Singapore Stroke Registry
Annual Report 2022

National Registry of Diseases Office

January 2025

Acknowledgements

Contents

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 Institutes of Health Stroke Scale
NRIC	National Registration Identity Card
SSR	Singapore Stroke Registry

2.   EXECUTIVE SUMMARY

The number of stroke episodes had increased by more than 50% from 6,367 episodes in 2012 to 9,702 episodes in 2022. The age-standardised incidence rate (ASIR) increased significantly by about 5% from 157.6 to 164.9 per 100,000 population during this period, indicating that most of the increase in cases was due to population ageing. The median age at onset of stroke increased slightly from 67.6 years in 2012 to 70.2 years in 2022.

There was an approximately 20% increase in the number of stroke deaths from 783 in 2012 to 938 in 2022. However, the age-standardised mortality rate (ASMR) declined significantly from 18.5 to 14.2 per 100,000 population during this period. A significant drop in 30-day case fatality rate (CFR) from 9.3% in 2012 to 8.1% in 2022 was also observed.

About 80% of stroke incidence each year were ischaemic strokes (IS), while 20% were haemorrhagic strokes (HS). Correspondingly, the ASIRs of IS were consistently higher than HS across the years. In contrast to the disparity in the incidence of IS and HS, IS generally accounted for only a slightly higher proportion of stroke deaths every year. 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 2022, ASMRs for IS and HS were 6.3 and 7.8 per 100,000 population respectively. In terms of 30-day CFR, the rates among HS patients were consistently higher (CFR of 4.3% for IS compared to 23.8% for HS in 2022). This is likely due to HS generally being a more severe condition with a higher likelihood of fatality.

Between 2012 and 2022, hyperlipidaemia and hypertension were consistently the two most common risk factors among stroke patients. In 2022, 83.7% of the patients had hyperlipidaemia and 81.0% had hypertension. Diabetes, smoking and atrial fibrillation/flutter were also prevalent among stroke patients, with 44.1%, 34.7% and 19.8% of them having these risk factors respectively in 2022.

Relating to treatment, the proportion of IS patients who received thrombolytic agents increased from 4.1% in 2012 to 5.8% in 2022. The proportion of IS patients who underwent endovascular thrombectomy (EVT) approximately doubled from 2.6% in 2018 to 5.3% in 2022. The proportion of IS patients without AF treated with anti-platelets was at least 94% or above every year, while the proportion of IS patients with AF who were administered anti-coagulants remained high at 99% or above every year.

The median length of hospitalisation ranged from 6 to 8 days in the past decade, and was longer for HS compared to IS (16 and 7 days respectively in 2022).

3. INTRODUCTION

Cerebrovascular diseases were the fourth most common cause of death in 2022, accounting for 5.8% 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 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, hyperlipidaemia, diabetes, atrial fibrillation/flutter (AF), smoking and old age.

The proportion of Singapore residents aged 65 years and above rose from about 10% (1 in 10) in 2012 to 16.6% (1 in 6) in 2022[2]. This figure has been projected to rise to about 24.1% (1 in 4) in 2030[3]. Due to 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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[1] Death Statistics by cause in Singapore. HealthHub. https://www.healthhub.sg/a-z/health-statistics/principal-causes-of-death Accessed on 26 June 2024.

[2] SingStat Table Builder, Population and Population Structure, Annual Population, Singapore Residents by age group, ethnic group and sex. Department of Statistics, Singapore. https://tablebuilder.singstat.gov.sg/table/TS/M810011. Accessed on 23 April 2024.

[3] Population Trends – Overview. National Population and Talent Division, Prime Minister's Office, Singapore. https://www.population.gov.sg/our-population/population-trends/overview/. Accessed 18 June 2024.

4.   METHODOLOGY

The National Registry of Diseases Office (NRDO) collects and analyses epidemiological data to support 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 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[4].

The death status of all patients registered in the SSR were updated till 30 September 2023 by matching the patients' NRIC number with the death information from the MHA.

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[4] 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[5]. The Segi World population estimates used for age standardisation are available on the World Health Organization website[6].

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 2012 to 2022 as they stood on 9 May 2024. 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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[5] 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.
[6] Omar BA et al. Age standardization of rates: a new WHO standard. GPE discussion paper series: no. 31. EIP.GPE/EBD World Health Organization 2001.

5.   FINDINGS

5.1   Incidence

Over the span of a decade, the number of stroke episodes increased by more than 50% from 6,367 in 2012 to 9,702 in 2022 and there was a significant increase in the crude incidence rate (CIR) during this period (p<0.010) (Table 5.1.1 and Figure 5.1.1). The age-standardised incidence rate (ASIR) of stroke also rose significantly, by about 5%, from 157.6 to 164.9 per 100,000 population from 2012 to 2022 (p=0.010). In contrast, studies have shown that although age-standardised stroke incidence has been declining in high-income countries (including Western Europe and North America), ageing populations would nevertheless result in the continued increase of the yearly number of stroke cases[7]. Results from the 2021 iteration of the Global Burden of Disease (GBD) study showed a 12.5% increase in the number of strokes from 2011 to 2021 in high-income countries, coupled with a 6.6% decrease in age-standardised stroke incidence in these countries[8].

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

Year of onset	Number	CIR	95% CI	ASIR	95% CI
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	7457	223.4	218.4-228.5	156.3	152.7-160.0
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	9694	284.3	278.7-290.0	172.0	168.5-175.6
2022	9702	277.9	272.4-283.4	164.9	161.5-168.4
P for trend	-	<0.001**	-	0.010*	-

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

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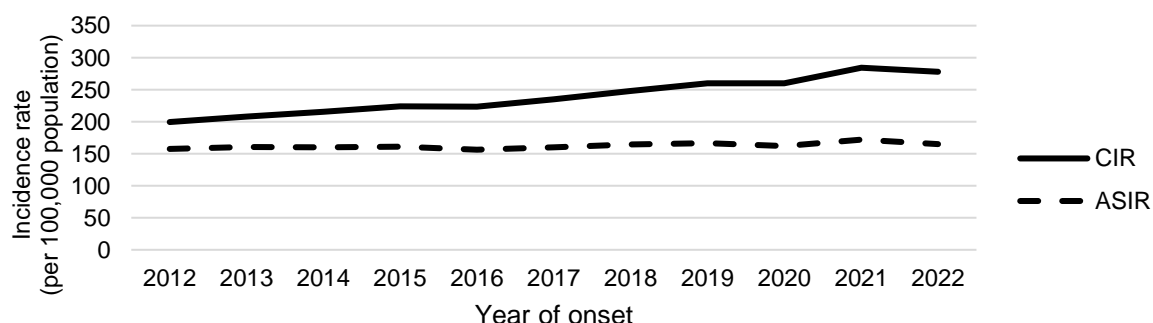
[7] Li L, Scott C., and Rothwell P. Trends in Stroke Incidence in High-Income Countries in the 21st Century Population-Based Study and Systematic Review. Stroke. 2020;51:1372-1380.
[8] GBD Results. Institute for Health Metrics and Evaluation (IHME) 2024. https://vizhub.healthdata.org/gbd-results/. Accessed on 13 July 2024.

The median age at onset of stroke increased from 67.6 years in 2012 to 70.2 years in 2022 (p<0.001) (Table 5.1.2). Almost 80% of stroke patients were aged 60 years and above in 2022, a gradual increase from about 70% in 2012 (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	%
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	579	6.0
2022	70.2	38	0.4	154	1.6	599	6.2
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	19.1	1991	26.7	1624	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	2640	27.2	2370	24.4	2424	25.0
2022	1344	13.9	2652	27.3	2559	26.4	2356	24.3

Figure 5.1.2: Age distribution at onset of stroke
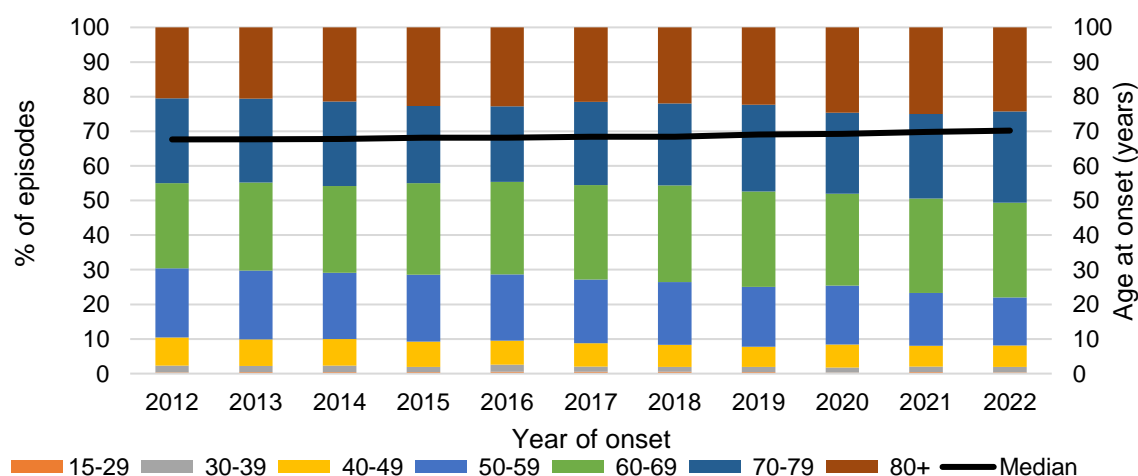
The incidence of stroke increased with age, with the oldest age group having the highest incidence rate (Figures 5.1.3a and 5.1.3b). Older individuals are at greater risk of stroke due to higher prevalence of cardiovascular risk factors such as hypertension, hyperlipidaemia and diabetes, and this was also reflected in the National Population Health Survey 2022, whereby the age-specific prevalence of these risk factors increased with age[9]. In general, the incidence of stroke globally has been noted to double for each decade after 55 years of age[10]. 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 2012 and 2022, a significant rise in incidence rates was observed for all age groups, with the exception of the two oldest groups (70-79 years, and 80 years and above) (Table 5.1.3). Additionally, while the age-specific incidence of stroke rose by less than 10% for age groups above 49 years of age, greater changes in stroke incidence were observed for younger adults under 50 years of age (at least 20%). An England-based cohort study also found that stroke incidence rose by 67% among individuals younger than 55 years of age but declined in those aged 55 years or older[11]. In comparison, GBD study results show that between 2011 and 2021, while age-specific stroke incidence remained similar for those aged 15-49 years, there were slight declines for those aged 50 years and above[12].

Figure 5.1.3a: Age-specific incidence rate of stroke (per 100,000 population) across age groups
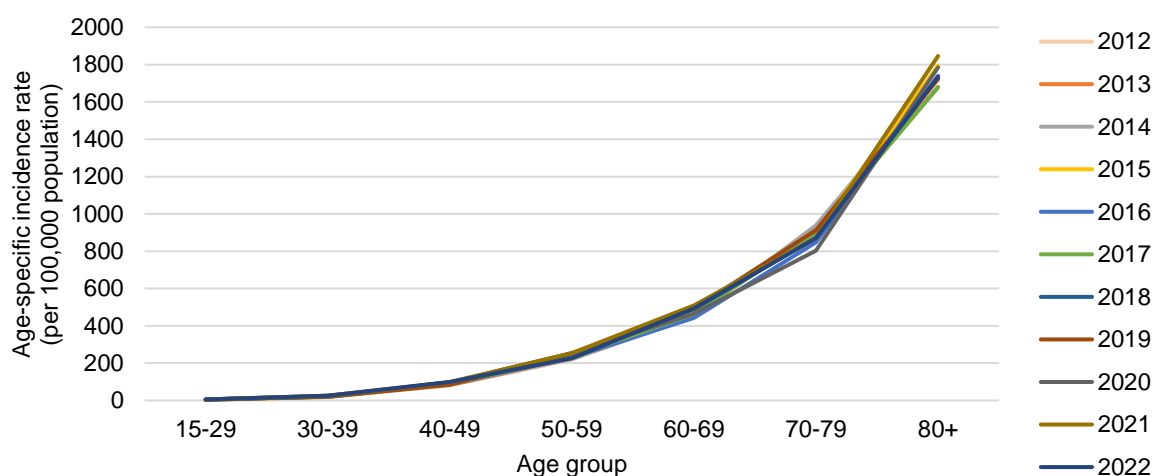
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[9] National Population Health Survey 2022 (Household Interview and Health Examination). Ministry of Health, Singapore. https://www.moh.gov.sg/resources-statistics/reports/national-population-health-survey-2022 Accessed on 4 October 2023.
[10] Boehme AK, Esenwa C and Elkind M. Stroke Risk Factors, Genetics, and Prevention. Circ Res. 2017;120:472-495.
[11] Linxin Li, Catherine A. Scott, Peter M. Rothwell. Association of Younger vs Older Ages With Changes in Incidence of Stroke and Other Vascular Events, 2002-2018. JAMA. 2022;328(6):563-574
[12] GBD Results. Institute for Health Metrics and Evaluation (IHME) 2024. https://vizhub.healthdata.org/gbd-results/. Accessed on 13 July 2024.

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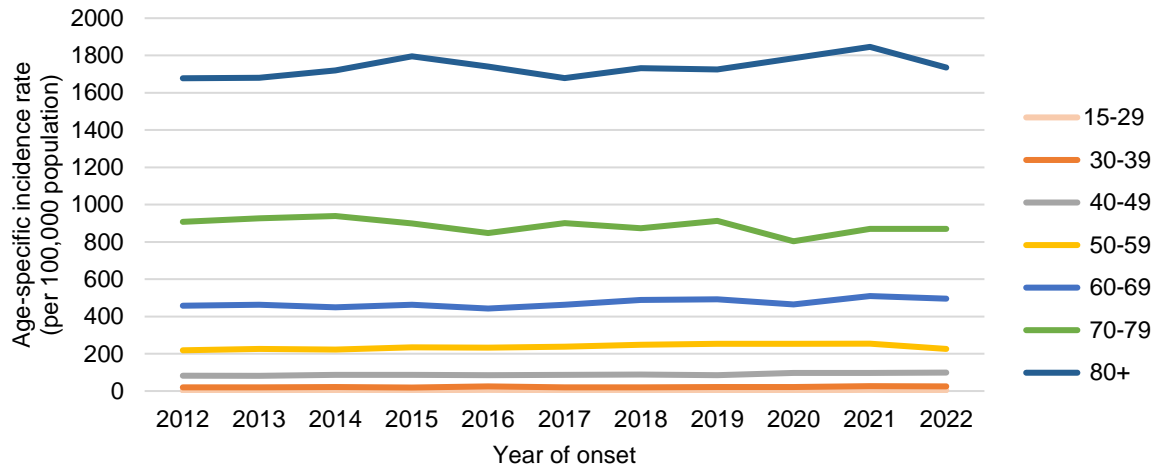
Table 5.1.3: Age-specific incidence rate of stroke (per 100,000 population)

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
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	218.4-228.5	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	284.3	278.7-290.0	5.6	3.8-7.3	26.4	22.3-30.6	97.7	89.7-105.6
2022	277.9	272.4-283.4	5.3	3.6-7.0	25.3	21.3-29.3	99.1	91.2-107.1
P for trend	<0.001**	-	0.030*	-	0.046*	-	<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
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	846.9	805.7-888.1	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	509.6	490.2-529.1	870.4	835.3-905.4	1846.0	1772.5-1919.5
2022	226.7	214.6-238.8	494.8	476.0-513.7	869.3	835.6-903.0	1734.6	1664.5-1804.6
P for trend	0.020*	-	0.009*	-	0.057	-	0.070	-

Although the sex 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 211.1 per 100,000 population, while females had an ASIR of 120.9 per 100,000 population in 2022. In addition, a significant upward trend in ASIR was observed for males (p=0.002) but not for females (p=0.516). Available data from the GBD study shows that for high-income countries, while males and females accounted for similar numbers of stroke cases each year in 2011 and 2021, the ASIR of stroke among males was comparatively higher. In addition, unlike for Singapore, the ASIRs of stroke for both sexes dropped slightly over the decade.

Males are known to have a higher risk of stroke compared to females[13]. The underlying causes are multi-factorial and related to the pathophysiological sex differences in stroke[14]. Furthermore, the prevalence of hypertension, hyperlipidaemia, 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[15].

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

Male						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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	5631	58.1	339.6	330.8-348.5	220.7	214.8-226.6
2022	5625	58.0	332.3	323.6-340.9	211.1	205.4-216.7
P for trend	-	-	<0.001**	-	0.002**	-
Female						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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	3111	41.7	181.8	175.4-188.2	114.3	110.1-118.6
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

[13] Bushnell CD. et al. Sex differences in stroke: Challenges and opportunities. Journal of Cerebral Blood Flow & Metabolism 2018;38(12): 2179–2191.
[14] Reeves MJ et al. Sex differences in stroke: epidemiology, clinical presentation, medical care, and outcomes. Lancet Neurology 2008; 7(10): 915-926.
[15] National Population Health Survey 2022 (Household Interview and Health Examination). Ministry of Health, Singapore. https://www.moh.gov.sg/resources-statistics/reports/national-population-health-survey-2022 Accessed on 4 October 2023.

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	4063	41.9	231.9	224.8-239.1	125.7	121.5-129.8
2022	4077	42.0	226.7	219.7-233.7	120.9	116.9-124.9
P for trend	-	-	<0.001**	-	0.516	-

Figure 5.1.4: Incidence rate of stroke (per 100,000 population) by sex
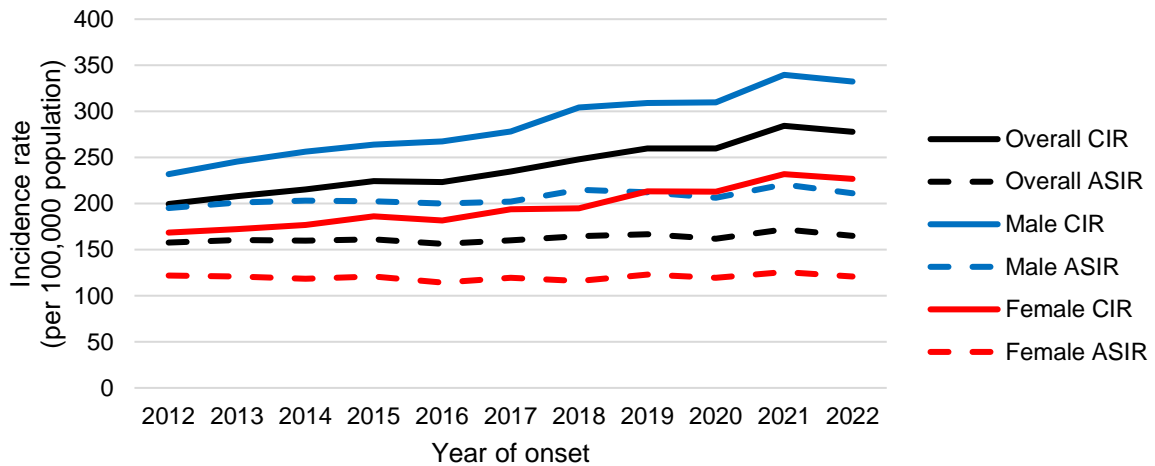
The median age at onset of stroke among males increased from 64.3 years in 2012 to 67.8 years in 2022 (p<0.001), and the proportion of stroke patients aged 60 years and above increased from 63.7% in 2012 to 74.6% in 2022 (Table 5.1.5a). In 2022, nearly 1 in 3 (31.8%) of male stroke cases were aged 60-69 years (31.8%) – the largest among all age groups (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	%
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	67.3	24	0.4	101	1.8	367	6.5
2022	67.8	19	0.3	99	1.8	369	6.6
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1070	20.8	1634	31.7	1250	24.2	734	14.2
2020	1080	20.8	1594	30.7	1197	23.1	865	16.7
2021	1034	18.4	1795	31.9	1339	23.8	971	17.2
2022	942	16.7	1787	31.8	1487	26.4	922	16.4

Figure 5.1.5a: Age distribution at onset of stroke among males
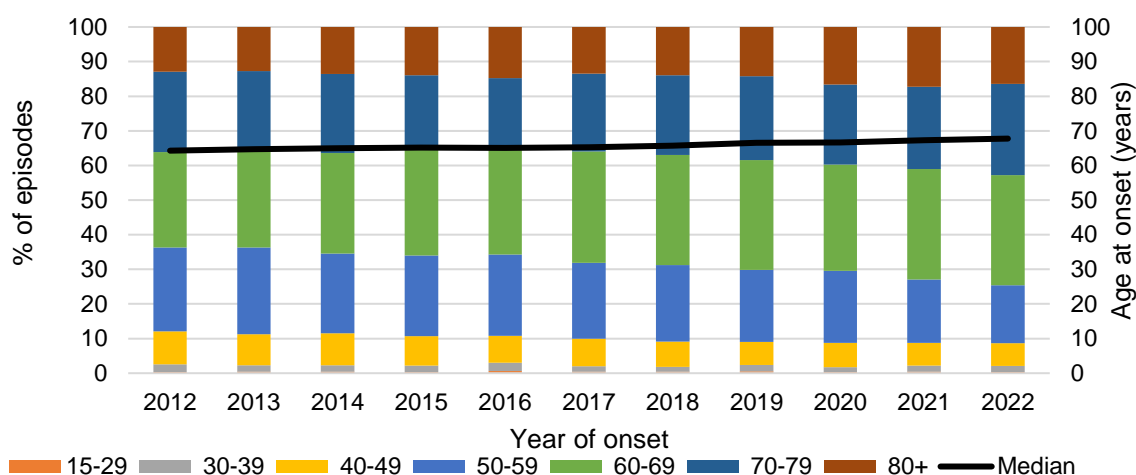
The median age at onset of stroke among females rose from 72.4 years to 74.5 years over the past decade (p=0.023) (Table 5.1.5b), about 8 years older than the median age at onset among males (Table 5.1.5a). In general, globally, women tend to be several years older than men at stroke onset[16]. This 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[17]. In 2022, those aged 80 years and above (35.2%) formed the highest proportion of female stroke patients; and the proportion of female stroke patients aged 80 years and above every year was also more than twice the corresponding percentage for males (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[18,19,20,21]. Furthermore, there has also been evidence that pregnancy-related conditions such as gestational hypertension and preeclampsia increase the long-term risk of cardiovascular disease[22].

[16] Rexrode KM et al. The Impact of Sex and Sex on Stroke. Circulation Research. 2022; 130: 512–528.
[17] 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.
[18] Roy-O'Reilly M & McCullough LD. Age and Sex Are Critical Factors in Ischemic Stroke Pathology. Endocrinology 2018;159(8): 3120–3131.
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[20] Bushnell CD. et al. Sex differences in stroke: Challenges and opportunities. Journal of Cerebral Blood Flow & Metabolism 2018;38(12): 2179–2191.
[21] Boehme AK, Esenwa C and Elkind M. Stroke Risk Factors, Genetics, and Prevention. Circ Res. 2017;120:472-495.
[22] Rexrode KM et al. The Impact of Sex and Sex on Stroke. Circulation Research. 2022; 130: 512–528.

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	%
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
2022	74.5	19	0.5	55	1.3	230	5.6
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	763	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	845	20.8	1031	25.4	1453	35.8
2022	402	9.9	865	21.2	1072	26.3	1434	35.2

Figure 5.1.5b: Age distribution at onset of stroke among females
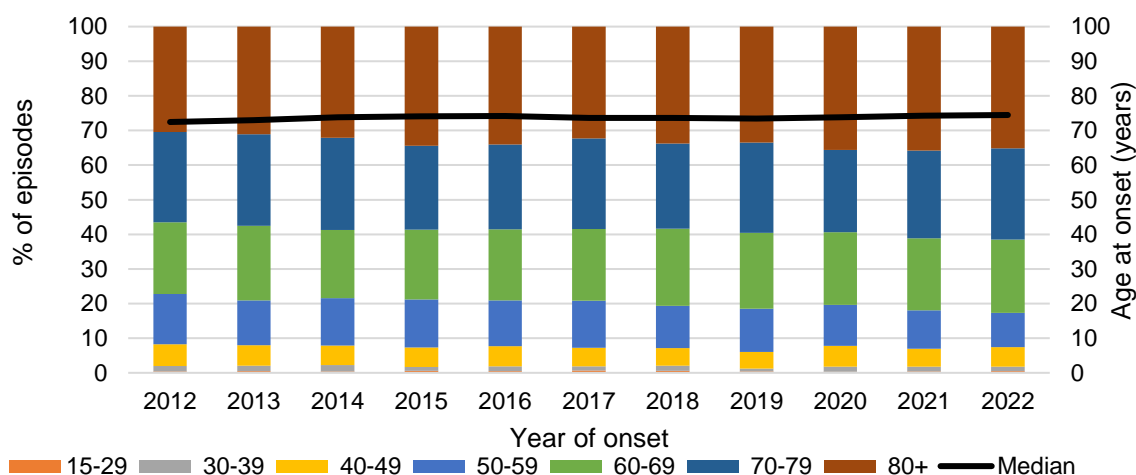
Malays consistently had the highest CIRs and ASIRs of stroke across the years (Table 5.1.6, Figure 5.1.6). The ASIRs were 150.4, 240.2 and 176.7 per 100,000 population for Chinese, Malays and Indians respectively in 2022. However, changes in the ASIR of stroke in the last decade were significant only among Indians.

The prevalence of hypertension, hyperlipidaemia, 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[23]. 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
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	6007	75.9	236.0	230.0-241.9	148.1	144.2-152.0
2018	6392	75.7	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	7238	74.7	281.5	275.0-288.0	155.1	151.3-158.8
2022	7302	75.3	277.9	271.6-284.3	150.4	146.7-154.0
P for trend	-	-	<0.001**	-	0.136	-

Malay						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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	1176	15.9	279.9	263.9-295.9	254.2	239.3-269.0
2016	1160	15.6	272.4	256.7-288.1	245.4	230.9-259.9
2017	1230	15.5	285.5	269.5-301.4	247.2	233.1-261.3
2018	1319	15.6	303.0	286.7-319.4	257.3	243.2-271.4
2019	1397	15.7	318.1	301.5-334.8	264.5	250.4-278.6
2020	1371	15.3	310.0	293.6-326.4	249.5	236.1-263.0
2021	1429	14.7	324.4	307.6-341.3	256.9	243.3-270.4
2022	1390	14.3	310.5	294.2-326.8	240.2	227.3-253.1
P for trend	-	-	<0.001**	-	0.478	-

Indian						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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	468	6.3	163.6	148.8-178.4	152.1	138.0-166.3
2016	499	6.7	173.0	157.8-188.2	155.6	141.6-169.6

[23] 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.

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	676	7.5	226.1	209.1-243.2	180.1	166.5-193.7
2021	724	7.5	246.6	228.7-264.6	195.2	180.8-209.5
2022	700	7.2	229.0	212.1-246.0	176.7	163.5-189.9
P for trend	-	-	<0.001**	-	0.003*	-

Figure 5.1.6: Incidence rate of stroke (per 100,000 population) by ethnicity
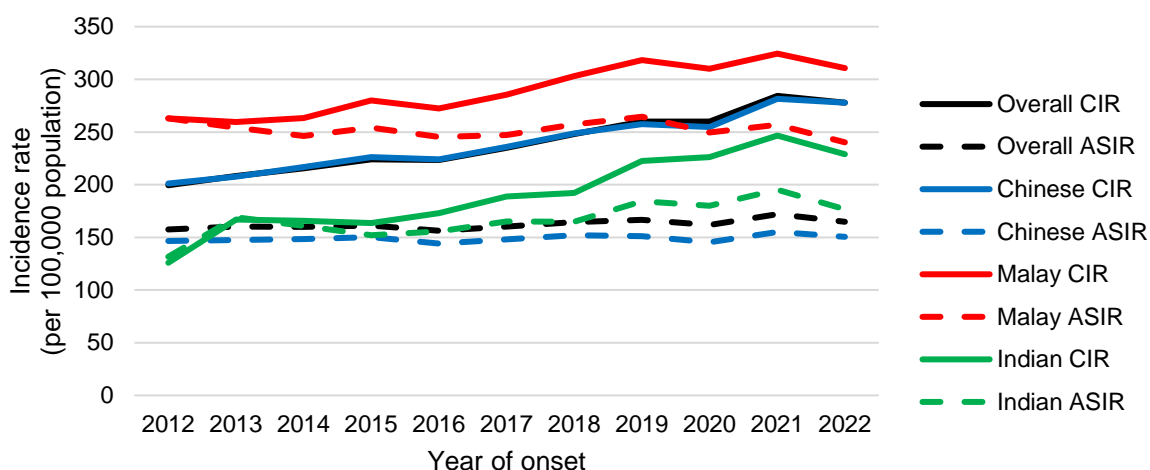
Among the ethnic groups, the Chinese had the oldest median age at onset of stroke, which increased from 69.2 years in 2012 to 71.7 years in 2022 (p<0.001), and the proportion of Chinese stroke patients aged 60 years and above had increased steadily from 72.6% in 2012 to 81.4% in 2022 (Table 5.1.7a). In 2022, those aged 70-79 years and 80 years and above were the two biggest age groups among Chinese stroke patients, approximately equal at 27.7% and 27.4% respectively (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	%
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	379	5.2
2022	71.7	24	0.3	83	1.1	399	5.5
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%

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	1594	26.5	1587	26.4	1399	23.3
2018	1043	16.3	1750	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	13.5	1843	25.5	1867	25.8	2061	28.5
2022	845	11.6	1924	26.3	2023	27.7	2004	27.4

Figure 5.1.7a: Age distribution at onset of stroke among Chinese
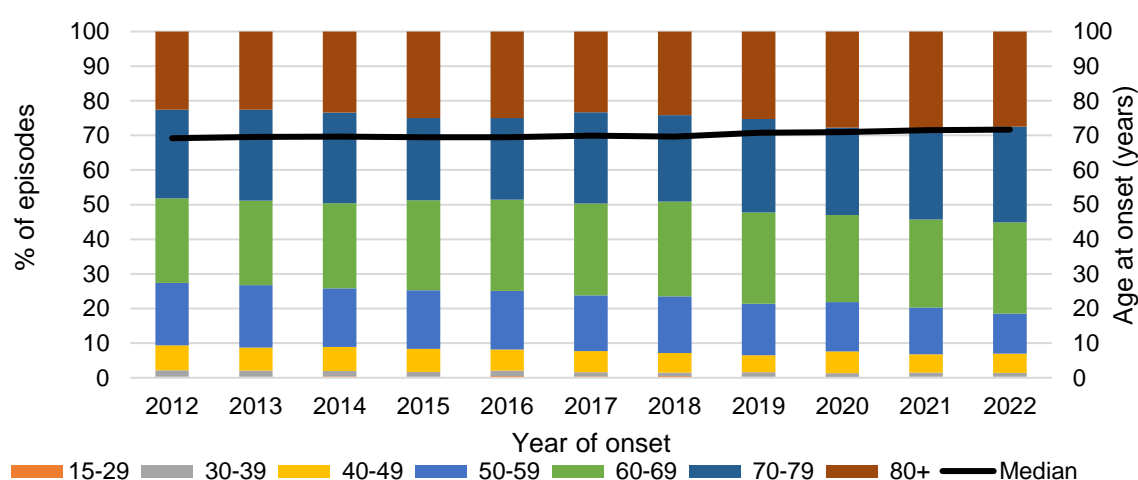
The median age at onset of stroke among Malays rose from 63.7 to 65.8 years over the past decade (p=0.011) – about 6 years younger than the Chinese (Table 5.1.7b). In 2022, those aged 60-69 years (30.2%) formed the highest proportion of Malay stroke patients (Figure 5.1.7b). Compared to the Chinese, a slightly smaller percentage of Malay stroke patients were aged 60 years and above each year (between 59% 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	%
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	100	8.5
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	2022	65.8	9	0.6	39	2.8	106	7.6

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	184	15.9	172	14.8
2017	320	26.0	374	30.4	209	17.0	184	15.0
2018	303	23.0	390	29.6	269	20.4	207	15.7
2019	343	24.6	449	32.1	264	18.9	182	13.0
2020	332	24.2	453	33.0	235	17.1	200	14.6
2021	319	22.3	465	32.5	295	20.6	193	13.5
2022	305	21.9	420	30.2	342	24.6	169	12.2

Figure 5.1.7b: Age distribution at onset of stroke among Malays
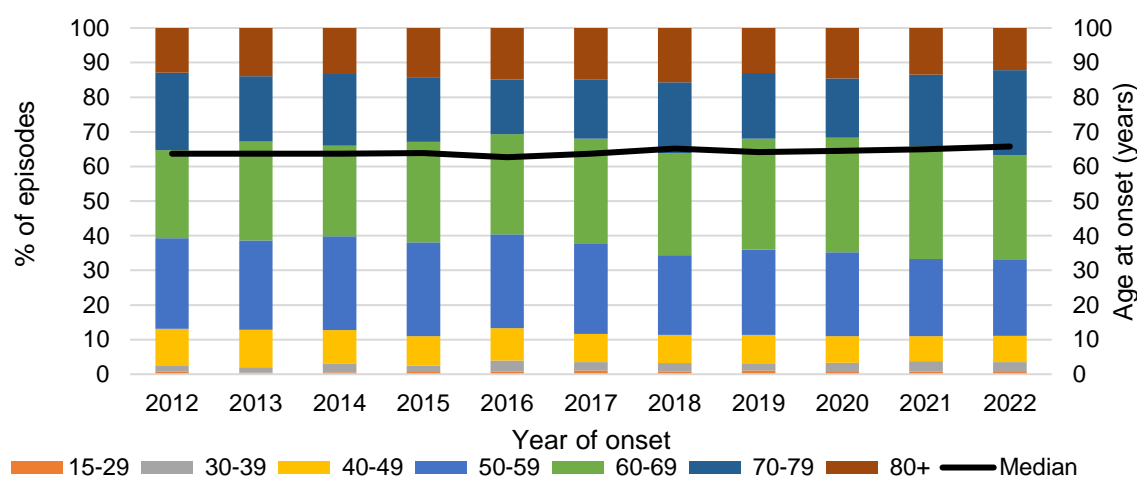
The median age at onset of stroke among Indians rose from 61.5 years to 65.5 years over the past decade (p=0.001) (Table 5.1.7c). In 2022, those aged 60-69 years (30.7%) formed the highest proportion of Indian stroke patients, while two in three (66.7%) Indian stroke patients were aged 60 years and above – 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	%
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	47	10.0
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	64.5		1	0.1	9	1.3	57	8.4
2021	65.1		7	1.0	17	2.3	77	10.6
2022	65.5		5	0.7	17	2.4	64	9.1

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	182	26.9	193	28.6	122	18.0	112	16.6
2021	143	19.8	225	31.1	147	20.3	108	14.9
2022	147	21.0	215	30.7	129	18.4	123	17.6

Figure 5.1.7c: Age distribution at onset of stroke among Indians
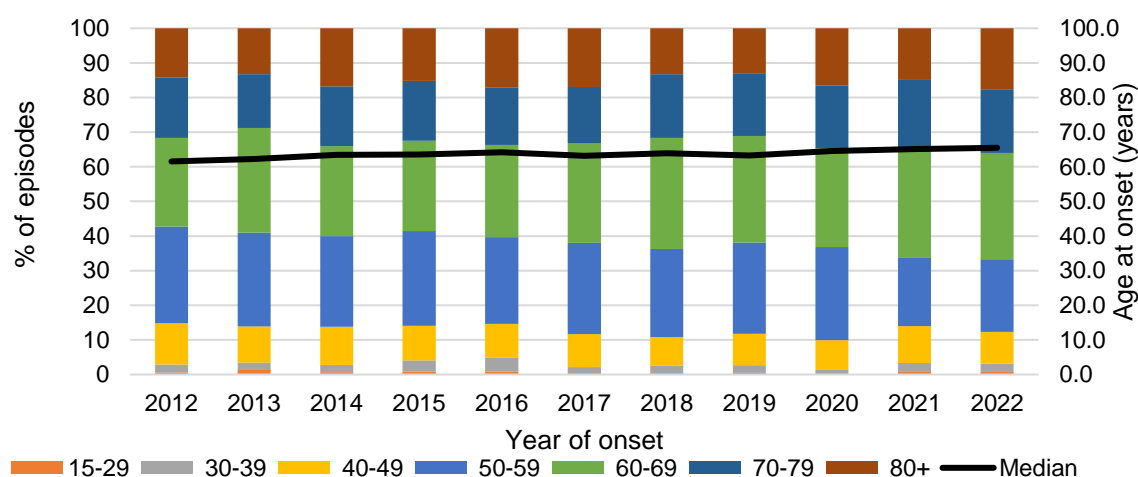
IS was consistently more common than HS, accounting for about 80% of stroke episodes (about 4 in 5) per year (Table 5.1.8); both CIR and ASIR of IS were approximately four times that of HS (Figure 5.1.8). The ASIRs were 130.8 and 34.1 per 100,000 population for IS and HS respectively in 2022, both significant rises from 2012. The proportions of IS and HS amongst all stroke differ from global and regional patterns observed from the GBD study results, where IS constituted 65.34% of all strokes globally in 2021 and 55.6% of strokes in the Association of Southeast Asian Nations (ASEAN). The distribution of IS and HS in Singapore was closer to that of high-income countries, where IS constituted 74.1% of strokes in 2021. These differing trends were possibly due to differences in the prevalence and management of various risk factors[24].

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[24] 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

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
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	6038	81.0	180.9	176.4-185.5	125.1	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	7928	81.8	232.5	227.4-237.6	138.4	135.2-141.5
2022	7812	80.5	223.7	218.8-228.7	130.8	127.8-133.8
P for trend	-	-	<0.001**	-	0.035*	-
Haemorrhagic stroke						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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	1765	18.2	51.8	49.3-54.2	33.7	32.0-35.3
2022	1890	19.5	54.1	51.7-56.6	34.1	32.5-35.8
P for trend	-	-	<0.001**	-	0.005*	-

Figure 5.1.8: Incidence rate of stroke (per 100,000 population) by stroke subtype
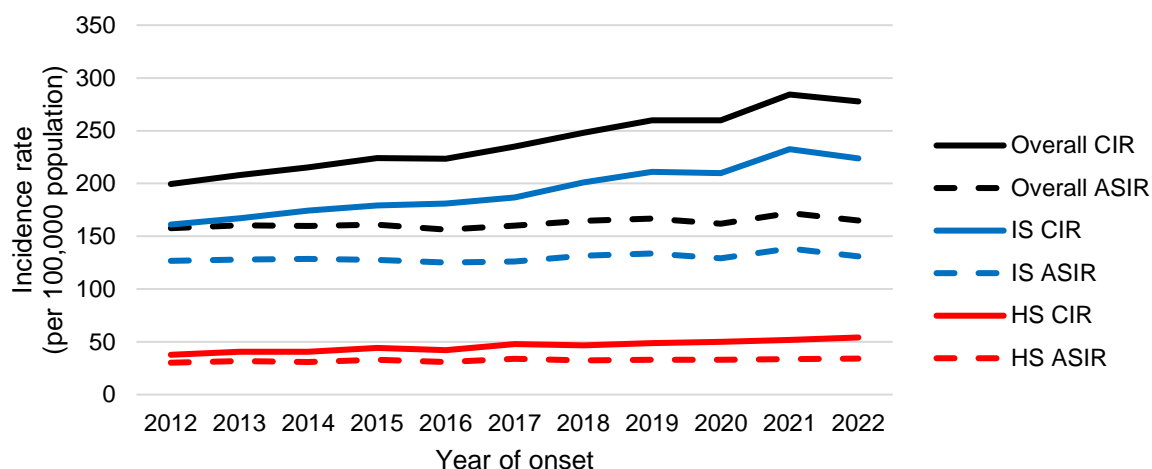
The median age at onset of IS increased from 68.7 years to 70.6 years over the past decade (p<0.001) (Table 5.1.9a). In 2022, 80.0% of IS patients (4 in 5) were aged 60 years and above, a gradual increase from 71.9% in 2012 (Figure 5.1.9a).

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	%
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	392	4.9
2022	70.6	22	0.3	86	1.1	410	5.2
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1381	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	2223	28.0	2021	25.5	2017	25.4
2022	1046	13.4	2195	28.1	2115	27.1	1938	24.8

Figure 5.1.9a: Age distribution at onset of ischaemic stroke
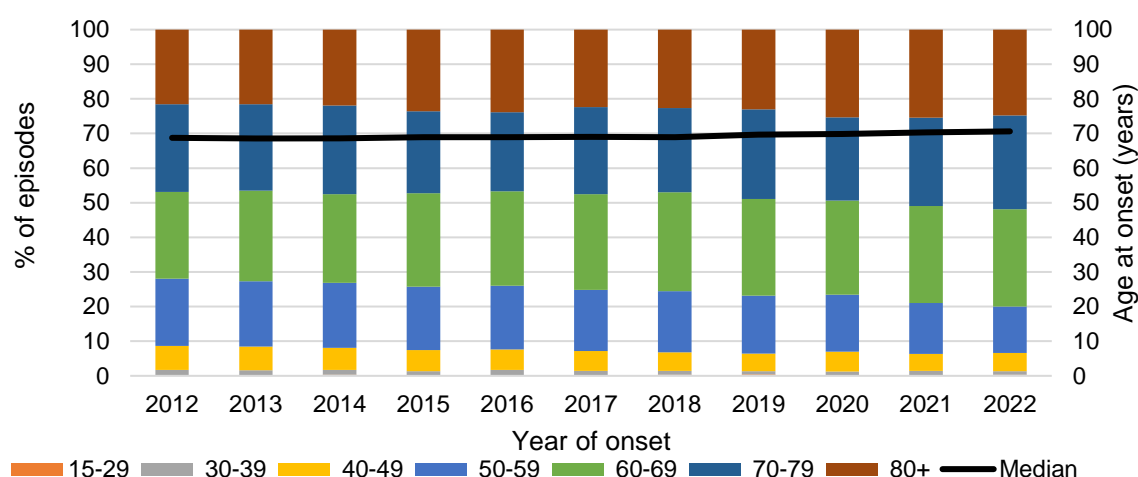
The median age at onset of HS increased from 63.2 years in 2012 to 68.5 years in 2022 (p<0.001)(Table 5.1.9b), although it remains lower than that of IS (Table 5.1.9a). As with IS, the percentage of HS patients aged 60 years and above also increased from 59.0% in 2012 to 69.8% in 2022, although it remained about 10 percentage points 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	%
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	10.5
2022	68.5	16	0.8	68	3.6	189	10.0
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	18.1	417	23.6	349	19.8	407	23.1
2022	298	15.8	457	24.2	444	23.5	418	22.1

Figure 5.1.9b: Age distribution at onset of haemorrhagic stroke
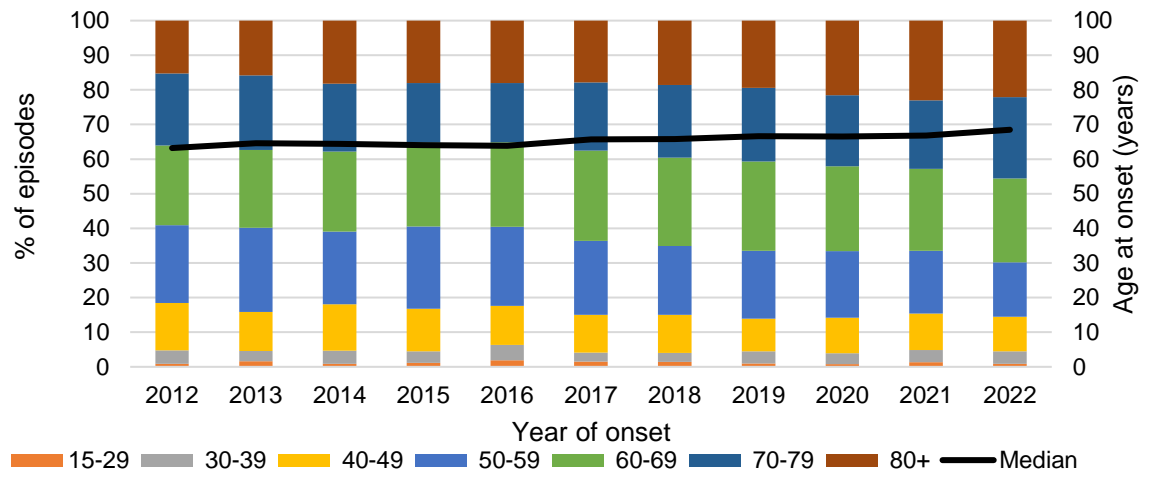
5.2 Mortality

The yearly number of stroke deaths had risen by about 20% over a decade, and while the crude mortality rate (CMR) had not changed significantly, the age-standardised mortality rate (ASMR) dropped significantly (by about 23%) from 18.5 to 14.2 per 100,000 population (Table 5.2.1, Figure 5.2.1). Based on results from the GBD 2021 study, although the absolute number of deaths globally due to stroke had increased by 14.3% between 2011 and 2021, the age-standardised rate had dropped by 14.9%. In comparison, while the number of stroke deaths in ASEAN nations and high-income countries had risen 21.3% and 3.7% respectively, the corresponding ASMRs had dropped 13.9% and 19.9%[25].

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

Year of death	Number	CMR	95% CI	ASMR	95% CI
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
2022	938	26.9	25.1-28.6	14.2	13.2-15.1
P for trend	-	0.682	-	0.002*	-

Figure 5.2.1: Mortality rate of stroke (per 100,000 population)
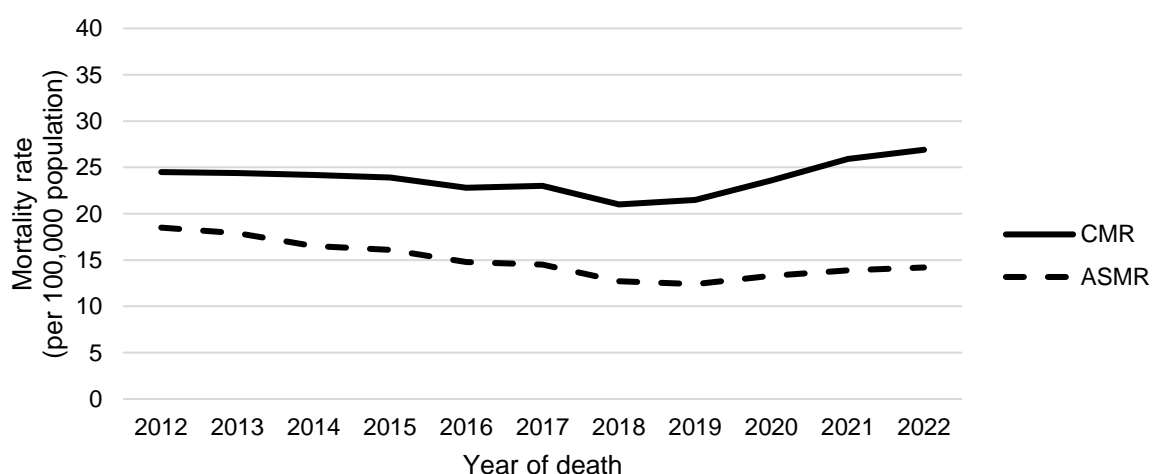
[25] GBD Results. Institute for Health Metrics and Evaluation (IHME) 2024. https://vizhub.healthdata.org/gbd-results/. Accessed on 13 July 2024.

There was no significant change in median age at death over the past decade, ranging between 75.6 years and 78.7 years (p=0.070) (Table 5.2.2). Every year, more than 80% of stroke deaths occurred in those aged 60 years and above; in 2022, 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	%
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
2022	78.1	1	0.1	11	1.2	47	5.0

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2022	64	6.8	167	17.8	231	24.6	417	44.5

Figure 5.2.2: Age distribution at death of stroke
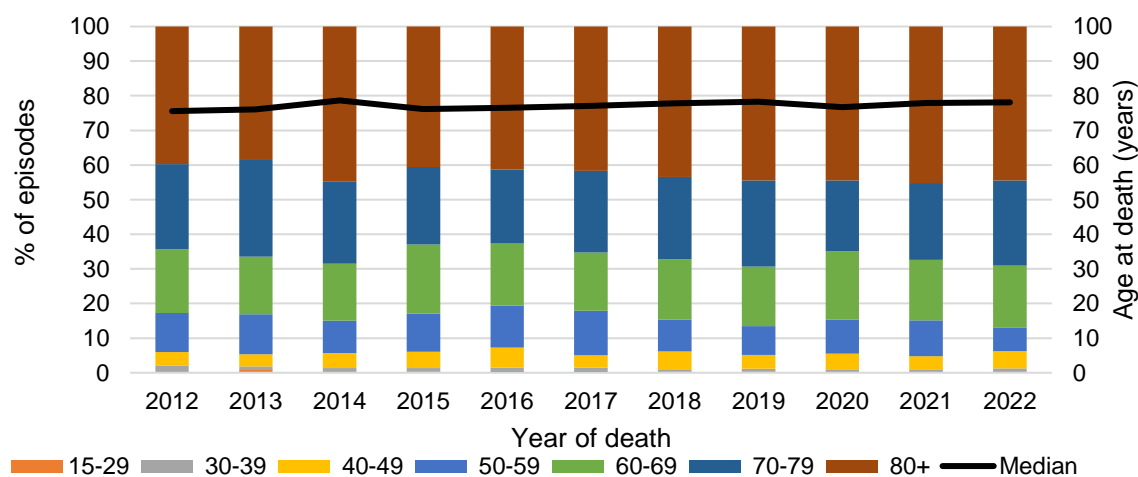
The age-specific mortality rate of stroke increased with age, with the oldest age group having the highest mortality rate (Figure 5.2.3a-b). Significant drops in mortality rates were observed among those aged 60 years and above (Table 5.2.3).

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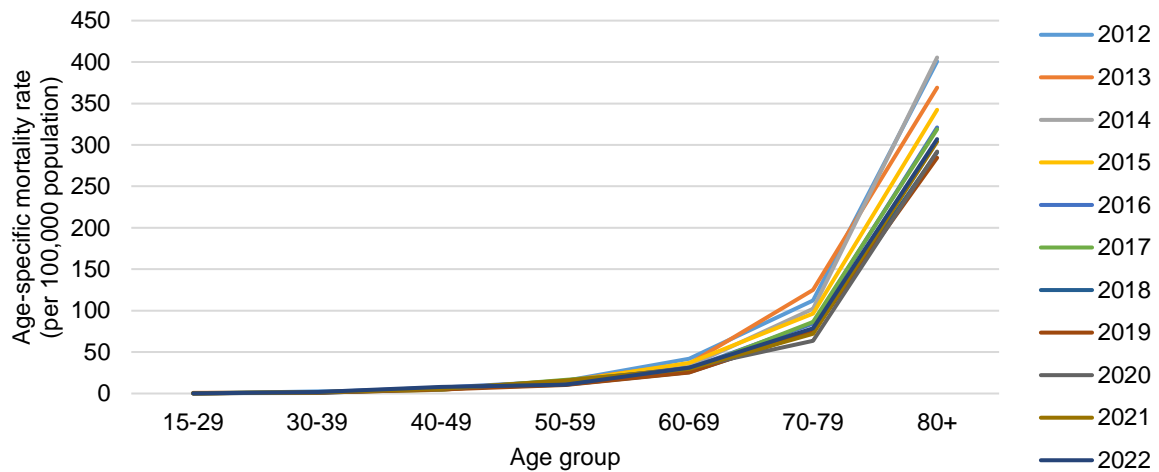
Figure 5.2.3b: Age-specific mortality rate of stroke (per 100,000 population) across years
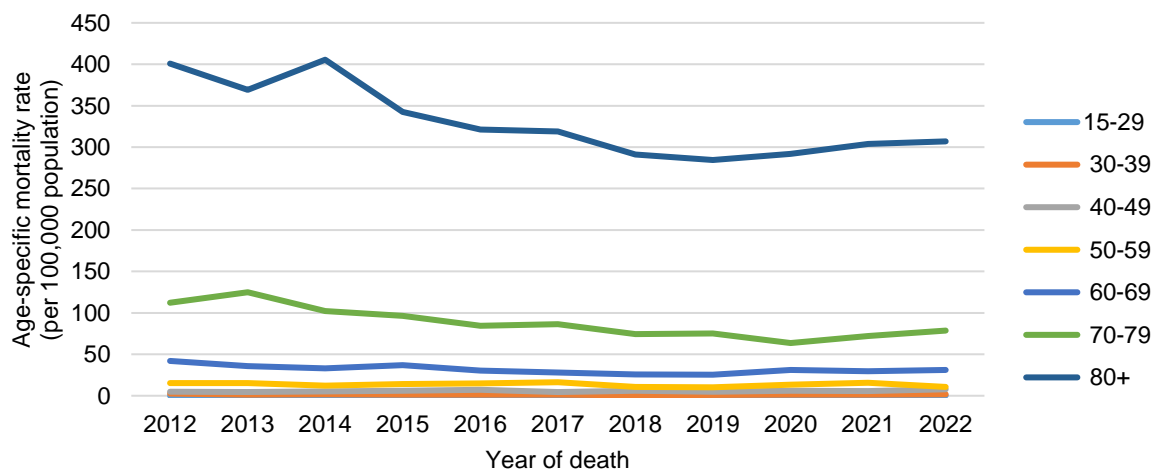
Table 5.2.3: Age-specific mortality rate of stroke (per 100,000 population)

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
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
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
2022	26.9	25.1-28.6	0.1	0.0-0.4	1.8	0.7-2.9	7.8	5.6-10.0
P for trend	0.682	-	0.094	-	0.347	-	0.131	-

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2012	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
2022	10.8	8.2-13.4	31.2	26.4-35.9	78.5	68.4-88.6	307.0	277.5-336.5
P for trend	0.202	-	0.029*	-	<0.001**	-	0.001**	-

In contrast to stroke incidence whereby about 57%-60% of cases occurred in males (Table 5.1.4), a slightly higher percentage of stroke deaths occurred among females (ranging between 51%-55% for most years in the past decade) (Table 5.2.4) 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[26]. The sex distribution of stroke deaths in Singapore was similar to that of high-income countries, whereby males constituted 43.7% of stroke deaths in 2021[27]. The sex disparity in stroke mortality can be explained by the age distribution at stroke onset – since the severity of stroke increases with age, females are at greater risk of death following the onset of stroke[28].

While the CMR was slightly higher among females for most years, the ASMR of stroke was consistently higher among males (Table 5.2.4). In 2022, males had an ASMR of 15.2 per 100,000 population, while females had an ASMR of 12.9 per 100,000 population. The ASMRs declined significantly over the years for both sexes (males: p=0.004, females: p=0.004) (Figure 5.2.4).

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

Male						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
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
2022	425	45.3	25.1	22.7-27.5	15.2	13.7-16.7
P for trend	-	-	0.573	-	0.004*	-
Female						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
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

[26] Rexrode KM et al. The Impact of Sex and Sex on Stroke. Circulation Research. 2022; 130: 512–528.
[27] GBD Results. Institute for Health Metrics and Evaluation (IHME) 2024. https://vizhub.healthdata.org/gbd-results/. Accessed on 13 July 2024.
[28] Dennis J. et al. Sex Differences in Stroke Hospitalization Incidence, 30-Day Mortality, and Readmission in a Regional Medical Center in the Southwestern United States. Southern Medical Journal. 2021;114(3).

2021	453	51.3	25.9	23.5-28.2	11.8	10.6-12.9
2022	513	54.7	28.5	26.1-31.0	12.9	11.7-14.1
P for trend	-	-	0.917	-	0.004*	-

Figure 5.2.4: Mortality rate of stroke (per 100,000 population) by sex
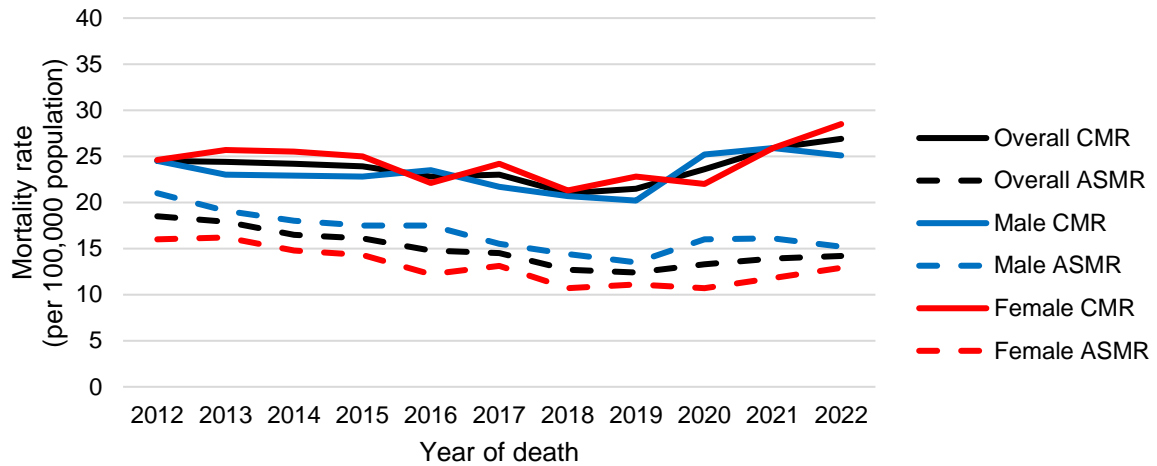
The median age at death due to stroke among males ranged between 69.7 and 73.6 years in the past decade (p=0.175) (Table 5.2.5a). In 2022, more than 80% of males who died from stroke were aged 60 years and above; and those aged 80 years and above (32.7%) formed the biggest age group among males who died 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	%
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
2022	73.6	0	0.0	8	1.9	30	7.1
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2022	41	9.6	97	22.8	110	25.9	139	32.7

Figure 5.2.5a: Age distribution at death of stroke among males
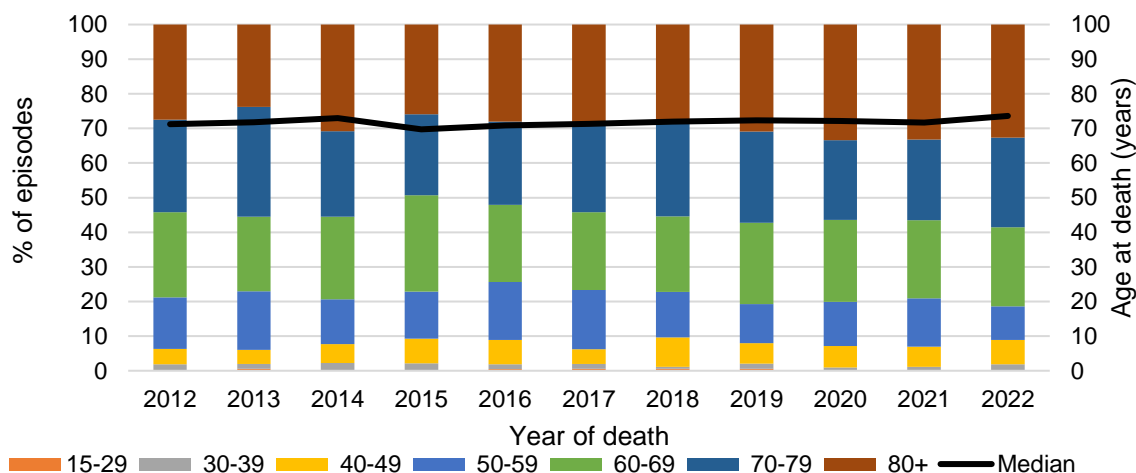
With females having an older median age at onset of stroke compared to males (Tables 5.1.5a and 5.1.5b), they were also found to have an older median age at death – about a decade older than that of males. The median age at death due to stroke among females had risen from 80.7 years to 82.1 years over the past decade (p=0.029) (Table 5.2.5b). In 2022, more than 90% of females who died of stroke were aged 60 years and above; and those aged 80 years and above was the largest age group among females who died of stroke (54.2%), substantially higher than that of males (Figure 5.2.5b). Similarly, in the United States, the greatest sex difference in excess stroke mortality was found in females aged 85 years and above, compared to males of the same age group[29].

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	%
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
2022	82.1	1	0.2	3	0.6	17	3.3

[29] Rexrode KM et al. The Impact of Sex and Sex 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	%
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
2022	23	4.5	70	13.6	121	23.6	278	54.2

Figure 5.2.5b: Age distribution at death of stroke among females
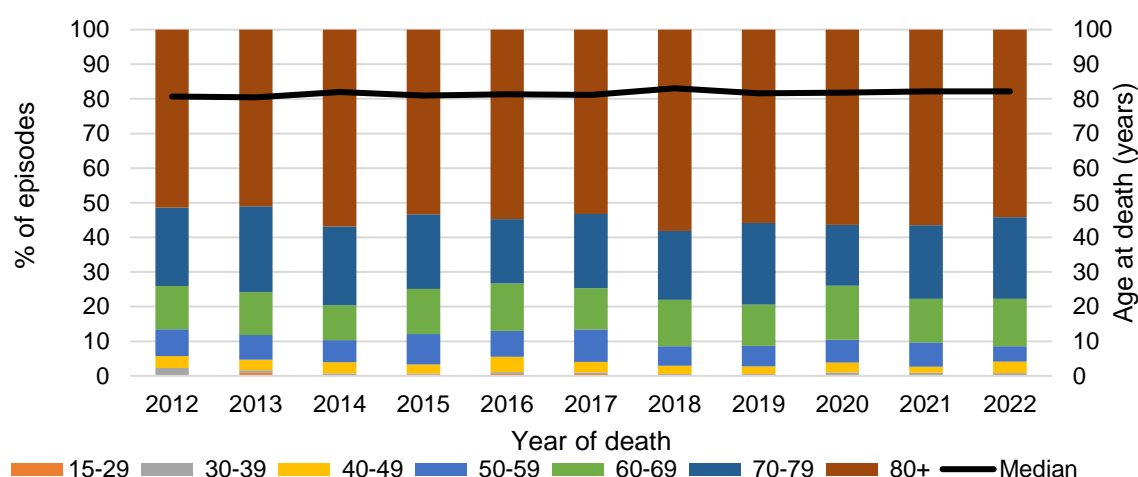
Compared to Chinese and Indians, Malays consistently had higher ASIRs of stroke across the years (Table 5.1.6); similarly, they also consistently had the highest ASMRs (Table 5.2.6). In 2022, the ASMR of stroke among the Chinese, Malays, and Indians were 13.3, 18.8, and 12.9 per 100,000 population respectively. The ASMRs showed a downward trend over the years for Chinese (p=0.003) and Malays (p<0.001), but remained relatively unchanged for the Indians (p=0.593) (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
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
2022	743	79.2	28.3	26.2-30.3	13.3	12.3-14.3
P for trend	-	-	0.671	-	0.003*	-
Malay						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
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
2022	109	11.6	24.3	19.8-28.9	18.8	15.2-22.4
P for trend	-	-	0.008*	-	<0.001**	-
Indian						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
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
2022	54	5.8	17.7	13.0-22.4	12.9	9.4-16.4
P for trend	-	-	0.016*	-	0.593	-

Figure 5.2.6: Mortality rate of stroke (per 100,000 population) by ethnicity
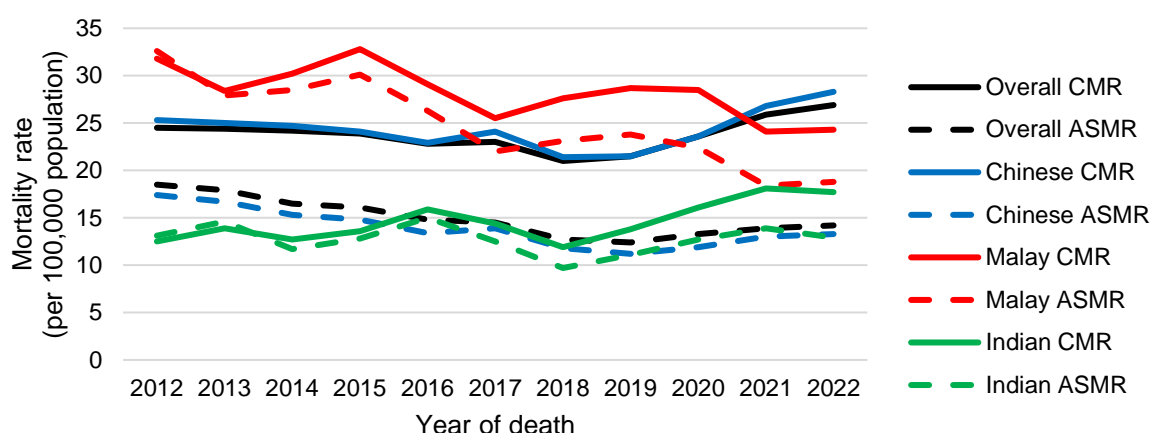
In addition to having the oldest median age at onset of stroke (Tables 5.1.7a to 5.1.7c), the Chinese also had the oldest median age at death, rising from 76.9 years to 79.5 years over the past decade (p=0.008) (Table 5.2.7a). In 2022, almost 90% of stroke deaths among the Chinese occurred among those aged 60 years and above; while those aged 80 years and above constituted the largest age group, comprising almost half of all stroke deaths among the Chinese (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	%
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
2022	79.5	1	0.1	7	0.9	31	4.2
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2022	38	5.1	123	16.6	187	25.2	356	47.9

Figure 5.2.7a: Age distribution at death of stroke among Chinese
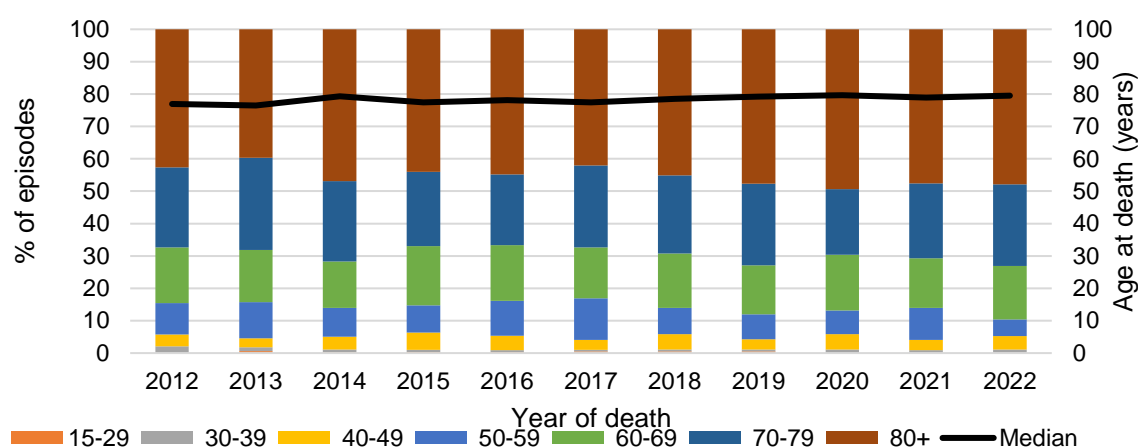
The median age at death due to stroke among Malays ranged between 69.1 and 75.6 years in the past decade (p=0.598), about 4 to 6 years younger than that of the Chinese (Table 5.2.7b). In 2022, about 3 in 4 stroke deaths among the Malays occurred in those aged 60 years and above; with those aged 60-69 years, 70-79 years, and above 80 years each accounting for about a quarter of stroke deaths among Malays (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	%
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
2022	70.3	0	0.0	4	3.7	10	9.2
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2022	12	11.0	27	24.8	29	26.6	27	24.8

Figure 5.2.7b: Age distribution at death of stroke among Malays
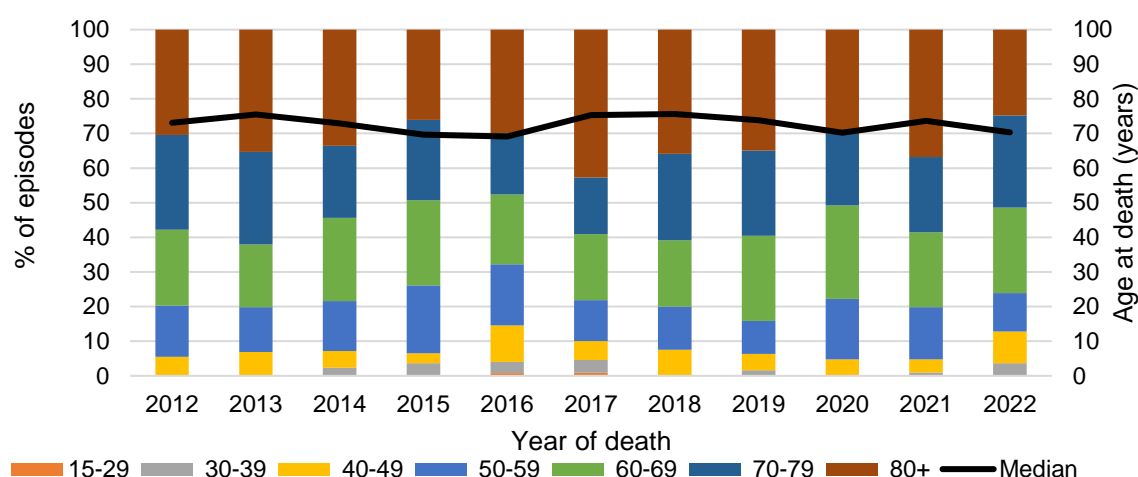
The median age at death due to stroke among Indians ranged between 66.0 and 79.4 years in the past decade (p=0.468) (Table 5.2.7c). In 2022, almost 3 in 4 stroke deaths among Indian occurred in those aged 60 years and above, while those aged 80 years and above comprised the largest age group among Indian stroke deaths (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	%
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
2022	70.1	0	0.0	0	0.0	5	9.3

Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2022	10	18.5	12	22.2	6	11.1	21	38.9

Figure 5.2.7c: Age distribution at death of stroke among Indians
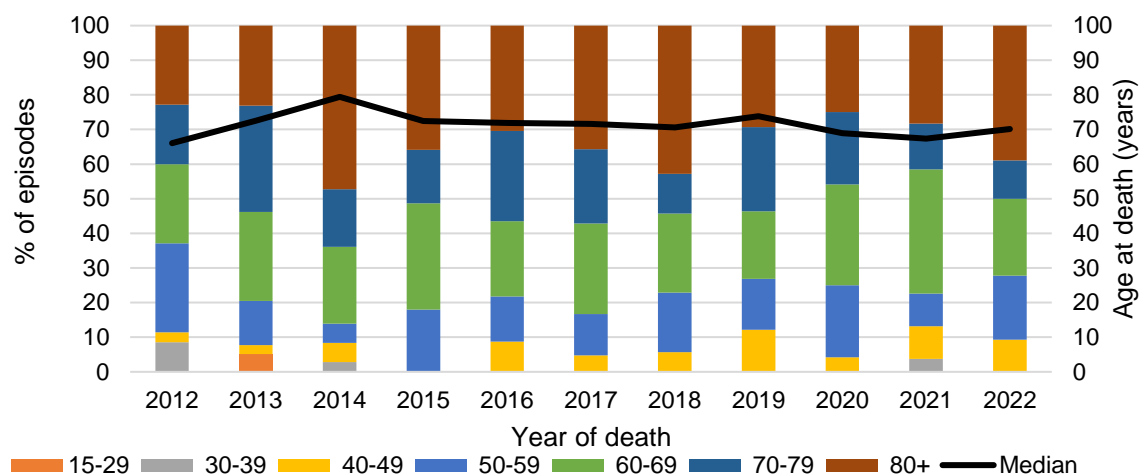
While there were approximately four times as many IS than HS every year, the disparity between IS and HS in terms of number of deaths was far less marked, with IS accounting for only a slightly higher proportion of deaths across most years. In contrast to incidence trends whereby the ASIRs of IS were consistently higher than HS across the years (Table 5.1.8), the ASMR of IS was initially higher than that of HS, but the gap has since narrowed (Table 5.2.8). From 2017 onwards, the ASMRs for IS and HS were relatively similar. Similarly, results of the GBD study revealed that there were approximately equal numbers of IS and HS deaths globally in 2021, as well as similar age-standardised mortality rates. In contrast, IS accounted for 62.7% of all stroke deaths in high-income countries, with a correspondingly higher mortality rate compared to HS; but in ASEAN countries, the opposite was true, with HS making up 61.8% of all stroke deaths[30].

The ASMR of IS declined significantly from 10.3 per 100,000 population in 2012 to 6.3 per 100,000 population in 2022 (p<0.001). However, that for HS remained largely unchanged over the years (p=0.283); in 2022, the ASMR of HS was 7.8 per 100,000 population (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 2021 study; the same was true for ASEAN and high-income countries[31].

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.

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[30] GBD Results. Institute for Health Metrics and Evaluation (IHME) 2024. https://vizhub.healthdata.org/gbd-results/. Accessed on 13 July 2024.
[31] Ibid.

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

Year of death	Number	%	CMR	95% CI	ASMR	95% CI
Ischaemic stroke						
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
2021	453	51.3	13.3	12.1-14.5	6.7	6.0-7.3
2022	462	49.3	13.2	12.0-14.4	6.3	5.7-6.9
P for trend	-	-	0.277	-	<0.001**	-
Haemorrhagic stroke						
Year of death	**Number**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
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	7.8	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
2021	430	48.7	12.6	11.4-13.8	7.2	6.5-8.0
2022	476	50.7	13.6	12.4-14.9	7.8	7.1-8.6
P for trend	-	-	0.038*	-	0.283	-

**Figure 5.2.8: Mortality rate of stroke (per 100,000 population) by stroke subtype**
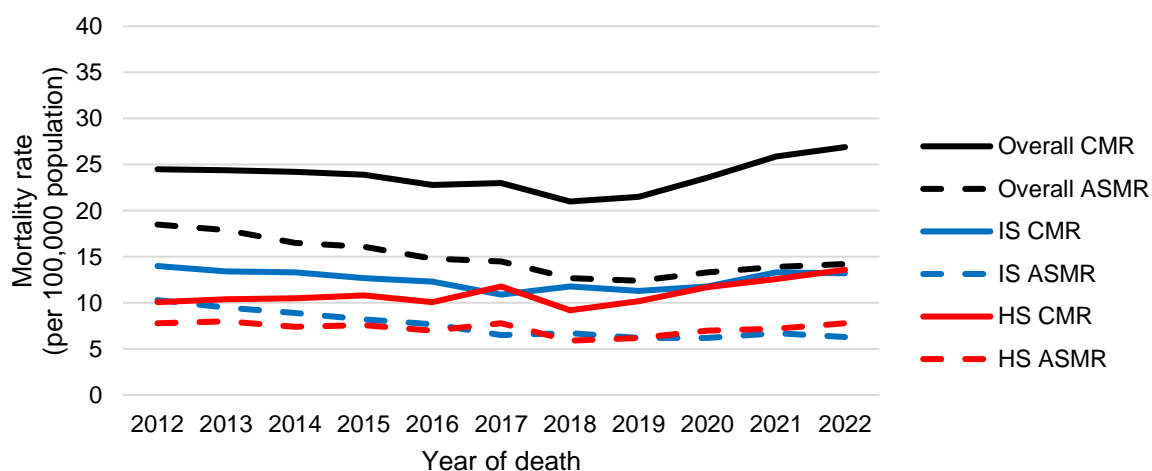
The median age at death due to stroke among IS patients rose from 79.4 years to 82.7 years over the past decade (p<0.001); and about 90% of IS deaths each year occurred among those aged 60 years and above, peaking at 94.2% in 2022 (Table 5.2.9a). In 2022, those aged 80 years and above accounted for the majority of IS patients who died of stroke (57.1%), an increase from 48.5% in 2012 (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	%
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
2022	82.7	0	0.0	1	0.2	6	1.3
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2022	20	4.3	67	14.5	104	22.5	264	57.1

**Figure 5.2.9a: Age distribution at death of ischaemic stroke**
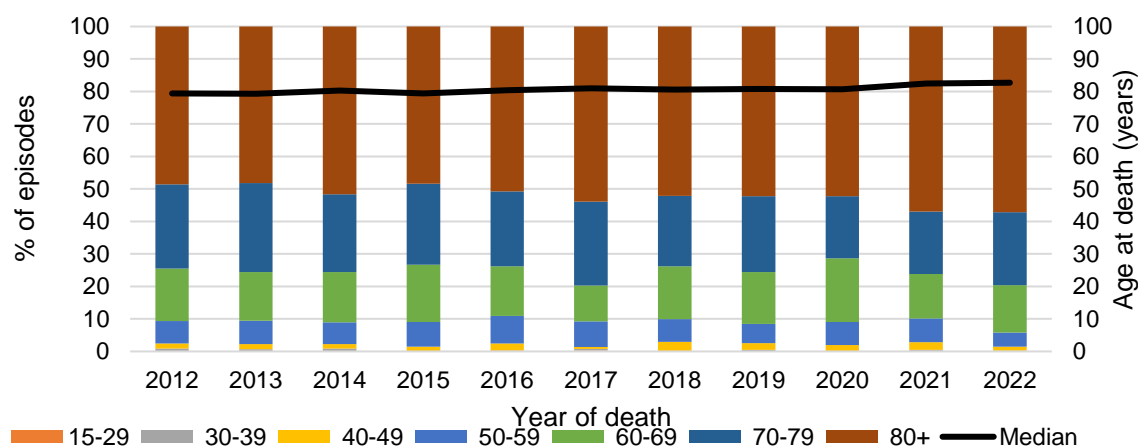
Median age at onset was younger among HS than IS patients (Tables 5.1.9a and 5.1.9b); HS patients were also younger at death. The median age at death due to stroke among HS patients ranged between 69.3 and 74.9 years in the past decade (p=0.201), and between 70-80% of HS deaths occurred in those aged 60 years and above (Table 5.2.9b). In 2022, those aged 80 years and above formed the biggest age group among HS deaths (32.1%), 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	%
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
2022	73.5	1	0.2	10	2.1	41	8.6
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2022	44	9.2	100	21.0	127	26.7	153	32.1

**Figure 5.2.9b: Age distribution at death of haemorrhagic stroke**
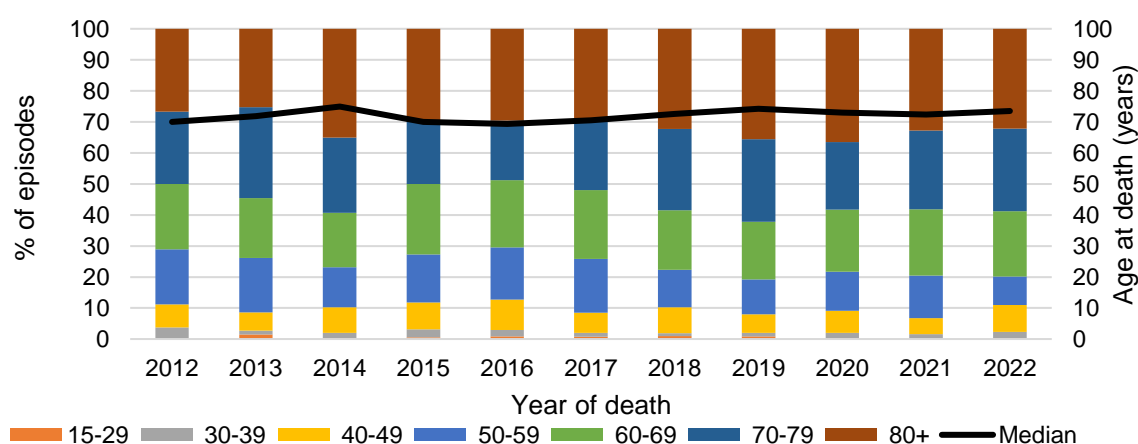
5.3 30-Day Case Fatality

The number of stroke deaths within 30 days of stroke onset increased by about 33% between 2012 and2022 (Table 5.3.1), a comparably less drastic increase than in the number of stroke episodes for the same period (more than 50%) (Table 5.1.1). While the 30-day case fatality rate (CFR) decreased from 9.3% in 2012 to 6.7% in 2019, it has since increased to 8.1% in 2022 (Figure 5.3.1).

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

Year of onset	Number	CFR	95% CI
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	698	7.5	6.9-8.0
2022	763	8.1	7.5-8.7
P for trend	-	0.034*	-

Figure 5.3.1: Case fatality rate of stroke (%)
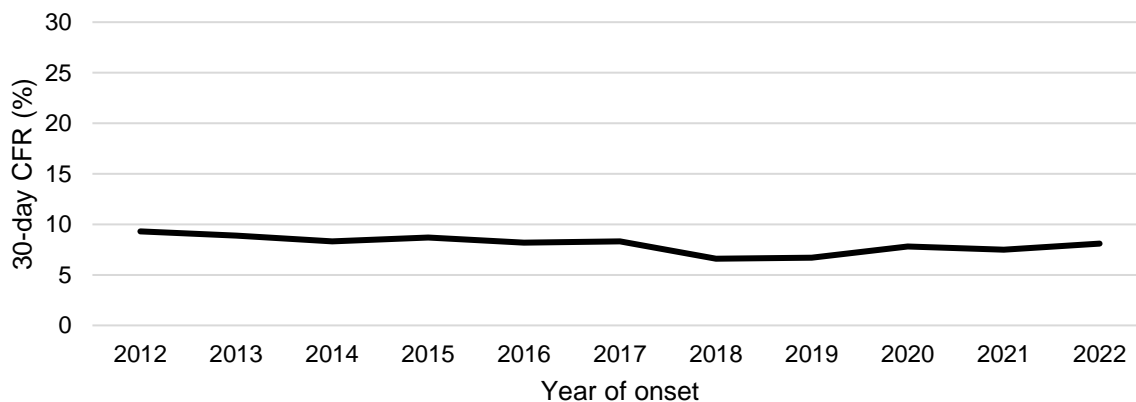
Similar to the patterns for overall stroke mortality, females likewise generally comprised a slightly higher proportion of stroke patients who died within 30 days of onset. Although the ASMRs for males were consistently higher than females across the years (Table 5.2.4), the CFRs for males were consistently lower than females (Table 5.3.2). The CFR was 6.7% for males and 10.1% for females in 2022. 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[32]. The CFR fell significantly over the years for females but not males (males: p=0.15, females: p<0.012) (Figure 5.3.2).

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[32] Rexrode KM et al. The Impact of Sex and Sex on Stroke. Circulation Research. 2022; 130: 512–528.

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

Male				
Year of onset	Number	%	CFR	95% CI
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	359	51.4	6.6	5.9-7.3
2022	364	47.7	6.7	6.0-7.4
P for trend	-	-	0.150	-
Female				
Year of onset	Number	%	CFR	95% CI
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	7.7-9.5
2022	399	52.3	10.1	9.1-11.0
P for trend	-	-	0.012*	-

Figure 5.3.2: Case fatality rate of stroke (%) by sex
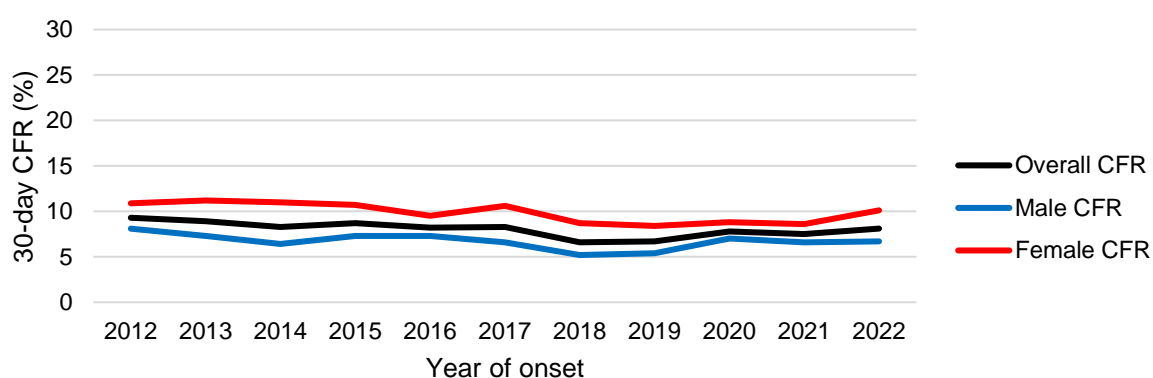
Among the ethnic groups, although the Malays consistently had the highest ASMRs (Table 5.2.6), the Indians generally had lower CFRs in comparison to the Chinese and Malays (Table 5.3.3). The slightly higher CFR among the Chinese was likely due to the Chinese being older at the onset of stroke (Tables 5.1.7a and 5.1.7b). The CFRs were 8.7%, 6.2% and 5.8% for the Chinese, Malays and Indians respectively in 2022.

There were no significant changes in the CFR for the Chinese (p=0.057), Malays (p=0.062), and Indians (p=0.524) (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
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	8.6	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	551	78.9	7.9	7.2-8.5
2022	612	80.2	8.7	8.0-9.4
P for trend	-	-	0.057	-
Malay				
Year of onset	Number	%	CFR	95% CI
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
2022	84	11.0	6.2	4.9-7.5
P for trend	-	-	0.062	-
Indian				
Year of onset	Number	%	CFR	95% CI
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	4.3-8.0
2022	39	5.1	5.8	4.0-7.6
P for trend	-	-	0.524	-

Figure 5.3.3: Case fatality rate of stroke (%) by ethnicity
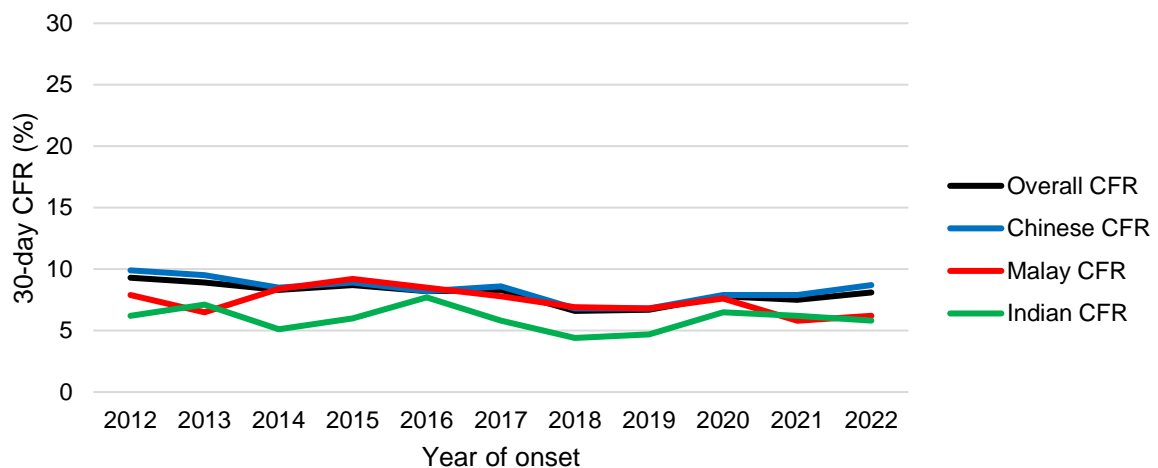
Generally, HS accounted for a slightly higher percentage of stroke deaths occurring within 30 days of onset each year (Table 5.3.4). In 2022, the CFRs were 4.3% and 23.8% for IS and HS respectively. This is likely because HS is a more severe condition with higher likelihood of fatality. The baseline 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 is indicative of a 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: median NIHSS score remained stable remained at 4 from 2015-2022, 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[33].

The CFR fell over the years for IS (p=0.002) but not HS (p=0.457) 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. Figures for overall CFR include cases of unknown etiology.

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[33] Andersen KK et al. Hemorrhagic and Ischemic Strokes Compared: Stroke Severity, Mortality, and Risk Factors. Stroke. 2009;40:2068-2072.

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

Ischaemic stroke				
Year of onset	Number	%	CFR	95% CI
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	4.3	3.9-4.8
2021	304	43.6	4.0	3.5-4.4
2022	322	42.2	4.3	3.8-4.7
P for trend	-	-	0.002*	-
Haemorrhagic stroke				
Year of onset	Number	%	CFR	95% CI
2012	285	49.8	24.4	4.9-6.2
2013	302	51.8	23.4	4.5-5.7
2014	294	51.8	22.6	4.1-5.3
2015	320	51.3	22.3	4.5-5.7
2016	303	50.9	22.0	4.3-5.4
2017	377	59.2	23.8	3.7-4.7
2018	269	49.8	17.3	3.6-4.6
2019	313	54.3	19.1	3.3-4.2
2020	371	54.8	22.0	3.9-4.8
2021	394	56.4	22.8	3.5-4.4
2022	441	57.8	23.8	3.8-4.7
P for trend	-	-	0.457	-

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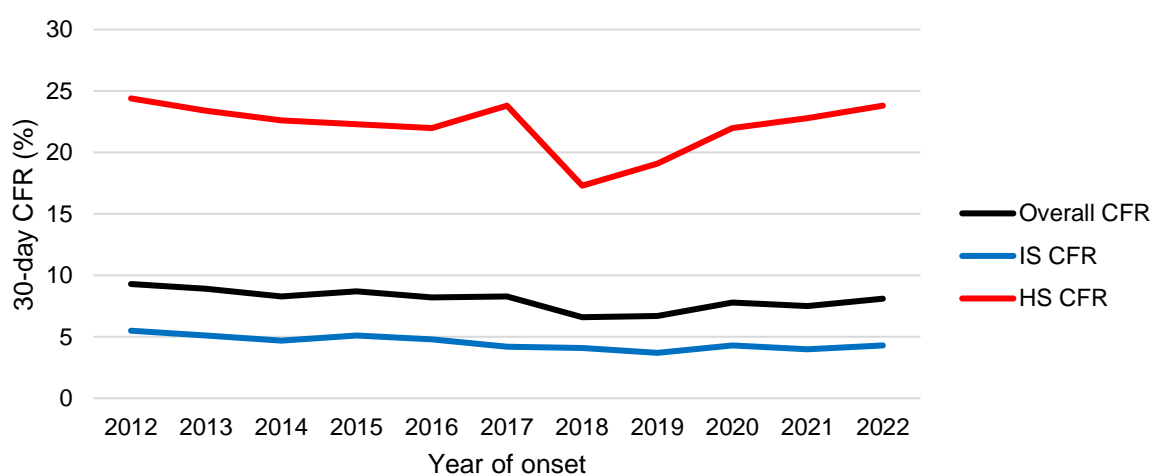
5.4 Risk Factors

Hypertension, hyperlipidaemia, Type 2 diabetes, obesity, and smoking have been identified as the five main modifiable risk factors of cardiovascular diseases (CVD), which could lead to stroke[34]. Globally, high systolic blood pressure was found to be the leading contributor to the burden of stroke worldwide, contributing to 55% of total stroke Disability-Adjusted Life Years (DALYs)[35]. In Singapore, the increasing prevalence of hypertension, high blood cholesterol and high-risk BMI could partly explain the rise in crude incidence of stroke[36]. In 2019, CVD accounted for about 80% of the total societal costs locally (in the form of healthcare costs and productivity losses) attributed to the trio of metabolic risk factors (high blood pressure, high blood glucose, high cholesterol)[37]. It has also been found that the risk factors for CVD tend to cluster – for example, high blood pressure often co-exists with high cholesterol, resulting in a synergistic effect and presenting a greater likelihood of developing disease compared to an individual risk factor alone[38].

Hypertension, hyperlipidemia, diabetes and AF were defined as present 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 2012 and 2022, hyperlipidemia and hypertension were consistently the two most common risk factors among stroke patients, with over 80% of stroke patients having each risk factor every year (Figure 5.4.1). In 2022, 83.7% of the patients had hyperlipidemia and 81.0% had hypertension. Diabetes, smoking and AF were also prevalent among stroke patients, with 44.1%, 34.7% and 19.8% of them having these risk factors respectively in 2022. Apart from smoking whereby the proportion of patients who smoked dropped slightly over the past decade, and diabetes which saw a slight increase, the proportion of stroke patients with the other risk factors remained relatively unchanged during this period.

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[34] Tan J. et al. Strategies to prevent cardiovascular disease in Singapore: A call to action from Singapore Heart Foundation, Singapore Cardiac Society, and Chapter of Cardiologists of the Academy of Medicine, Singapore. Ann Acad Med Singap 2024;53: 23-33

[35] Felgin V et al. World Stroke Organization (WSO): Global Stroke Fact Sheet 2022. International Journal of Stroke. 2022;(1): 18–29.

[36] Tan J. et al. Strategies to prevent cardiovascular disease in Singapore: A call to action from Singapore Heart Foundation, Singapore Cardiac Society, and Chapter of Cardiologists of the Academy of Medicine, Singapore. Ann Acad Med Singap 2024;53: 23-33

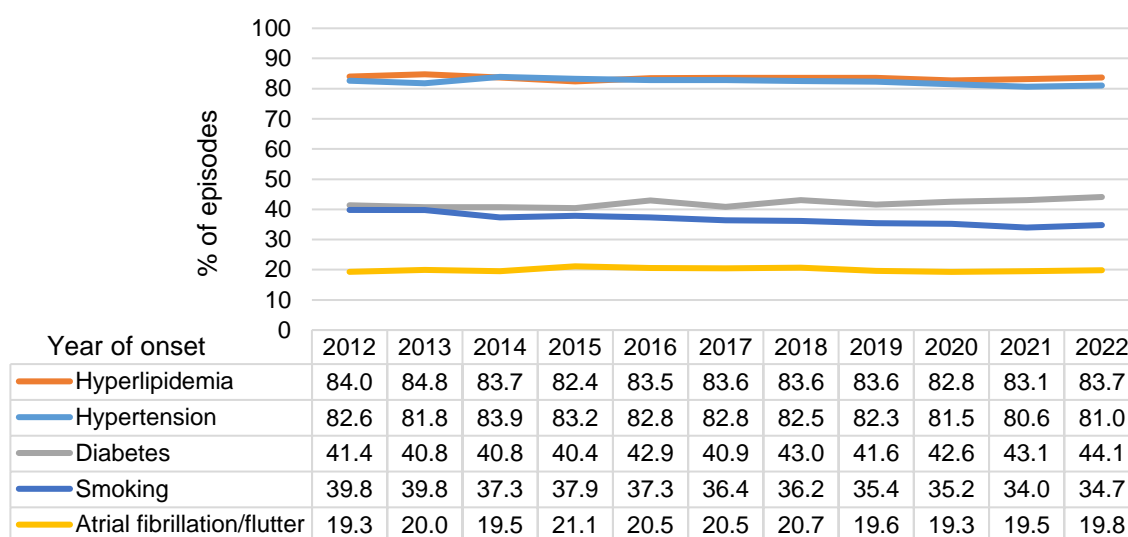[37] Tan V., Lim J., Katika A., Chow WL., Ma S., Chen C. The societal cost of modifiable risk factors in Singapore. BMC Public Health 2023; 23:1285
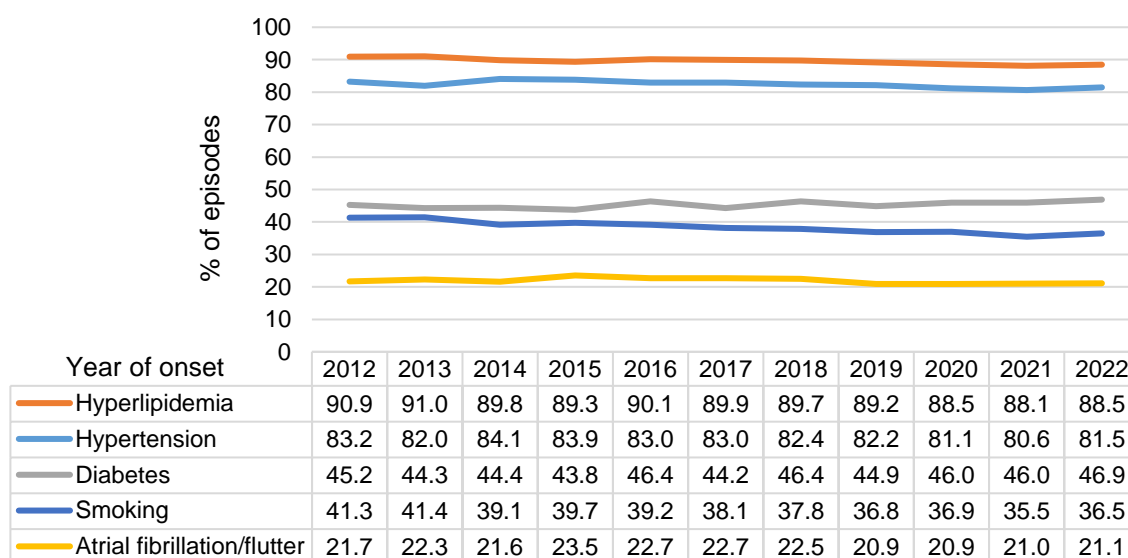
[38] Ibid.

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

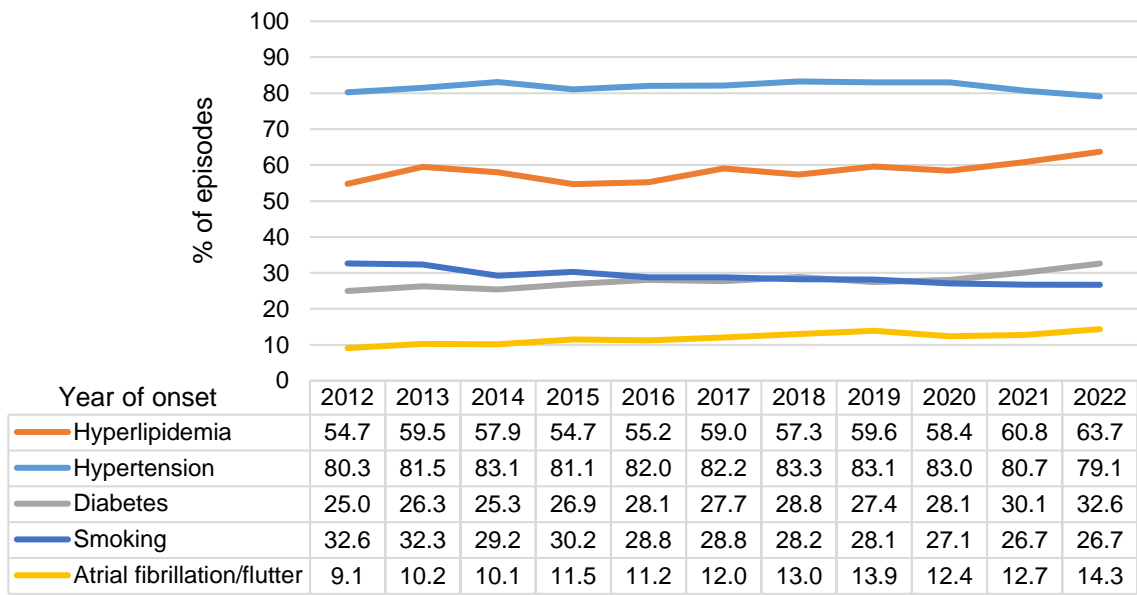| Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Hyperlipidemia	84.0	84.8	83.7	82.4	83.5	83.6	83.6	83.6	82.8	83.1	83.7
Hypertension	82.6	81.8	83.9	83.2	82.8	82.8	82.5	82.3	81.5	80.6	81.0
Diabetes	41.4	40.8	40.8	40.4	42.9	40.9	43.0	41.6	42.6	43.1	44.1
Smoking	39.8	39.8	37.3	37.9	37.3	36.4	36.2	35.4	35.2	34.0	34.7
Atrial fibrillation/flutter	19.3	20.0	19.5	21.1	20.5	20.5	20.7	19.6	19.3	19.5	19.8

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[39].

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

Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Hyperlipidemia	90.9	91.0	89.8	89.3	90.1	89.9	89.7	89.2	88.5	88.1	88.5
Hypertension	83.2	82.0	84.1	83.9	83.0	83.0	82.4	82.2	81.1	80.6	81.5
Diabetes	45.2	44.3	44.4	43.8	46.4	44.2	46.4	44.9	46.0	46.0	46.9
Smoking	41.3	41.4	39.1	39.7	39.2	38.1	37.8	36.8	36.9	35.5	36.5
Atrial fibrillation/flutter	21.7	22.3	21.6	23.5	22.7	22.7	22.5	20.9	20.9	21.0	21.1

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[39] 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.

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

Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Hyperlipidemia	54.7	59.5	57.9	54.7	55.2	59.0	57.3	59.6	58.4	60.8	63.7
Hypertension	80.3	81.5	83.1	81.1	82.0	82.2	83.3	83.1	83.0	80.7	79.1
Diabetes	25.0	26.3	25.3	26.9	28.1	27.7	28.8	27.4	28.1	30.1	32.6
Smoking	32.6	32.3	29.2	30.2	28.8	28.8	28.2	28.1	27.1	26.7	26.7
Atrial fibrillation/flutter	9.1	10.2	10.1	11.5	11.2	12.0	13.0	13.9	12.4	12.7	14.3

5.5 Treatment

There are two main options for reperfusion therapy for IS – intravenous thrombolysis (IVT) and endovascular therapy[40,41]. The administration of thrombolytic agents intravenously to dissolve the blood clot in eligible patients with IS [42] 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[43,44]. Beyond the 4.5-hour window, the harm of IVT may exceed the benefit[45]. Endovascular therapy involves the use of catheter-guided devices to assist restoration of blood flow to occluded (blocked) vessels. Endovascular thrombectomy (EVT), a type of endovascular therapy, currently represents the standard of care of IS due to large vessel occlusion[46].

Patients who were enrolled in stroke clinical trials were excluded from the calculation of thrombolytic agents, anti-platelets, and anti-coagulants given. As the administration of thrombolytic agents is time sensitive, patients who were transferred from another hospital were further excluded from the calculation of thrombolytic agent given.

The proportion of IS patients who received thrombolytic agents increased from 4.1% in 2012 to 5.8% in 2022 (Figures 5.6.2). The rise was likely due to more patients meeting the 4.5-hour recommended window for thrombolysis to be administered. Meanwhile, the proportion of patients who underwent EVT doubled from 2.6% in 2018 to 5.3% in 2022. In comparison, a meta-analysis of 67 studies based in Asia that were published after 2010 showed that the overall use of IVT for IS in Asia was 9.1%, with Central and North Asia having substantially higher rates (17.5%) compared to Southeast Asia (6.8%).

Anti-platelet therapy is a key component of the management of non-cardioembolic stroke, and most IS patients will be started on low-dose aspirin (a common type of anti-platelet drug) as either monotherapy or as part of a dual-antiplatelet (DAPT) regimen, unless they have a history of, or were newly diagnosed with atrial fibrillation (AF). In the presence of diagnosed AF, anti-coagulants represent the therapy of preference for stroke over anti-platelet drugs[47]. Oral anti-coagulants are also used for the secondary prevention of stroke in patients with AF[48].

Individuals with documented medical contraindications (such as bleeding disorders or allergies) were excluded for the calculation of anti-platelets and anti-coagulants given. From 2015, patients with others probable reasons for omission of medication (such as

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[40] Hindsholm M et al. Management and Prognosis of Acute Stroke in Atrial Fibrillation. J. Clin. Med. 2023; 12.
[41] Gajurel BP et al. Utilization rates of intravenous thrombolysis for acute ischemic stroke in Asian countries: A systematic review and meta-analysis. Medicine 2023;102:42(e35560).
[42] Examples of ineligible patients include those on blood thinning medication and those with extensive brain damage, high risk of bleeding and recent bleeding.
[43] 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.
[44] TPA Therapy. National Library of Medicine, National Center for Biotechnology Information. https://www.ncbi.nlm.nih.gov/books/NBK482376/ Accessed on 16 June 2023.
[45] Hindsholm M et al. Management and Prognosis of Acute Stroke in Atrial Fibrillation. J. Clin. Med. 2023; 12.
[46] D'Anna L. et al. Safety and outcomes of different endovascular treatment techniques for anterior circulation ischaemic stroke in the elderly: data from the Imperial College Thrombectomy Registry. Journal of Neurology (2024) 271:1366–1375.
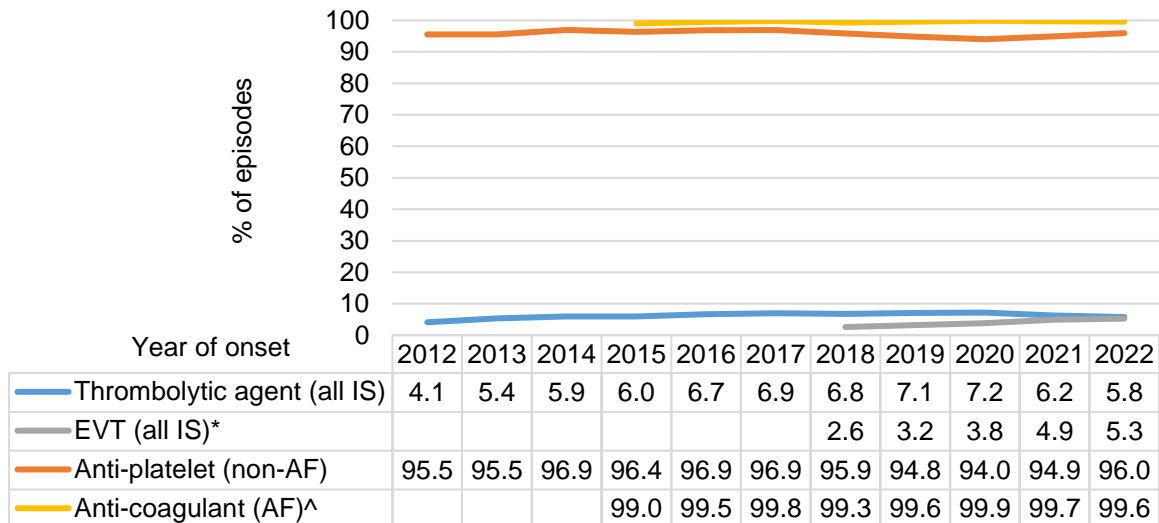[47] Coutsoumbas G V. and Di Pasquale G. Ischaemic stroke in the absence of documented atrial fibrillation: is there who could benefit from anticoagulant therapy? European Heart Journal. 2022;24: I89–I95.
[48] Altavilla R. et al. Anticoagulation After Stroke in Patients With Atrial Fibrillation. Stroke. 2019;50:2093-2100.

old age or history of poor compliance to medications) were also excluded from the calculation for anti-coagulants given. As long as anti-platelets and anti-coagulants were given at any point of the index admission (as stat dose, regular dose or at discharge), it would be counted as given.

The proportion of eligible IS patients without AF who were given anti-platelets remained high, at 94% or above every year. Meanwhile, at least 99% of IS patients with AF were given anti-coagulants each year.

Figure 5.5.1: Treatment (%) among ischaemic stroke

Year of onset	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Thrombolytic agent (all IS)	4.1	5.4	5.9	6.0	6.7	6.9	6.8	7.1	7.2	6.2	5.8
EVT (all IS)*							2.6	3.2	3.8	4.9	5.3
Anti-platelet (non-AF)	95.5	95.5	96.9	96.4	96.9	96.9	95.9	94.8	94.0	94.9	96.0
Anti-coagulant (AF)^				99.0	99.5	99.8	99.3	99.6	99.9	99.7	99.6

Data collection for EVT started in 2018
^ Complete data for probable reasons for omission of anti-coagulants the entire year was available from 2015 onwards.
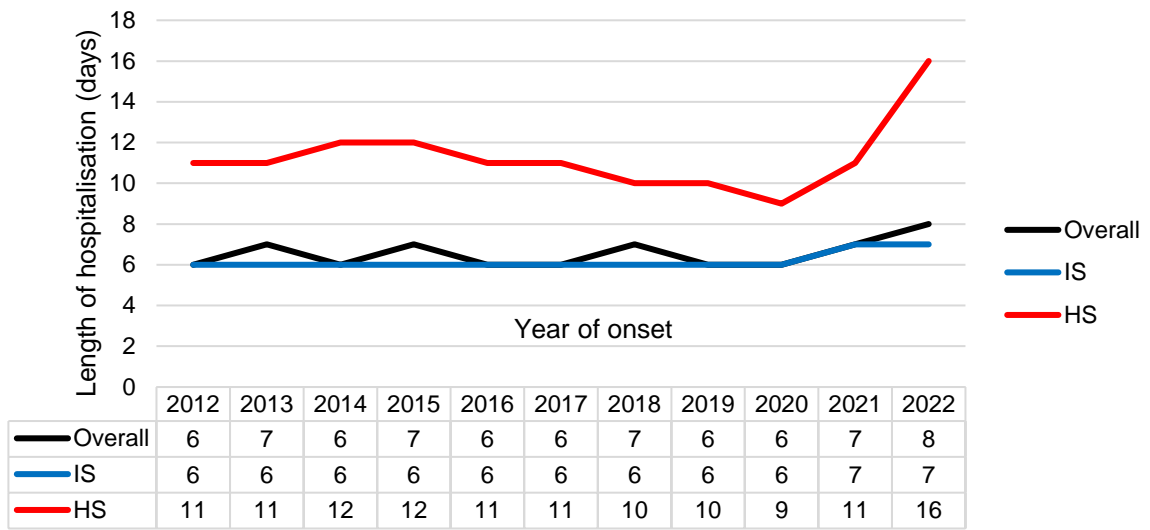
5.6   Length of Hospitalisation

The length of hospital stay (LOS) refers to the number of days from arrival to discharge from acute care. Patients who died during hospitalisation, patients who were transferred from another hospital, and patients who were admitted for a non-stroke condition but developed stroke during hospitalisation, were excluded from the calculation of LOS as the LOS would be abnormally short or long under such scenarios.

The median LOS ranged between 6 and 8 days from 2012 to 2022. The median LOS for IS patients were considerably shorter at 6-7 days, compared to 9-16 days for HS. A plausible reason for the longer LOS among HS patients was that HS patients generally had higher level of impairment as indicated by their higher median baseline NIHSS score (ranging from 10-13, compared to 4 for IS, from 2015-2022), hence a longer duration of acute care was warranted. Furthermore, HS patients are also more susceptible to suffering more post-stroke complications, thus resulting in a prolonged LOS[49].

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[49] Pinzon RT & Wijaya VO. Complications as Poor Prognostic Factors in Patients with Hemorrhagic Stroke: A Hospital-Based Stroke Registry. Int J Neurol Neurother 2020, 7:096.

Figure 5.6.1: Length of stay (days)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Overall	6	7	6	7	6	6	7	6	6	7	8
IS	6	6	6	6	6	6	6	6	6	7	7
HS	11	11	12	12	11	11	10	10	9	11	16

6.   CONCLUSION

In 2021, stroke accounted for about 3.3% of Singapore's total burden of ill health and premature death due to diseases, injuries, and risk factors[50]; and cerebrovascular diseases (including stroke) accounted for about 6% of deaths locally in 2022[51]. 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[52].

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, 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[53].

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 recommended regular health screening and follow-ups, and controlling blood pressure, blood cholesterol and blood glucose levels well[54,55]. 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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[50] GBD Results. Institute for Health Metrics and Evaluation (IHME) 2024. https://vizhub.healthdata.org/gbd-results/. Accessed on 13 July 2024.
[51] Death Statistics by cause in Singapore. HealthHub. https://www.healthhub.sg/a-z/health-statistics/principal-causes-of-death Accessed on 26 June 2024.
[52] Stroke: Impact of Stroke. HealthHub. https://www.healthhub.sg/a-z/diseases-and-conditions/677/stroke-impact-of-stroke Accessed on 16 June 2023.
[53] 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.
[54] Ibid.
[55] 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.