0.4	74	1.3	377	6.7
2016	69.5	26	0.5	90	1.6	345	6.1
2017	69.9	23	0.4	73	1.2	365	6.1
2018	69.7	29	0.5	69	1.1	361	5.6
2019	70.7	23	0.3	82	1.2	329	4.9
2020	71.0	14	0.2	76	1.2	404	6.2

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	832	18.5	1051	23.4	1168	26.0	1035	23.0
2011	885	19.0	1090	23.4	1265	27.1	1033	22.1
2012	876	18.1	1181	24.4	1245	25.7	1093	22.5
2013	913	18.0	1238	24.4	1330	26.3	1143	22.6
2014	904	16.9	1317	24.7	1398	26.2	1248	23.4
2015	952	16.9	1467	26.0	1337	23.7	1410	25.0
2016	956	16.9	1488	26.3	1335	23.6	1409	24.9
2017	966	16.1	1593	26.5	1587	26.4	1399	23.3
2018	1043	16.3	1751	27.4	1594	24.9	1546	24.2
2019	995	14.9	1755	26.3	1807	27.1	1683	25.2
2020	928	14.2	1642	25.1	1653	25.3	1823	27.9

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



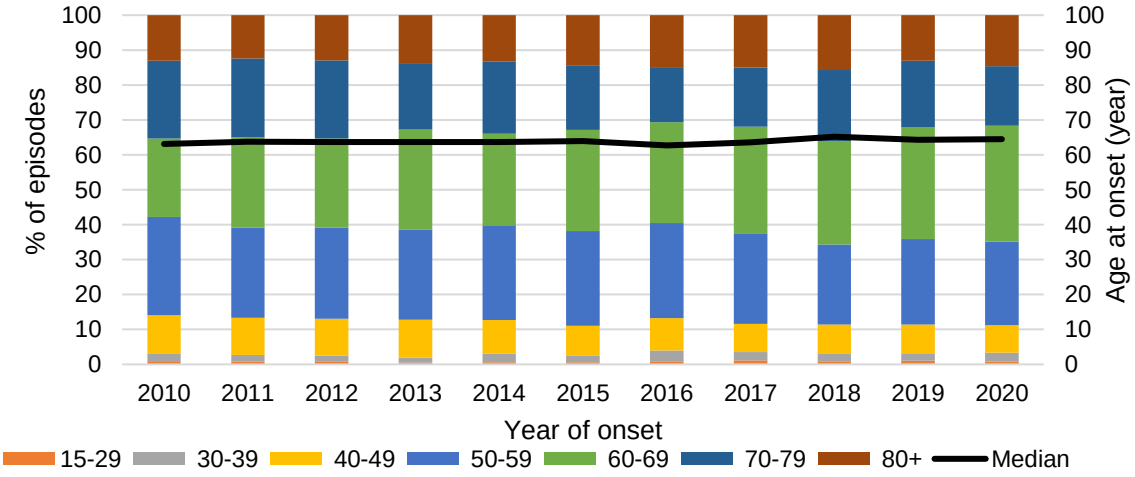
The median age at onset of stroke among Malays ranged between 62.7 and 65.2 years in the past decade (Table 5.1.7b). In 2020, those aged 60-69 years (33.2%) formed the highest proportion of Malay stroke patients (Figure 5.1.7b).

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

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	63.1	6	0.7	23	2.5	101	11.0
2011	63.8	8	0.8	18	1.8	104	10.7
2012	63.7	9	0.8	18	1.7	112	10.6
2013	63.7	5	0.5	16	1.5	115	10.8
2014	63.7	6	0.5	28	2.6	105	9.6
2015	63.9	7	0.6	22	1.9	101	8.6
2016	62.7	10	0.9	36	3.1	108	9.3
2017	63.6	14	1.1	29	2.4	100	8.1
2018	65.2	11	0.8	31	2.4	108	8.2
2019	64.3	15	1.1	26	1.9	118	8.5
2020	64.5	10	0.7	36	2.7	106	7.8

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	259	28.1	207	22.5	205	22.3	120	13.0
2011	252	25.8	252	25.8	220	22.6	121	12.4
2012	277	26.1	270	25.4	238	22.4	137	12.9
2013	274	25.8	303	28.6	200	18.9	148	13.9
2014	296	27.1	286	26.2	226	20.7	145	13.3
2015	319	27.1	341	29.0	218	18.5	169	14.4
2016	315	27.2	335	28.9	183	15.8	173	14.9
2017	320	26.0	376	30.5	209	17.0	184	14.9
2018	303	23.0	389	29.5	270	20.5	207	15.7
2019	342	24.5	448	32.1	265	19.0	182	13.0
2020	325	23.9	450	33.2	232	17.1	198	14.6

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



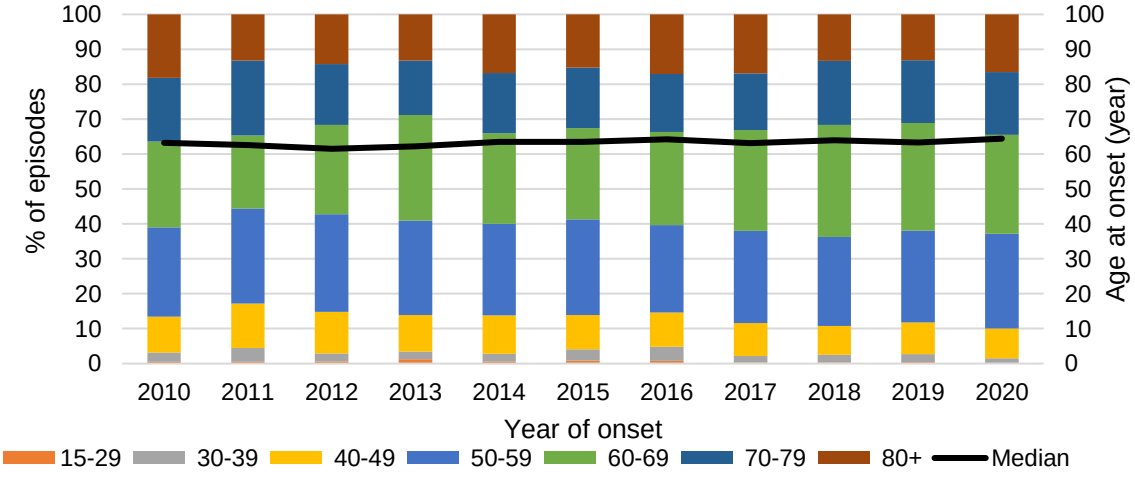
The median age at onset of stroke among Indians ranged between 61.5 and 64.4 years in the past decade (Table 5.1.7c). In 2020, those aged 60-69 years (28.3%) formed the highest proportion of Indian stroke patients (Figure 5.1.7c).

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

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	63.2	2	0.5	10	2.6	39	10.3
2011	62.6	2	0.5	16	4.0	51	12.7
2012	61.5	2	0.6	8	2.3	42	12.0
2013	62.2	6	1.3	10	2.1	49	10.4
2014	63.5	3	0.6	10	2.1	52	11.1
2015	63.5	4	0.9	15	3.2	46	9.9
2016	64.2	4	0.8	20	4.0	49	9.8
2017	63.1	2	0.4	10	1.8	52	9.5
2018	63.9	2	0.4	12	2.1	47	8.3
2019	63.3	3	0.5	15	2.3	60	9.1
2020	64.4	1	0.1	9	1.3	57	8.5

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	97	25.6	93	24.5	69	18.2	69	18.2
2011	109	27.2	84	20.9	86	21.4	53	13.2
2012	98	27.9	90	25.6	61	17.4	50	14.2
2013	127	27.1	142	30.3	73	15.6	62	13.2
2014	123	26.2	122	26.0	81	17.2	79	16.8
2015	128	27.4	122	26.1	81	17.3	71	15.2
2016	125	25.1	133	26.7	83	16.6	85	17.0
2017	145	26.4	159	28.9	89	16.2	93	16.9
2018	144	25.5	181	32.0	104	18.4	75	13.3
2019	174	26.3	204	30.8	119	18.0	87	13.1
2020	181	27.1	189	28.3	120	18.0	110	16.5

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



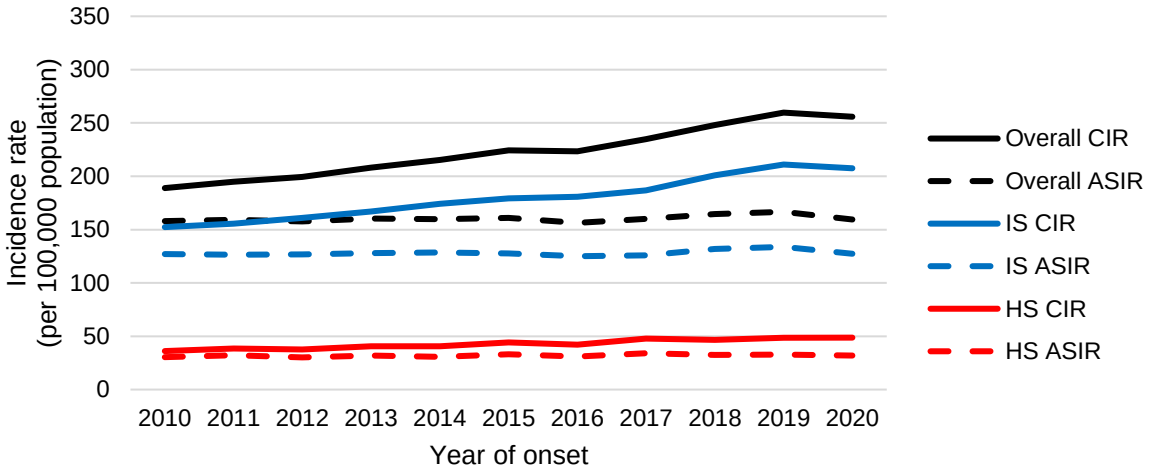
There were more IS than HS episodes (Table 5.1.8) and the ASIRs for IS were consistently higher than HS across the years (Figure 5.1.8). The ASIRs were 127.5 and 32.0 per 100,000 population for IS and HS respectively in 2020. The ASIRs of both IS and HS remained stable over the years.

As the percentages in Table 5.1.8 are among all stroke and patients without documentation of IS or HS are not shown, the sum of the percentages for IS and HS are less than 100% for each year.

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

Ischaemic stroke						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2010	4749	80.6	152.3	148.0-156.7	127.2	123.5-130.9
2011	4900	79.8	155.4	151.1-159.8	126.5	122.8-130.1
2012	5140	80.7	161.1	156.6-165.5	126.8	123.3-130.3
2013	5391	80.2	167.0	162.5-171.4	128.0	124.5-131.4
2014	5687	80.9	174.3	169.8-178.8	128.6	125.2-132.0
2015	5915	79.9	179.2	174.7-183.8	127.7	124.3-131.0
2016	6037	81.0	180.9	176.3-185.5	125.0	121.8-128.3
2017	6295	79.5	186.7	182.1-191.3	126.0	122.8-129.1
2018	6840	81.1	201.0	196.2-205.8	131.7	128.6-134.9
2019	7249	81.3	211.0	206.2-215.9	133.8	130.6-136.9
2020	7167	81.0	207.4	202.6-212.2	127.5	124.4-130.5
P for trend	-	-	<0.001	-	0.172	-
Haemorrhagic stroke						
Year of onset	**Number**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2010	1125	19.1	36.1	34.0-38.2	30.4	28.6-32.2
2011	1213	19.7	38.5	36.3-40.6	32.1	30.2-33.9
2012	1202	18.9	37.7	35.5-39.8	30.2	28.4-31.9
2013	1310	19.5	40.6	38.4-42.8	31.9	30.2-33.7
2014	1322	18.8	40.5	38.3-42.7	30.8	29.1-32.5
2015	1459	19.7	44.2	41.9-46.5	33.0	31.3-34.8
2016	1403	18.8	42.0	39.8-44.2	30.9	29.3-32.6
2017	1613	20.4	47.8	45.5-50.2	34.0	32.3-35.7
2018	1589	18.8	46.7	44.4-49.0	32.5	30.9-34.2
2019	1669	18.7	48.6	46.3-50.9	32.8	31.2-34.5
2020	1678	19.0	48.6	46.2-50.9	32.0	30.4-33.6
P for trend	-	-	<0.001	-	0.073	-

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



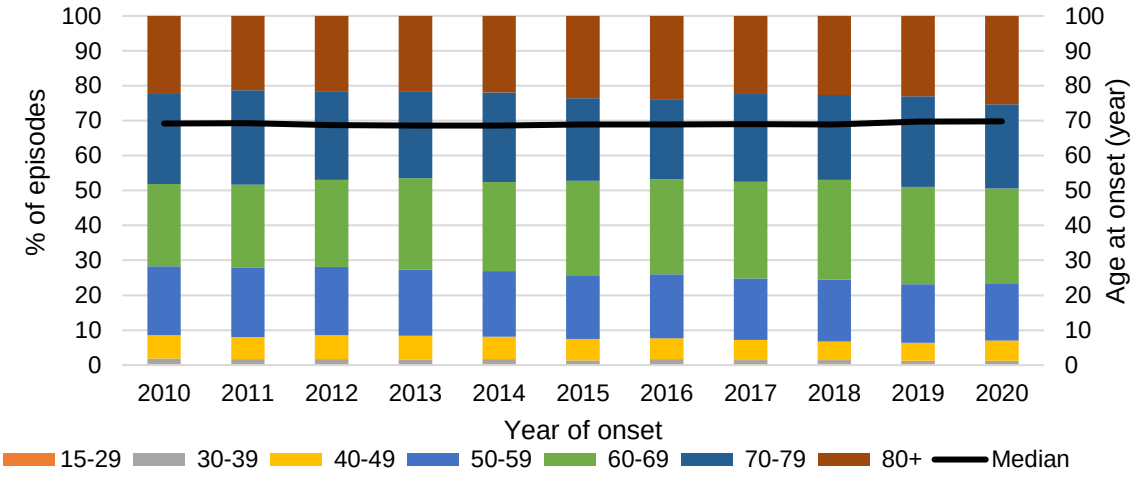
The median age at onset of IS remained stable between 68.6 and 69.8 years in the past decade (Table 5.1.9a). In 2020, 76.6% of IS patients were aged 60 years or above (Figure 5.1.9a).

Table 5.1.9a: Age distribution at onset of ischaemic stroke

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	69.2	16	0.3	75	1.6	315	6.6
2011	69.3	16	0.3	67	1.4	311	6.3
2012	68.7	13	0.3	77	1.5	352	6.8
2013	68.6	8	0.1	77	1.4	369	6.8
2014	68.6	20	0.4	77	1.4	365	6.4
2015	68.9	15	0.3	64	1.1	362	6.1
2016	68.9	15	0.2	87	1.4	361	6.0
2017	69.0	17	0.3	73	1.2	363	5.8
2018	68.9	21	0.3	79	1.2	363	5.3
2019	69.7	27	0.4	67	0.9	369	5.1
2020	69.8	14	0.2	73	1.0	418	5.8

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	940	19.8	1115	23.5	1239	26.1	1049	22.1
2011	969	19.8	1171	23.9	1325	27.0	1041	21.2
2012	1001	19.5	1285	25.0	1306	25.4	1106	21.5
2013	1019	18.9	1411	26.2	1346	25.0	1161	21.5
2014	1068	18.8	1452	25.5	1459	25.7	1246	21.9
2015	1080	18.3	1599	27.0	1402	23.7	1393	23.6
2016	1106	18.3	1647	27.3	1380	22.9	1441	23.9
2017	1112	17.7	1740	27.6	1584	25.2	1406	22.3
2018	1210	17.7	1955	28.6	1661	24.3	1551	22.7
2019	1214	16.7	2026	27.9	1879	25.9	1667	23.0
2020	1173	16.4	1945	27.1	1727	24.1	1817	25.4

Figure 5.1.9a: Age distribution at onset of ischaemic stroke

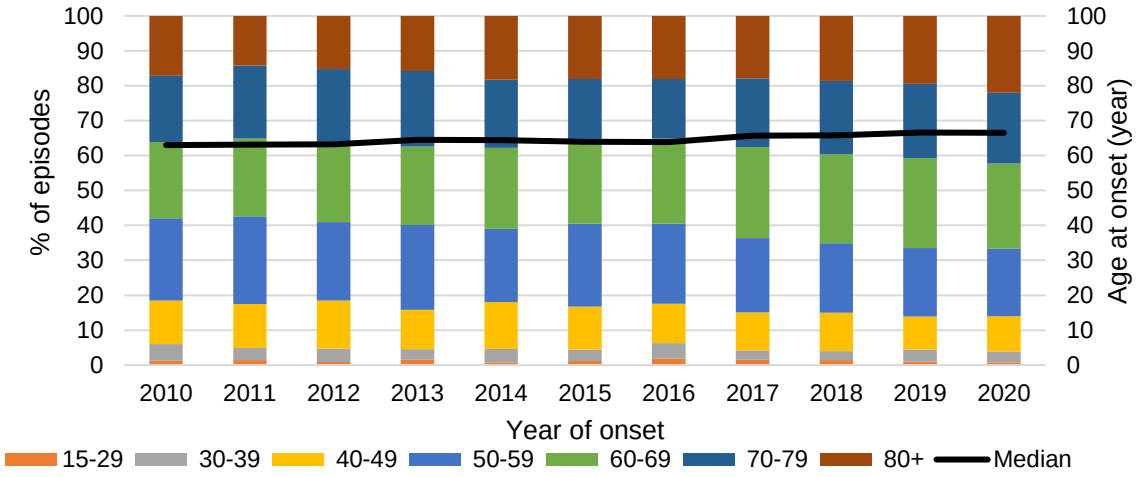


The median age at onset of HS increased from 63.0 years in 2010 to 66.5 years in 2020 (Table 5.1.9b), but it is still a few years younger than the median age at onset of IS (Table 5.1.9a). In 2020, 66.7% of HS patients were aged 60 years or above (Figure 5.1.9b).

Table 5.1.9b: Age distribution at onset of haemorrhagic stroke

Year of onset	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	63.0	14	1.2	54	4.8	140	12.4
2011	63.1	18	1.5	42	3.5	152	12.5
2012	63.2	11	0.9	46	3.8	165	13.7
2013	64.5	21	1.6	39	3.0	148	11.3
2014	64.4	11	0.8	51	3.9	177	13.4
2015	64.0	17	1.2	48	3.3	180	12.3
2016	63.9	27	1.9	62	4.4	158	11.3
2017	65.7	24	1.5	43	2.7	176	10.9
2018	65.8	23	1.4	41	2.6	175	11.0
2019	66.6	16	1.0	59	3.5	157	9.4
2020	66.5	13	0.8	53	3.2	169	10.1
Year of onset	**Age 50-59**		**Age 60-69**		**Age 70-79**		**Age 80+**
	Number	**%**	**Number**	**%**	**Number**	**%**	**Number**	**%**
2010	265	23.6	246	21.9	213	18.9	193	17.2
2011	305	25.1	270	22.3	253	20.9	173	14.3
2012	270	22.5	277	23.0	250	20.8	183	15.2
2013	318	24.3	294	22.4	283	21.6	207	15.8
2014	277	21.0	306	23.1	259	19.6	241	18.2
2015	346	23.7	354	24.3	251	17.2	263	18.0
2016	321	22.9	342	24.4	240	17.1	253	18.0
2017	344	21.3	420	26.0	318	19.7	288	17.9
2018	315	19.8	406	25.6	333	21.0	296	18.6
2019	327	19.6	431	25.8	354	21.2	325	19.5
2020	325	19.4	409	24.4	339	20.2	370	22.1

Figure 5.1.9b: Age distribution at onset of haemorrhagic stroke



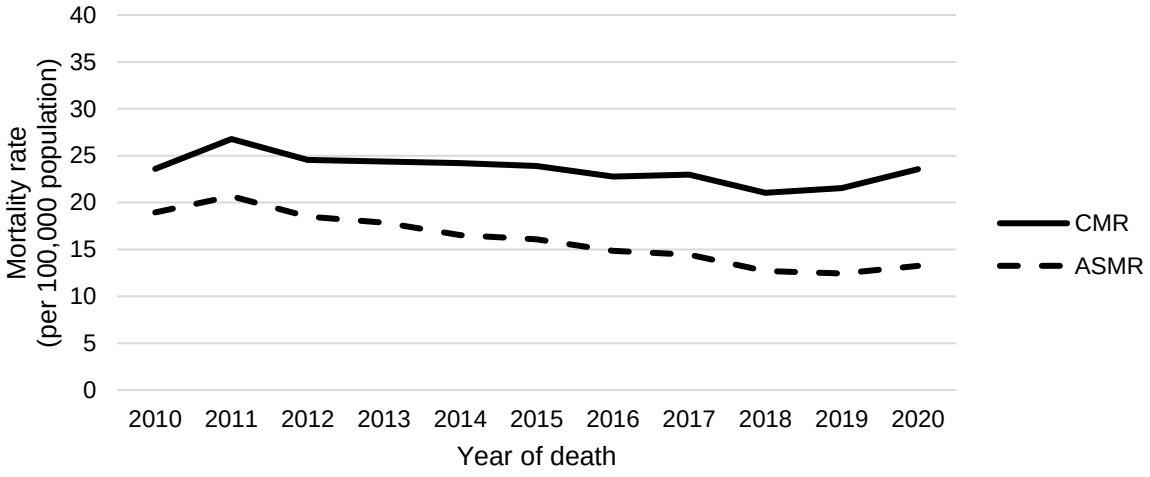
5.2 Mortality

The number of deaths due to stroke was 814 in 2020, a slight rise compared to 735 in 2010 (Table 5.2.1), despite the comparatively higher increase in the number of stroke episodes (Table 5.1.1). The crude mortality rate (CMR) and the age-standardised mortality rate (ASMR) dropped over the years, but a rise was observed in 2020 (Figure 5.2.1). The overall downward trends in CMR and ASMR over the years were likely due to the timely commencement of stroke treatment.

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

Year of death	Number	CMR	95% CI	ASMR	95% CI
2010	735	23.6	21.9-25.3	18.9	17.5-20.3
2011	844	26.8	25.0-28.6	20.7	19.2-22.1
2012	783	24.5	22.8-26.3	18.5	17.2-19.8
2013	787	24.4	22.7-26.1	17.9	16.6-19.1
2014	790	24.2	22.5-25.9	16.5	15.3-17.7
2015	789	23.9	22.2-25.6	16.1	14.9-17.2
2016	760	22.8	21.2-24.4	14.8	13.8-15.9
2017	775	23.0	21.4-24.6	14.5	13.4-15.5
2018	716	21.0	19.5-22.6	12.7	11.7-13.6
2019	740	21.5	20.0-23.1	12.4	11.5-13.4
2020	814	23.6	21.9-25.2	13.3	12.3-14.2
P for trend	-	0.018	-	<0.001	-

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



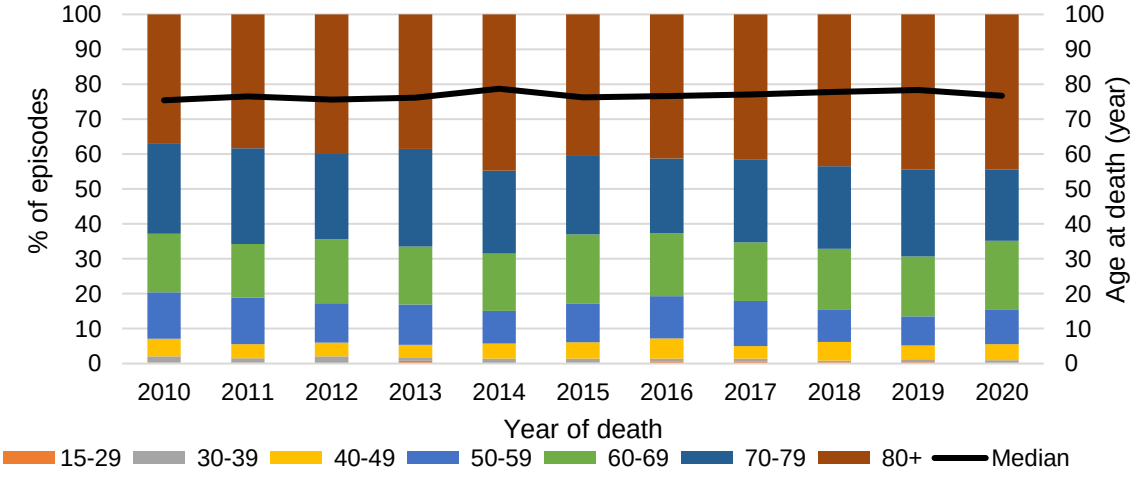
The median age at death ranged between 75.4 and 78.7 years in the past decade (Table 5.2.2). In 2020, close to half of the patients who died of stroke were aged 80 years or above (Figure 5.2.2).

Table 5.2.2: Age distribution at death of stroke

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	75.4	2	0.3	13	1.8	37	5.0
2011	76.5	2	0.2	11	1.3	34	4.0
2012	75.6	0	0.0	16	2.0	31	4.0
2013	76.1	6	0.8	8	1.0	28	3.6
2014	78.7	1	0.1	10	1.3	34	4.3
2015	76.2	2	0.3	9	1.1	37	4.7
2016	76.6	4	0.5	7	0.9	44	5.8
2017	77.1	4	0.5	7	0.9	28	3.6
2018	77.8	3	0.4	3	0.4	38	5.3
2019	78.3	3	0.4	6	0.8	29	3.9
2020	76.7	1	0.1	7	0.9	37	4.5

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	98	13.3	123	16.7	191	26.0	271	36.9
2011	113	13.4	129	15.3	231	27.4	324	38.4
2012	88	11.2	144	18.4	193	24.6	311	39.7
2013	91	11.6	131	16.6	220	28.0	303	38.5
2014	74	9.4	130	16.5	187	23.7	354	44.8
2015	87	11.0	157	19.9	177	22.4	320	40.6
2016	92	12.1	137	18.0	162	21.3	314	41.3
2017	100	12.9	130	16.8	183	23.6	323	41.7
2018	66	9.2	125	17.5	170	23.7	311	43.4
2019	62	8.4	127	17.2	184	24.9	329	44.5
2020	80	9.8	161	19.8	166	20.4	362	44.5

Figure 5.2.2: Age distribution at death of stroke



The age-specific mortality rate of stroke increased with age, with the oldest age group having the highest mortality rate (Figure 5.2.3a) but also the highest drop in mortality rate over the years (Figure 5.2.3b). Significant drop in mortality rates were observed among those aged 30-39 years and 50 years and above (Table 5.2.3).

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

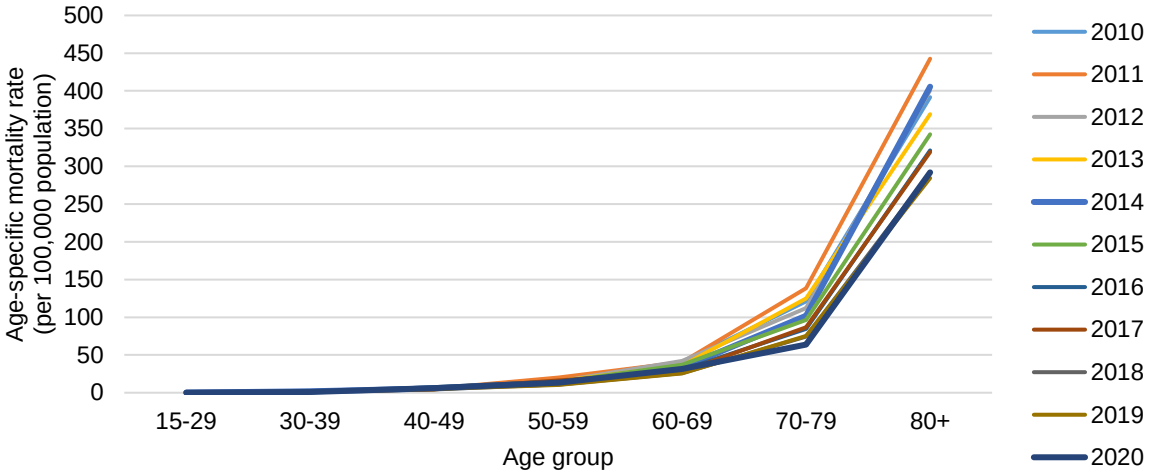


Figure 5.2.3b: Age-specific mortality rate of stroke (per 100,000 population) across years

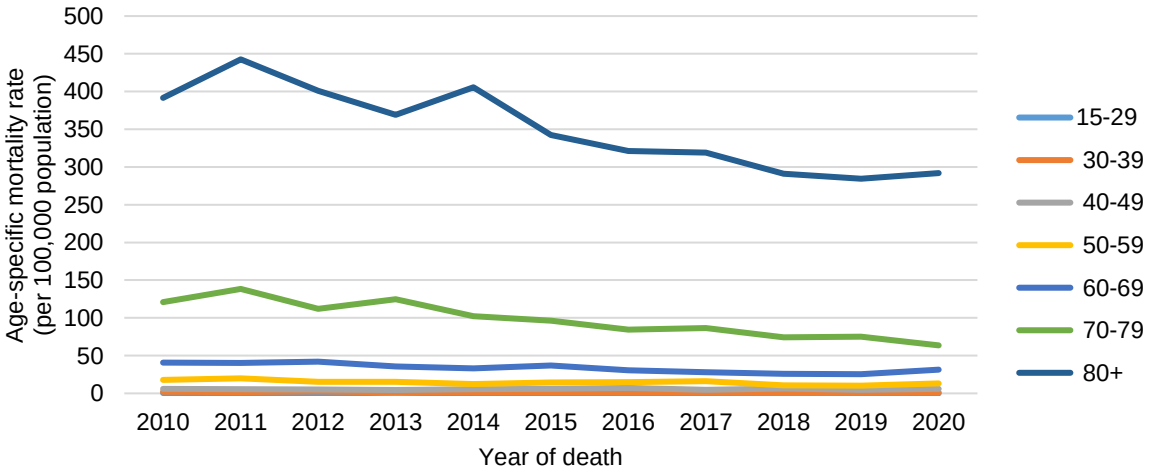


Table 5.2.3: Age-specific mortality rate of stroke (per 100,000 population)

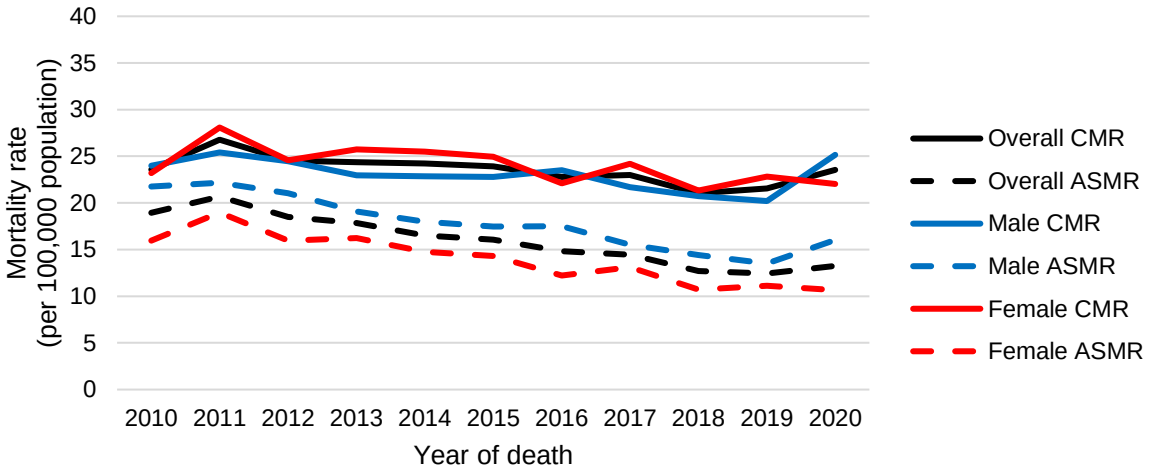
Year of death	Overall		Age 15-29		Age 30-39		Age 40-49	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2010	23.6	21.9-25.3	0.3	0.0-0.6	2.1	1.0-3.2	5.8	4.0-7.7
2011	26.8	25.0-28.6	0.3	0.0-0.6	1.8	0.7-2.9	5.4	3.6-7.2
2012	24.5	22.8-26.3	0.0	-	2.6	1.3-3.9	4.9	3.2-6.7
2013	24.4	22.7-26.1	0.8	0.2-1.4	1.3	0.4-2.2	4.5	2.8-6.1
2014	24.2	22.5-25.9	0.1	0.0-0.4	1.7	0.6-2.7	5.4	3.6-7.3
2015	23.9	22.2-25.6	0.3	0.0-0.6	1.5	0.5-2.5	6.0	4.0-7.9
2016	22.8	21.2-24.4	0.5	0.0-1.0	1.2	0.3-2.1	7.2	5.0-9.3
2017	23.0	21.4-24.6	0.5	0.0-1.0	1.2	0.3-2.1	4.6	2.9-6.2
2018	21.0	19.5-22.6	0.4	0.0-0.8	0.5	0.0-1.1	6.2	4.2-8.2
2019	21.5	20.0-23.1	0.4	0.0-0.8	1.0	0.2-1.8	4.7	3.0-6.5
2020	23.6	21.9-25.2	0.1	0.0-0.4	1.2	0.3-2.0	6.1	4.1-8.0
P for trend	0.018	-	0.689	-	0.010	-	0.660	-
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2010	17.8	14.2-21.3	40.6	33.4-47.7	121.1	103.9-138.3	391.6	345.0-438.2
2011	19.9	16.2-23.5	40.2	33.3-47.2	138.4	120.6-156.3	442.6	394.4-490.8
2012	15.1	12.0-18.3	42.0	35.1-48.9	112.2	96.4-128.0	400.8	356.2-445.3
2013	15.3	12.2-18.5	35.6	29.5-41.7	124.9	108.4-141.4	369.1	327.5-410.6
2014	12.3	9.5-15.0	33.1	27.4-38.8	102.1	87.5-116.8	405.5	363.3-447.8
2015	14.3	11.3-17.3	37.1	31.3-42.9	96.3	82.1-110.5	342.4	304.9-380.0
2016	15.0	11.9-18.0	30.5	25.4-35.6	84.5	71.5-97.5	321.1	285.6-356.6
2017	16.3	13.1-19.5	27.9	23.1-32.6	86.5	74.0-99.1	318.9	284.1-353.7
2018	10.8	8.2-13.4	25.8	21.3-30.4	74.3	63.1-85.4	291.0	258.6-323.3
2019	10.2	7.7-12.7	25.4	21.0-29.8	75.2	64.3-86.0	284.5	253.7-315.2
2020	13.3	10.4-16.2	31.3	26.5-36.2	63.6	53.9-73.3	292.0	261.9-322.1
P for trend	0.012	-	0.001	-	<0.001	-	<0.001	-

As the ASIRs were consistently higher among males than females across the years (Table 5.1.4), the ASMRs were also consistently higher among males (Table 5.2.4). In 2020, males had an ASMR of 16.0 per 100,000 population, while females had an ASMR of 10.7 per 100,000 population. The ASMRs declined over the years for both genders (males: p<0.001, females: p<0.001) (Figure 5.2.4).

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

Male						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2010	366	49.8	24.0	21.5-26.4	21.8	19.5-24.0
2011	392	46.4	25.4	22.9-27.9	22.2	19.9-24.4
2012	382	48.8	24.5	22.0-26.9	21.0	18.9-23.2
2013	362	46.0	23.0	20.6-25.3	19.1	17.1-21.1
2014	364	46.1	22.9	20.5-25.2	18.0	16.1-19.9
2015	367	46.5	22.8	20.5-25.1	17.5	15.7-19.3
2016	382	50.3	23.5	21.1-25.9	17.5	15.7-19.3
2017	356	45.9	21.7	19.4-24.0	15.5	13.9-17.2
2018	343	47.9	20.7	18.5-22.9	14.4	12.9-16.0
2019	337	45.5	20.2	18.0-22.4	13.5	12.0-15.0
2020	422	51.8	25.2	22.8-27.6	16.0	14.5-17.6
P for trend	-	-	0.108	-	<0.001	-
Female						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2010	369	50.2	23.2	20.8-25.6	16.0	14.3-17.7
2011	452	53.6	28.1	25.5-30.7	19.0	17.1-20.8
2012	401	51.2	24.6	22.2-27.0	16.0	14.3-17.6
2013	425	54.0	25.7	23.3-28.2	16.2	14.6-17.8
2014	426	53.9	25.5	23.1-27.9	14.8	13.3-16.2
2015	422	53.5	25.0	22.6-27.3	14.3	12.9-15.8
2016	378	49.7	22.1	19.9-24.3	12.2	10.9-13.5
2017	419	54.1	24.2	21.9-26.5	13.1	11.8-14.4
2018	373	52.1	21.3	19.2-23.5	10.7	9.6-11.9
2019	403	54.5	22.8	20.6-25.0	11.1	10.0-12.3
2020	392	48.2	22.0	19.9-24.2	10.7	9.5-11.8
P for trend	-	-	0.028	-	<0.001	-

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



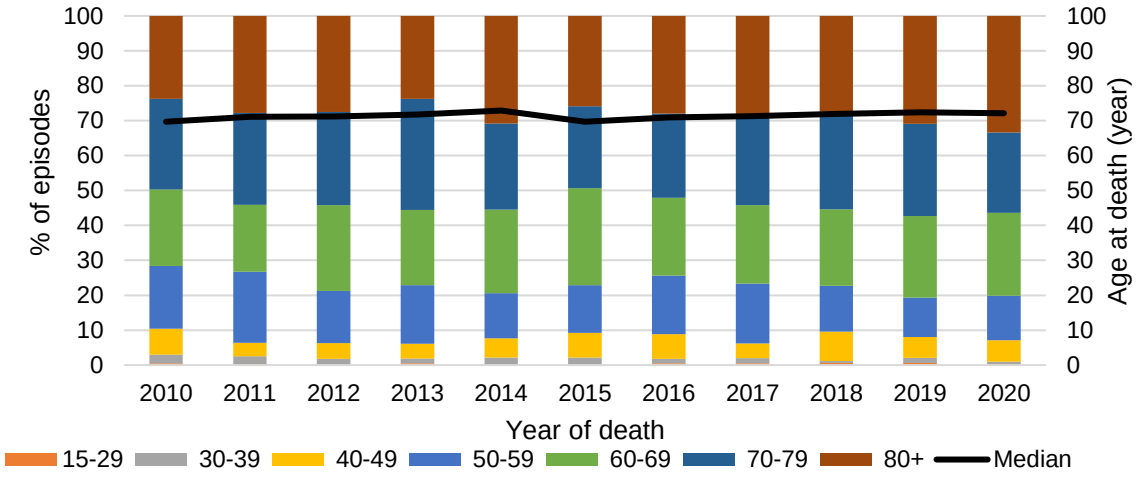
The median age at death due to stroke among males ranged between 69.7 and 72.9 years in the past decade (Table 5.2.5a). In 2020, those aged 80 years and above (33.4%) formed the highest proportion of males who died of stroke (Figure 5.2.5a).

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

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	69.7	2	0.5	9	2.5	27	7.4
2011	71.1	1	0.3	9	2.3	15	3.8
2012	71.2	0	0.0	7	1.8	17	4.5
2013	71.8	2	0.6	5	1.4	15	4.1
2014	72.9	0	0.0	8	2.2	20	5.5
2015	69.7	0	0.0	8	2.2	26	7.1
2016	70.9	2	0.5	5	1.3	27	7.1
2017	71.3	2	0.6	5	1.4	15	4.2
2018	71.9	2	0.6	2	0.6	29	8.5
2019	72.4	2	0.6	5	1.5	20	5.9
2020	72.1	1	0.2	3	0.7	26	6.2

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	66	18.0	80	21.9	95	26.0	87	23.8
2011	80	20.4	75	19.1	103	26.3	109	27.8
2012	57	14.9	94	24.6	102	26.7	105	27.5
2013	61	16.9	78	21.5	115	31.8	86	23.8
2014	47	12.9	87	23.9	90	24.7	112	30.8
2015	50	13.6	102	27.8	86	23.4	95	25.9
2016	64	16.8	85	22.3	92	24.1	107	28.0
2017	61	17.1	80	22.5	93	26.1	100	28.1
2018	45	13.1	75	21.9	96	28.0	94	27.4
2019	38	11.3	79	23.4	89	26.4	104	30.9
2020	54	12.8	100	23.7	97	23.0	141	33.4

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



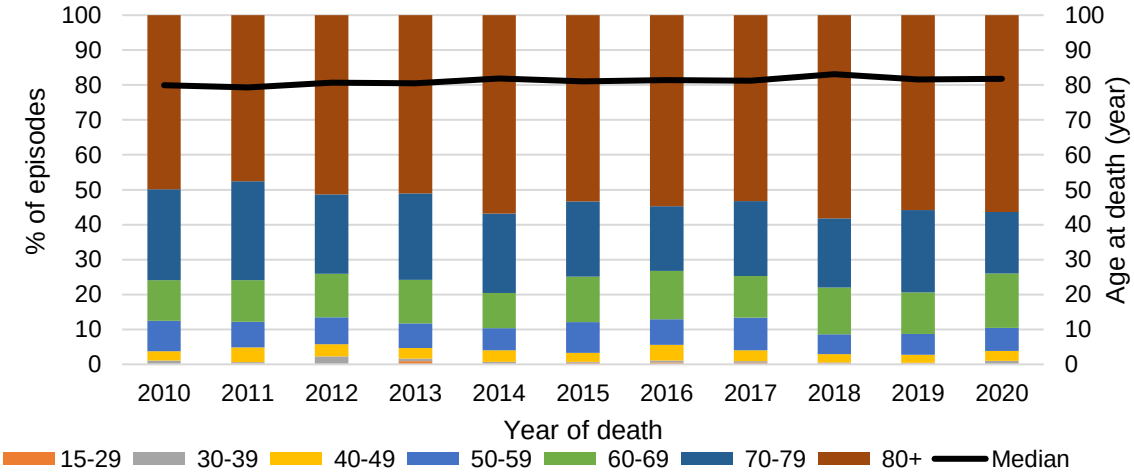
With females having an older median age at onset of stroke compared to males (Tables 5.1.5a and 5.1.5b), they were also found to have an older median age at death. The median age at death due to stroke among females ranged between 79.3 and 83.1 years in the past decade (Table 5.2.5b). In 2020, those aged 80 years and above (56.4%) formed the highest proportion of females who died of stroke (Figure 5.2.5b).

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

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	79.9	0	0.0	4	1.1	10	2.7
2011	79.3	1	0.2	2	0.4	19	4.2
2012	80.7	0	0.0	9	2.2	14	3.5
2013	80.5	4	0.9	3	0.7	13	3.1
2014	81.9	1	0.2	2	0.5	14	3.3
2015	81.0	2	0.5	1	0.2	11	2.6
2016	81.4	2	0.5	2	0.5	17	4.5
2017	81.2	2	0.5	2	0.5	13	3.1
2018	83.1	1	0.3	1	0.3	9	2.4
2019	81.6	1	0.2	1	0.2	9	2.2
2020	81.8	0	0.0	4	1.0	11	2.8

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	32	8.7	43	11.7	96	26.0	184	49.9
2011	33	7.3	54	11.9	128	28.3	215	47.6
2012	31	7.7	50	12.5	91	22.7	206	51.4
2013	30	7.1	53	12.5	105	24.7	217	51.1
2014	27	6.3	43	10.1	97	22.8	242	56.8
2015	37	8.8	55	13.0	91	21.6	225	53.3
2016	28	7.4	52	13.8	70	18.5	207	54.8
2017	39	9.3	50	11.9	90	21.5	223	53.2
2018	21	5.6	50	13.4	74	19.8	217	58.2
2019	24	6.0	48	11.9	95	23.6	225	55.8
2020	26	6.6	61	15.6	69	17.6	221	56.4

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

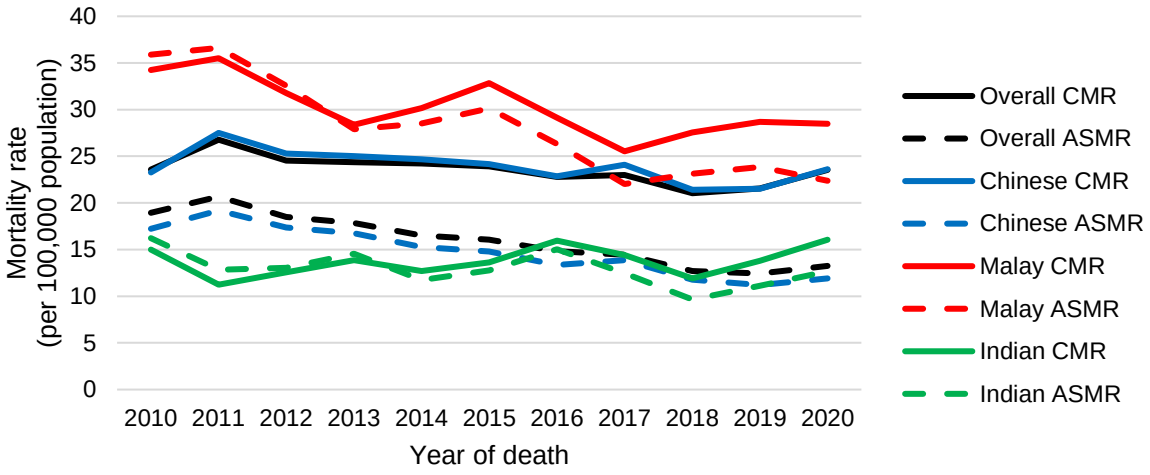


Among the ethnic groups, as Malays consistently had the highest ASIRs across the years (Table 5.1.6), they also consistently had the highest ASMRs (Table 5.2.6). The ASMR of 22.4 per 100,000 population among Malays was higher than the ASMR for Chinese (11.9 per 100,000 population) and Indians (12.7 per 100,000 population) in 2020. The ASMRs showed a downward trend over the years for Chinese ($p<0.001$) and Malays ($p<0.001$), while it fluctuated for Indians ($p=0.061$) (Figure 5.2.6).

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

Chinese						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2010	548	74.6	23.3	21.3-25.2	17.2	15.7-18.7
2011	655	77.6	27.5	25.4-29.6	19.2	17.7-20.7
2012	610	77.9	25.3	23.3-27.3	17.4	15.9-18.8
2013	610	77.5	25.0	23.0-27.0	16.7	15.4-18.1
2014	608	77.0	24.7	22.7-26.6	15.3	14.0-16.5
2015	602	76.3	24.1	22.2-26.1	14.8	13.6-16.0
2016	576	75.8	22.9	21.0-24.7	13.4	12.2-14.5
2017	613	79.1	24.1	22.2-26.0	13.9	12.7-15.0
2018	550	76.8	21.4	19.6-23.2	11.8	10.8-12.8
2019	558	75.4	21.5	19.7-23.3	11.2	10.2-12.2
2020	616	75.7	23.6	21.8-25.5	11.9	10.9-12.9
P for trend	-	-	0.028	-	<0.001	-
Malay						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2010	134	18.2	34.2	28.4-40.0	35.9	29.6-42.2
2011	141	16.7	35.5	29.6-41.4	36.6	30.3-42.9
2012	128	16.3	31.8	26.3-37.3	32.6	26.7-38.4
2013	116	14.7	28.4	23.2-33.5	27.9	22.7-33.1
2014	125	15.8	30.2	24.9-35.4	28.5	23.4-33.6
2015	138	17.5	32.8	27.4-38.3	30.1	25.0-35.3
2016	124	16.3	29.1	24.0-34.2	26.3	21.5-31.1
2017	110	14.2	25.5	20.8-30.3	22.0	17.8-26.2
2018	120	16.8	27.6	22.6-32.5	23.1	18.9-27.3
2019	126	17.0	28.7	23.7-33.7	23.8	19.6-28.1
2020	126	15.5	28.5	23.5-33.5	22.4	18.4-26.4
P for trend	-	-	0.009	-	<0.001	-
Indian						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2010	41	5.6	15.0	10.4-19.6	16.2	11.1-21.4
2011	31	3.7	11.2	7.3-15.2	12.8	8.1-17.6
2012	35	4.5	12.5	8.4-16.7	13.1	8.6-17.6
2013	39	5.0	13.9	9.5-18.2	14.6	9.9-19.2
2014	36	4.6	12.7	8.5-16.8	11.7	7.8-15.7
2015	39	4.9	13.6	9.4-17.9	12.8	8.6-16.9
2016	46	6.1	15.9	11.3-20.6	15.0	10.5-19.6
2017	42	5.4	14.4	10.1-18.8	12.5	8.6-16.3
2018	35	4.9	11.9	8.0-15.8	9.7	6.4-12.9
2019	41	5.5	13.8	9.6-18.0	11.1	7.7-14.6
2020	48	5.9	16.1	11.5-20.6	12.7	9.1-16.3
P for trend	-	-	0.293	-	0.061	-

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

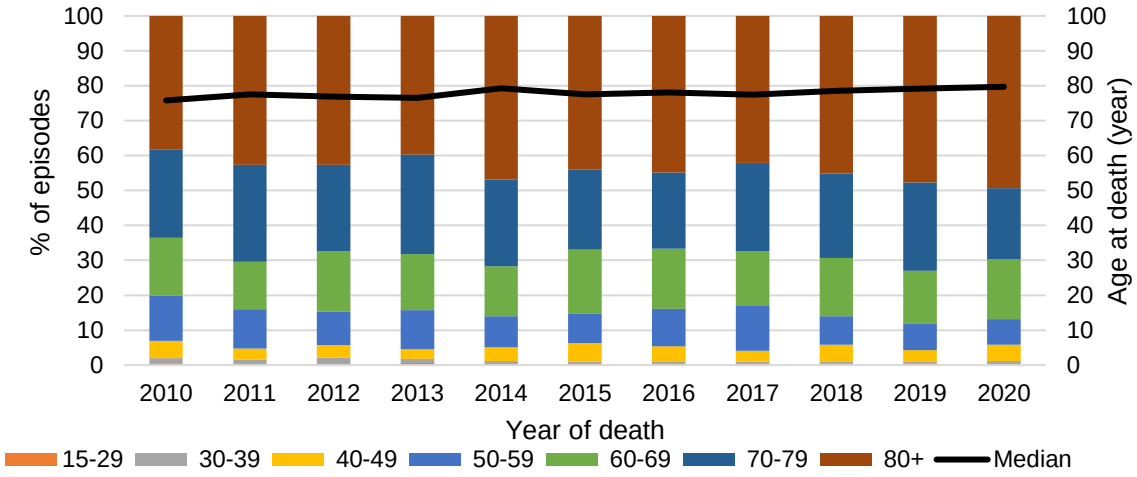


Similar to having the oldest median age at onset of stroke (Tables 5.1.7a to 5.1.7c), Chinese also had the oldest median age at death, which ranged between 75.8 and 79.7 years in the past decade (Table 5.2.7a). In 2020, those aged 80 years and above (49.4%) formed the highest proportion of Chinese who died of stroke (Figure 5.2.7a).

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

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	75.8	2	0.4	9	1.6	27	4.9
2011	77.5	1	0.2	9	1.4	21	3.2
2012	76.9	0	0.0	13	2.1	22	3.6
2013	76.5	4	0.7	7	1.1	17	2.8
2014	79.3	1	0.2	6	1.0	24	3.9
2015	77.5	2	0.3	4	0.7	32	5.3
2016	78.1	2	0.3	3	0.5	26	4.5
2017	77.4	3	0.5	3	0.5	19	3.1
2018	78.5	3	0.5	3	0.5	26	4.7
2019	79.2	3	0.5	3	0.5	18	3.2
2020	79.7	0	0.0	7	1.1	29	4.7
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	71	13.0	91	16.6	138	25.2	210	38.3
2011	74	11.3	89	13.6	182	27.8	279	42.6
2012	59	9.7	105	17.2	151	24.8	260	42.6
2013	68	11.1	98	16.1	174	28.5	242	39.7
2014	54	8.9	87	14.3	151	24.8	285	46.9
2015	51	8.5	110	18.3	138	22.9	265	44.0
2016	62	10.8	99	17.2	126	21.9	258	44.8
2017	79	12.9	96	15.7	155	25.3	258	42.1
2018	45	8.2	92	16.7	133	24.2	248	45.1
2019	43	7.7	84	15.1	141	25.3	266	47.7
2020	45	7.3	106	17.2	125	20.3	304	49.4

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



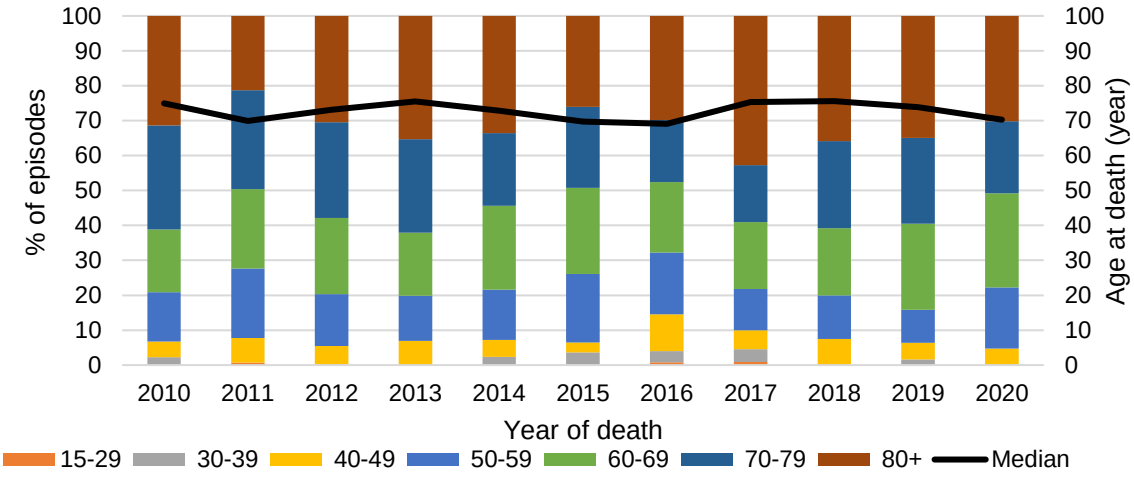
The median age at death due to stroke among Malays ranged between 69.1 and 75.6 years in the past decade (Table 5.2.7b). In 2020, those aged 80 years and above (30.2%) formed the highest proportion of Malays who died of stroke (Figure 5.2.7b).

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

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	75.0	0	0.0	3	2.2	6	4.5
2011	69.9	1	0.7	0	0.0	10	7.1
2012	73.1	0	0.0	0	0.0	7	5.5
2013	75.5	0	0.0	0	0.0	8	6.9
2014	72.9	0	0.0	3	2.4	6	4.8
2015	69.7	0	0.0	5	3.6	4	2.9
2016	69.1	1	0.8	4	3.2	13	10.5
2017	75.3	1	0.9	4	3.6	6	5.5
2018	75.6	0	0.0	0	0.0	9	7.5
2019	73.9	0	0.0	2	1.6	6	4.8
2020	70.3	0	0.0	0	0.0	6	4.8

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	19	14.2	24	17.9	40	29.9	42	31.3
2011	28	19.9	32	22.7	40	28.4	30	21.3
2012	19	14.8	28	21.9	35	27.3	39	30.5
2013	15	12.9	21	18.1	31	26.7	41	35.3
2014	18	14.4	30	24.0	26	20.8	42	33.6
2015	27	19.6	34	24.6	32	23.2	36	26.1
2016	22	17.7	25	20.2	22	17.7	37	29.8
2017	13	11.8	21	19.1	18	16.4	47	42.7
2018	15	12.5	23	19.2	30	25.0	43	35.8
2019	12	9.5	31	24.6	31	24.6	44	34.9
2020	22	17.5	34	27.0	26	20.6	38	30.2

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



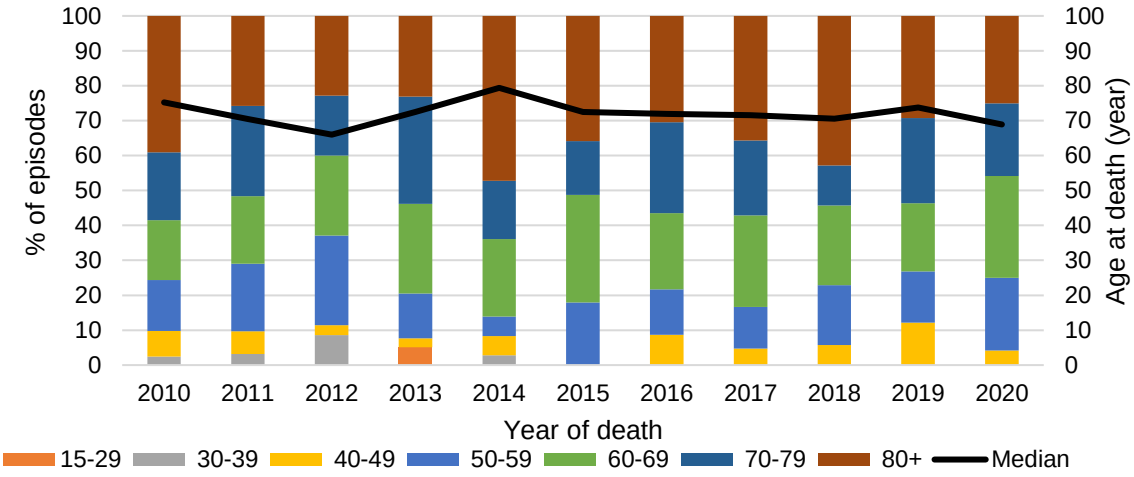
The median age at death due to stroke among Indians ranged between 66.0 and 79.4 years in the past decade (Table 5.2.7c). In 2020, those aged 60-69 years (29.2%) formed the highest proportion of Indians who died of stroke (Figure 5.2.7c).

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

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	75.2	0	0.0	1	2.4	3	7.3
2011	70.5	0	0.0	1	3.2	2	6.5
2012	66.0	0	0.0	3	8.6	1	2.9
2013	72.5	2	5.1	0	0.0	1	2.6
2014	79.4	0	0.0	1	2.8	2	5.6
2015	72.5	0	0.0	0	0.0	0	0.0
2016	71.9	0	0.0	0	0.0	4	8.7
2017	71.6	0	0.0	0	0.0	2	4.8
2018	70.6	0	0.0	0	0.0	2	5.7
2019	73.8	0	0.0	0	0.0	5	12.2
2020	68.9	0	0.0	0	0.0	2	4.2

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	6	14.6	7	17.1	8	19.5	16	39.0
2011	6	19.4	6	19.4	8	25.8	8	25.8
2012	9	25.7	8	22.9	6	17.1	8	22.9
2013	5	12.8	10	25.6	12	30.8	9	23.1
2014	2	5.6	8	22.2	6	16.7	17	47.2
2015	7	17.9	12	30.8	6	15.4	14	35.9
2016	6	13.0	10	21.7	12	26.1	14	30.4
2017	5	11.9	11	26.2	9	21.4	15	35.7
2018	6	17.1	8	22.9	4	11.4	15	42.9
2019	6	14.6	8	19.5	10	24.4	12	29.3
2020	10	20.8	14	29.2	10	20.8	12	25.0

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



As the ASIRs of IS were consistently higher than HS across the years (Table 5.1.8), the ASMRs of IS were also generally higher (Table 5.2.8). The ASMR of IS declined from 9.9 per 100,000 population in 2010 to 6.2 per 100,000 population in 2020 (p<0.001). Similarly, the ASMR of HS declined from 8.9 per 100,000 population in 2010 to 7.0 per 100,000 population in 2020 (p=0.002) (Figure 5.2.8).

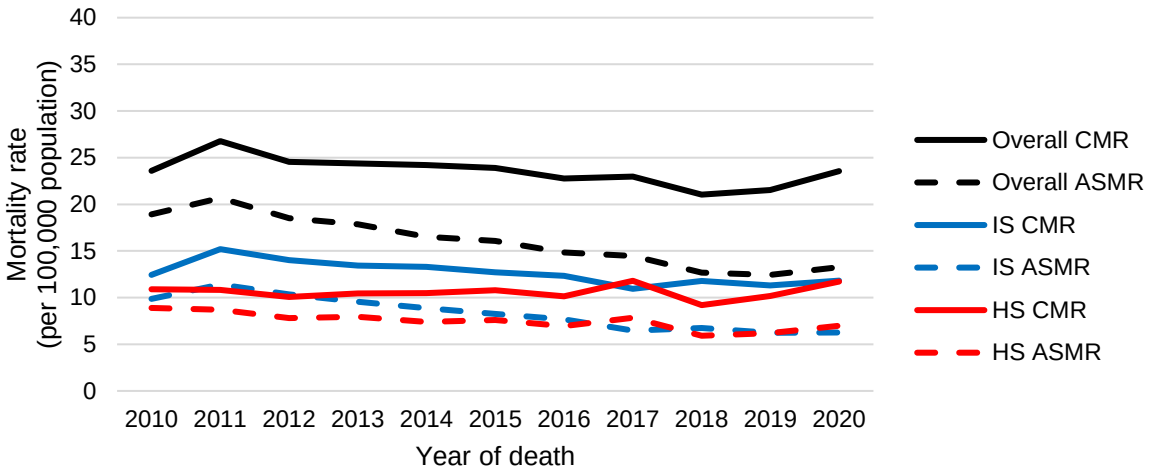
As the percentages in Table 5.2.8 are among all stroke and patients without documentation of IS or HS are not shown, the sum of the percentages for IS and HS are less than 100% for each year.

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

Ischaemic stroke						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2010	388	52.8	12.4	11.2-13.7	9.9	8.8-10.9
2011	479	56.8	15.2	13.8-16.6	11.4	10.4-12.4
2012	447	57.1	14.0	12.7-15.3	10.3	9.4-11.3
2013	434	55.1	13.4	12.2-14.7	9.5	8.6-10.5
2014	434	54.9	13.3	12.1-14.6	8.9	8.0-9.7
2015	420	53.2	12.7	11.5-13.9	8.2	7.4-9.1
2016	412	54.2	12.3	11.2-13.5	7.7	6.9-8.4
2017	369	47.6	10.9	9.8-12.1	6.5	5.8-7.1
2018	401	56.0	11.8	10.6-12.9	6.7	6.1-7.4
2019	389	52.6	11.3	10.2-12.4	6.2	5.6-6.9
2020	408	50.1	11.8	10.7-13.0	6.2	5.6-6.9
P for trend	-	-	0.008	-	<0.001	-

Haemorrhagic stroke						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2010	340	46.3	10.9	9.7-12.1	8.9	7.9-9.9
2011	341	40.4	10.8	9.7-12.0	8.7	7.8-9.6
2012	322	41.1	10.1	9.0-11.2	7.8	6.9-8.7
2013	337	42.8	10.4	9.3-11.6	8.0	7.1-8.8
2014	342	43.3	10.5	9.4-11.6	7.4	6.6-8.2
2015	356	45.1	10.8	9.7-11.9	7.6	6.8-8.4
2016	338	44.5	10.1	9.0-11.2	7.0	6.2-7.7
2017	398	51.4	11.8	10.6-13.0	7.9	7.1-8.6
2018	313	43.7	9.2	8.2-10.2	5.9	5.2-6.6
2019	349	47.2	10.2	9.1-11.2	6.2	5.5-6.9
2020	405	49.8	11.7	10.6-12.9	7.0	6.3-7.7
P for trend	-	-	0.941	-	0.002	-

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



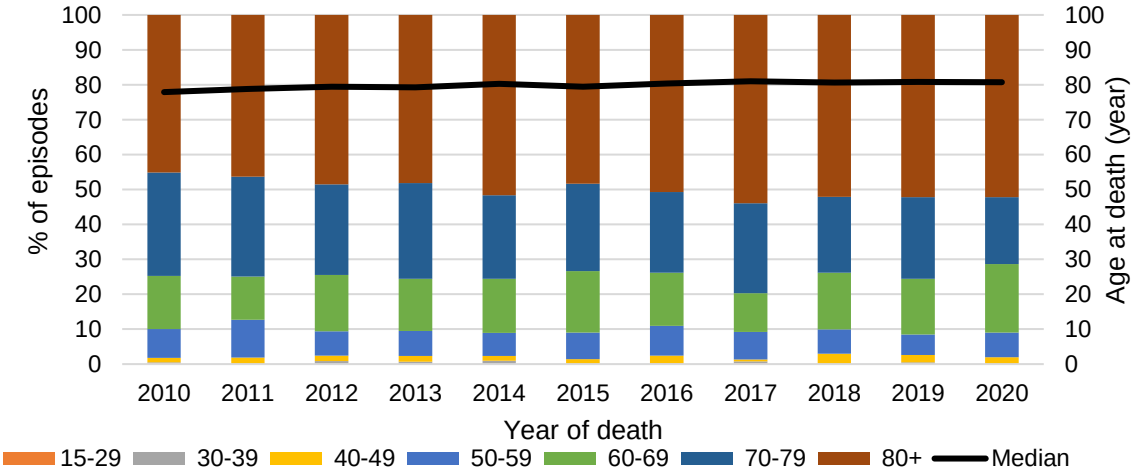
The median age at death due to stroke among IS patients ranged between 77.9 and 81.0 years in the past decade (Table 5.2.9a). In 2020, those aged 80 years and above (52.2%) formed the highest proportion of IS patients who died of stroke (Figure 5.2.9a).

Table 5.2.9a: Age distribution at death of ischaemic stroke

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	77.9	1	0.3	1	0.3	5	1.3
2011	78.8	0	0.0	0	0.0	9	1.9
2012	79.4	0	0.0	4	0.9	7	1.6
2013	79.3	0	0.0	3	0.7	7	1.6
2014	80.3	0	0.0	4	0.9	6	1.4
2015	79.4	0	0.0	0	0.0	6	1.4
2016	80.4	1	0.2	0	0.0	9	2.2
2017	81.0	1	0.3	2	0.5	2	0.5
2018	80.6	0	0.0	0	0.0	12	3.0
2019	80.8	0	0.0	2	0.5	8	2.1
2020	80.7	0	0.0	0	0.0	8	2.0

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	32	8.2	59	15.2	115	29.6	175	45.1
2011	52	10.9	59	12.3	137	28.6	222	46.3
2012	31	6.9	72	16.1	116	26.0	217	48.5
2013	31	7.1	65	15.0	119	27.4	209	48.2
2014	29	6.7	67	15.4	104	24.0	224	51.6
2015	32	7.6	74	17.6	105	25.0	203	48.3
2016	35	8.5	63	15.3	95	23.1	209	50.7
2017	29	7.9	41	11.1	95	25.7	199	53.9
2018	28	7.0	65	16.2	87	21.7	209	52.1
2019	23	5.9	62	15.9	91	23.4	203	52.2
2020	29	7.1	80	19.6	78	19.1	213	52.2

Figure 5.2.9a: Age distribution at death of ischaemic stroke



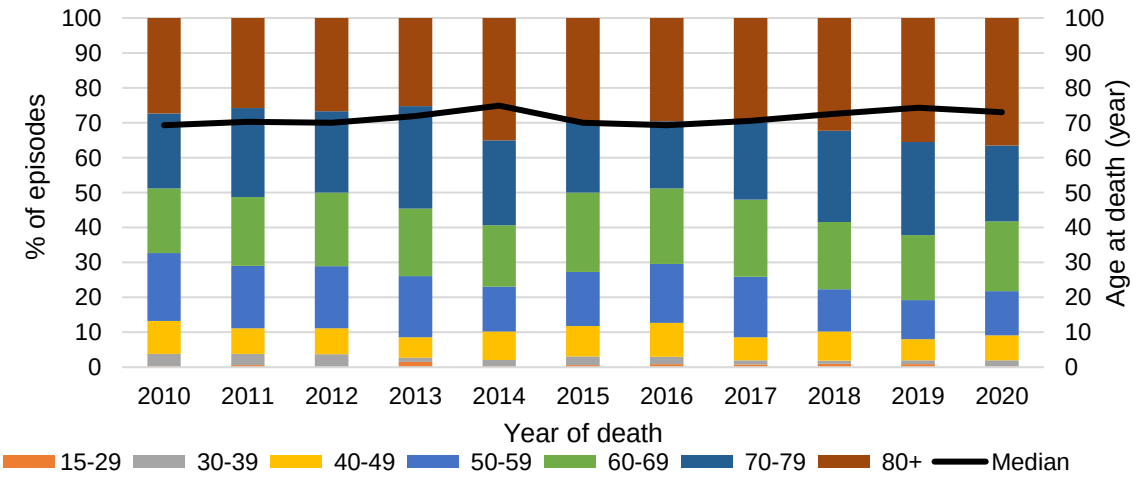
Similar to having a younger median age at stroke onset (Tables 5.1.9a and 5.1.9b), HS patients had a younger median age at death than IS patients. The median age at death due to stroke among HS patients ranged between 69.3 and 74.9 years in the past decade (Table 5.2.9b). In 2020, those aged 80 years and above (36.5%) formed the highest proportion of HS patients who died of stroke (Figure 5.2.9b).

Table 5.2.9b: Age distribution at death of haemorrhagic stroke

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2010	69.3	1	0.3	12	3.5	32	9.4
2011	70.3	2	0.6	11	3.2	25	7.3
2012	70.0	0	0.0	12	3.7	24	7.5
2013	71.9	5	1.5	4	1.2	20	5.9
2014	74.9	1	0.3	6	1.8	28	8.2
2015	70.0	2	0.6	9	2.5	31	8.7
2016	69.3	3	0.9	7	2.1	33	9.8
2017	70.5	3	0.8	5	1.3	26	6.5
2018	72.6	3	1.0	3	1.0	26	8.3
2019	74.3	3	0.9	4	1.1	21	6.0
2020	73.0	1	0.2	7	1.7	29	7.2

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2010	66	19.4	63	18.5	73	21.5	93	27.4
2011	61	17.9	67	19.6	87	25.5	88	25.8
2012	57	17.7	68	21.1	75	23.3	86	26.7
2013	59	17.5	65	19.3	99	29.4	85	25.2
2014	44	12.9	60	17.5	83	24.3	120	35.1
2015	55	15.4	81	22.8	72	20.2	106	29.8
2016	57	16.9	73	21.6	65	19.2	100	29.6
2017	69	17.3	88	22.1	88	22.1	119	29.9
2018	38	12.1	60	19.2	82	26.2	101	32.3
2019	39	11.2	65	18.6	93	26.6	124	35.5
2020	51	12.6	81	20.0	88	21.7	148	36.5

Figure 5.2.9b: Age distribution at death of haemorrhagic stroke



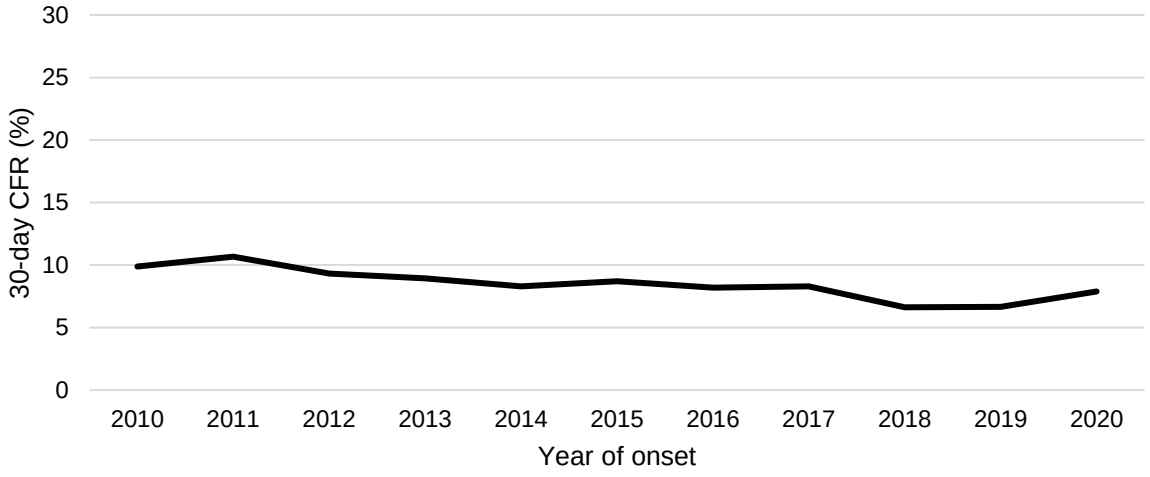
5.3 30-Day Case Fatality

The number of deaths due to stroke within 30 days from onset of stroke (Table 5.3.1) did not increase as much as the number of stroke episodes over the years (Table 5.1.1). While the 30-day case fatality rate (CFR) decreased from 9.9% in 2010 to 6.7% in 2019, it increased to 7.9% in 2020 (Figure 5.3.1). As 2020 was the first year affected by COVID-19 pandemic, the trend in CFR will be monitored to see if it continues to rise after 2020 and warrants further intervention.

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

Year of onset	Number	CFR	95% CI
2010	566	9.9	9.1-10.7
2011	638	10.7	9.8-11.5
2012	572	9.3	8.5-10.1
2013	583	8.9	8.2-9.7
2014	568	8.3	7.6-9.0
2015	624	8.7	8.0-9.4
2016	595	8.2	7.5-8.9
2017	637	8.3	7.7-8.9
2018	540	6.6	6.1-7.2
2019	576	6.7	6.1-7.2
2020	677	7.9	7.3-8.5
P for trend	-	0.001	-

Figure 5.3.1: Case fatality rate of stroke (%)

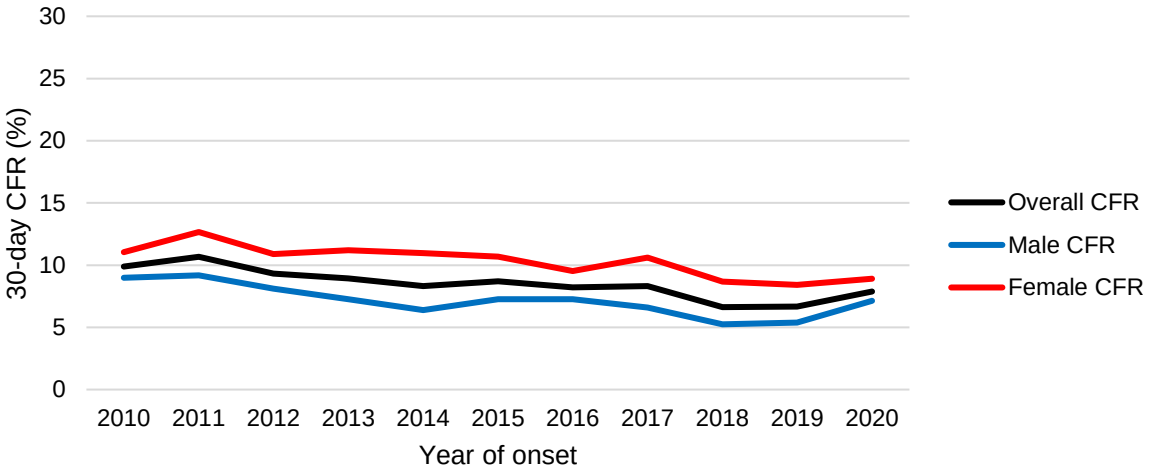


Although the ASMRs for males were consistently higher than females across the years (Table 5.2.4), the CFRs for males were consistently lower than females (Table 5.3.2). The CFR was 7.1% for males and 8.9% for females in 2020. As females tended to have stroke at an older age than males (Tables 5.1.5a and 5.1.5b), they were likely to have more co-morbidities when the stroke happened, which led to poorer prognosis. The CFR fell over the years for both genders (males: p=0.004, females: p=0.001) (Figure 5.3.2).

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

Male				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	288	50.9	9.0	7.9-10.0
2011	314	49.2	9.2	8.2-10.2
2012	284	49.7	8.1	7.2-9.1
2013	272	46.7	7.3	6.4-8.1
2014	253	44.5	6.4	5.6-7.2
2015	298	47.8	7.3	6.4-8.1
2016	307	51.6	7.3	6.5-8.1
2017	291	45.7	6.6	5.8-7.4
2018	255	47.2	5.2	4.6-5.9
2019	269	46.7	5.4	4.8-6.0
2020	353	52.1	7.1	6.4-7.9
P for trend	-	-	0.004	-
Female				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	278	49.1	11.1	9.8-12.4
2011	324	50.8	12.7	11.3-14.0
2012	288	50.3	10.9	9.6-12.1
2013	311	53.3	11.2	10.0-12.5
2014	315	55.5	11.0	9.7-12.2
2015	326	52.2	10.7	9.5-11.8
2016	288	48.4	9.5	8.4-10.6
2017	346	54.3	10.6	9.5-11.7
2018	285	52.8	8.7	7.7-9.7
2019	307	53.3	8.4	7.5-9.4
2020	324	47.9	8.9	7.9-9.9
P for trend	-	-	0.001	-

Figure 5.3.2: Case fatality rate of stroke (%) by gender



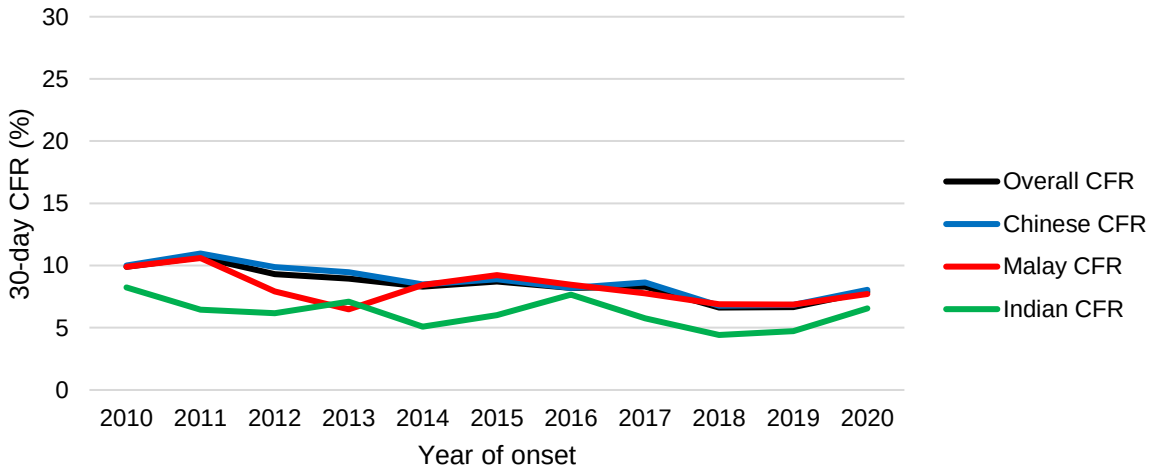
Although Malays consistently had the highest ASMRs among the ethnic groups (Table 5.2.6), the CFRs of Chinese and Malays were not distinctly different across the years (Table 5.3.3). The higher CFR among Chinese was likely due to Chinese being the oldest at the onset of stroke (Tables 5.1.7a and 5.1.7b). The CFRs were 8.0%, 7.7% and 6.6% for Chinese, Malays and Indians respectively in 2020. The CFR fell over the years for Chinese (p=0.001), but it fluctuated for Malays (p=0.057) and Indians (p=0.099) (Figure 5.3.3).

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

Chinese				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	437	77.2	10.0	9.1-10.9
2011	499	78.2	11.0	10.0-11.9
2012	462	80.8	9.9	9.0-10.8
2013	466	79.9	9.5	8.6-10.3
2014	441	77.6	8.5	7.7-9.3
2015	485	77.7	8.9	8.1-9.7
2016	451	75.8	8.2	7.4-9.0
2017	504	79.1	8.7	7.9-9.4
2018	418	77.4	6.8	6.1-7.4
2019	443	76.9	6.8	6.2-7.5
2020	512	75.6	8.0	7.3-8.7
P for trend	-	-	0.001	-

Malay				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	89	15.7	9.9	7.9-12.0
2011	100	15.7	10.6	8.5-12.7
2012	81	14.2	7.9	6.2-9.6
2013	67	11.5	6.5	4.9-8.0
2014	90	15.8	8.4	6.7-10.2
2015	106	17.0	9.2	7.5-11.0
2016	95	16.0	8.5	6.8-10.2
2017	93	14.6	7.8	6.2-9.4
2018	88	16.3	6.9	5.5-8.3
2019	92	16.0	6.9	5.5-8.3
2020	101	14.9	7.7	6.2-9.2
P for trend	-	-	0.057	-
Indian				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	30	5.3	8.2	5.3-11.2
2011	25	3.9	6.5	3.9-9.0
2012	21	3.7	6.2	3.5-8.8
2013	32	5.5	7.1	4.6-9.6
2014	23	4.0	5.1	3.0-7.2
2015	27	4.3	6.0	3.7-8.3
2016	37	6.2	7.7	5.2-10.1
2017	30	4.7	5.8	3.7-7.8
2018	24	4.4	4.4	2.7-6.2
2019	30	5.2	4.7	3.0-6.4
2020	42	6.2	6.6	4.6-8.5
P for trend	-	-	0.099	-

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



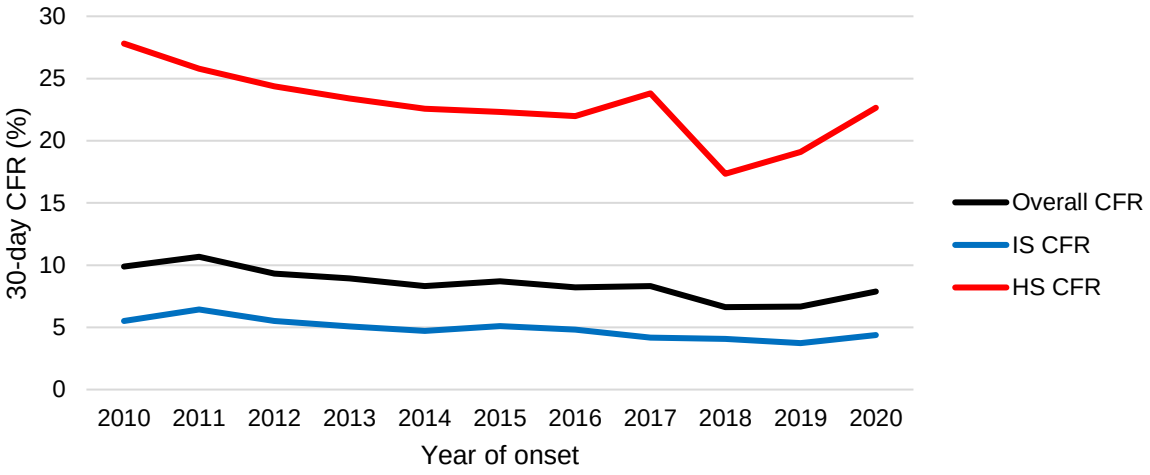
Although IS patients generally had higher ASMRs than HS patients across the years (Table 5.2.8), the CFRs among IS patients were consistently lower than HS patients (Table 5.3.4). In 2020, the CFRs were 4.4% and 22.6% for IS and HS patients respectively. A plausible reason is that HS is a more severe condition with higher likelihood of fatality if not treated promptly. The baseline National Institutes of Health Stroke Scale (NIHSS) measures the severity of stroke based on 11 items, with a score that ranges from 0 to 42 and a higher score indicative of higher level of impairment. It is more commonly used on IS patients than HS patients. Based on available data, the median baseline NIHSS score for IS patients was consistently lower compared to that for HS patients in the past decade (IS patients: NIHSS score remained stable between 4 and 5 in 2015 to 2020, while the score for HS patients remained stable between 10 and 12 during this period). The CFR fell over the years for both IS ($p<0.001$) and HS ($p=0.007$) patients (Figure 5.3.4).

As the percentages in Table 5.3.4 are among all stroke and patients without documentation of IS or HS are not shown, the sum of the percentages for IS and HS are less than 100% for each year.

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

Ischaemic stroke				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	254	44.9	5.5	4.8-6.2
2011	306	48.0	6.4	5.7-7.2
2012	273	47.7	5.5	4.9-6.2
2013	265	45.5	5.1	4.5-5.7
2014	260	45.8	4.7	4.1-5.3
2015	291	46.6	5.1	4.5-5.7
2016	282	47.4	4.8	4.3-5.4
2017	253	39.7	4.2	3.7-4.7
2018	269	49.8	4.1	3.6-4.6
2019	261	45.3	3.7	3.3-4.2
2020	305	45.1	4.4	3.9-4.9
P for trend	-	-	<0.001	-
Haemorrhagic stroke				
Year of onset	**Number**	**%**	**CFR**	**95% CI**
2010	307	54.2	27.8	24.7-30.9
2011	308	48.3	25.8	22.9-28.7
2012	285	49.8	24.4	21.5-27.2
2013	302	51.8	23.4	20.8-26.0
2014	294	51.8	22.6	20.0-25.1
2015	320	51.3	22.3	19.9-24.8
2016	303	50.9	22.0	19.5-24.5
2017	377	59.2	23.8	21.4-26.2
2018	269	49.8	17.3	15.3-19.4
2019	313	54.3	19.1	17.0-21.2
2020	371	54.8	22.6	20.3-25.0
P for trend	-	-	0.007	-

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



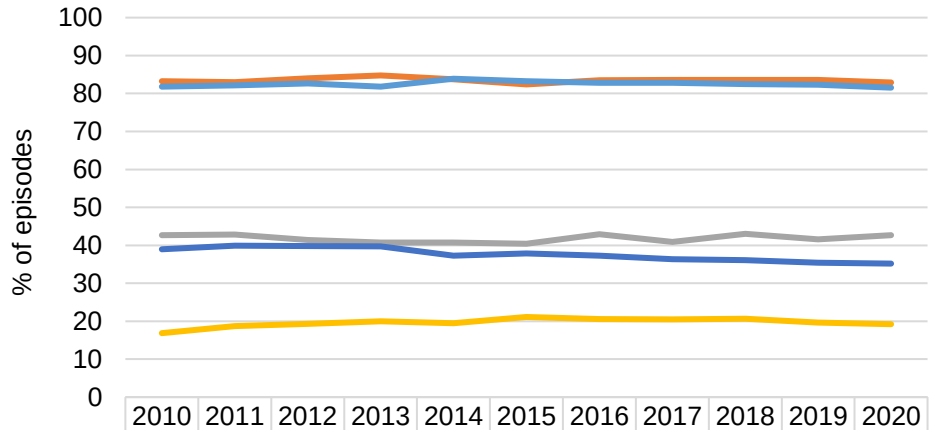
5.4 Risk Factors

Hypertension, hyperlipidemia, diabetes, smoking and atrial fibrillation/flutter (AF) are well-established risk factors of stroke[9]. Hypertension, hyperlipidemia, diabetes, smoking are modifiable risk factors, while AF is not preventable for everyone. However, leading a healthy lifestyle, getting diagnosed for AF early and getting the right treatment for AF, can reduce the complications from AF[10].

Hypertension, hyperlipidemia, diabetes and AF were defined as positive if there was history of the condition, or if it was newly diagnosed during index admission. Smoking included former or current smokers. As a patient could have multiple risk factors, the percentages in Figure 5.4.1 will not add up to 100% for each year.

Between 2010 and 2020, hyperlipidemia and hypertension were consistently the two most common risk factors among stroke patients (Figure 5.4.1). In 2020, 82.9% of the patients had hyperlipidemia and 81.5% had hypertension. Diabetes, smoking and AF were also prevalent among stroke patients, with 42.7%, 35.2% and 19.2% of them having these risk factors respectively in 2020. Aside from smoking whereby the proportion of patients who smoked dropped slightly over the past decade, the proportion of stroke patients with the other risk factors remained stable during this period.

Figure 5.4.1: Risk factors (%) among all stroke patients

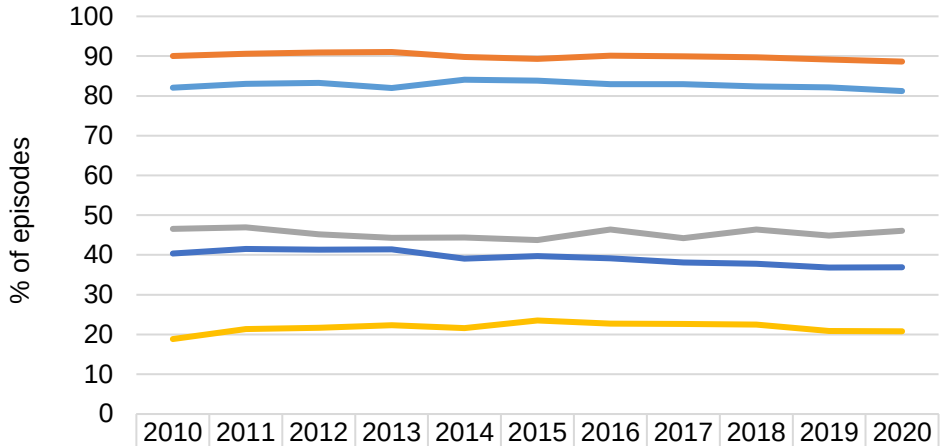


Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hyperlipidemia	83.2	83.0	84.0	84.8	83.7	82.4	83.5	83.6	83.6	83.6	82.9
Hypertension	81.8	82.1	82.6	81.8	83.9	83.2	82.8	82.8	82.5	82.3	81.5
Diabetes	42.7	42.9	41.4	40.8	40.8	40.4	42.9	40.9	43.0	41.6	42.7
Smoking	38.9	39.9	39.8	39.8	37.3	37.9	37.3	36.3	36.1	35.4	35.2
Atrial fibrillation/flutter	16.9	18.7	19.3	20.0	19.5	21.1	20.6	20.5	20.7	19.6	19.2

[9] Boehme AK et al. Stroke risk factors, genetics, and prevention. Circulation Research 2017; 120(3): 472-495.
[10] Shah SR, Luu SW, Calestino M, David J, Christopher B. Management of atrial fibrillation-flutter: uptodate guideline paper on the current evidence. Journal of Community Hospital Internal Medicine Perspectives. 2018; 8(5): 269-275.

Compared to HS patients, the proportions of IS patients with hyperlipidemia, diabetes, AF and who smoked were higher (Figures 5.4.2 and 5.4.3). This finding is consistent with a case-control study based on 32 countries worldwide, which found that hypertension was more associated with HS, while apolipoproteins, diabetes, cardiac causes and smoking were more associated with IS[11].

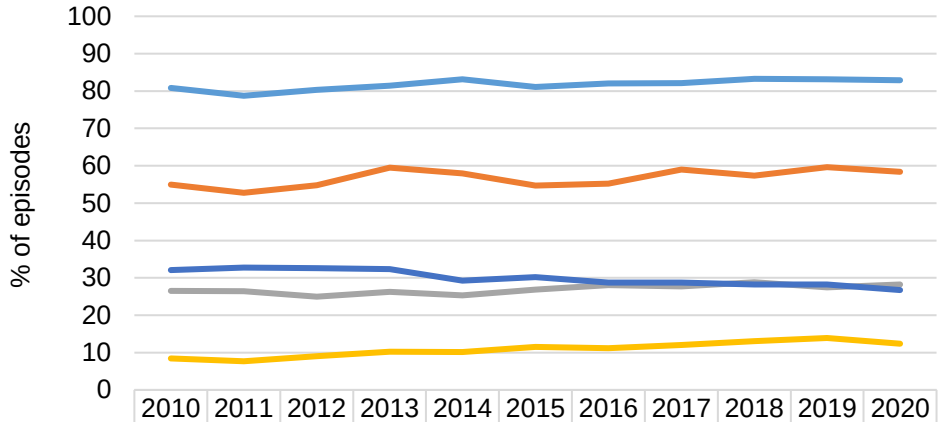
Figure 5.4.2: Risk factors (%) among ischaemic stroke patients



Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hyperlipidemia	90.0	90.6	90.9	91.0	89.8	89.3	90.1	89.9	89.7	89.2	88.6
Hypertension	82.1	83.0	83.2	82.0	84.1	83.9	83.0	83.0	82.4	82.2	81.2
Diabetes	46.5	46.9	45.2	44.3	44.4	43.8	46.4	44.2	46.4	44.9	46.0
Smoking	40.4	41.5	41.3	41.4	39.1	39.7	39.2	38.1	37.8	36.8	36.9
Atrial fibrillation/flutter	18.9	21.4	21.7	22.3	21.6	23.5	22.7	22.7	22.5	20.9	20.8

[11] O'Donnell MJ et al. Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): a case-control study. Lancet 2016; 388(10046): 761-775.

Figure 5.4.3: Risk factors (%) among haemorrhagic stroke patients



Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Hyperlipidemia	54.9	52.8	54.7	59.5	57.9	54.7	55.2	59.0	57.3	59.6	58.3
Hypertension	80.8	78.7	80.3	81.5	83.1	81.1	82.0	82.2	83.3	83.1	82.9
Diabetes	26.5	26.4	25.0	26.3	25.3	26.9	28.1	27.7	28.8	27.4	28.2
Smoking	32.1	32.8	32.6	32.3	29.2	30.2	28.7	28.8	28.2	28.2	26.7
Atrial fibrillation/flutter	8.4	7.7	9.1	10.2	10.1	11.5	11.2	12.0	13.0	13.9	12.4

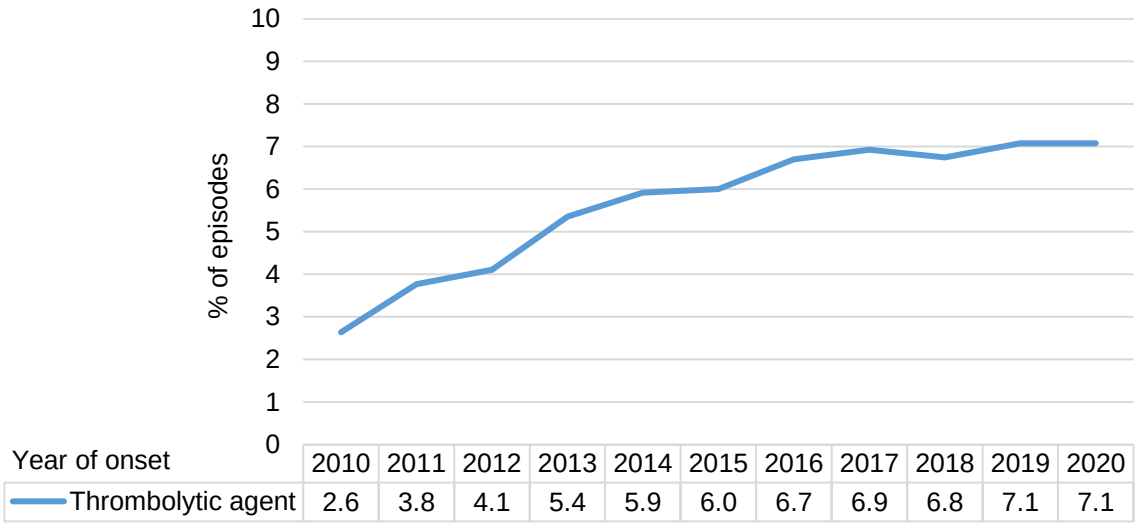
5.5 Treatment

The administration of thrombolytic agent to eligible patients with IS [12] has been shown to be beneficial in several clinical trials, with optimal recovery rate when given within 3 hours from onset of stroke and moderate recovery rate when given within 3 to 4.5 hours from onset[13].

As the administration of thrombolytic agent is time sensitive, patients who were transferred from another hospital were excluded from the calculation of thrombolytic agent given. Patients who were enrolled in stroke clinical trials were also excluded.

The proportion of IS patients who received thrombolytic agent increased from 2.6% in 2010 to 7.1% in 2020 (Figure 5.5.1). The rise was likely due to more patients meeting the 4.5-hour recommended window for thrombolysis.

Figure 5.5.1: Thrombolysis (%) among ischaemic stroke



Year of onset	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Thrombolytic agent	2.6	3.8	4.1	5.4	5.9	6.0	6.7	6.9	6.8	7.1	7.1

[12] Examples of ineligible patients include those on blood thinning medication and those with extensive brain damage, high risk of bleeding and recent bleeding.
[13] Powers WJ et al. Guidelines for the early management of patients with acute ischemic stroke: A guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2018; 49(3): e46-e110.

6. CONCLUSION

The top contributor to the combined burden of early death and disability in Singapore was cardiovascular diseases and they accounted for 14.2% of the total disability-adjusted life years in 2017[14]. It is important for individuals with high risk of stroke to take preventive action. One can reduce his/her chances of developing stroke by adopting a healthy lifestyle, such as eating all food in moderation and opting for healthier products, leading an active lifestyle and maintaining a healthy weight, avoiding smoking, going for health screening and follow-ups, and controlling blood pressure, cholesterol and glucose levels well[15]. For individuals with symptoms of stroke, seeking medical help promptly plays a crucial role in prognosis. For individuals who survived a stroke, adherence to medication and healthy lifestyle can reduce the risk of subsequent cardiovascular event and death.

[14] The Burden of Disease in Singapore, 1990-2017. Ministry of Health, Singapore. www.healthdata.org/sites/default/files/files/policy_report/2019/GDB_2017_Singapore_Report.pdf Accessed on 1 Mar 2022.

[15] O'Donnell MJ et al. Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): a case-control study. Lancet 2016; 388(10046): 761-775.