



# **Singapore Stroke Registry Annual Report 2021**

**National Registry of Diseases Office**  
November 2023

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## 1. GLOSSARY

<b>AF</b>	Atrial fibrillation/ flutter
<b>ASIR</b>	Age-standardised incidence rate
<b>ASMR</b>	Age-standardised mortality rate
<b>CFR</b>	Case fatality rate
<b>CI</b>	Confidence interval
<b>CIR</b>	Crude incidence rate
<b>CMR</b>	Crude mortality rate
<b>CT</b>	Computed tomography
<b>HS</b>	Haemorrhagic stroke
<b>ICD</b>	International Classification of Diseases
<b>IS</b>	Ischaemic stroke
<b>MHA</b>	Ministry of Home Affairs
<b>MONICA</b>	Monitoring Trends and Determinants in Cardiovascular Disease
<b>MRI</b>	Magnetic resonance imaging
<b>NIHSS</b>	National Institutes of Health Stroke Scale
<b>NRIC</b>	National Registration Identity Card
<b>SCDF</b>	Singapore Civil Defence Force
<b>SSR</b>	Singapore Stroke Registry

## 2. EXECUTIVE SUMMARY

The number of stroke episodes increased from 6,143 episodes in 2011 to 9,680 episodes in 2021. The age-standardised incidence rate (ASIR) increased significantly from 159.2 to 171.8 per 100,000 population during this period. The median age at onset of stroke increased slightly from 68.0 years in 2011 to 69.8 years in 2021.

There was a slight increase in the number of stroke deaths from 844 in 2011 to 883 in 2021. However, in terms of age-standardised mortality rate (ASMR), there was a significant decline from 20.7 to 13.9 per 100,000 population during this period. A significant drop in 30-day case fatality rate (CFR) from 10.7% in 2011 to 7.5% in 2021 was also observed.

About 80% of stroke incidence each year were ischaemic strokes (IS), while 20% were haemorrhagic strokes (HS), and the ASIRs of IS were consistently higher than HS across the years. In the earlier half of the past decade, the ASMRs of IS were higher compared to those for HS, though the rates have narrowed over the years, mainly due to a sharper decline in IS mortality. In 2021, ASMRs for IS and HS were 6.7 and 7.2 per 100,000 population respectively. In terms of 30-day CFR, the rates among HS patients were consistently higher (CFR of 4.0% for IS compared to 22.9% for HS in 2021). This is likely due to HS generally being a more severe condition with a higher likelihood of fatality.

Between 2011 and 2021, hyperlipidemia and hypertension were consistently the two most common risk factors among stroke patients. In 2021, 83.2% of the patients had hyperlipidemia and 80.6% had hypertension. Diabetes, smoking and atrial fibrillation/flutter were also prevalent among stroke patients, with 43.1%, 34.0% and 19.5% of them having these risk factors respectively in 2021. Apart from smoking whereby the proportion of patients who smoked has dropped slightly over the years, the proportion of stroke patients with the other risk factors has remained relatively unchanged.

With regard to treatment, the proportion of IS patients who received thrombolytic agents increased from 3.8% in 2011 to 6.2% in 2021.

### 3. INTRODUCTION

Cerebrovascular disease was the fourth most common cause of death in 2021, accounting for 6.1% of all deaths in Singapore<sup>1</sup>. Stroke is a type of cerebrovascular disease.

There are two main types of stroke – ischaemic stroke (IS) and haemorrhagic stroke (HS). IS occurs due to occlusion of blood vessels, which limits blood flow to the brain, and is more prevalent. HS (comprising subarachnoid and parenchyma haemorrhage) is more severe and occurs due to blood vessel rupture that causes bleeding in the brain. Treatment for IS typically involves blood-thinning drugs, such as anti-platelets and anti-coagulants, while HS may be treated with surgery or endovascular therapy.

Regardless of stroke subtype, 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 38 years in 2011 to 41.8 years in 2021, and the proportion of residents aged 65 years and above rose from 9.3% in 2011 to 16.0% in 2021<sup>2</sup>. With Singapore's rapidly ageing population, the incidence of stroke is expected to rise. 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.

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<sup>1</sup> Principal Causes of Death. Ministry of Health, Singapore. [www.moh.gov.sg/resources-statistics/singapore-health-facts/principal-causes-of-death](http://www.moh.gov.sg/resources-statistics/singapore-health-facts/principal-causes-of-death) Accessed on 17 May 2022.

<sup>2</sup> Population Trends 2021. Department of Statistics, Singapore. [www.singstat.gov.sg/publications/population/population-trends](http://www.singstat.gov.sg/publications/population/population-trends) Accessed on 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. As of 2005, data is collected 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 9<sup>th</sup> 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<sup>3</sup>.

The death status of all patients registered in the SSR were updated till 30 November 2022 by matching the patients' NRIC number with the death information from the MHA.

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<sup>3</sup> 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<sup>4</sup>. The Segi World population estimates used for age standardisation are available on the World Health Organization website<sup>5</sup>.

## 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 and above, diagnosed with stroke and treated in public healthcare institutions in the past decade, from 2011 to 2021 as they stood on 10 May 2023. 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 this information was 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.

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<sup>4</sup> 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 2023.

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

## 5. FINDINGS

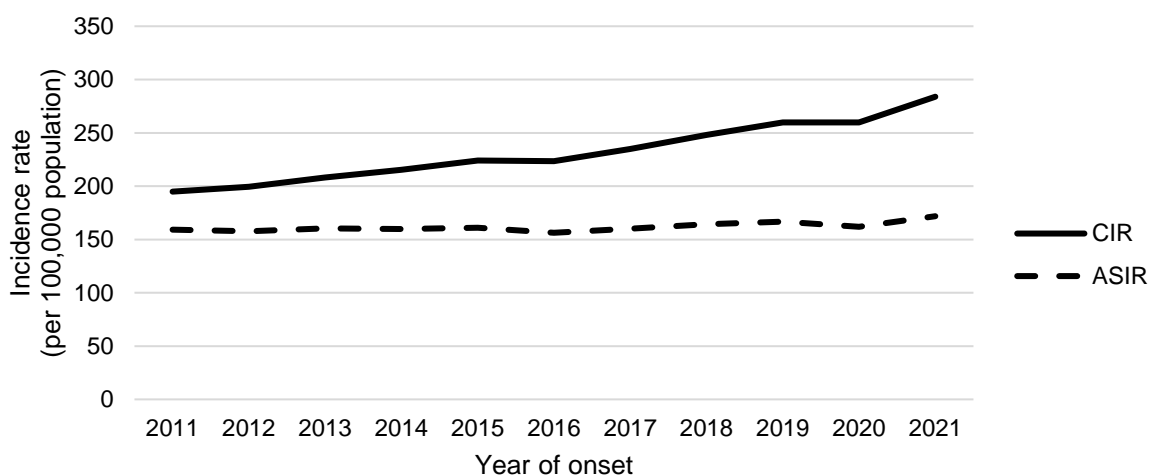
### 5.1 Incidence

The number of stroke episodes increased from 6,143 to 9,680 between 2011 and 2021 and there was a significant increase in the crude incidence rate (CIR) during this period (Table 5.1.1 and Figure 5.1.1). The age-standardised incidence rate (ASIR) also increased significantly from 159.2 to 171.8 per 100,000 population from 2011 to 2021.

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

Year of onset	Number	CIR	95% CI	ASIR	95% CI
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	8923	259.8	254.4-265.1	166.7	163.1-170.2
2020	8978	259.8	254.4-265.2	161.9	158.5-165.4
2021	9680	283.9	278.2-289.6	171.8	168.2-175.4
<b>P for trend</b>	-	<0.001	-	0.01	-

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

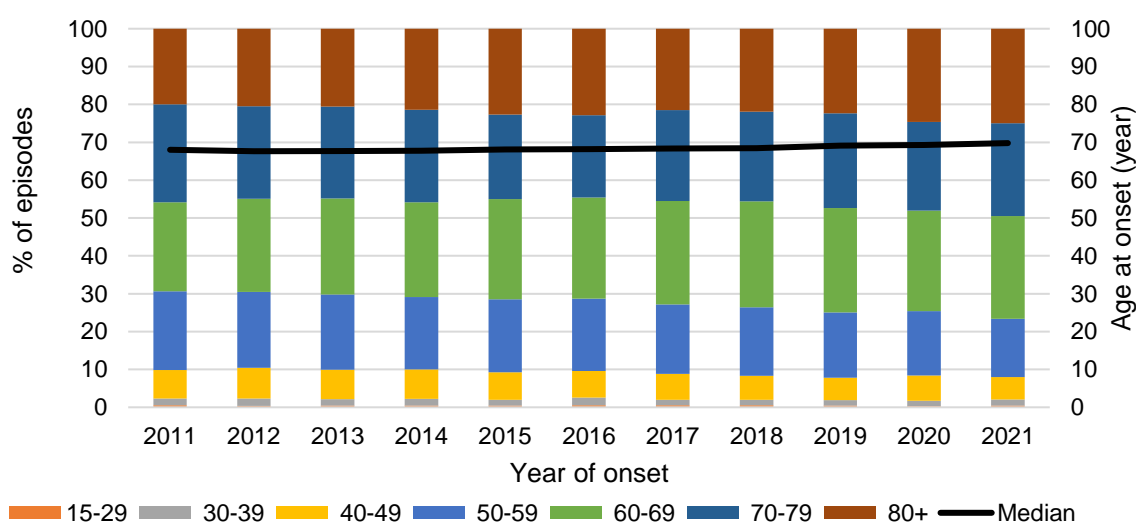


The median age at onset of stroke increased slightly from 68.0 years in 2011 to 69.8 years in 2021 (Table 5.1.2). About 3 in 4 patients were aged 60 years and above in 2021, a gradual increase from about 69% (7 in 10) in 2011 (Figure 5.1.2).

**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	%
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		28	0.3	127	1.4	597	6.6
2021	69.8		40	0.4	156	1.6	578	6.0
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1542	17.3	2458	27.5	2234	25.0	1994	22.3
2020	1527	17.0	2389	26.6	2097	23.4	2213	24.6
2021	1485	15.3	2635	27.2	2367	24.5	2419	25.0

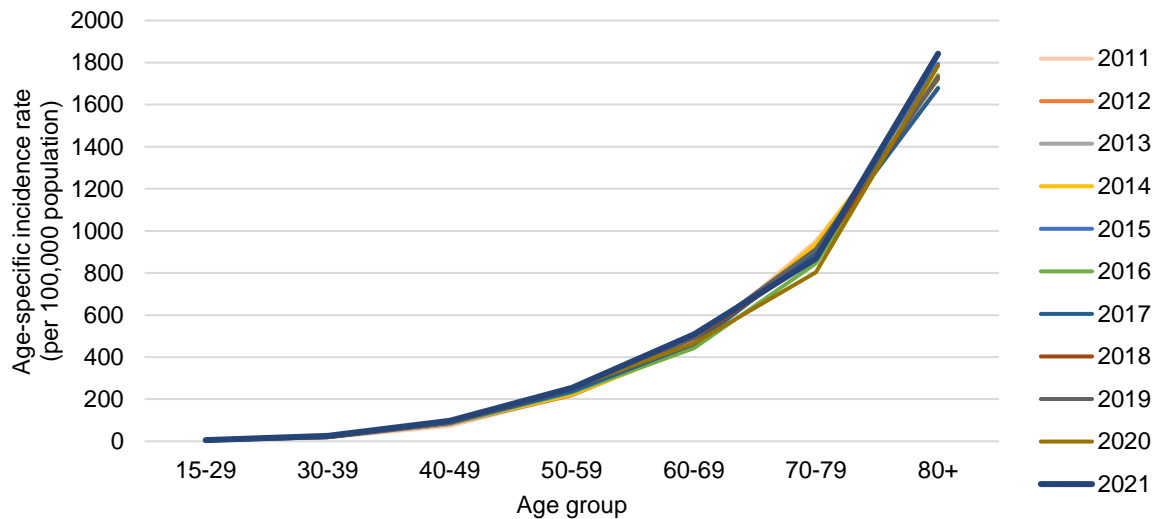
**Figure 5.1.2: Age distribution at onset of stroke**



The ASIR increased with age, with the oldest age group having the highest incidence rate (Figures 5.1.3a and 5.1.3b). Older individuals are at greater risk of stroke due to higher prevalence of cardiovascular risk factors such as hypertension, hyperlipidaemia and diabetes, and this was also reflected in the National Population Health Survey 2022, whereby the age-specific prevalence of these risk factors increased with age<sup>6</sup>. In general, the incidence of stroke globally has been noted to double for each decade after 55 years of age<sup>7</sup>. From 2011-2021, the age-specific incidence of stroke among older age groups in Singapore reflected this pattern as well, approximately doubling with every subsequent 10-year age group from 50 years onwards.

Between 2011 and 2021, a significant rise in incidence rates was observed for all age groups, with the exception of those aged 15-29 years (Table 5.1.3).

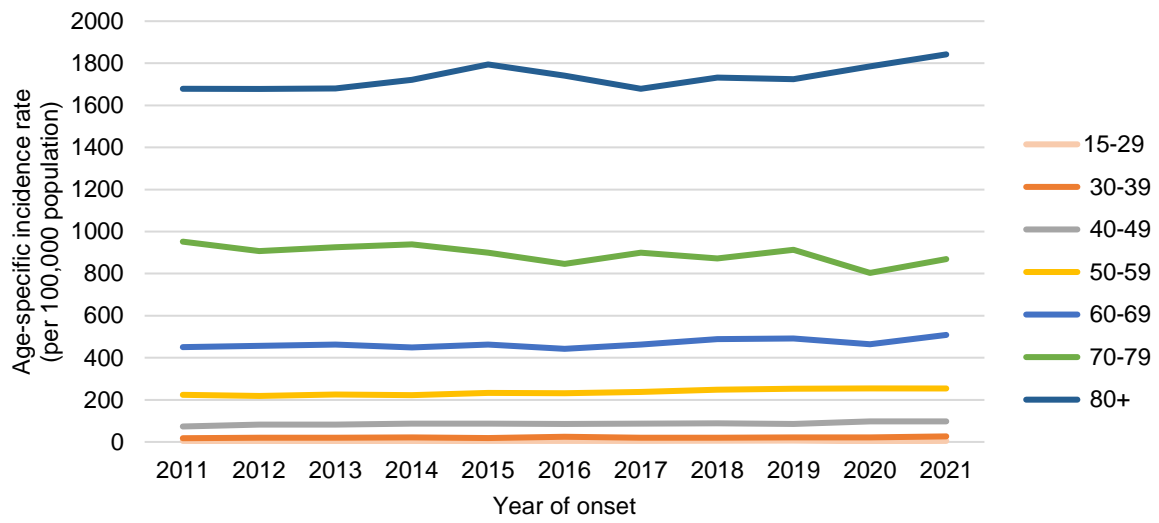
**Figure 5.1.3a: Age-specific incidence rate of stroke (per 100,000 population) across age groups**



<sup>6</sup> 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 on 4 October 2023.

<sup>7</sup> Boehme AK, Esenwa C and Elkind M. Stroke Risk Factors, Genetics, and Prevention. *Circ Res.* 2017;120:472-495.

**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
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	259.8	254.4-265.1	5.7	4.0-7.4	21.2	17.5-24.9	85.9	78.5-93.2
2020	259.8	254.4-265.2	3.7	2.4-5.1	21.3	17.6-25.0	97.7	89.9-105.5
2021	283.9	278.2-289.6	5.6	3.8-7.3	26.4	22.3-30.6	97.5	89.5-105.4
P for trend	<0.001	-	0.062	-	0.043	-	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
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	253.4	240.8-266.1	491.5	472.0-510.9	912.9	875.0-950.7	1724.1	1648.4-1799.7
2020	253.7	241.0-266.4	464.8	446.1-483.4	803.5	769.1-837.8	1785.1	1710.7-1859.4
2021	254.2	241.3-267.1	508.7	489.3-528.1	869.2	834.2-904.3	1842.2	1768.8-1915.6
P for trend	<0.001	-	0.013	-	0.018	-	0.016	-

Although the gender distribution was almost equal in the general population, there were more males suffering from stroke than females, with males comprising about 60% (3 in 5) of stroke episodes each year (Table 5.1.4). The ASIRs for males were consistently higher than females across the years (Figure 5.1.4). Males had an ASIR of 220.4 per 100,000 population, while females had an ASIR of 125.5 per 100,000 population in 2021. In addition, a significant upward trend in ASIR was observed for males ( $p < 0.001$ ) but not for females ( $p = 0.860$ ).

Males are known to have a higher risk of stroke compared to females<sup>8</sup>. The underlying causes are multi-factorial and related to the pathophysiological gender differences in stroke<sup>9</sup>. 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 2022<sup>10</sup>.

**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
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	5156	57.8	309.1	300.7-317.5	212.2	206.3-218.1
2020	5193	57.8	309.6	301.2-318.0	206.4	200.7-212.1
2021	5622	58.1	339.1	330.2-348.0	220.4	214.5-226.3
P for trend	-	-	<0.001	-	0.001	-
Female						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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	3785	42.2	212.8	206.0-219.6	119.5	115.4-123.5
2021	4058	41.9	231.7	224.5-238.8	125.5	121.4-129.7

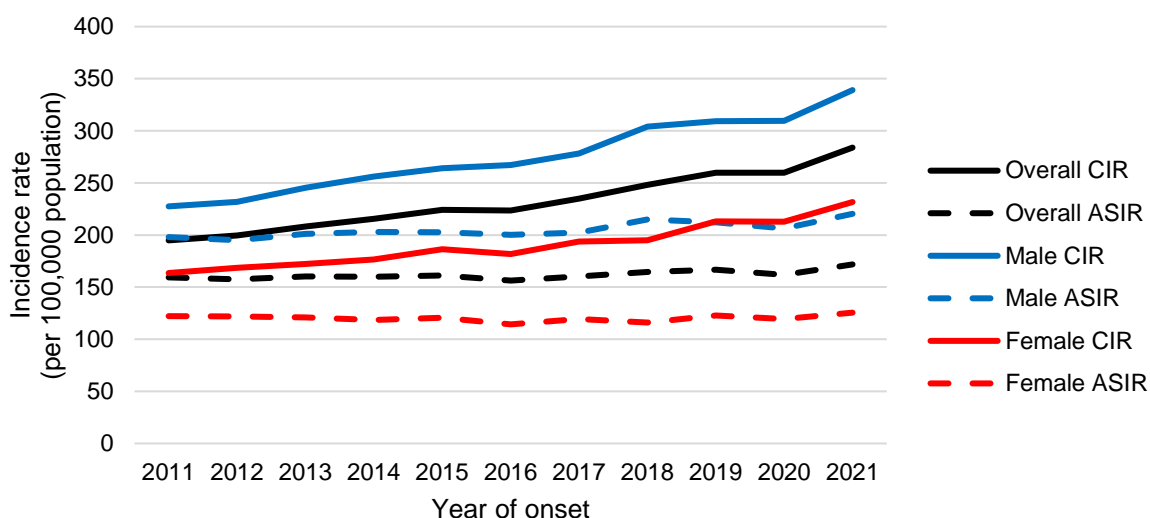
<sup>8</sup> Bushnell CD. et al. Sex differences in stroke: Challenges and opportunities. *Journal of Cerebral Blood Flow & Metabolism* 2018;38(12): 2179–2191.

<sup>9</sup> Reeves MJ et al. Sex differences in stroke: epidemiology, clinical presentation, medical care, and outcomes. *Lancet Neurology* 2008; 7(10): 915-926.

<sup>10</sup> 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 on 4 October 2023.

<b>P for trend</b>	-	-	<0.001	-	0.860	-
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**Figure 5.1.4: Incidence rate of stroke (per 100,000 population) by gender**



The median age at onset of stroke among males increased from 64.2 years in 2011 to 67.2 years in 2021, and the proportion of stroke patients aged 60 years and above increased from 62.3% in 2011 to 72.9% in 2021 (Table 5.1.5a). In 2021, those aged 60-69 years (31.9%) formed the highest proportion of male stroke patients (Figure 5.1.5a).

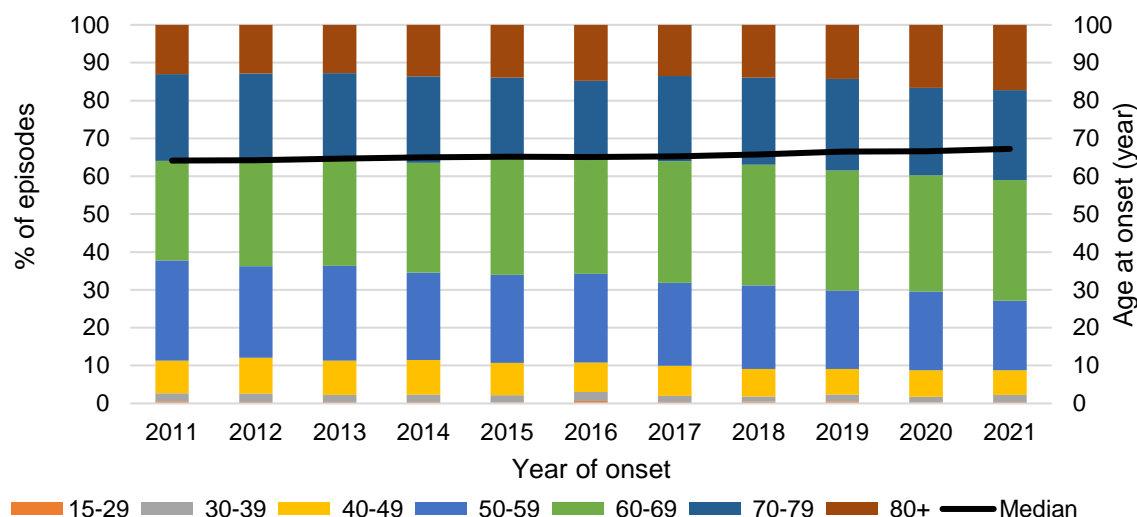
**Table 5.1.5a: Age distribution at onset of stroke among males**

Year of onset	Overall		Age 15-29		Age 30-39		Age 40-49	
	Median age		Number	%	Number	%	Number	%
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		17	0.3	72	1.4	368	7.1
2021	67.2		24	0.4	101	1.8	366	6.5
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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



<b>2018</b>	1112	22.1	1603	31.9	1157	23.0	701	13.9
<b>2019</b>	1070	20.8	1634	31.7	1250	24.2	734	14.2
<b>2020</b>	1080	20.8	1594	30.7	1197	23.1	865	16.7
<b>2021</b>	1034	18.4	1791	31.9	1337	23.8	969	17.2

**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 general, globally, women tend to be several years older than men at stroke onset<sup>11</sup>. This could be due to the higher prevalence of risk factors such as diabetes, hypertension and hyperlipidaemia in males compared to females of the same age group, namely those under 60 years of age, as consistently documented in national health surveys, including the latest National Population Health Survey 2022<sup>12</sup>. In 2021, those aged 80 years and above (35.7%) formed the highest proportion of female stroke patients (Figure 5.1.5b). This trend of stroke incidence being lower in women from early through mid-adulthood but becoming higher with advanced age has been well-documented, and is partly related to the longer life expectancies of women<sup>13,14,15,16</sup>. Furthermore, there has also been evidence that pregnancy-related conditions such as gestational hypertension and preeclampsia increase the long-term risk of cardiovascular disease<sup>17</sup>.

**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	%
<b>2011</b>	73.2	14	0.5	34	1.3	162	6.2

<sup>11</sup> Rexrode KM et al. The Impact of Sex and Gender on Stroke. *Circulation Research*. 2022; 130: 512–528.

<sup>12</sup> 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 on 4 October 2023.

<sup>13</sup> Roy-O'Reilly M & McCullough LD. Age and Sex Are Critical Factors in Ischemic Stroke Pathology. *Endocrinology* 2018;159(8): 3120–3131.

<sup>14</sup> Reeves MJ et al. Sex differences in stroke: epidemiology, clinical presentation, medical care, and outcomes. *Lancet Neurology* 2008; 7(10): 915-926.

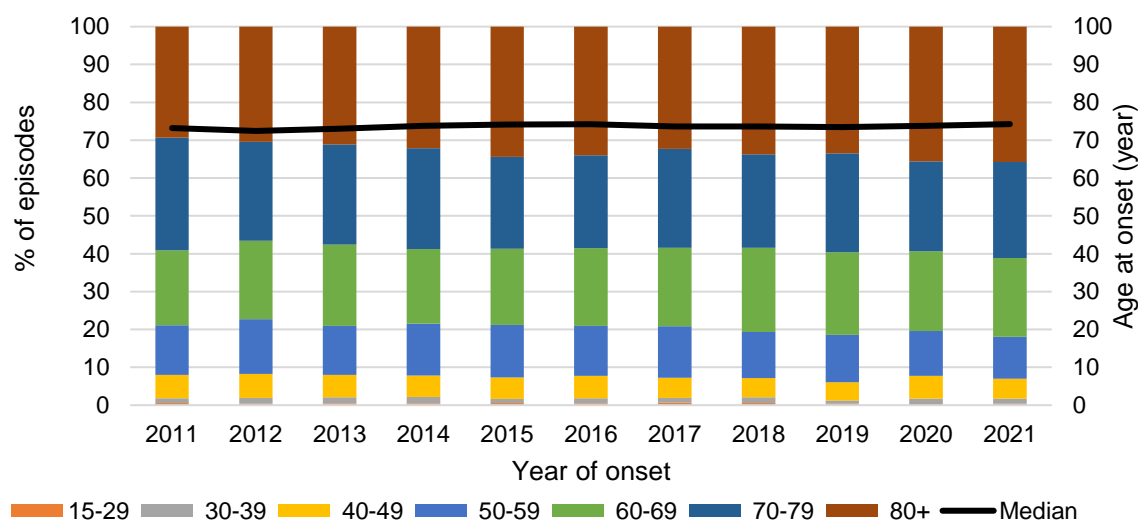
<sup>15</sup> Bushnell CD. et al. Sex differences in stroke: Challenges and opportunities. *Journal of Cerebral Blood Flow & Metabolism* 2018;38(12): 2179–2191.

<sup>16</sup> Boehme AK, Esenwa C and Elkind M. Stroke Risk Factors, Genetics, and Prevention. *Circ Res*. 2017;120:472-495.

<sup>17</sup> Rexrode KM et al. The Impact of Sex and Gender on Stroke. *Circulation Research*. 2022; 130: 512–528.

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	229	6.1	
2021	74.2	16	0.4	55	1.4	212	5.2	
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	447	11.8	795	21.0	900	23.8	1348	35.6
2021	451	11.1	844	20.8	1030	25.4	1450	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 154.7, 257.9, and 194.6 per 100,000 population for Chinese, Malays and Indians respectively in 2021. However, changes in the ASIR of stroke in the last decade were significant only among Indians.

The prevalence of hypertension, hyperlipidemia, high-risk BMI and smoking, which are common risk factors of stroke, were highest among Malays in the general population based on the National Population Health Survey 2022<sup>18</sup>. The higher prevalence of stroke risk factors among the Malay population increases their susceptibility to stroke, 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
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	6675	74.8	257.4	251.2-263.6	151.0	147.2-154.8
2020	6644	74.0	254.7	248.6-260.9	145.4	141.8-149.1
2021	7222	74.6	280.9	274.4-287.4	154.7	150.9-158.5
<b>P for trend</b>	-	-	<0.001	-	0.146	-

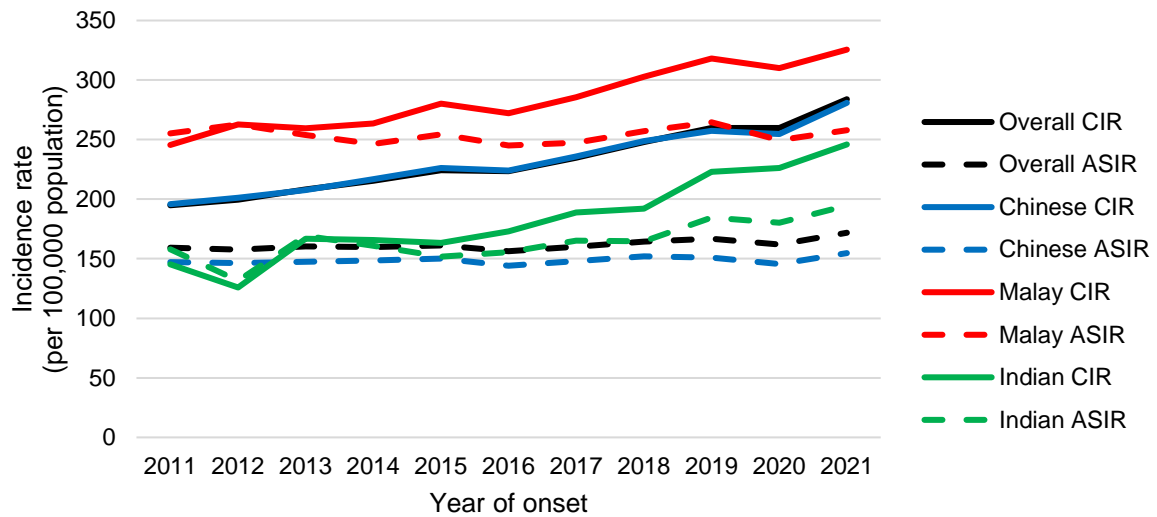
Malay						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
2011	975	15.9	245.5	230.1-260.9	255.2	238.4-271.9
2012	1059	16.6	262.8	247.0-278.6	262.8	246.5-279.1
2013	1061	15.8	259.5	243.9-275.2	254.0	238.3-269.6
2014	1092	15.5	263.4	247.8-279.1	246.3	231.4-261.3
2015	1177	15.9	280.2	264.2-296.2	254.4	239.5-269.3
2016	1159	15.5	272.2	256.5-287.8	245.1	230.6-259.6
2017	1231	15.5	285.7	269.7-301.7	247.4	233.3-261.5
2018	1318	15.6	302.8	286.4-319.1	257.2	243.1-271.3
2019	1397	15.7	318.1	301.5-334.8	264.6	250.5-278.7
2020	1371	15.3	310.0	293.6-326.4	249.5	236.1-263.0
2021	1434	14.8	325.6	308.7-342.4	257.9	244.3-271.5
<b>P for trend</b>	-	-	<0.001	-	0.928	-

Indian						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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

<sup>18</sup> 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 on 4 October 2023.

<b>2017</b>	550	6.9	188.8	173.0-204.6	165.1	151.1-179.1
<b>2018</b>	565	6.7	192.1	176.3-208.0	164.7	151.0-178.4
<b>2019</b>	663	7.4	222.9	205.9-239.9	184.5	170.3-198.6
<b>2020</b>	676	7.5	226.1	209.1-243.2	180.1	166.5-193.7
<b>2021</b>	722	7.5	246.0	228.0-263.9	194.6	180.3-208.9
<b>P for trend</b>	-	-	<0.001	-	0.006	-

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

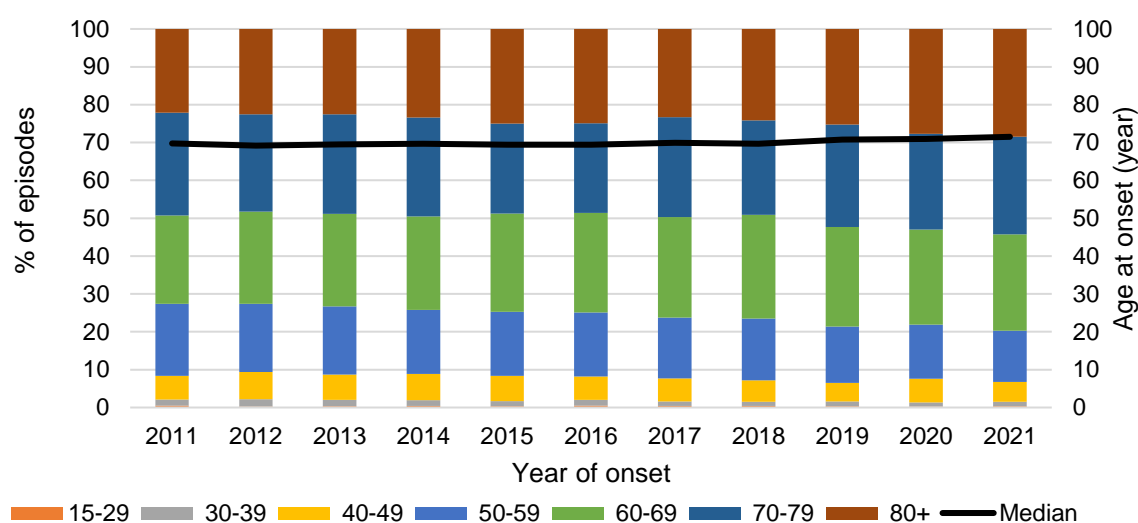


Among the ethnic groups, the Chinese had the oldest median age at onset of stroke, which increased slightly from 69.8 years in 2011 to 71.5 years in 2021, and the proportion of Chinese stroke patients aged 60 years and above had increased steadily from 72.6% in 2011 to 79.7% in 2021 (Table 5.1.7a). In 2021, those aged 80 years and above (28.5%) formed the highest proportion of Chinese stroke patients, a gradual increase from 22.1% in 2011 (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	%
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	77	1.2	413	6.2
2021	71.5		22	0.3	87	1.2	378	5.2
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1756	26.3	1807	27.1	1683	25.2
2020	948	14.3	1670	25.1	1679	25.3	1843	27.7
2021	979	13.6	1837	25.4	1863	25.8	2056	28.5

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



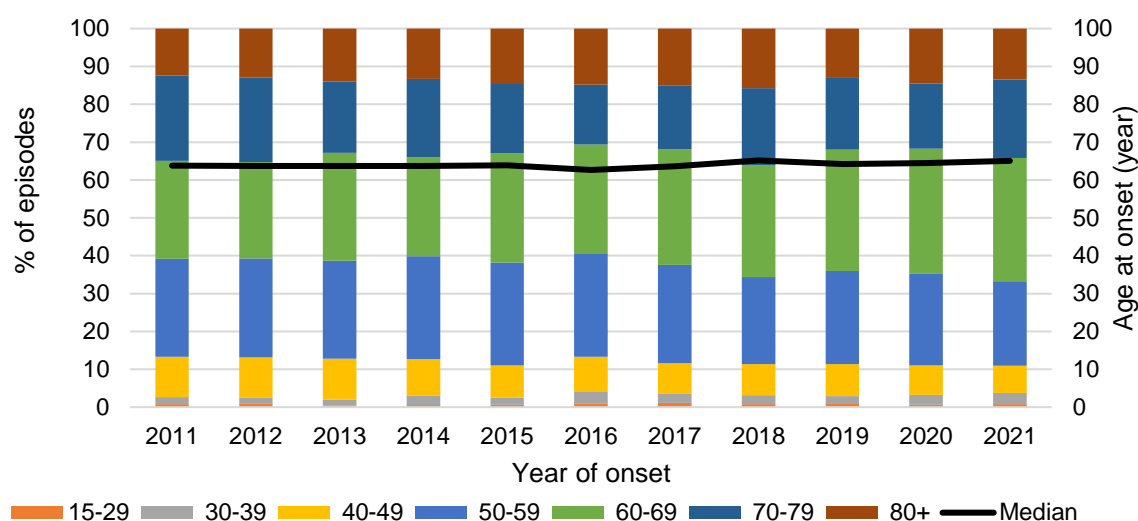
The median age at onset of stroke among Malays ranged between 62.7 and 65.2 years in the past decade (Table 5.1.7b). In 2021, those aged 60-69 years (32.6%) formed the highest proportion of Malay stroke patients (Figure 5.1.7b). Compared to the Chinese, a slightly smaller percentage of Malay stroke patients were aged 60 years and above each year (between 60% to 67%).

**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	%
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	63.7		14	1.1	29	2.4	100	8.1
2018	65.2		11	0.8	31	2.4	108	8.2
2019	64.2		15	1.1	26	1.9	118	8.4
2020	64.5		9	0.7	36	2.6	106	7.7
2021	65.0		11	0.8	43	3.0	103	7.2
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2011	252	25.8	252	25.8	220	22.6	121	12.4
2012	277	26.2	269	25.4	237	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	172	14.8
2017	320	26.0	375	30.5	209	17.0	184	14.9
2018	303	23.0	389	29.5	269	20.4	207	15.7
2019	343	24.6	448	32.1	265	19.0	182	13.0

<b>2020</b>	332	24.2	453	33.0	235	17.1	200	14.6
<b>2021</b>	320	22.3	467	32.6	297	20.7	193	13.5

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



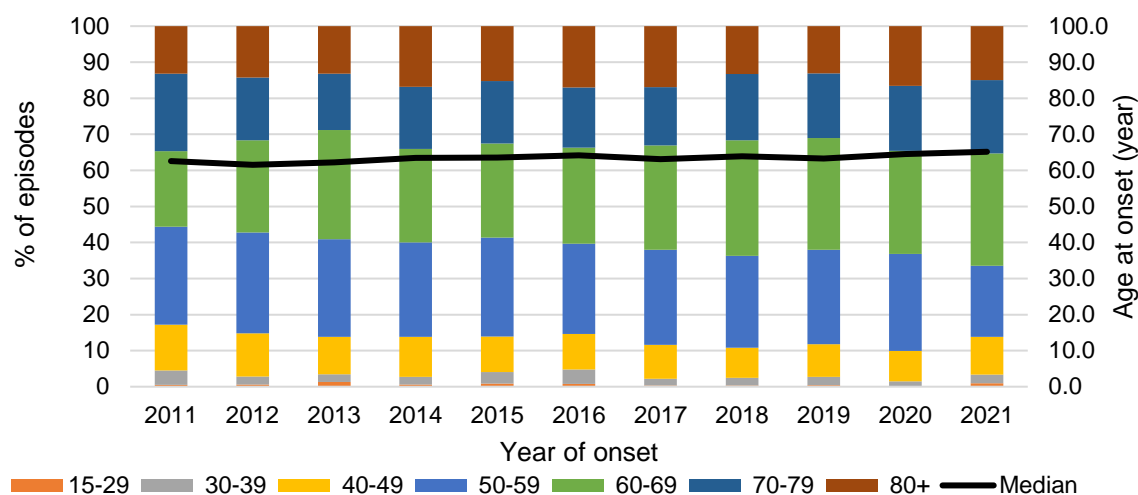
The median age at onset of stroke among Indians ranged between 61.5 and 65.2 years in the past decade (Table 5.1.7c). In 2021, those aged 60-69 years (31.2%) formed the highest proportion of Indian stroke patients, while two in three (66.6%) Indian stroke patients were aged 60 years and above – similar to that of the Malays (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	%
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	9.0
2020	64.5		1	0.1	9	1.3	57	8.4
2021	65.2		7	1.0	17	2.4	76	10.5
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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

<b>2017</b>	145	26.4	159	28.9	89	16.2	93	16.9
<b>2018</b>	144	25.5	181	32.0	104	18.4	75	13.3
<b>2019</b>	174	26.2	205	30.9	119	17.9	87	13.1
<b>2020</b>	182	26.9	193	28.6	122	18.0	112	16.6
<b>2021</b>	142	19.7	225	31.2	147	20.4	108	15.0

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



There were more IS than HS episodes, with IS accounting for about 80% of strokes annually (Table 5.1.8), and the ASIRs for IS were consistently higher than HS across the years (Figure 5.1.8). The ASIRs were 138.2 and 33.6 per 100,000 population for IS and HS respectively in 2021. The ASIR of both IS and HS had risen significantly over the years. This differs from global and regional patterns observed from the Global Burden of Disease (GBD) study, whereby globally, IS constituted 62.4% of all strokes in 2019 and 52.0% of strokes in Southeast Asia, possibly due to differences in the prevalence and control of various risk factors. Additionally, the ASIR for both subtypes of stroke exhibited a decrease from 2011-2019 both globally and regionally in Southeast Asia<sup>19</sup>.

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 will not add up to 100% each year. Figures for overall CIR and ASIR include cases of unknown etiology.

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

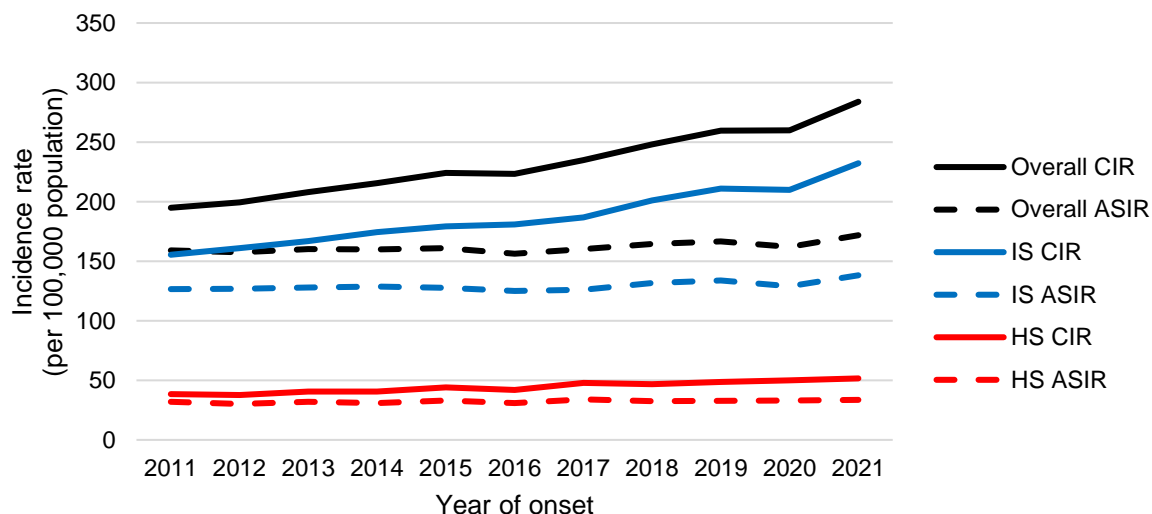
Ischaemic stroke						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
<b>2011</b>	4900	79.8	155.4	151.1-159.8	126.5	122.8-130.1
<b>2012</b>	5140	80.7	161.1	156.6-165.5	126.8	123.3-130.3

<sup>19</sup> GBD Results. Institute for Health Metrics and Evaluation (IHME) 2020. <https://vizhub.healthdata.org/gbd-results/>. Accessed on 16 June 2023..



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	7250	81.3	211.1	206.2-215.9	133.8	130.6-137.0
2020	7253	80.8	209.9	205.0-214.7	129.0	125.9-132.0
2021	7919	81.8	232.3	227.1-237.4	138.2	135.0-141.4
P for trend	-	-	<0.001	-	0.020	-
Haemorrhagic stroke						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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	1670	18.7	48.6	46.3-50.9	32.9	31.2-34.5
2020	1724	19.2	49.9	47.5-52.2	33.0	31.3-34.6
2021	1760	18.2	51.6	49.2-54.0	33.6	31.9-35.3
P for trend	-	-	<0.001	-	0.032	-

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

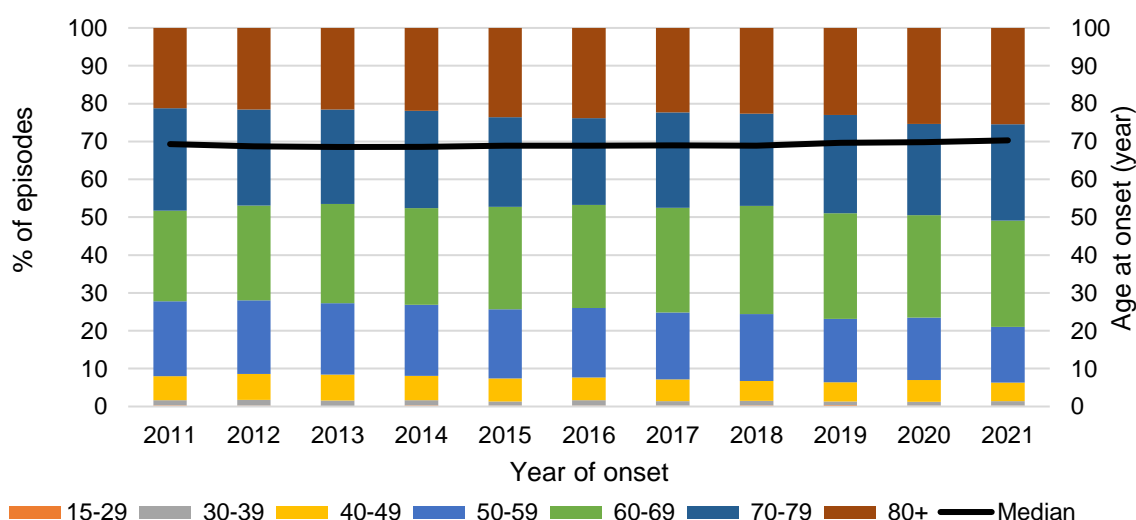


The median age at onset of IS remained relatively stable between 68.6 and 70.3 years in the past decade (Table 5.1.9a). In 2021, 78.9% of IS patients (4 in 5) were aged 60 years and above, a gradual increase from 72.1% in 2011 (Figure 5.1.9a).

**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	%
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	74	1.0	420	5.8
2021	70.3		16	0.2	94	1.2	391	4.9
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1215	16.8	2026	27.9	1879	25.9	1667	23.0
2020	1194	16.5	1967	27.1	1744	24.0	1840	25.4
2021	1165	14.7	2220	28.0	2018	25.5	2015	25.4

**Figure 5.1.9a: Age distribution at onset of ischaemic stroke**



The median age at onset of HS increased from 63.1 years in 2011 to 66.8 years in 2021 (Table 5.1.9b), although it remains lower than that of IS (Table 5.1.9a). As with IS, the percentage of HS patients aged 60 years and above also increased from 57.5%

in 2011 to 66.4% in 2021, although it remained substantially lower than that of IS (Figure 5.1.9b).

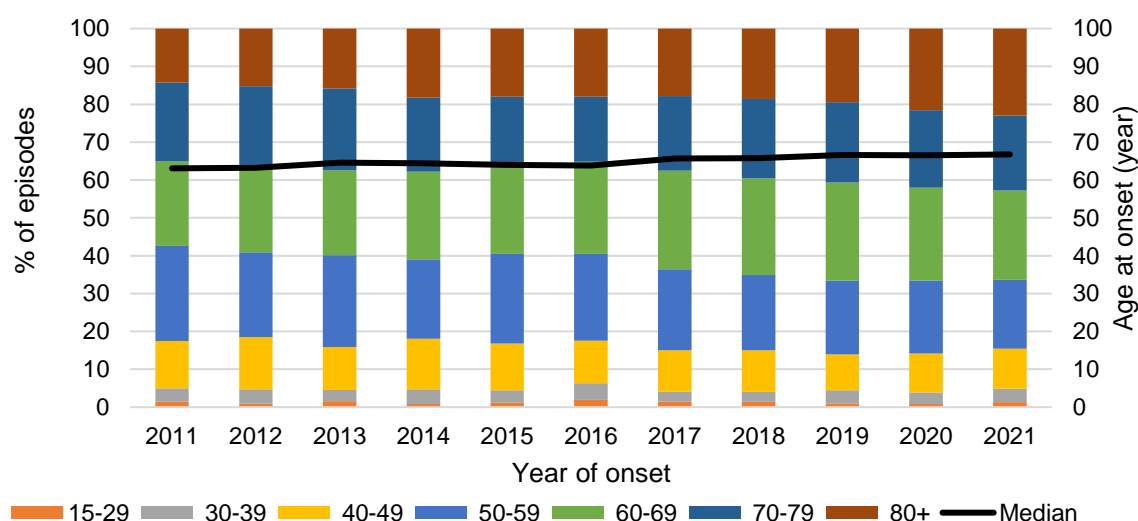
**Table 5.1.9b: Age distribution at onset of haemorrhagic stroke**

Year of onset	Overall		Age 15-29		Age 30-39		Age 40-49	
	Median age		Number	%	Number	%	Number	%
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		14	0.8	53	3.1	177	10.3
2021	66.8		24	1.4	62	3.5	186	10.6

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	432	25.9	354	21.2	325	19.5
2020	333	19.3	422	24.5	353	20.5	372	21.6
2021	320	18.2	415	23.6	349	19.8	404	23.0

**Figure 5.1.9b: Age distribution at onset of haemorrhagic stroke**



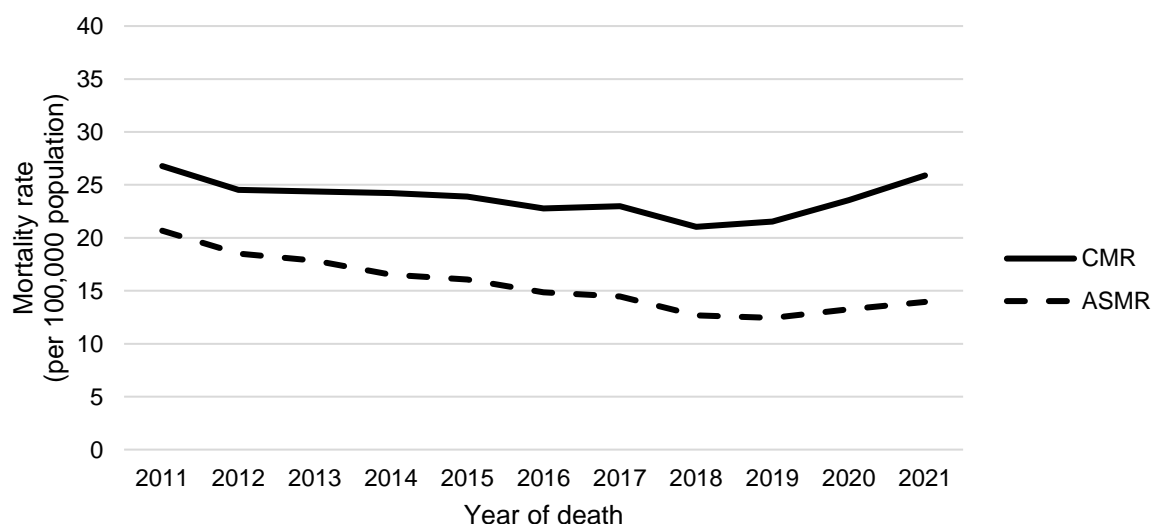
## 5.2 Mortality

Some fluctuations in terms of the number of deaths due to stroke were observed between 2011 and 2021 (ranging between 716 to 883) (Table 5.2.1), despite the continual yearly increase seen in the number of stroke episodes during this period (from 6,143 in 2011 to 9,680 stroke episodes in 2021) (Table 5.1.1). The age-standardised mortality rate (ASMR) dropped significantly from 20.7 to 13.9 per 100,000 population over the past decade, but a rising trend was observed from 2019 to 2021 (Figure 5.2.1). The overall downward trend in ASMR over the years was likely due to the timely commencement of stroke treatment. Based on the data from the GBD 2019 study, although the absolute number of deaths globally due to stroke had increased by 11.8% between 2011-2019, the age-standardised rate had dropped by 12.3%<sup>20</sup>.

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

Year of death	Number	CMR	95% CI	ASMR	95% CI
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
2021	883	25.9	24.2-27.6	13.9	13.0-14.9
P for trend	-	0.19	-	<0.001	-

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



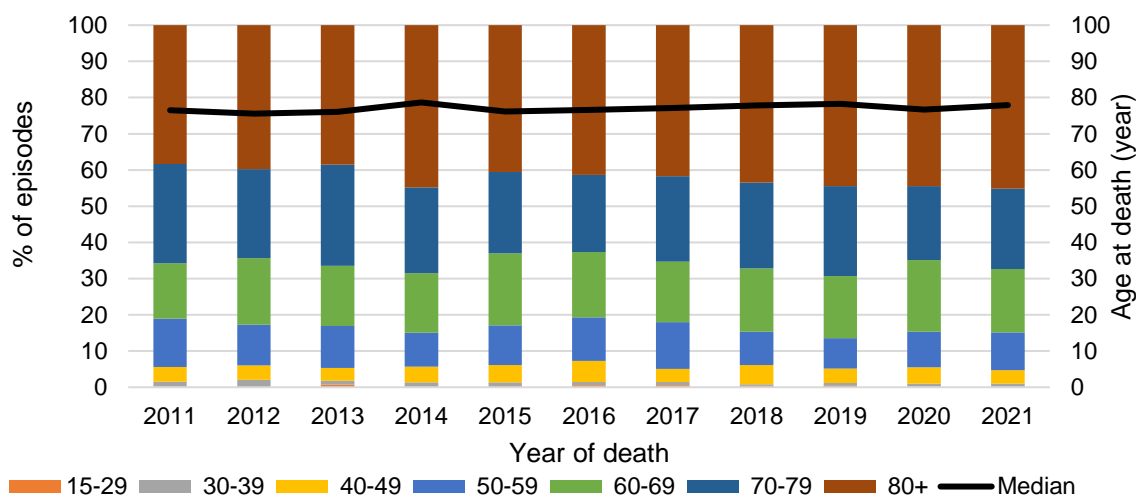
<sup>20</sup> GBD Results. Institute for Health Metrics and Evaluation (IHME) 2020. <https://vizhub.healthdata.org/gbd-results/>. Accessed on 16 June 2023.

The median age at death ranged between 75.6 and 78.7 years in the past decade (Table 5.2.2). Every year, more than 80% of stroke deaths occurred in those aged 60 years and above; in 2021, nearly half of the patients who died of stroke were aged 80 years and above (Figure 5.2.2).

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

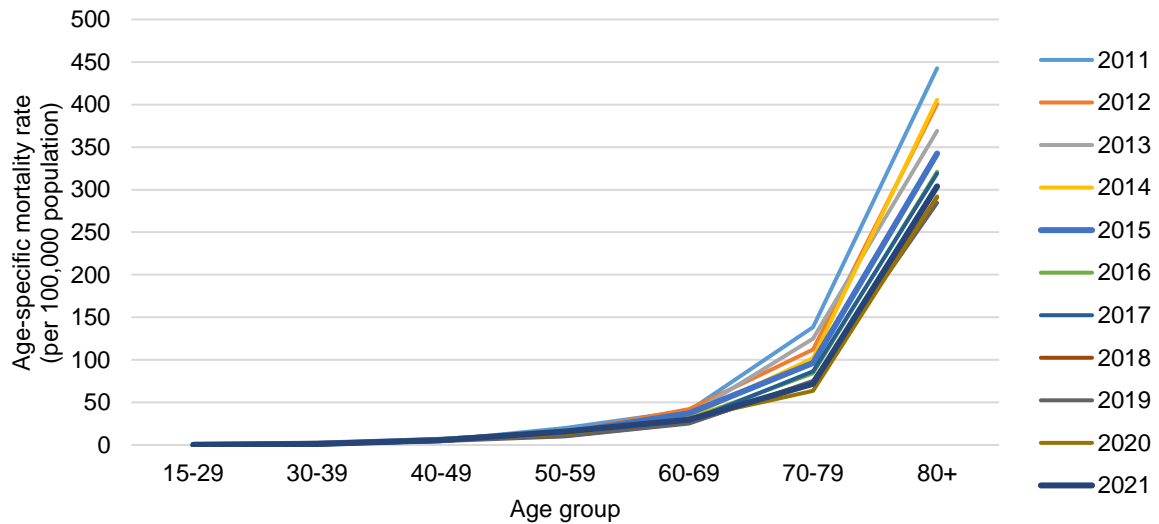
Year of death	Overall		Age 15-29		Age 30-39		Age 40-49	
	Median age		Number	%	Number	%	Number	%
2011	76.5		2	0.2	11	1.3	34	4.0
2012	75.6		0	0.0	16	2.0	31	4.0
2013	76.1		6	0.8	8	1.0	28	3.6
2014	78.7		1	0.1	10	1.3	34	4.3
2015	76.2		2	0.3	9	1.1	37	4.7
2016	76.6		4	0.5	7	0.9	44	5.8
2017	77.1		4	0.5	7	0.9	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
2021	77.9		1	0.1	8	0.9	33	3.7
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2021	92	10.4	154	17.4	196	22.2	399	45.2

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

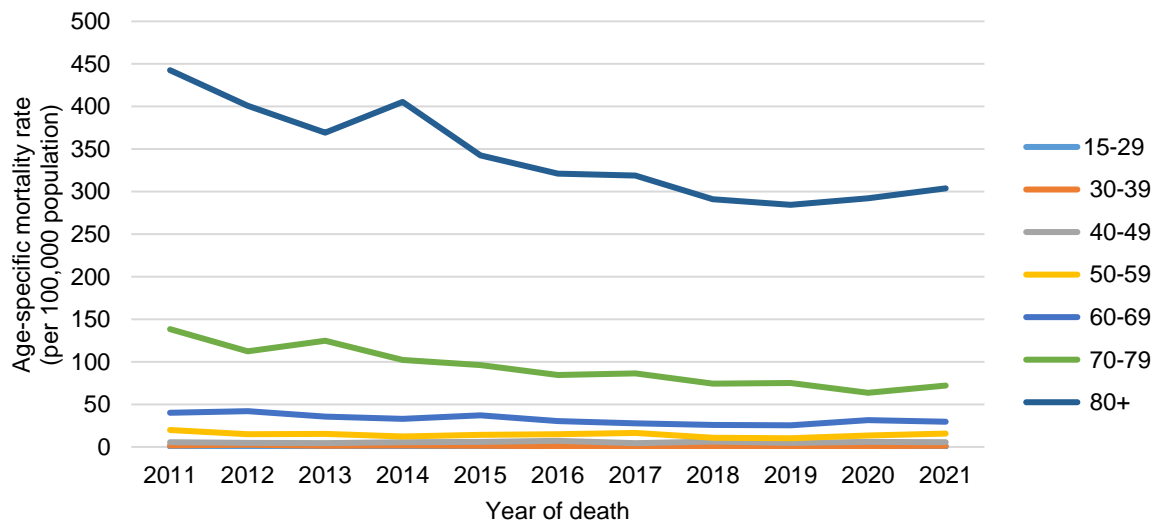


The age-specific mortality rate of stroke increased with age, with the oldest age group having the highest mortality rate (Figure 5.2.3a) but also the largest decrease in mortality rate over the years (Figure 5.2.3b). Significant drops in mortality rates were observed among those aged 60 years and above (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
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	-0.1-1.1	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
2021	25.9	24.2-27.6	0.1	0.0-0.4	1.4	0.4-2.3	5.6	3.7-7.5
<b>P for trend</b>	0.190	-	0.276	-	0.065	-	0.466	-
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2011	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
2021	15.7	12.5-19.0	29.7	25.0-34.4	72.0	61.9-82.1	303.9	274.0-333.7
<b>P for trend</b>	0.135	-	0.003	-	<0.001	-	<0.001	-

A higher number of stroke deaths occurred among females compared to males annually, with the exception of 2016 and 2020. A similar pattern was documented in the United States, whereby more stroke deaths occurred in females, and stroke also accounted for a higher percentage of all deaths among females than it did for males<sup>21</sup>. However, in terms of ASMR, the rates were consistently higher among males (Table 5.2.4), as the ASIRs were also consistently higher among males than females across the years (Table 5.1.4). This is likely due to the older age of stroke onset in women and consequently poorer prognosis in terms of mortality.

In 2021, males had an ASMR of 16.1 per 100,000 population, while females had an ASMR of 11.8 per 100,000 population. The ASMRs declined significantly over the years for both genders (males:  $p=0.001$ , females:  $p<0.001$ ) (Figure 5.2.4).

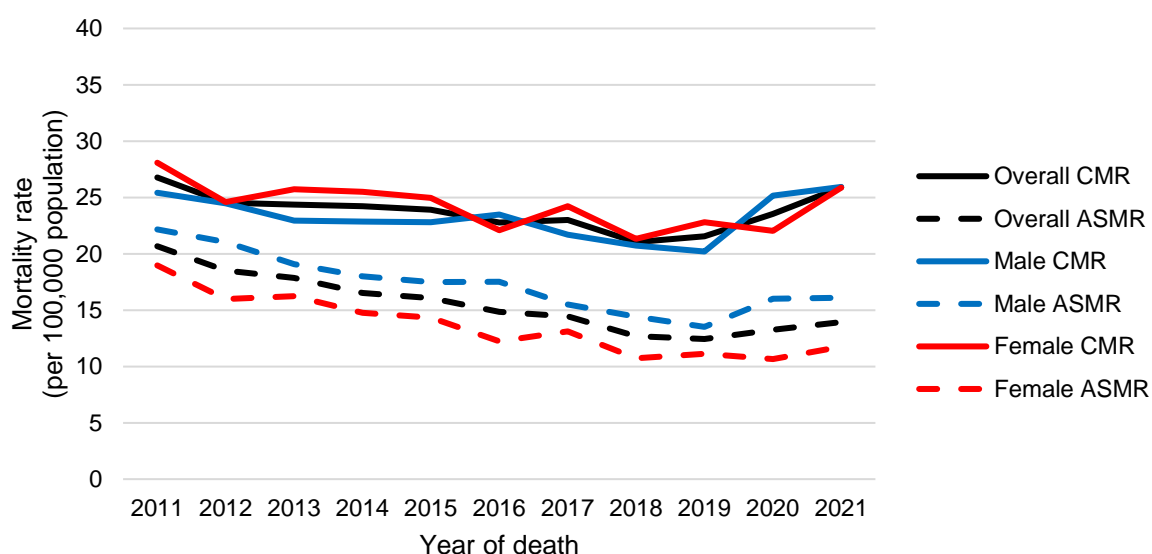
**Table 5.2.4: Mortality number and rate of stroke (per 100,000 population) by gender**

Male						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
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
2021	430	48.7	25.9	23.5-28.4	16.1	14.5-17.7
P for trend	-	-	0.642	-	0.001	-
Female						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
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
2021	453	51.3	25.9	23.5-28.2	11.8	10.6-12.9
P for trend	-	-	0.066	-	<0.001	-

<sup>21</sup> Rexrode KM et al. The Impact of Sex and Gender on Stroke. *Circulation Research*. 2022; 130: 512–528.



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

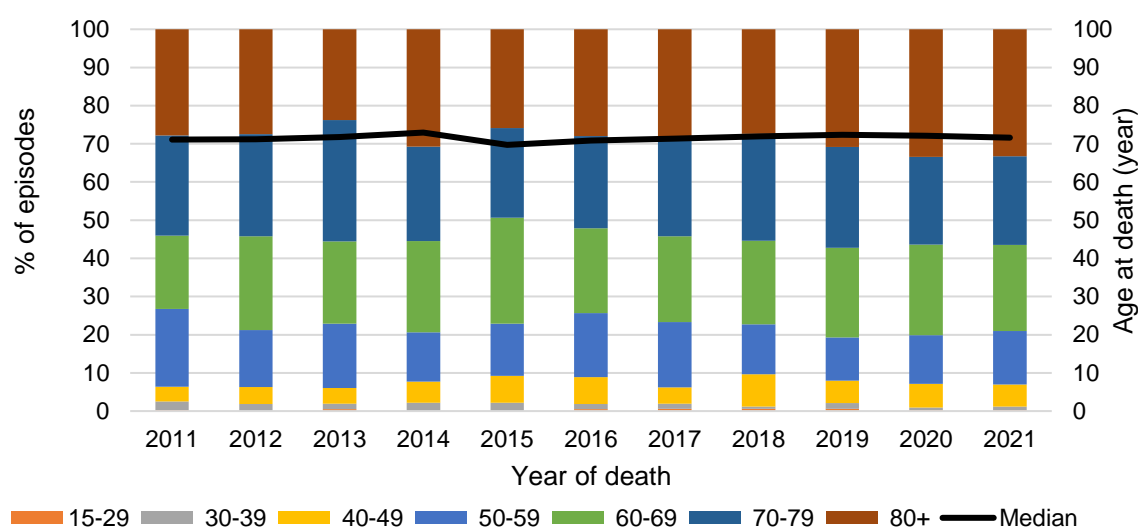


The median age at death due to stroke among males ranged between 69.7 and 72.9 years in the past decade (Table 5.2.5a). In 2021, about 80% of males who died from stroke were aged 60 years and above; and those aged 80 years and above (33.3%) formed the highest proportion of males who died of stroke (Figure 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	%
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
2021	71.6		1	0.2	4	0.9	25	5.8
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2021	60	14.0	97	22.6	100	23.3	143	33.3

**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 – about a decade older than that of males. 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 2021, about 90% of females who died of stroke were aged 60 years and above; and those aged 80 years and above (56.5%) formed the highest proportion of females who died of stroke, substantially higher than that of males (Figure 5.2.5b). Similarly, in the United States, the greatest gender difference in excess stroke mortality was found in females aged 85 years and above, compared to males of the same age group<sup>22</sup>.

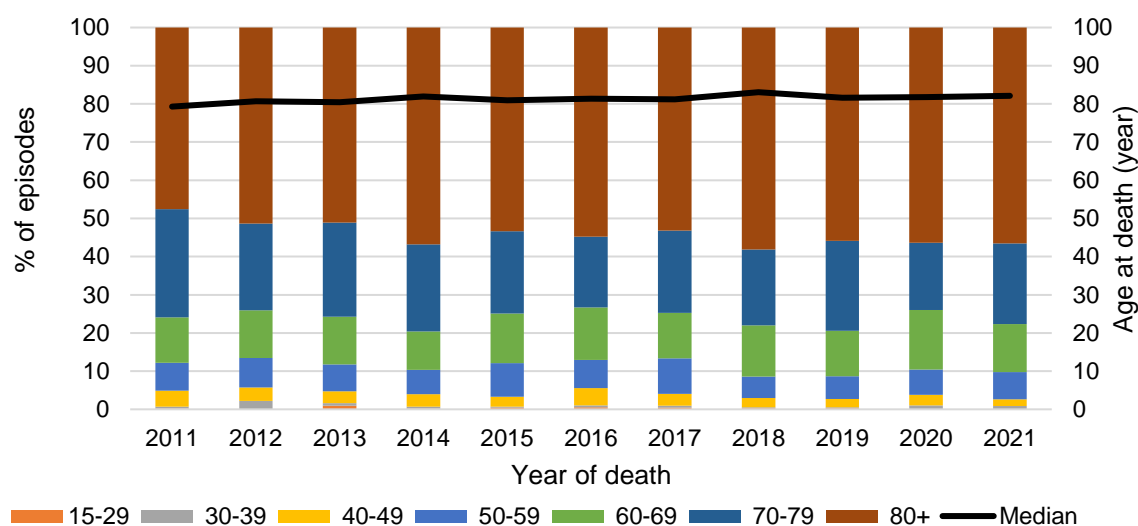
**Table 5.2.5b: Age distribution at death of stroke among females**

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
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
2021	82.1	0	0.0	4	0.9	8	1.8

<sup>22</sup> Rexrode KM et al. The Impact of Sex and Gender on Stroke. *Circulation Research*. 2022; 130: 512–528.

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2021	32	7.1	57	12.6	96	21.2	256	56.5

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

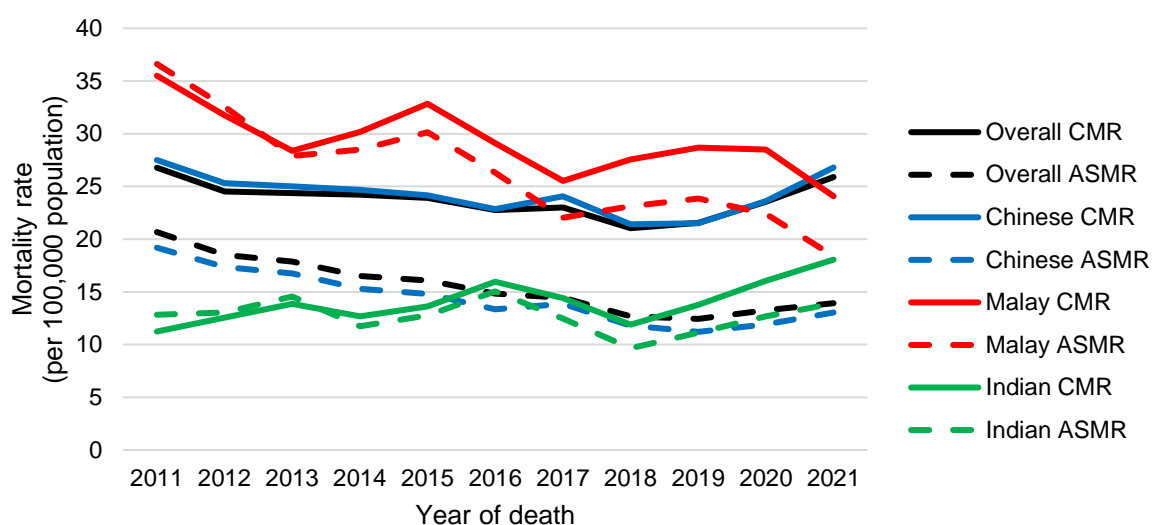


Among the ethnic groups, as Malays consistently had the highest ASIRs across the years (Table 5.1.6), they also consistently had the highest ASMRs (Table 5.2.6). The ASMR of 18.4 per 100,000 population among Malays was higher than the ASMR for Chinese (13.0 per 100,000 population) and Indians (13.9 per 100,000 population) in 2021. The ASMRs showed a downward trend over the years for Chinese ( $p < 0.001$ ) and Malays ( $p < 0.001$ ), but did not change significantly for Indians ( $p = 0.503$ ) (Figure 5.2.6).

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

<b>Chinese</b>						
<b>Year of death</b>	<b>Number</b>	<b>%</b>	<b>CMR</b>	<b>95% CI</b>	<b>ASMR</b>	<b>95% CI</b>
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
2021	689	78.0	26.8	24.8-28.8	13.0	12.0-14.1
<b>P for trend</b>	-	-	0.181	-	<0.001	-
<b>Malay</b>						
<b>Year of death</b>	<b>Number</b>	<b>%</b>	<b>CMR</b>	<b>95% CI</b>	<b>ASMR</b>	<b>95% CI</b>
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
2021	106	12.0	24.1	19.5-28.6	18.4	14.8-21.9
<b>P for trend</b>	-	-	0.006	-	<0.001	-
<b>Indian</b>						
<b>Year of death</b>	<b>Number</b>	<b>%</b>	<b>CMR</b>	<b>95% CI</b>	<b>ASMR</b>	<b>95% CI</b>
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
2021	53	6.0	18.1	13.2-22.9	13.9	10.1-17.7
<b>P for trend</b>	-	-	0.015	-	0.503	-

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

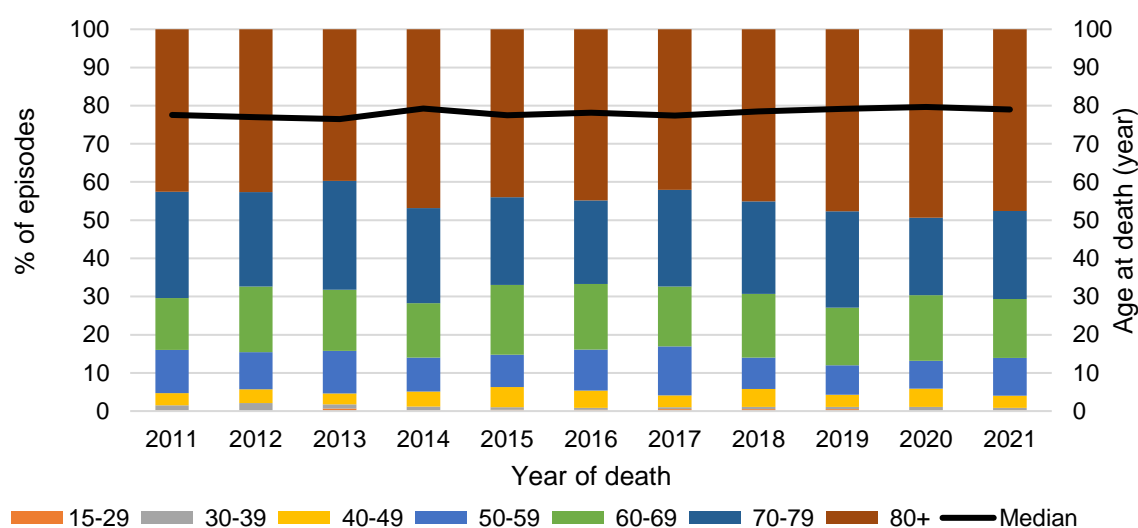


In addition to having the oldest median age at onset of stroke (Tables 5.1.7a to 5.1.7c), the Chinese also had the oldest median age at death, which ranged between 76.5 and 79.7 years in the past decade (Table 5.2.7a). In 2021, those aged 80 years and above (47.6%) formed the highest proportion of Chinese 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	%
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
2021	78.9		1	0.1	5	0.7	22	3.2
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2021	68	9.9	106	15.4	159	23.1	328	47.6

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

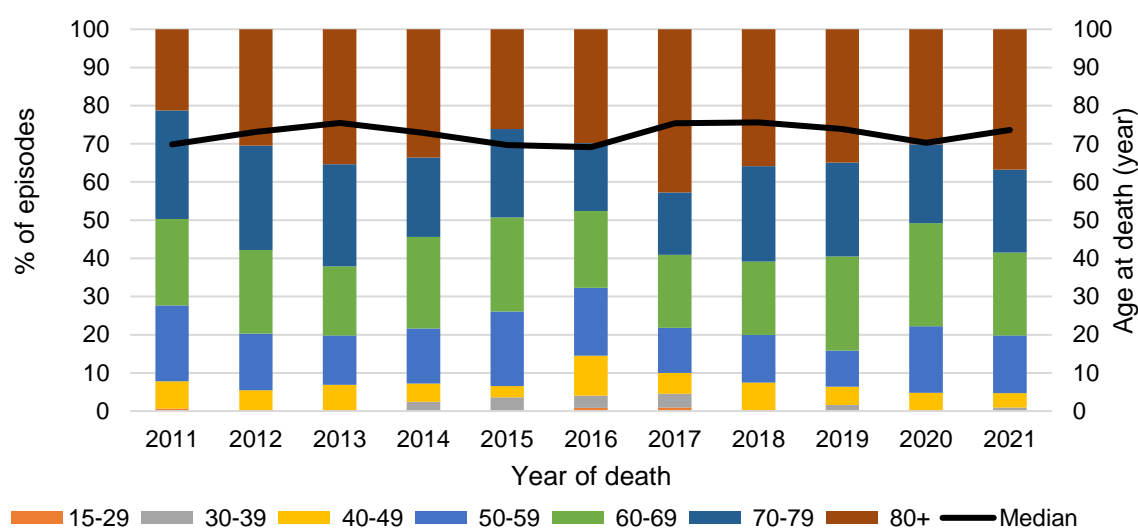


The median age at death due to stroke among Malays ranged between 69.1 and 75.6 years in the past decade, about 4 to 6 years younger than that of the Chinese (Table 5.2.7b). In 2021, those aged 80 years and above (36.8%) formed the highest proportion of Malays who died of stroke (Figure 5.2.7b).

**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	%
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
2021	73.6		0	0.0	1	0.9	4	3.8
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2021	16	15.1	23	21.7	23	21.7	39	36.8

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

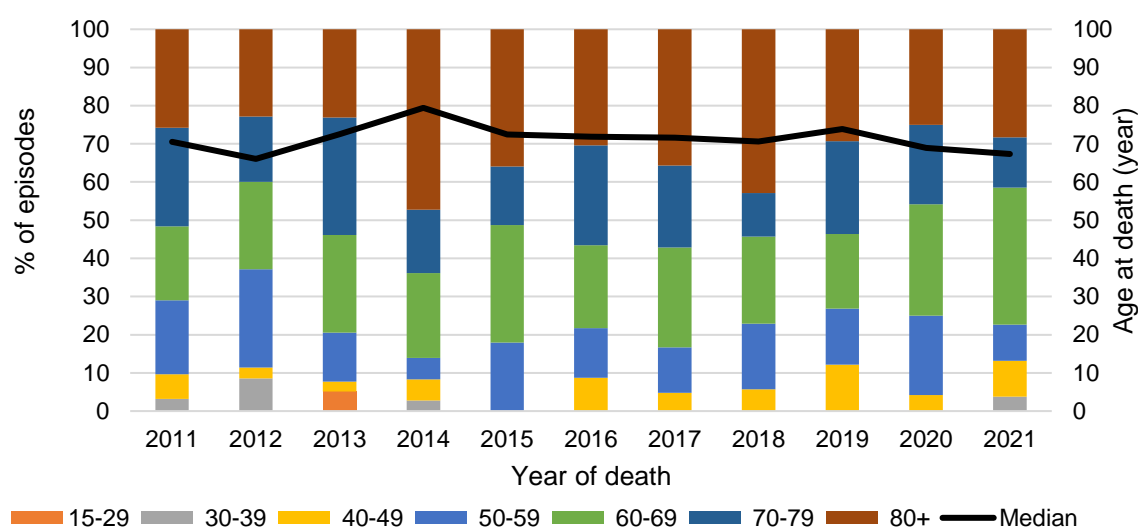


The median age at death due to stroke among Indians ranged between 66.0 and 79.4 years in the past decade (Table 5.2.7c). In 2021, those aged 60-69 years (35.8%) formed the highest proportion of Indians who died of stroke (Figure 5.2.7c).

**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	%
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
2021	67.4		0	0.0	2	3.8	5	9.4
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2021	5	9.4	19	35.8	7	13.2	15	28.3

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



While there were approximately four times as many IS as HS every year, the disparity between IS and HS in terms of number of deaths was far less marked, with IS accounting for only a slightly higher proportion of deaths across most years. Although the ASIRs of IS were consistently higher than HS across the years (Table 5.1.8), the ASMRs of IS were higher only between 2011 and 2016 (Table 5.2.8). From 2017 onwards, the ASMR for IS and HS have grown closer. Similarly, data from the GBD study revealed that there were approximately equal numbers of IS and HS deaths globally in 2019, as well as similar age-standardised mortality rates<sup>23</sup>.

The ASMR of IS declined from 11.4 per 100,000 population in 2011 to 6.7 per 100,000 population in 2021 ( $p < 0.001$ ). Similarly, the ASMR of HS declined from 8.7 per 100,000 population in 2011 to 7.2 per 100,000 population in 2021 ( $p = 0.020$ ) (Figure 5.2.8). Likewise, there has also been a global pattern of decrease for both IS and HS mortality based on findings from the GBD 2019 data<sup>24</sup>.

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. Figures for overall CMR and ASMR include cases of unknown etiology.

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

Ischaemic stroke						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
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

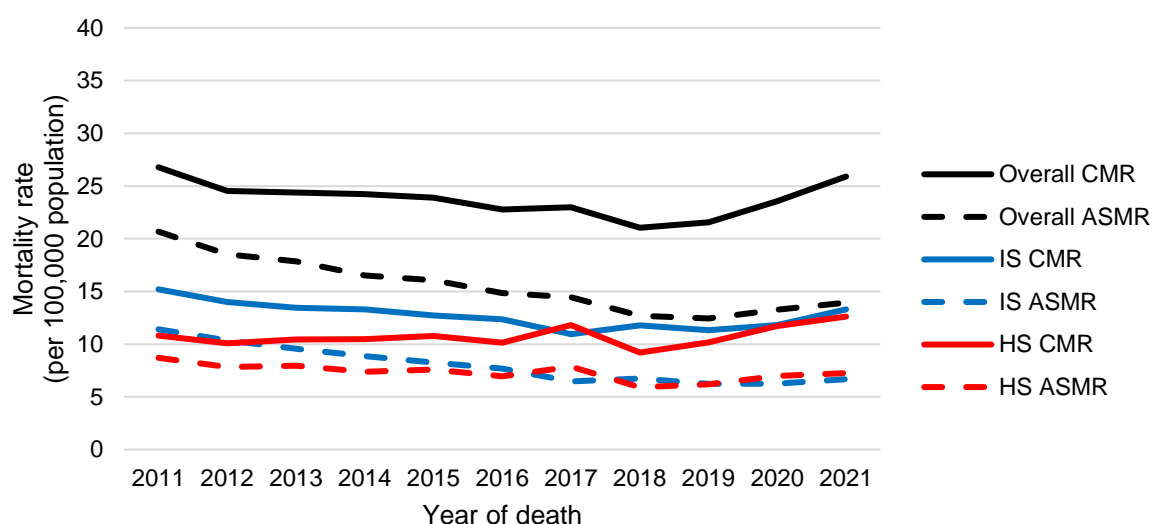
<sup>23</sup> Feigin V. et al. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Neurol* 2021;20: 795–820.

<sup>24</sup> Ibid.



<b>2014</b>	434	54.9	13.3	12.1-14.6	8.9	8.0-9.7
<b>2015</b>	420	53.2	12.7	11.5-13.9	8.2	7.4-9.1
<b>2016</b>	412	54.2	12.3	11.2-13.5	7.7	6.9-8.4
<b>2017</b>	369	47.6	10.9	9.8-12.1	6.5	5.8-7.1
<b>2018</b>	401	56.0	11.8	10.6-12.9	6.7	6.1-7.4
<b>2019</b>	389	52.6	11.3	10.2-12.4	6.2	5.6-6.9
<b>2020</b>	408	50.1	11.8	10.7-13.0	6.2	5.6-6.9
<b>2021</b>	453	51.3	13.3	12.1-14.5	6.7	6.0-7.3
<b>P for trend</b>	-	-	0.017	-	<0.001	-
<b>Haemorrhagic stroke</b>						
<b>Year of death</b>	<b>Number</b>	<b>%</b>	<b>CMR</b>	<b>95% CI</b>	<b>ASMR</b>	<b>95% CI</b>
<b>2011</b>	341	40.4	10.8	9.7-12.0	8.7	7.8-9.6
<b>2012</b>	322	41.1	10.1	9.0-11.2	7.8	6.9-8.7
<b>2013</b>	337	42.8	10.4	9.3-11.6	8.0	7.1-8.8
<b>2014</b>	342	43.3	10.5	9.4-11.6	7.4	6.6-8.2
<b>2015</b>	356	45.1	10.8	9.7-11.9	7.6	6.8-8.4
<b>2016</b>	338	44.5	10.1	9.0-11.2	7.0	6.2-7.7
<b>2017</b>	398	51.4	11.8	10.6-13.0	7.9	7.1-8.6
<b>2018</b>	313	43.7	9.2	8.2-10.2	5.9	5.2-6.6
<b>2019</b>	349	47.2	10.2	9.1-11.2	6.2	5.5-6.9
<b>2020</b>	405	49.8	11.7	10.6-12.9	7.0	6.3-7.7
<b>2021</b>	430	48.7	12.6	11.4-13.8	7.2	6.5-8.0
<b>P for trend</b>	-	-	0.242	-	0.020	-

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

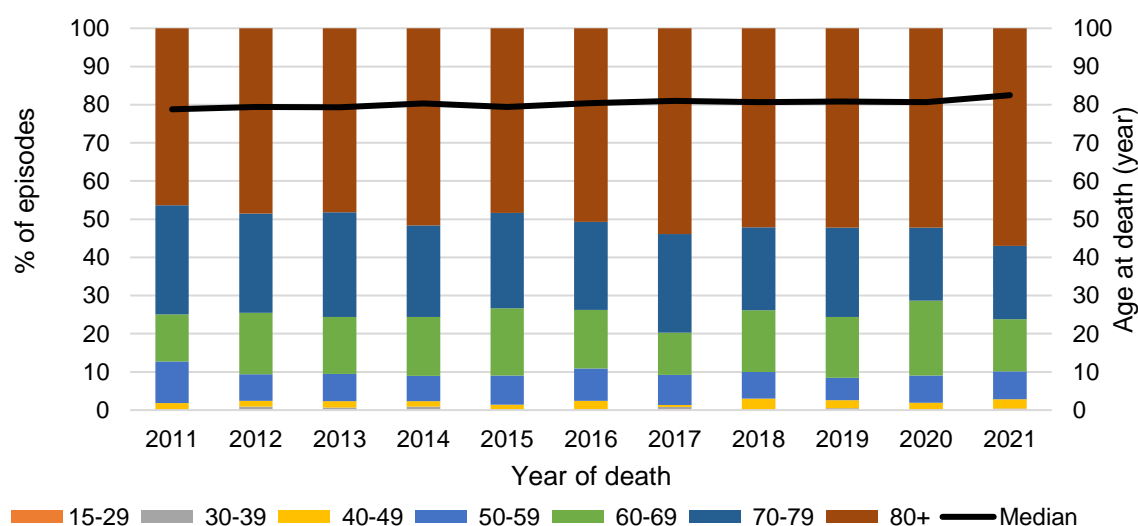


The median age at death due to stroke among IS patients ranged between 78.8 and 82.5 years in the past decade; and about 90% of IS deaths each year occurred among those aged 60 years and above (Table 5.2.9a). In 2021, those aged 80 years and above (57.0%) accounted for the majority of IS patients who died of stroke, an increase from 46.3% in 2011 (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	%
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
2021	82.5		1	0.2	1	0.2	11	2.4
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2021	33	7.3	62	13.7	87	19.2	258	57.0

**Figure 5.2.9a: Age distribution at death of ischaemic stroke**



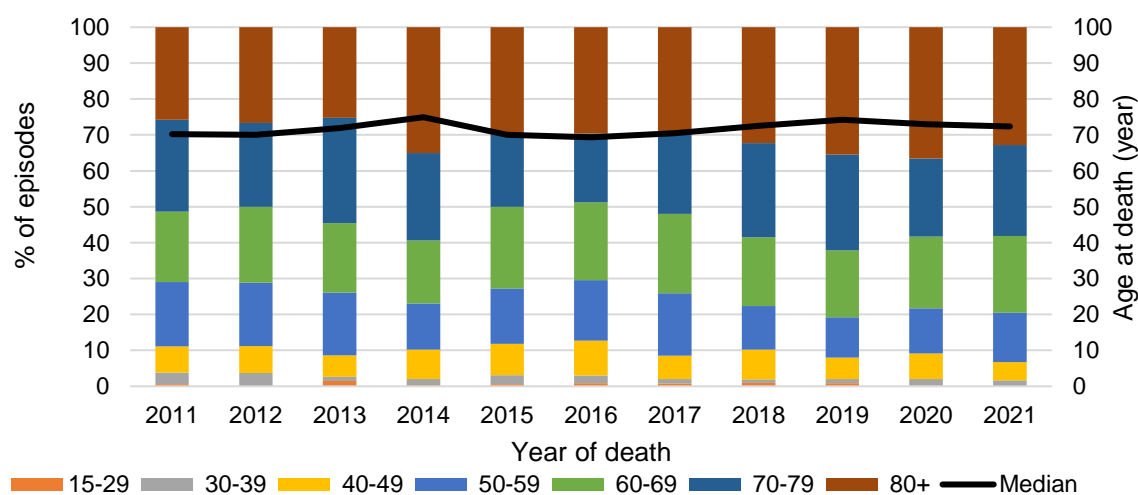
In addition to having a younger median age at stroke onset (Tables 5.1.9a and 5.1.9b), HS patients had a younger median age at death than IS patients. The median age at death due to stroke among HS patients ranged between 69.3 and 74.9 years in the

past decade, and between 70-80% of HS deaths occurred in those aged 60 years and above (Table 5.2.9b). In 2021, those aged 80 years and above (32.8%) formed the highest proportion of HS patients who died of stroke, significantly less than that of IS (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	%
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
2021	72.4		0	0.0	7	1.6	22	5.1
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2021	59	13.7	92	21.4	109	25.3	141	32.8

**Figure 5.2.9b: Age distribution at death of haemorrhagic stroke**



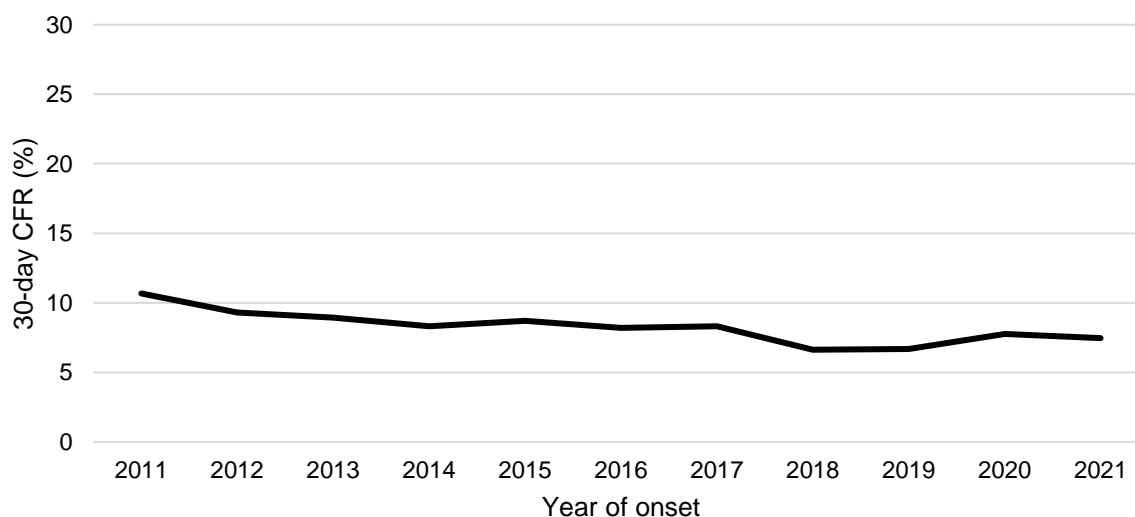
### 5.3 30-Day Case Fatality

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 10.7% in 2011 to 6.7% in 2019, it increased to 7.8% in 2020 followed by a slight dip to 7.5% in 2021 (Figure 5.3.1). As 2020 was also the year that the COVID-19 pandemic first affected Singapore, the trend in CFR will continue to be monitored to see if further interventions may be required.

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

Year of onset	Number	CFR	95% CI
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	7.8	7.2-8.4
2021	697	7.5	6.9-8.0
P for trend	-	0.002	-

**Figure 5.3.1: Case fatality rate of stroke (%)**



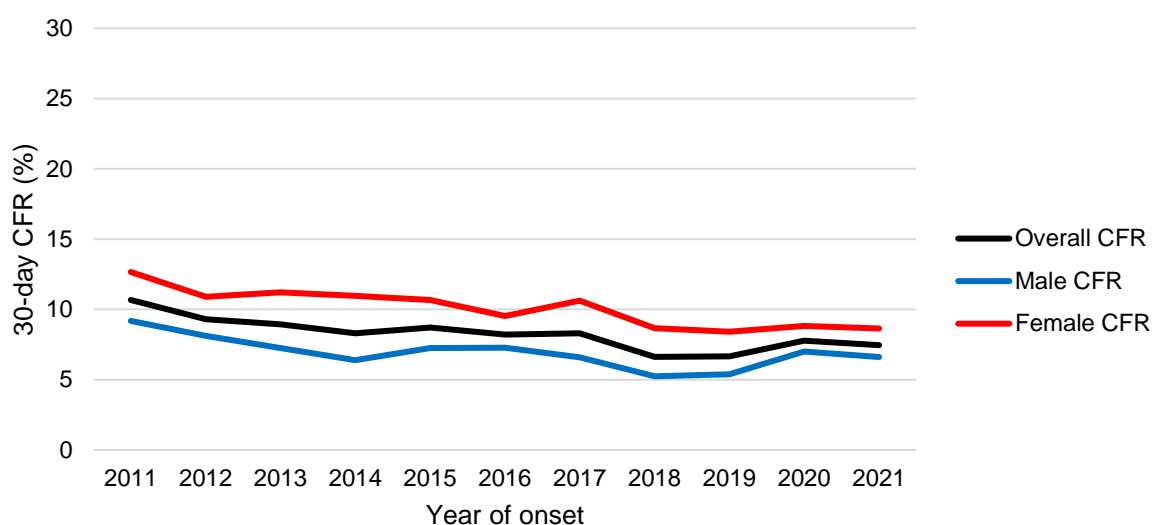
Although the ASMRs for males were consistently higher than females across the years (Table 5.2.4), the CFRs for males were consistently lower than females (Table 5.3.2). The CFR was 6.6% for males and 8.6% for females in 2021. As females tended to have stroke at an older age than males (Tables 5.1.5a and 5.1.5b), they were likely to have more co-morbidities when the stroke happened, which led to poorer prognosis<sup>25</sup>. The CFR fell significantly over the years for both genders (males:  $p=0.023$ , 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
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	4.7-6.0
2020	353	52.1	7.0	6.3-7.7
2021	358	51.4	6.6	5.9-7.3
P for trend	-	-	0.023	-
Female				
Year of onset	Number	%	CFR	95% CI
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	8.8	7.9-9.8
2021	339	48.6	8.6	7.7-9.6
P for trend	-	-	<0.001	-

<sup>25</sup> Rexrode KM et al. The Impact of Sex and Gender on Stroke. *Circulation Research*. 2022; 130: 512–528.

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



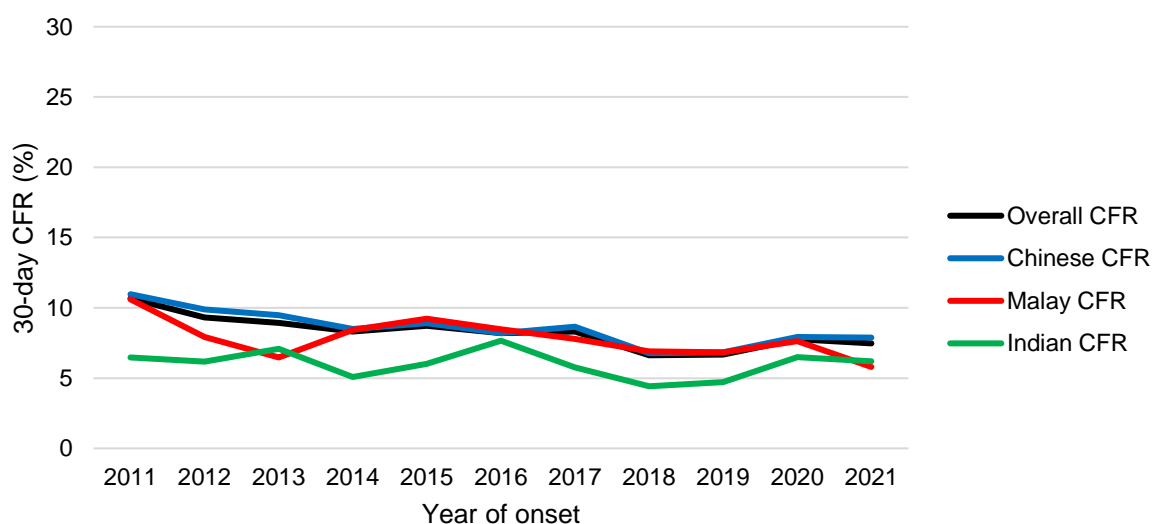
Among the ethnic groups, although the Malays consistently had the highest ASMRs (Table 5.2.6), the CFRs of Chinese and Malays were not drastically different across the years (Table 5.3.3). The slightly higher CFR among the Chinese was likely due to the Chinese being older at the onset of stroke (Tables 5.1.7a and 5.1.7b). The CFRs were 7.9%, 5.8% and 6.2% for the Chinese, Malays and Indians respectively in 2021. While the CFR decreased significantly over the years for the Chinese ( $p=0.002$ ) and Malays ( $p=0.035$ ), it remained constant for the Indians ( $p=0.392$ ) (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
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	7.9	7.2-8.6
2021	550	78.9	7.9	7.2-8.5
<b>P for trend</b>	-	-	0.002	-

Malay				
Year of onset	Number	%	CFR	95% CI
2011	100	15.7	10.6	8.5-12.7
2012	81	14.2	7.9	6.2-9.7
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	6.8	5.4-8.2
2020	101	14.9	7.6	6.1-9.1
2021	80	11.5	5.8	4.5-7.1
P for trend	-	-	0.035	-
Indian				
Year of onset	Number	%	CFR	95% CI
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	6.5	4.5-8.5
2021	43	6.2	6.2	4.4-8.1
P for trend	-	-	0.392	-

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



Although the ASMR of IS was higher between 2011-2016 and similar to that of HS from 2017 onwards (Table 5.2.8), the CFRs among IS patients were consistently and substantially lower than HS patients (Table 5.3.4). In 2021, the CFRs were 4.0% and 22.9% for IS and HS patients respectively. This is likely because HS is a more severe condition with higher likelihood of fatality. 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. Based on available data, the median baseline NIHSS score for IS patients was consistently lower compared to that for HS patients (IS patients: NIHSS score remained stable between 4 and 5 from 2014-2021, while the score for HS patients ranged between 10 and 13 during this period). Besides the initial severity, the nature of stroke lesions also affects the CFR – haematoma expansions, oedema formation and intraventricular haemorrhage leading to elevated intracranial pressure in HS could also likely contribute to a higher CFR<sup>26</sup>.

The CFR fell over the years for both IS ( $p < 0.001$ ) and HS ( $p = 0.072$ ) patients, although there is a trend of increasing CFR observed for HS from 2018 onwards (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. Figures for overall CFR include cases of unknown etiology.

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

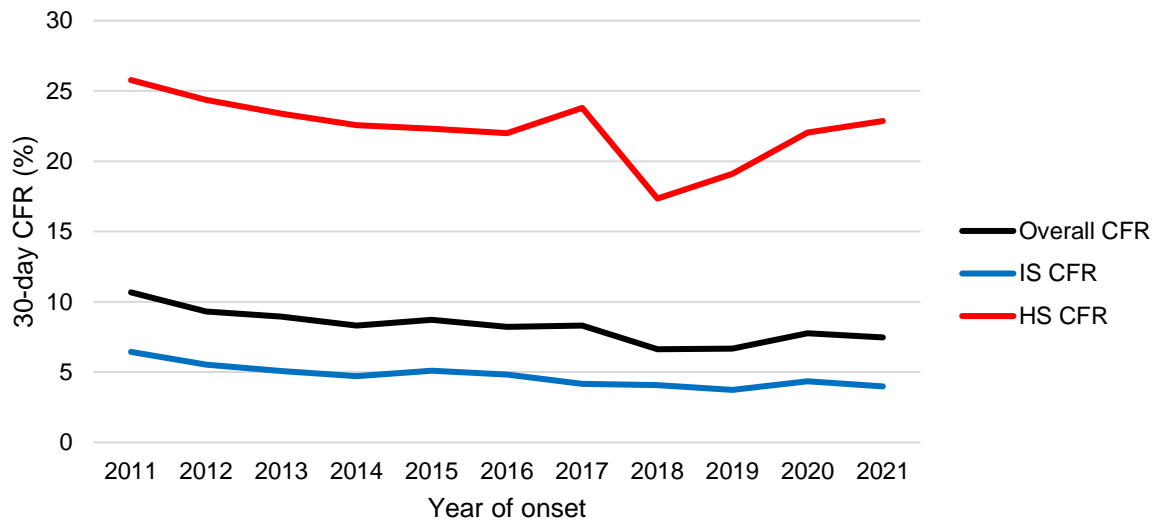
<b>Ischaemic stroke</b>				
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CFR</b>	<b>95% CI</b>
<b>2011</b>	306	48.0	6.4	5.7-7.2
<b>2012</b>	273	47.7	5.5	4.9-6.2
<b>2013</b>	265	45.5	5.1	4.5-5.7
<b>2014</b>	260	45.8	4.7	4.1-5.3
<b>2015</b>	291	46.6	5.1	4.5-5.7
<b>2016</b>	282	47.4	4.8	4.3-5.4
<b>2017</b>	253	39.7	4.2	3.7-4.7
<b>2018</b>	269	49.8	4.1	3.6-4.6
<b>2019</b>	261	45.3	3.7	3.3-4.2
<b>2020</b>	305	45.1	4.3	3.9-4.8
<b>2021</b>	303	43.5	4.0	3.5-4.4
<b>P for trend</b>	-	-	<0.001	-
<b>Haemorrhagic stroke</b>				
<b>Year of onset</b>	<b>Number</b>	<b>%</b>	<b>CFR</b>	<b>95% CI</b>
<b>2011</b>	308	48.3	25.8	22.9-28.7
<b>2012</b>	285	49.8	24.4	21.5-27.2
<b>2013</b>	302	51.8	23.4	20.8-26.0
<b>2014</b>	294	51.8	22.6	20.0-25.1
<b>2015</b>	320	51.3	22.3	19.9-24.8

<sup>26</sup> Andersen KK et al. Hemorrhagic and Ischemic Strokes Compared: Stroke Severity, Mortality, and Risk Factors. *Stroke*. 2009;40:2068-2072.



<b>2016</b>	303	50.9	22.0	19.5-24.5
<b>2017</b>	377	59.2	23.8	21.4-26.2
<b>2018</b>	269	49.8	17.3	15.3-19.4
<b>2019</b>	313	54.3	19.1	17.0-21.2
<b>2020</b>	371	54.8	22.0	19.8-24.3
<b>2021</b>	394	56.5	22.9	20.6-25.1
<b>P for trend</b>	-	-	0.072	-

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



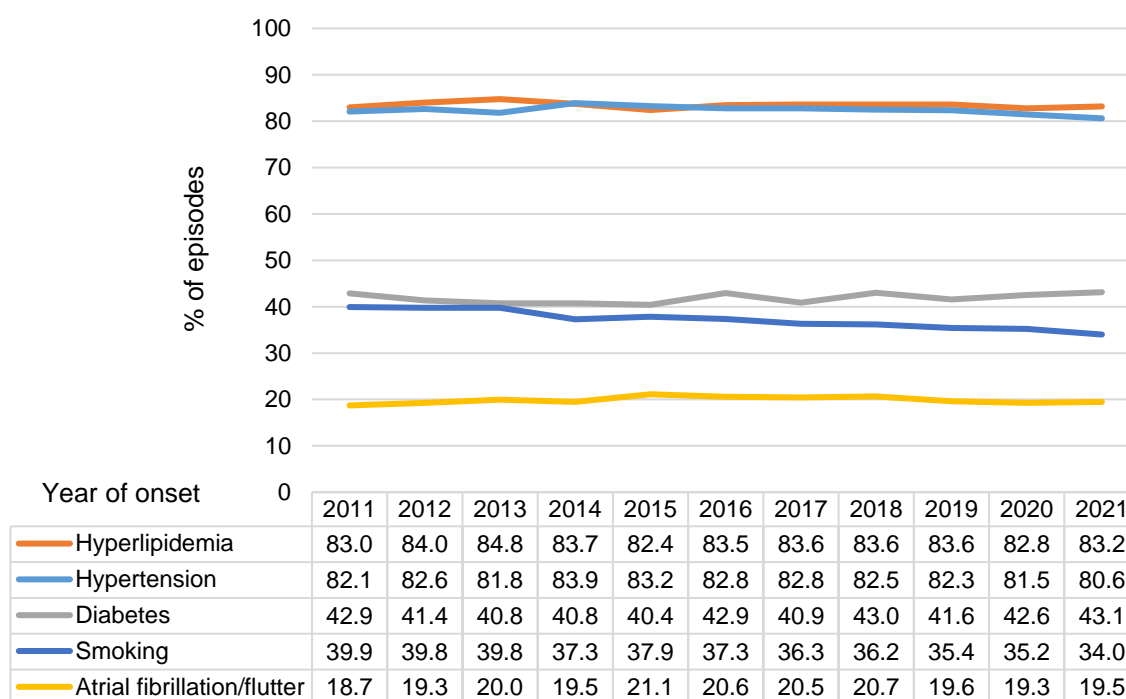
## 5.4 Risk Factors

Hypertension, hyperlipidemia, diabetes, smoking and atrial fibrillation/flutter (AF) are well-established risk factors of stroke<sup>27</sup>. Hypertension, hyperlipidemia, diabetes, and smoking are potentially modifiable risk factors. Although AF may not be preventable, leading a healthy lifestyle, obtaining an early diagnosis and right treatment for AF, may reduce the complications from AF<sup>28</sup>.

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

Between 2011 and 2021, hyperlipidemia and hypertension were consistently the two most common risk factors among stroke patients (Figure 5.4.1). In 2021, 83.2% of the patients had hyperlipidemia and 80.6% had hypertension. Diabetes, smoking and AF were also prevalent among stroke patients, with 43.1%, 34.0% and 19.5% of them having these risk factors respectively in 2021. Apart 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 relatively unchanged during this period.

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

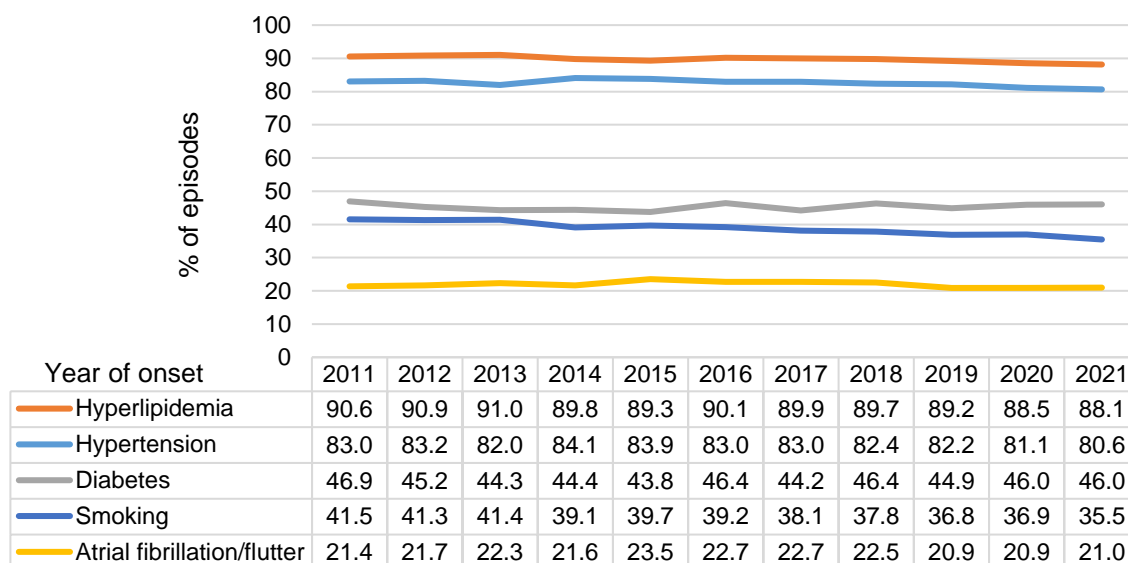


<sup>27</sup> Boehme AK, Esenwa C and Elkind M. Stroke Risk Factors, Genetics, and Prevention. *Circ Res.* 2017;120:472-495.

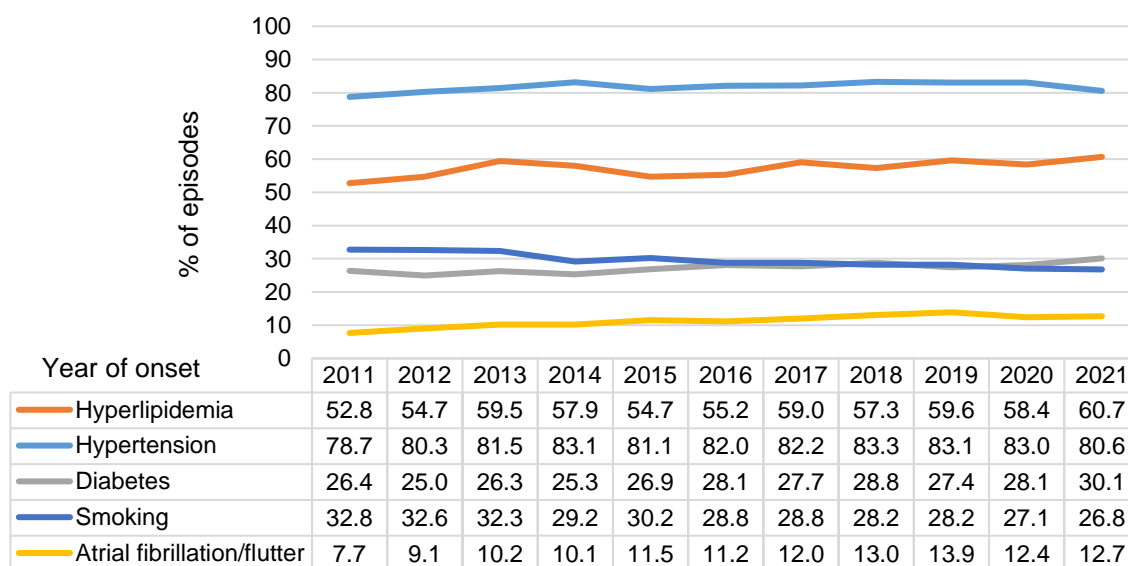
<sup>28</sup> Shah SR, Luu SW, Caestino M, David J, Christopher B. Management of atrial fibrillation-flutter: uptodate guideline paper on the current evidence. *Journal of Community Hospital Internal Medicine Perspectives.* 2018; 8(5): 269-275.

While the proportions of IS and HS patients with hypertension were similar, 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 is in line with what was found by Feigin et al using data from the GBD study 2019, whereby proportions of disease burden attributed to high blood glucose and high cholesterol levels were higher for ischaemic stroke as compared to haemorrhagic stroke across most geographical regions, including globally and in Southeast Asia, while high blood pressure was consistently the leading risk factor regardless of stroke subtype<sup>29</sup>.

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



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



<sup>29</sup> Feigin V. et al. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Neurol* 2021;20: 795–820.

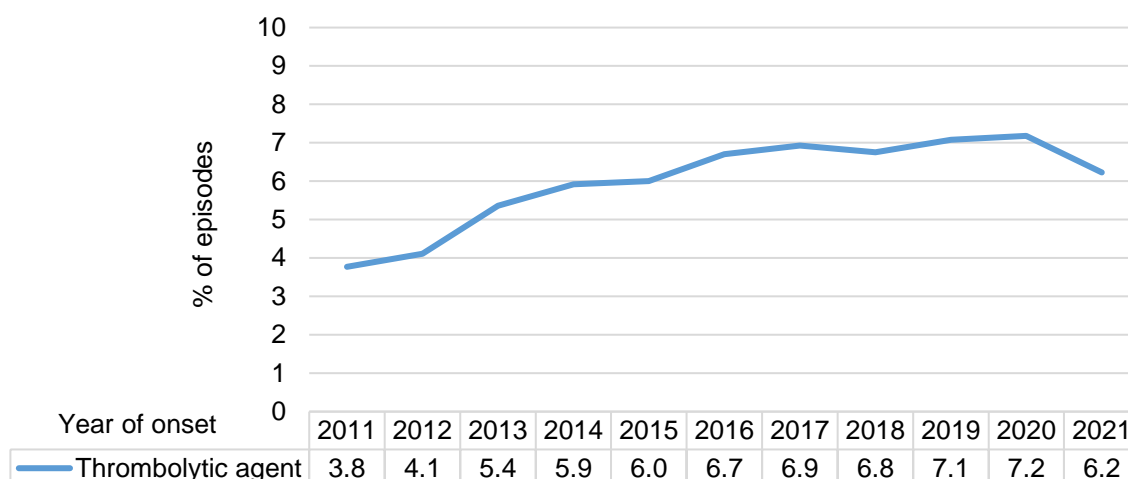
## 5.5 Treatment

The administration of thrombolytic agents to eligible patients with IS<sup>30</sup> has been shown to be safe and efficacious, with optimal recovery rate when given within 3 hours from the onset of stroke and moderate recovery rate when given within 3 to 4.5 hours from onset<sup>31,32</sup>.

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

The proportion of IS patients who received thrombolytic agents increased from 3.8% in 2011 to 6.2% in 2021 (Figure 5.6.1). The rise was likely due to more patients meeting the 4.5-hour recommended window for thrombolytic agents to be administered.

**Figure 5.5.1: Treatment (%) among ischaemic stroke**



<sup>30</sup> Examples of ineligible patients include those on blood thinning medication and those with extensive brain damage, high risk of bleeding and recent bleeding.

<sup>31</sup> Powers WJ et al. Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke*. 2019;50:e344–e418.

<sup>32</sup> TPA Therapy. National Library of Medicine, National Center for Biotechnology Information. <https://www.ncbi.nlm.nih.gov/books/NBK482376/> Accessed on 16 June 2023.

## 6. CONCLUSION

In 2019, stroke accounted for about 7% of Singapore's total burden of ill health and premature death due to diseases, injuries, and risk factors<sup>33</sup>. Stroke can impact individuals and their families significantly, as those who have had a stroke may have difficulties with mobility, activities of daily living, and emotional or behavioural changes<sup>34</sup>.

The INTERSTROKE study found that the following five risk factors accounted for more than 80% of the global risk of all strokes: hypertension, current smoking, abdominal obesity, unhealthy diet, and physical inactivity. Targeted interventions to reduce blood pressure and smoking, as well as to promote regular physical activity and healthy diets could therefore substantially reduce the global burden of stroke<sup>35</sup>.

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 having a balanced diet and opting for healthier food options, leading an active lifestyle and maintaining a healthy weight, avoiding smoking, going for regular health screening and follow-ups, and controlling blood pressure, blood cholesterol and blood glucose levels well<sup>36,37</sup>. 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 leading a healthy lifestyle can reduce the risk of subsequent cardiovascular events (including recurrent stroke) and premature mortality.

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<sup>33</sup> GBD Results. Institute for Health Metrics and Evaluation (IHME) 2020. <https://vizhub.healthdata.org/gbd-results/>. Accessed on 16 June 2023.

<sup>34</sup> Stroke: Impact of Stroke. HealthHub. <https://www.healthhub.sg/a-z/diseases-and-conditions/677/stroke-impact-of-stroke> Accessed on 16 June 2023.

<sup>35</sup> 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.

<sup>36</sup> Ibid.

<sup>37</sup> Feigin V. et al. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet Neurol* 2021;20: 795–820.