



Singapore Stroke Registry

Annual Report 2023

**National Registry of Diseases Office
March 2026**

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Staff of the Singapore Stroke Registry, Health Promotion Board

Director, Research, Evaluation & Monitoring Division

Dr Karen Cheong

Deputy Director, National Registry of Diseases Office

Dr Foo Ling Li

Data Manager

Mr Eric Lee

Epidemiologist

Ms Lydia Liu

Quality Assurance

Ms Cai Mingshi

Registry Coordinators

Ms Yeng Wai Koke (Team Leader)
Ms Jessica Chen
Ms Yang Yajing

With inputs from

Ministry of Health, Singapore

Disease Policy and Strategy Division
Hospital Services Division

Approved by

NRD Registrar

Dr Ruth Lim

Deputy Director-General of Health (Public Health)

Dr Derrick Heng

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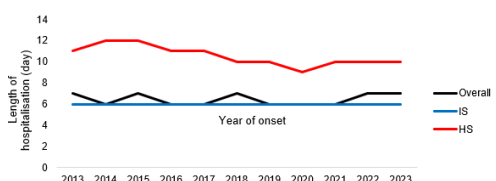
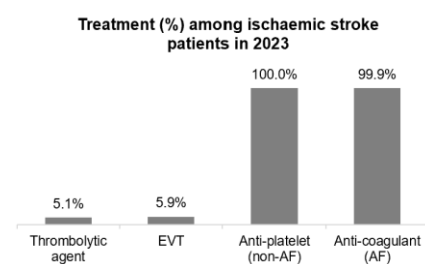
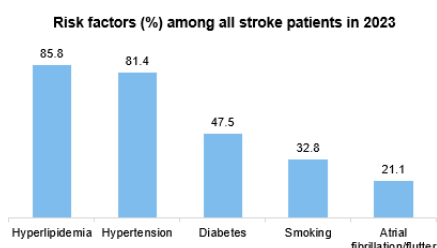
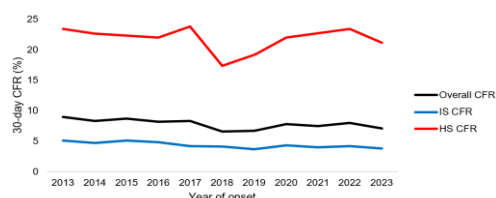
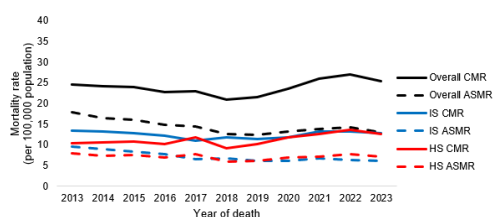
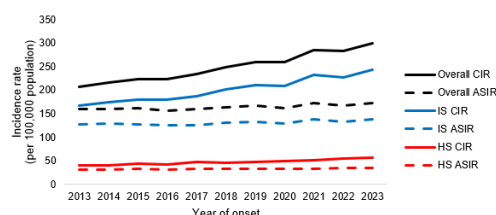
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1. GLOSSARY

AF	Atrial fibrillation/ flutter
ASIR	Age-standardised incidence rate
ASMR	Age-standardised mortality rate
ASPIR	Age-specific incidence rate
ASPMR	Age-specific 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

This annual report presents data on trends in incidence, mortality, 30-day case fatality, risk factors, treatment, and length of hospitalisation among Singapore residents with stroke over the latest 10-year period, from 2013 to 2023.



STROKE INCIDENCE

- The number of stroke episodes increased by more than 50%, from 6,720 in 2013 to 10,664 in 2023, with population ageing contributing to this increase.
- Over the same 10-year period, the age-standardised incidence rate (ASIR) rose significantly by 8%, from 160.3 to 173.4 per 100,000 population.
- Ischaemic strokes (IS) consistently accounted for about 80% of all stroke episodes each year, while haemorrhagic strokes (HS) made up the remaining 20%.
- Across the years, ASIRs for IS were higher than for HS.

STROKE MORTALITY & 30-DAY FATALITY

- The number of stroke deaths increased by approximately 15%, from 790 in 2013 to 906 in 2023.
- However, the age-standardised mortality rate (ASMR) declined significantly from 17.9 to 13.1 per 100,000 population during this period, indicating that the increase in deaths was due to population growth and ageing.
- While IS accounted for a slightly higher proportion of stroke deaths in the earlier years, from 2020 onwards, stroke deaths were similarly distributed between IS and HS.
- In 2023, the ASMR was 6.1 per 100,000 population for IS and 7.1 per 100,000 population for HS.
- A significant reduction in the 30-day case fatality rate (CFR) was observed, from 9.0% in 2013 to 7.1% in 2023.
- Throughout the decade, HS consistently exhibited higher CFRs than IS. In 2023, the CFR was 21.1% for HS compared with 3.8% for IS, reflecting the generally greater severity of HS.

RISK FACTORS

- Hyperlipidaemia and hypertension had consistently been the two most common risk factors among stroke patients in the past decade.
- In 2023, 85.8% of the patients had hyperlipidaemia and 81.4% had hypertension.
- Other prevalent risk factors included diabetes (47.5%), smoking (32.8%), and atrial fibrillation/flutter (21.2%).

TREATMENT

- The proportion of IS patients receiving thrombolytic therapy remained stable over the years, and it stood at 5.1% in 2023.
- Use of endovascular thrombectomy (EVT) more than doubled, increasing from 2.6% in 2018 to 5.9% in 2023.
- Among eligible IS patients without contraindications and without atrial fibrillation/flutter (AF), antiplatelet therapy coverage remained consistently high at close to 100%.
- Similarly, among eligible IS patients with AF, anticoagulant use remained high, at 99% or above each year.

DURATION OF HOSPITALISATION

- The median length of hospital stay remained stable at 6-7 days over the decade.
- HS patients consistently had longer hospital stays than IS patients. In 2023, the median length of stay was 10 days for HS compared with 6 days for IS.

3. INTRODUCTION

Cerebrovascular diseases were the fourth most common cause of death in 2023, accounting for 5.6% of all deaths in Singapore¹. Stroke is a major 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 the more prevalent subtype. HS (comprising subarachnoid and parenchyma haemorrhage) is generally more severe and occurs due to rupture of blood vessels, resulting in bleeding within the brain. Treatment for IS typically involves blood-thinning medications, such as antiplatelet agents and anticoagulants, while HS is managed with surgical or endovascular interventions.

Regardless of stroke subtype, common risk factors for stroke include hypertension, hyperlipidaemia, diabetes, atrial fibrillation/flutter (AF), smoking and advanced age.

The proportion of Singapore residents aged 65 years and above increased from 10.5% (1 in 10) in 2013 to 17.3% (1 in 6) in 2023². This proportion has been projected to rise further to 23.9% (1 in 4) by 2030³. In view of Singapore's rapidly ageing population, the incidence of stroke is expected to increase. To mitigate the impact of stroke, preventive measures aimed at reducing cerebrovascular risk, as well as post-stroke interventions to improve prognosis and reduce the risk of recurrence, remain essential.

¹ Principal Cause of Death. Ministry of Health. <https://www.moh.gov.sg/others/resources-and-statistics/principal-causes-of-death>. Accessed on 5 December 2025.

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 31 March 2025.

³ Population Trends – Longevity. National Population and Talent Division, Prime Minister's Office, Singapore. [Longevity](https://www.longevity.gov.sg/). Accessed on 5 December 2025.

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 established in 2002 as a joint initiative led by representatives from all public healthcare institutions. Data collection initially began with contributions from Tan Tock Seng Hospital and Singapore General Hospital. From 2005 onwards, data is collected from all public healthcare institutions.

Data sources

The SSR receives stroke case notifications from:

1. All public healthcare institutions via the Hospitals' Electronic Medical Record (EMR) systems (e.g. the Next Generation Electronic Medical Record [NGEMR] system).
2. Ministry of Health (MOH) via the MediClaim list, and
3. Death Registry of the Ministry of Home Affairs (MHA) via the national 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 prior to 2012. From 2012 onwards, ICD-10, Australian Modification (ICD-10-AM) codes I60 to I68 (excluding I62.0 and I62.1) were used. A master patient list was created by merging data from these sources using the patients' unique National Registration Identification Card (NRIC) numbers.

Registry coordinators confirmed stroke diagnoses by reviewing patients' medical records before extracting relevant clinical information. All cases collected by the SSR were diagnosed by qualified medical practitioners, 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) criteria were applied for episode management. Recurrent strokes occurring within 28 days of a preceding episode were merged with the earlier episode, while recurrences occurring after 28 days were counted as new stroke episodes⁴.

The death status of all patients registered in the SSR was updated up to 14 July 2025 by matching NRIC numbers with the death information from the MHA.

⁴ Thorvaldsen P et al. Stroke trends in the MONICA project. *Stroke* 1997; 28(3): 500-506.

Population estimates

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) annually⁵. The Segi World population estimates used for age standardisation were obtained from the World Health Organization website⁶.

Incidence rate

The incidence rate in each year was calculated by dividing the number of stroke episodes occurring in that year by the number of Singapore residents in the same year. Patients were categorised into 5-year age groups, and age standardisation was performed using the direct method with the Segi World population as the standard population.

Mortality rate

The mortality rate for each year was calculated by dividing the number of deaths with stroke as the primary cause of death occurring in that year by the number of Singapore residents in the same year. Patients were categorised into 5-year age groups and age standardisation was performed using the direct method with the Segi World population as the standard population.

Case fatality rate

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

This report focused on Singapore residents aged 15 years and above who were diagnosed with stroke and treated in public healthcare institutions in the past decade, from 2013 to 2023, as at 14 July 2025. All findings in this report, except mortality and case fatality, were based on episodes. The registry began capturing stroke onset date and time in 2014, but this information was often estimated or unavailable, as the initial stroke symptoms might be subtle. Hence, hospital arrival date and time were used for out-of-hospital strokes, while onset date and time were used for in-hospital strokes occurring after admission for non-stroke conditions. Hospital arrival date and time were also used when the onset date and time were unavailable.

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 31 March 2025.

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

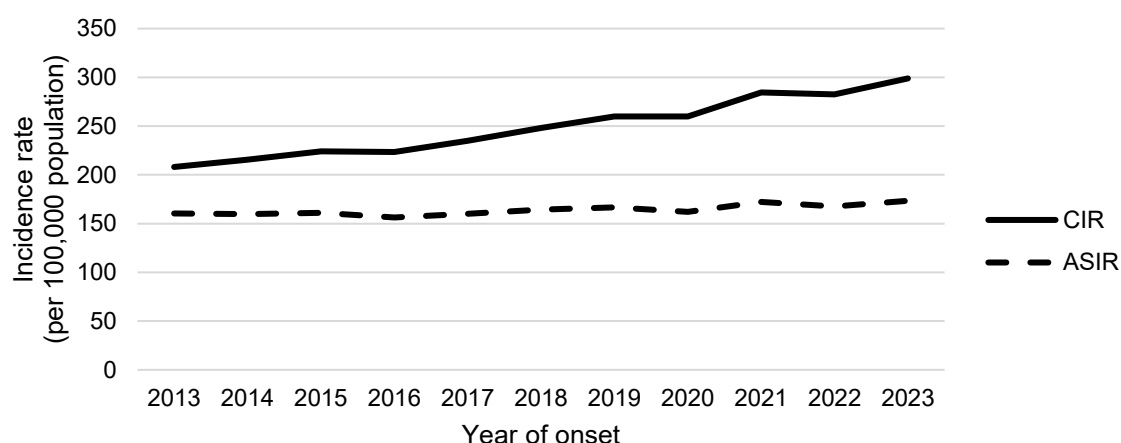
5.1 Incidence

Over the past decade, largely driven by population ageing, the number of stroke episodes increased by more than 50%, from 6,720 in 2013 to 10,664 in 2023. A significant increase in the crude incidence rate (CIR) was observed over the same period ($p<0.001$) (Table 5.1.1 and Figure 5.1.1). The age-standardised incidence rate (ASIR) of stroke also increased significantly, by approximately 8%, from 160.3 to 173.4 per 100,000 population between 2013 and 2023 ($p=0.002$). Findings from the 2023 Global Burden of Disease (GBD) study indicated that while the CIR in high-income countries increased by 3.9%, the overall ASIR declined significantly in these countries⁷.

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

Year of onset	Number	CIR	95% CI	ASIR	95% CI
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	8924	259.8	254.4-265.2	166.7	163.1-170.3
2020	8978	259.8	254.4-265.2	161.9	158.5-165.4
2021	9696	284.4	278.7-290.0	172.1	168.5-175.7
2022	9861	282.4	276.9-288.0	167.5	164.0-171.0
2023	10664	298.9	293.2-304.6	173.4	169.9-176.9
P for trend	-	<0.001**	-	0.002**	-

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



⁷ Global Burden of Disease Study 2023 (GBD 2023) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2024. <https://vizhub.healthdata.org/gbd-results>. Accessed on 5 December 2025.

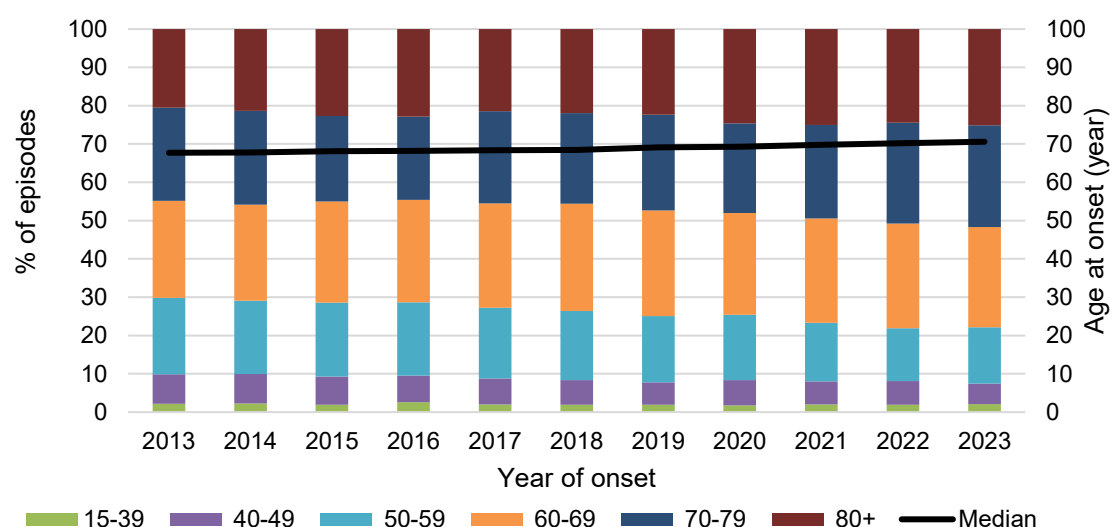
The median age at onset of stroke increased from 67.7 years in 2013 to 70.6 years in 2023 ($p < 0.001$) (Table 5.1.2). In 2023, 78% of stroke patients were aged 60 years or older, representing a gradual increase from 70% in 2013 (Figure 5.1.2).

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	%
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	580	6.0
2022	70.2		39	0.4	154	1.6	608	6.2
2023	70.6		53	0.5	170	1.6	566	5.3
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1543	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	1487	15.3	2640	27.2	2369	24.4	2424	25.0
2022	1361	13.8	2690	27.3	2594	26.3	2415	24.5
2023	1572	14.7	2787	26.1	2837	26.6	2679	25.1

Figure 5.1.2: Age distribution at onset of stroke

(Age groups 15-29 and 30-39 are combined for ease of visualisation.)



Stroke incidence increased markedly with age, with the oldest age group experiencing the highest incidence rates (Table 5.1.3; Figures 5.1.3a and 5.1.3b). Older individuals are at greater risk of stroke due to a higher prevalence of cardiovascular risk factors such as hypertension, hyperlipidaemia and diabetes. This pattern is consistent with findings from the National Population Health Survey 2023, which showed that the age-specific prevalence of these risk factors increased with age⁸. Globally, stroke incidence has been observed to approximately double with each successive decade after the age of 55⁹. The age-specific incidence of stroke among older age groups in Singapore reflected a similar pattern, with incidence rates approximately doubling across successive 10-year age bands from 50 years onwards.

Between 2013 and 2023, a significant increase in incidence rates was observed across most age groups, with the exception of those aged 70-79 years (Table 5.1.3). The greatest increases were observed among younger adults, particularly in the 15-29-year age group, where the age-specific incidence rate (ASPIR) increased from 3.9 to 7.4 per 100,000 population, and in the 30-39-year age group, where ASPIR increased from 19.4 to 27.3 per 100,000 population between 2013 and 2023.

Similar trends have been reported among some studies internationally. An England-based cohort study found that stroke incidence rose by 67% among individuals younger than 55 years, while declining among those aged 55 years or older¹⁰. Although reductions in overall stroke incidence have been reported in recent decades, particularly in high-income countries, an increasing trend among younger adults (<55 years) has been observed in the 21st century¹¹. In addition to traditional modifiable risk factors, emerging environmental, occupational, psychosocial and health-related factors have been suggested as potential contributors to stroke in younger populations, although further research is needed to establish their role¹². In contrast, findings from the GBD study results indicated that between 2013 and 2023, age-specific stroke incidence remained relatively stable among individuals younger than 55 years, while a decline was observed among those aged 55 years and above¹³.

⁸ National Population Health Survey 2023 Report. Ministry of Health, Singapore. Accessed on 2 October 2025.

⁹ Boehme AK, Esenwa C and Elkind M. Stroke Risk Factors, Genetics, and Prevention. *Circ Res*. 2017;120:472-495.

¹⁰ 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

¹¹ Nehme A, Li L. The rising incidence of stroke in the young: Epidemiology, causes and global impact. *Int J Stroke*. 2025 Jul 18;21(1):17474930251362583. doi: 10.1177/17474930251362583.

¹² Ibid

¹³ Global Burden of Disease Study 2023 (GBD 2023) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2024. <https://vizhub.healthdata.org/gbd-results>. Accessed on 5 December 2025.

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
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	254.4-265.2	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	284.4	278.7-290.0	5.6	3.8-7.3	26.4	22.3-30.6	97.8	89.9-105.8
2022	282.4	276.9-288.0	5.4	3.7-7.1	25.3	21.3-29.3	100.6	92.6-108.6
2023	298.9	293.2-304.6	7.4	5.4-9.4	27.3	23.2-31.4	92.4	84.8-100.0
P for trend	<0.001**	-	0.027*	-	0.016*	-	0.003**	-
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
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	253.6	240.9-266.3	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	254.5	241.6-267.5	509.6	490.2-529.1	870.0	834.9-905.0	1846.0	1772.5-1919.5
2022	229.6	217.4-241.8	501.9	483.0-520.9	881.2	847.3-915.1	1778.0	1707.1-1848.9
2023	260.7	247.8-273.6	504.1	485.4-522.9	889.6	856.9-922.4	1914.8	1842.3-1987.3
P for trend	0.011*	-	0.003**	-	0.168	-	0.013*	-

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

(For ease of visualisation, the graph shows only the ASPIR trend for 2013 and 2023 only. For detailed ASPIR information across years, please refer to Table 5.1.3.)

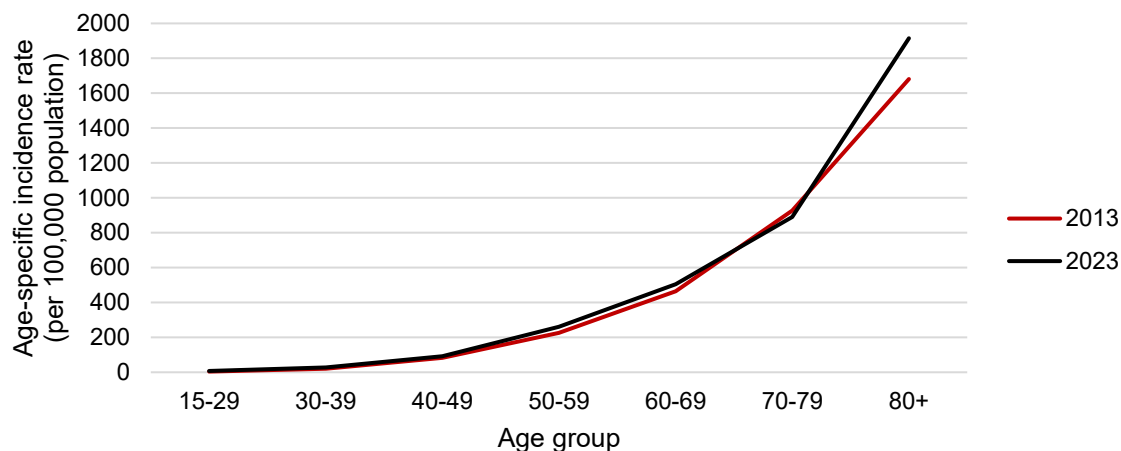
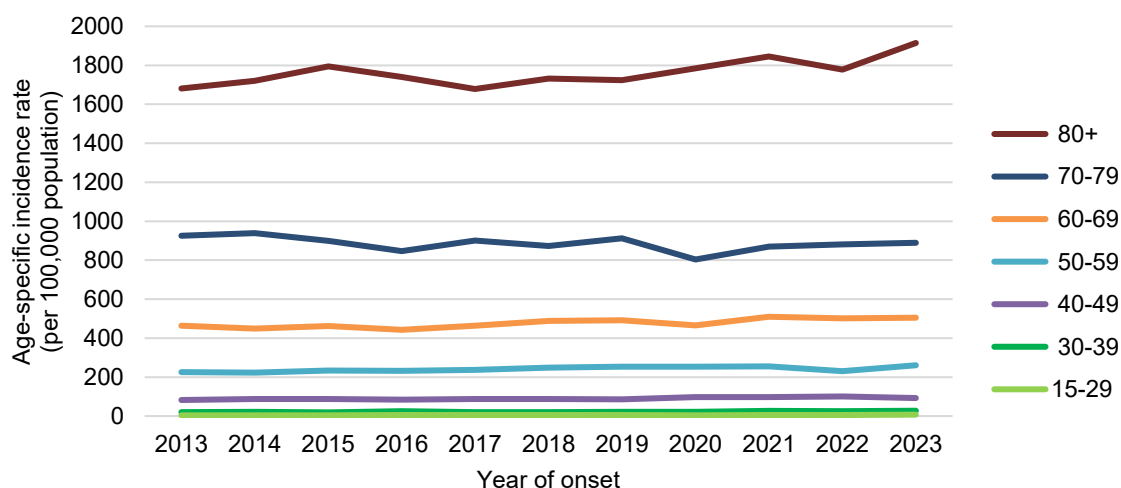


Figure 5.1.3b: Age-specific incidence rate of stroke (per 100,000 population) across years



Although the sex distribution in the general population was almost equal, males accounted for a higher proportion of stroke episodes than females, comprising about 58% (approximately 3 in 5) of cases each year (Table 5.1.4). The ASIRs for males were consistently higher than females across the years (Figure 5.1.4). In 2023, the ASIR for males was 221.9 per 100,000 population, compared with 127.0 per 100,000 population for females. Trend analysis showed a significant upward trend in ASIR among males ($p=0.001$), while ASIRs among females remained relatively stable ($p=0.053$). Consistent with local findings, data from the GBD study indicated that in high-income countries, both CIRs and ASIRs were higher among males than females from 2013 to 2023¹⁴.

¹⁴ Global Burden of Disease Study 2023 (GBD 2023) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2024. <https://vizhub.healthdata.org/gbd-results>. Accessed on 5 December 2025.

Males are known to have a higher risk of stroke compared with females¹⁵. The underlying causes are multifactorial and related to the pathophysiological sex differences in stroke¹⁶. Furthermore, the prevalence of hypertension, hyperlipidaemia, diabetes and smoking, which are common risk factors for stroke, was higher among males than females in the general population, based on the National Population Health Survey 2023¹⁷.

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

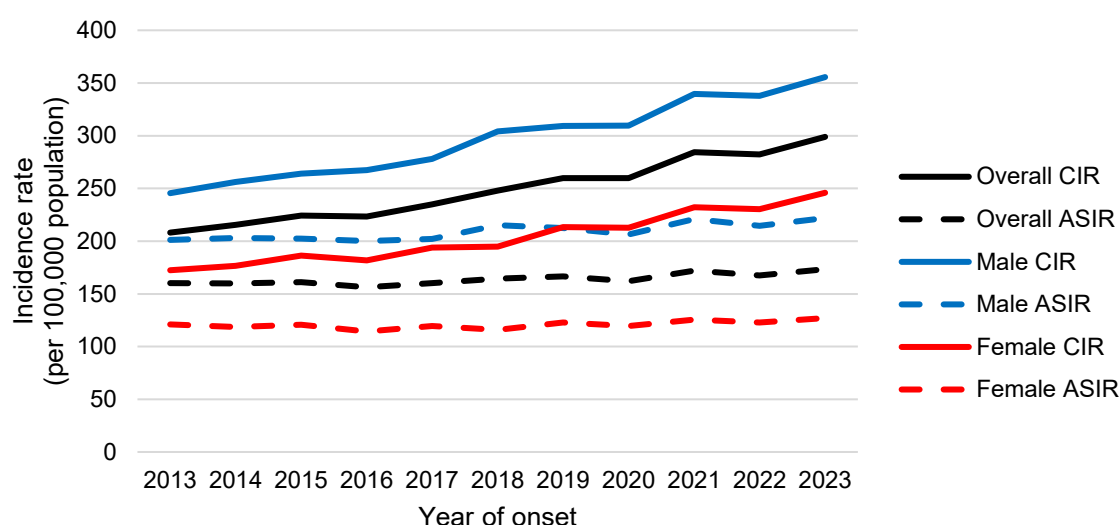
Male						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
2013	3872	57.6	245.5	237.8-253.2	201.2	194.8-207.6
2014	4079	58.0	256.2	248.3-264.0	203.0	196.7-209.2
2015	4249	57.4	264.0	256.1-271.9	202.5	196.4-208.7
2016	4346	58.3	267.3	259.4-275.3	200.1	194.1-206.1
2017	4563	57.6	278.1	270.1-286.2	202.2	196.3-208.2
2018	5031	59.6	304.1	295.7-312.5	215.0	209.0-221.0
2019	5157	57.8	309.2	300.7-317.6	212.3	206.4-218.2
2020	5193	57.8	309.6	301.2-318.0	206.4	200.7-212.1
2021	5632	58.1	339.7	330.8-348.6	220.8	214.9-226.7
2022	5717	58.0	337.7	328.9-346.4	214.4	208.6-220.1
2023	6133	57.5	355.6	346.7-364.5	221.9	216.1-227.6
P for trend	-	-	<0.001**	-	0.001**	-
Female						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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
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	4064	41.9	232.0	224.9-239.1	125.7	121.6-129.9
2022	4144	42.0	230.4	223.4-237.4	122.8	118.7-126.8
2023	4531	42.5	245.9	238.7-253.0	127.0	123.0-131.0
P for trend	-	-	<0.001**	-	0.053	-

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

¹⁶ Reeves MJ et al. Sex differences in stroke: epidemiology, clinical presentation, medical care, and outcomes. Lancet Neurology 2008; 7(10): 915-926.

¹⁷ National Population Health Survey 2023 Report. Ministry of Health, Singapore. Accessed on 2 October 2025.

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

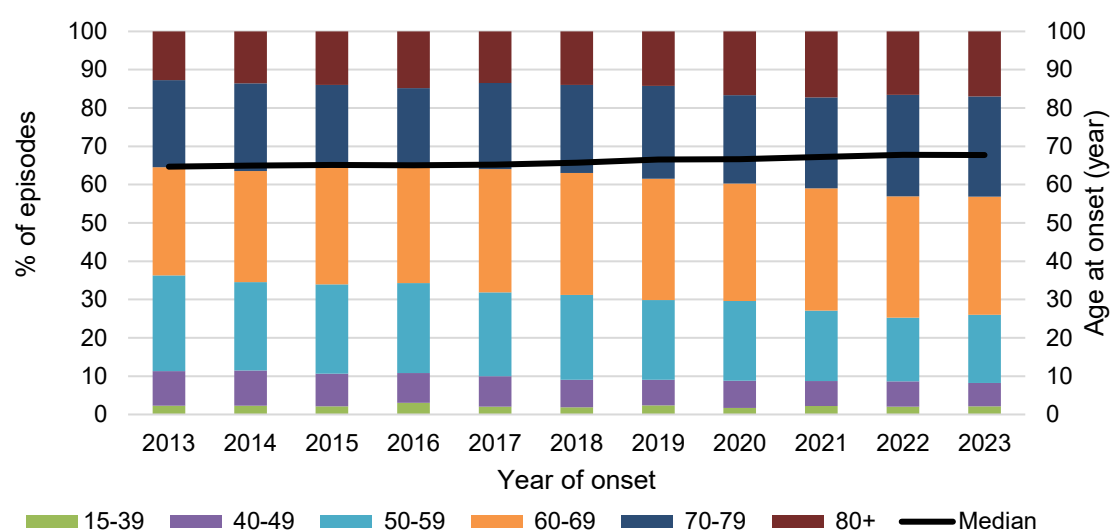


The median age at onset of stroke among males increased from 64.7 years in 2013 to 67.7 years in 2023 ($p < 0.001$), and the proportion of stroke patients aged 60 years or older increased from 63.7% in 2013 to 74.0% in 2023 (Table 5.1.5a). In 2023, nearly 1 in 3 (30.9%) of male stroke cases were aged 60-69 years, representing the largest proportion 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	%
2013	64.7		16	0.4	72	1.9	349	9.0
2014	65.0		18	0.4	76	1.9	375	9.2
2015	65.2		15	0.4	77	1.8	362	8.5
2016	65.0		28	0.6	105	2.4	338	7.8
2017	65.2		19	0.4	74	1.6	361	7.9
2018	65.8		24	0.5	69	1.4	365	7.3
2019	66.5		29	0.6	94	1.8	345	6.7
2020	66.6		17	0.3	72	1.4	368	7.1
2021	67.2		24	0.4	101	1.8	368	6.5
2022	67.8		20	0.3	99	1.7	375	6.6
2023	67.7		29	0.5	104	1.7	370	6.0
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1071	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	1035	18.4	1795	31.9	1338	23.8	971	17.2
2022	953	16.7	1811	31.7	1511	26.4	948	16.6
2023	1093	17.8	1893	30.9	1601	26.1	1043	17.0

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



The median age at onset of stroke among females rose from 73.0 years to 75.1 years over the past decade ($p=0.024$) (Table 5.1.5b), which is approximately 8 years older than the median age at onset among males (Table 5.1.5a). Globally, women tend to be several years older than men at stroke onset¹⁸. This could be due to the higher prevalence of risk factors such as diabetes, hypertension and hyperlipidaemia in males compared with females in the same age group, namely those under 60 years of age, as consistently documented in national health surveys, including the National Population Health Survey 2023¹⁹.

In 2023, those aged 80 years or older (36.1%) formed the highest proportion of female stroke patients, and the proportion of female stroke patients aged 80 years or older each year was also more than twice the corresponding percentage for males (Figure 5.1.5a, Figure 5.1.5b). Separately, the trend whereby stroke incidence is lower in women from early through mid-adulthood but becomes higher at more advanced ages has been well-documented^{20,21,22,23}. Furthermore, evidence suggests that pregnancy-related conditions such as gestational hypertension and pre-eclampsia increase the long-term risk of cardiovascular disease²⁴.

¹⁸ Rexrode KM et al. The Impact of Sex and Sex on Stroke. *Circulation Research*. 2022; 130: 512–528.

¹⁹ National Population Health Survey 2023 Report. Ministry of Health, Singapore. Accessed on 2 October 2025.

²⁰ Roy-O'Reilly M & McCullough LD. Age and Sex Are Critical Factors in Ischemic Stroke Pathology. *Endocrinology* 2018;159(8): 3120–3131.

²¹ Reeves MJ et al. Sex differences in stroke: epidemiology, clinical presentation, medical care, and outcomes. *Lancet Neurology* 2008; 7(10): 915-926.

²² Bushnell CD. et al. Sex differences in stroke: Challenges and opportunities. *Journal of Cerebral Blood Flow & Metabolism* 2018;38(12): 2179–2191.

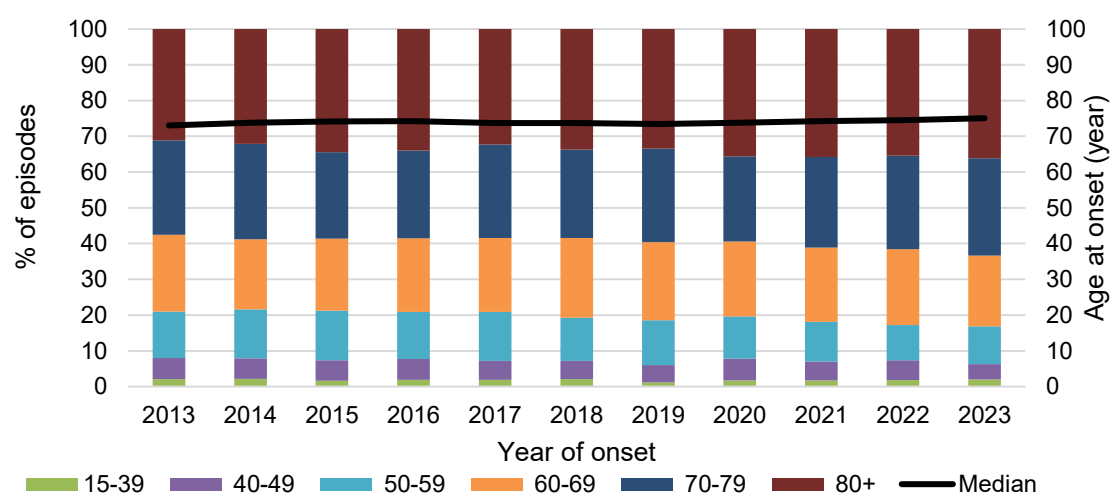
²³ Boehme AK, Esenwa C and Elkind M. Stroke Risk Factors, Genetics, and Prevention. *Circ Res*. 2017;120:472-495.

²⁴ 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	%
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	233	5.6
2023	75.1		24	0.5	66	1.5	196	4.3
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	452	11.1	845	20.8	1031	25.4	1453	35.8
2022	408	9.8	879	21.2	1083	26.1	1467	35.4
2023	479	10.6	894	19.7	1236	27.3	1636	36.1

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). In 2023, the ASIRs were 157.7, 245.8 and 178.5 per 100,000 population for Chinese, Malays and Indians respectively. However, changes in the ASIR of stroke over the past decade were significant only for Chinese and Indians. The prevalence of hypertension, hyperlipidaemia, high-risk BMI and smoking, which are common risk factors for stroke, was highest among Malays in the general

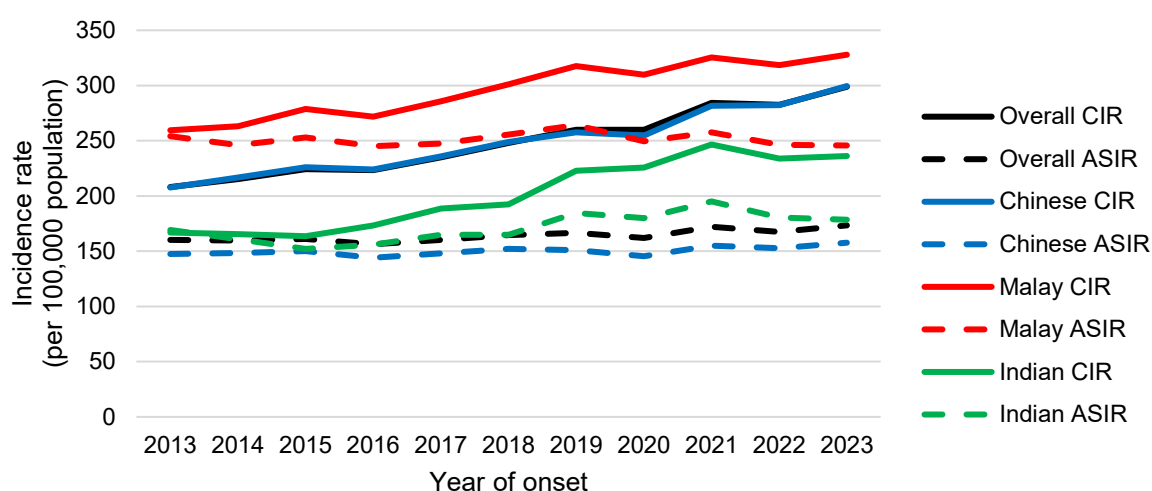
population, based on the National Population Health Survey 2023²⁵. The higher prevalence of stroke risk factors among the Malay population increases their susceptibility to stroke, relative to Chinese and Indians.

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
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	6677	74.8	257.5	251.3-263.7	151.0	147.3-154.8
2020	6645	74.0	254.8	248.6-260.9	145.5	141.8-149.1
2021	7241	74.7	281.6	275.2-288.1	155.1	151.3-158.9
2022	7418	75.2	282.3	275.9-288.8	152.6	148.9-156.3
2023	8030	75.3	299.5	292.9-306.0	157.7	154.0-161.4
P for trend	-	-	<0.001**	-	0.029*	-
Malay						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
2013	1061	15.8	259.5	243.9-275.2	254.0	238.3-269.6
2014	1090	15.5	263.0	247.3-278.6	246.0	231.0-260.9
2015	1171	15.8	278.7	262.8-294.7	253.1	238.2-267.9
2016	1158	15.5	271.9	256.3-287.6	245.1	230.5-259.6
2017	1231	15.5	285.7	269.7-301.7	247.4	233.3-261.5
2018	1311	15.5	301.2	284.9-317.5	255.6	241.6-269.7
2019	1395	15.6	317.7	301.0-334.4	264.1	250.0-278.2
2020	1370	15.3	309.8	293.4-326.2	249.4	235.9-262.8
2021	1433	14.8	325.4	308.5-342.2	257.6	244.0-271.2
2022	1426	14.5	318.6	302.0-335.1	246.4	233.4-259.5
2023	1486	13.9	327.9	311.2-344.5	245.8	233.0-258.6
P for trend	-	-	<0.001**	-	0.987	-
Indian						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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	500	6.7	173.3	158.1-188.5	155.8	141.9-169.8
2017	549	6.9	188.5	172.7-204.2	164.8	150.8-178.8
2018	566	6.7	192.5	176.6-208.3	165.0	151.3-178.7
2019	663	7.4	222.9	205.9-239.9	184.5	170.3-198.6
2020	675	7.5	225.8	208.8-242.8	179.9	166.2-193.5
2021	724	7.5	246.6	228.7-264.6	195.1	180.8-209.5
2022	715	7.3	233.9	216.8-251.1	180.5	167.2-193.8
2023	745	7.0	236.3	219.4-253.3	178.5	165.6-191.4
P for trend	-	-	<0.001**	-	0.01*	-

²⁵ National Population Health Survey 2023 Report. Ministry of Health, Singapore. Accessed on 2 October 2025.

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

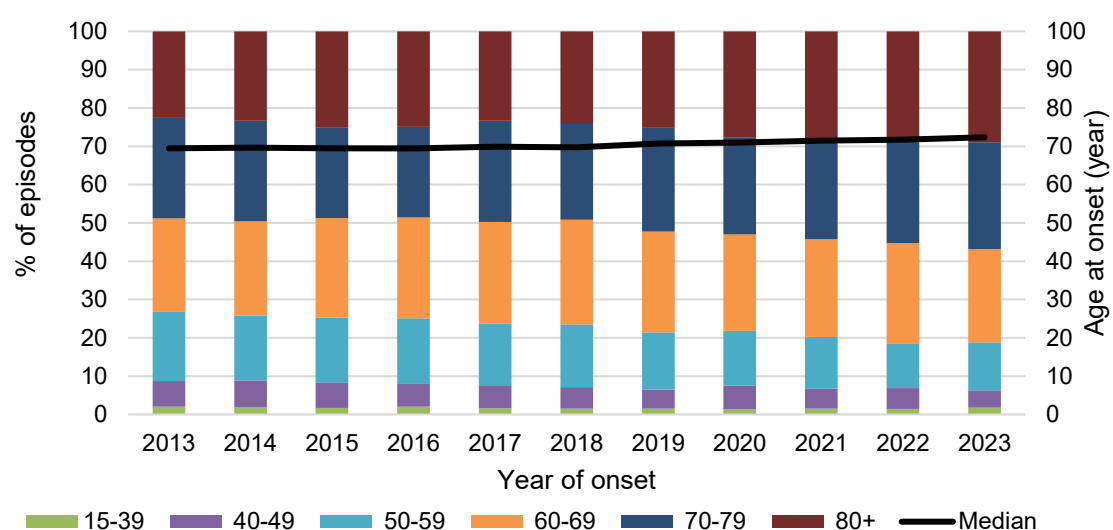


Among the ethnic groups, the Chinese had the oldest median age at onset of stroke, which increased from 69.5 years in 2013 to 72.4 years in 2023 ($p < 0.001$), and the proportion of Chinese stroke patients aged 60 years or older increased steadily from 73.3% in 2013 to 81.1% in 2023 (Table 5.1.7a). In 2023, those aged 70-79 years (27.9%) and 80 years or older (29.0%) were the two largest age groups among Chinese stroke patients (Figure 5.1.7a).

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

Year of onset	Overall		Age 15-29		Age 30-39		Age 40-49	
	Median age		Number	%	Number	%	Number	%
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	380	5.2
2022	71.7		25	0.3	83	1.1	404	5.4
2023	72.4		32	0.4	113	1.4	359	4.5
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	996	14.9	1756	26.3	1808	27.1	1683	25.2
2020	948	14.3	1670	25.1	1680	25.3	1843	27.7
2021	980	13.5	1843	25.5	1868	25.8	2061	28.5
2022	857	11.6	1950	26.3	2042	27.5	2057	27.7
2023	1010	12.6	1949	24.3	2241	27.9	2326	29.0

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

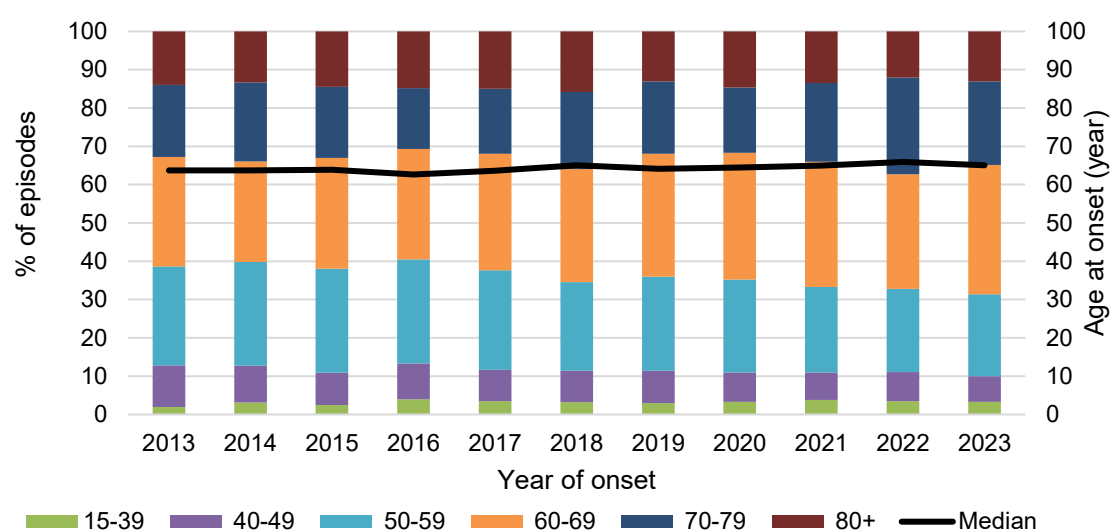


The median age at onset of stroke among Malays rose from 63.7 to 65.0 years over the past decade ($p=0.007$), approximately 7 years younger than that among the Chinese (Table 5.1.7b). In 2023, those aged 60-69 years (33.8%) formed the largest proportion of Malay stroke patients (Figure 5.1.7b). Compared with the Chinese, a slightly smaller percentage of Malay stroke patients were aged 60 years or older each year (ranging from 60% to 69%).

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	%
2013	63.7		5	0.5	16	1.5	115	10.8
2014	63.7		6	0.6	28	2.6	105	9.6
2015	63.9		7	0.6	22	1.9	99	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	65.1		11	0.8	31	2.4	108	8.2
2019	64.1		15	1.1	26	1.9	118	8.5
2020	64.5		9	0.7	36	2.6	106	7.7
2021	65.0		11	0.8	43	3.0	103	7.2
2022	65.9		9	0.6	40	2.8	109	7.6
2023	65.0		15	1.0	34	2.3	99	6.7
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2013	274	25.8	303	28.6	200	18.9	148	13.9
2014	295	27.1	286	26.2	225	20.6	145	13.3
2015	318	27.2	338	28.9	218	18.6	169	14.4
2016	315	27.2	334	28.8	184	15.9	171	14.8
2017	320	26.0	375	30.5	209	17.0	184	14.9
2018	303	23.1	387	29.5	264	20.1	207	15.8
2019	343	24.6	448	32.1	263	18.9	182	13.0
2020	332	24.2	453	33.1	234	17.1	200	14.6
2021	320	22.3	468	32.7	295	20.6	193	13.5
2022	310	21.7	426	29.9	360	25.2	172	12.1
2023	318	21.4	502	33.8	324	21.8	194	13.1

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

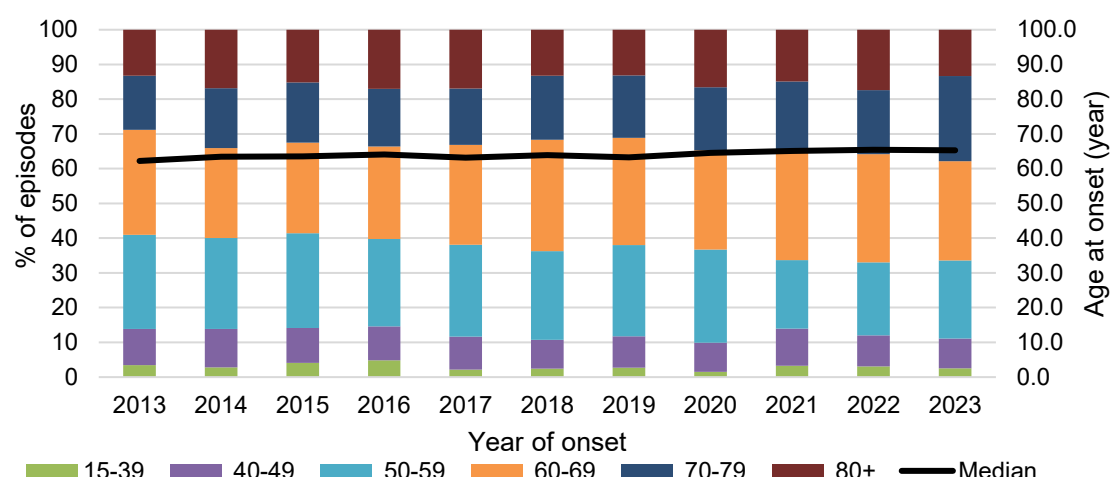


The median age at onset of stroke among Indians rose from 62.2 years to 65.3 years over the past decade ($p=0.001$) (Table 5.1.7c). In 2023, those aged 60-69 years (28.6%) formed the largest proportion of Indian stroke patients, while two in three (66.4%) Indian stroke patients were aged 60 years or older – 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	%
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	64.1		4	0.8	20	4.0	49	9.8
2017	63.2		2	0.4	10	1.8	52	9.5
2018	63.9		2	0.4	12	2.1	47	8.3
2019	63.3		3	0.5	15	2.3	60	9.0
2020	64.6		1	0.1	9	1.3	57	8.4
2021	65.1		7	1.0	17	2.3	77	10.6
2022	65.4		5	0.7	17	2.4	64	9.0
2023	65.3		6	0.8	13	1.7	64	8.6
Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	126	25.2	133	26.6	83	16.6	85	17.0
2017	145	26.4	158	28.8	89	16.2	93	16.9
2018	144	25.4	182	32.2	104	18.4	75	13.3
2019	174	26.2	205	30.9	119	17.9	87	13.1
2020	181	26.8	193	28.6	122	18.1	112	16.6
2021	143	19.8	226	31.2	146	20.2	108	14.9
2022	150	21.0	223	31.2	132	18.5	124	17.3
2023	167	22.4	213	28.6	183	24.6	99	13.3

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) each year (Table 5.1.8). Both CIR and ASIR for IS were approximately four times higher than those for HS (Figure 5.1.8). In 2023, the ASIRs were 138.4 and 35.0 per 100,000 population for IS and HS respectively – both representing significant increases from 2013. The distribution of IS and HS in Singapore was more similar to that of high-income countries, where IS accounted for 76.3% of strokes in 2023²⁶. Singapore also had a substantially higher proportion of IS than Association of Southeast Asian Nations (ASEAN) overall, where IS comprised 54.0% of strokes in 2023²⁷. These varying trends were possibly attributable to differences in the prevalence and management of various risk factors²⁸.

As the percentages in Table 5.1.8 are based on all stroke cases, 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
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	7251	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	7941	80.5	227.4	222.4-232.4	132.8	129.8-135.9
2023	8666	81.3	242.9	237.8-248.0	138.4	135.3-141.5
P for trend	-	-	<0.001**	-	0.006**	-

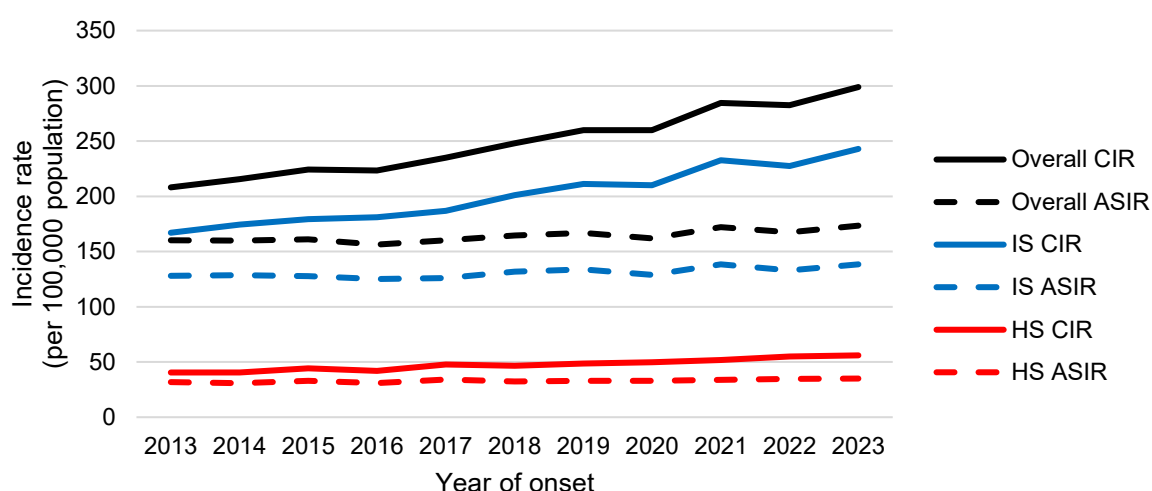
²⁶ Global Burden of Disease Study 2023 (GBD 2023) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2024. <https://vizhub.healthdata.org/gbd-results>. Accessed on 5 December 2025.

²⁷ Ibid

²⁸ 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

Haemorrhagic stroke						
Year of onset	Number	%	CIR	95% CI	ASIR	95% CI
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	1768	18.2	51.9	49.4-54.3	33.7	32.1-35.4
2022	1920	19.5	55.0	52.5-57.5	34.7	33.0-36.3
2023	1998	18.7	56.0	53.5-58.5	35.0	33.3-36.6
P for trend	-	-	<0.001**	-	0.004**	-

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



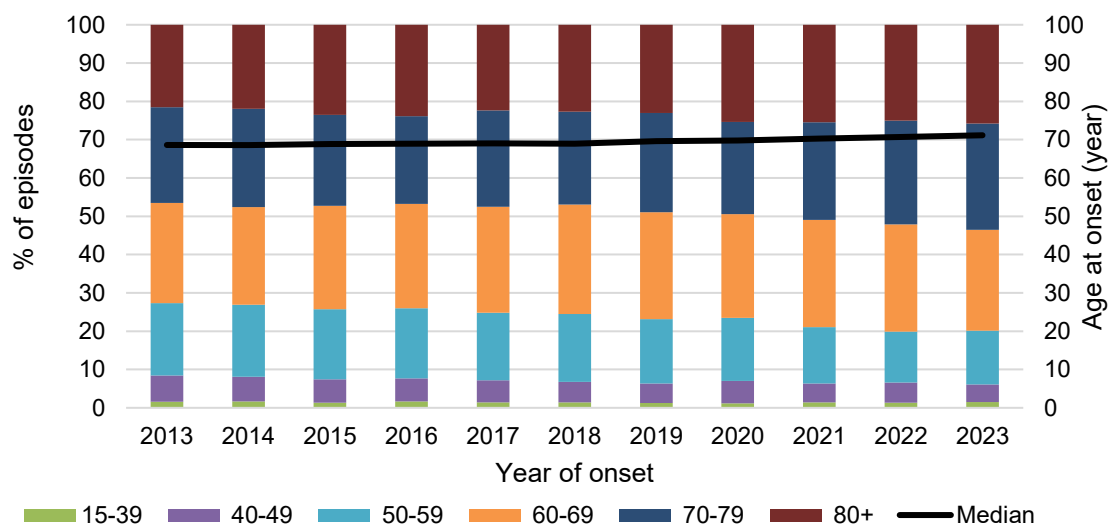
The median age at onset of IS increased from 68.6 years to 71.2 years over the past decade ($p < 0.001$) (Table 5.1.9a). In 2023, 79.9% of IS patients (about 4 in 5) were aged 60 years or older, representing a gradual increase from 72.7% in 2013 (Figure 5.1.9a).

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	%
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	393	5.0
2022	70.7	23	0.3	86	1.1	416	5.2
2023	71.2	34	0.4	95	1.1	401	4.6

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	1216	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	2020	25.5	2017	25.4
2022	1056	13.3	2224	28.0	2146	27.0	1990	25.1
2023	1213	14.0	2285	26.4	2404	27.7	2234	25.8

Figure 5.1.9a: Age distribution at onset of ischaemic stroke



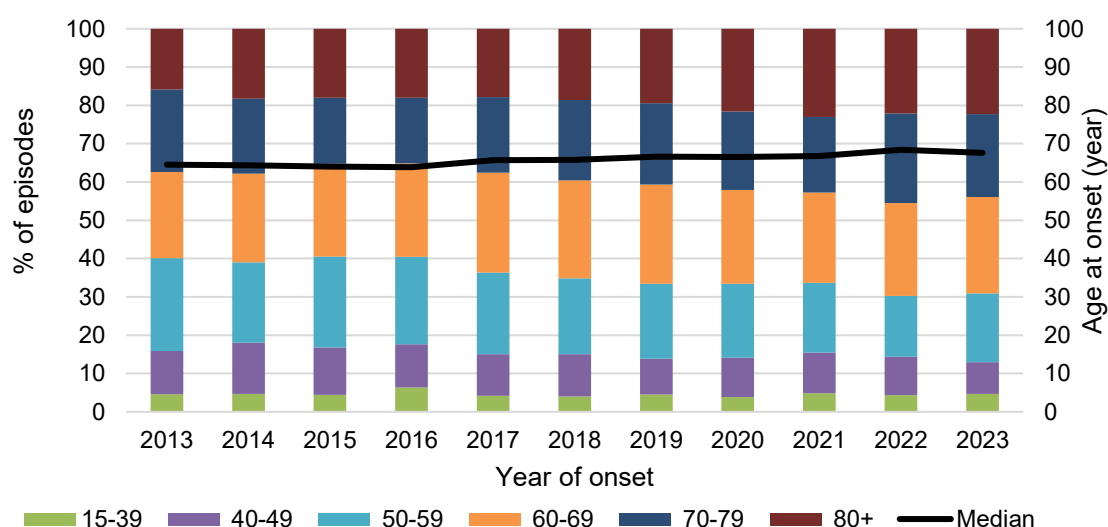
The median age at onset of HS increased from 64.5 years in 2013 to 67.6 years in 2023 ($p<0.001$) (Table 5.1.9b), although it remained lower than that of IS (Table 5.1.9a). As with IS, the percentage of HS patients aged 60 years or older also increased from 59.8% in 2013 to 69.1% in 2023, although it remained approximately 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	%
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	187	10.6
2022	68.4	16	0.8	68	3.5	192	10.0
2023	67.6	19	1.0	75	3.8	165	8.3

Year of onset	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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	322	18.2	417	23.6	349	19.7	407	23.0
2022	305	15.9	466	24.3	448	23.3	425	22.1
2023	359	18.0	502	25.1	433	21.7	445	22.3

Figure 5.1.9b: Age distribution at onset of haemorrhagic stroke



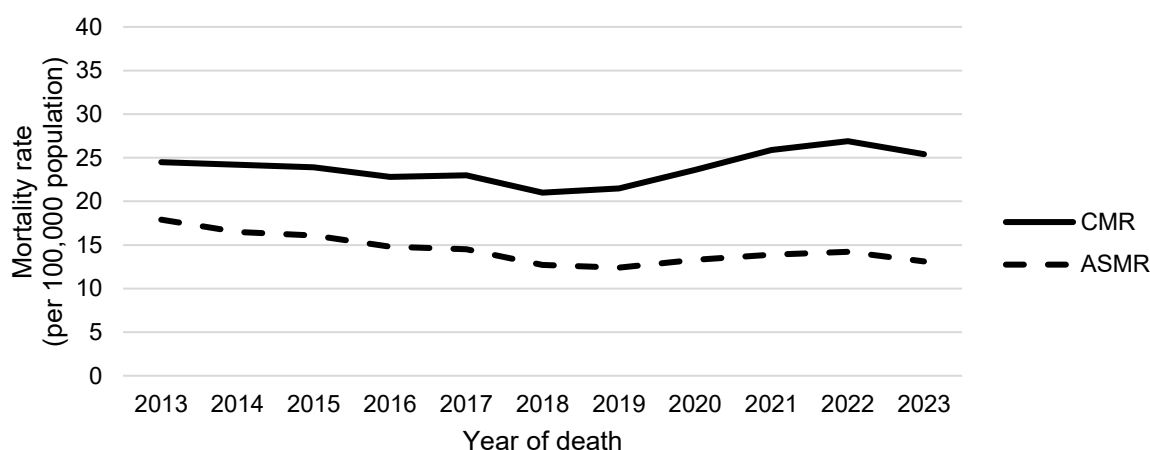
5.2 Mortality

The yearly number of stroke deaths increased by 14.7% over the past decade, from 790 in 2013 to 906 in 2023. While the crude mortality rate (CMR) did not change significantly, the age-standardised mortality rate (ASMR) declined significantly (by approximately 27%) from 17.9 to 13.1 per 100,000 population (Table 5.2.1, Figure 5.2.1). Based on results from the GBD 2023 study, although the absolute number of deaths globally due to stroke increased by 11.1% between 2013 and 2023, the age-standardised rate declined by 17.1%. In comparison, while the number of stroke deaths in ASEAN nations and high-income countries rose by 13.4% and 5.5%, respectively, the corresponding ASMRs declined 20.2% and 16.0%, respectively²⁹.

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

Year of death	Number	CMR	95% CI	ASMR	95% CI
2013	790	24.5	22.8-26.2	17.9	16.7-19.2
2014	790	24.2	22.5-25.9	16.5	15.3-17.7
2015	790	23.9	22.3-25.6	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	939	26.9	25.2-28.6	14.2	13.2-15.1
2023	906	25.4	23.7-27.0	13.1	12.2-14.0
P for trend	-	0.308	-	0.005**	-

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



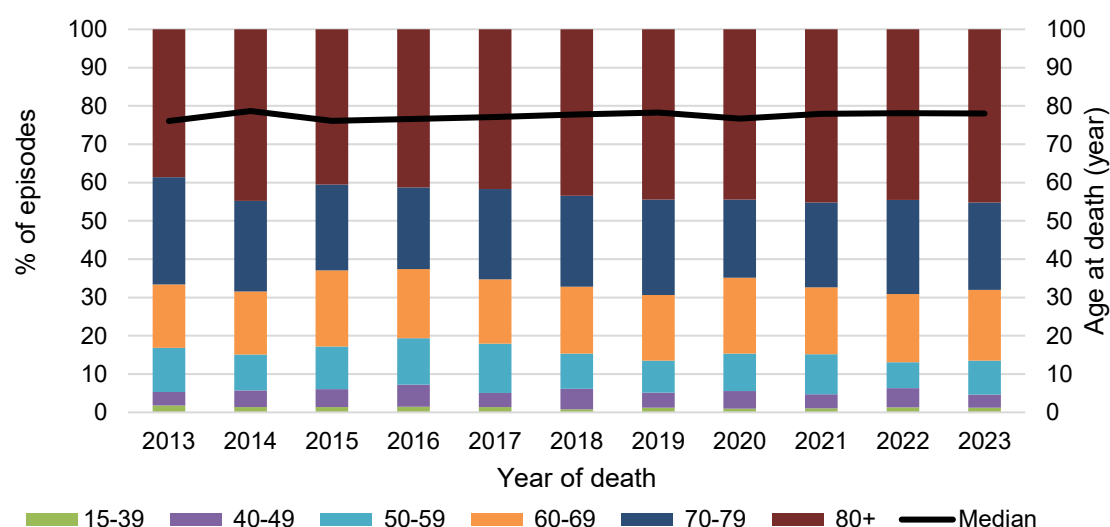
²⁹ Global Burden of Disease Study 2023 (GBD 2023) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2024. <https://vizhub.healthdata.org/gbd-results>. Accessed on 5 December 2025.

There was no significant change in the median age at death over the past decade, which ranged between 76.1 years and 78.7 years ($p=0.153$) (Table 5.2.2). Since 2018, approximately 85% of stroke deaths occurred among individuals aged 60 years or older, and about 45% of patients who died from stroke were aged 80 years or older (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	%
2013	76.1		6	0.8	8	1.0	28	3.5
2014	78.7		1	0.1	10	1.3	34	4.3
2015	76.1		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
2023	78.0		2	0.2	9	1.0	31	3.4
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2013	91	11.5	131	16.6	221	28.0	305	38.6
2014	74	9.4	130	16.5	187	23.7	354	44.8
2015	88	11.1	157	19.9	177	22.4	320	40.5
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	418	44.5
2023	80	8.8	168	18.5	206	22.7	410	45.3

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 rates (Figure 5.2.3a and 5.2.3b). Significant declines in mortality rates were observed among those aged 70 years and older (Table 5.2.3).

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

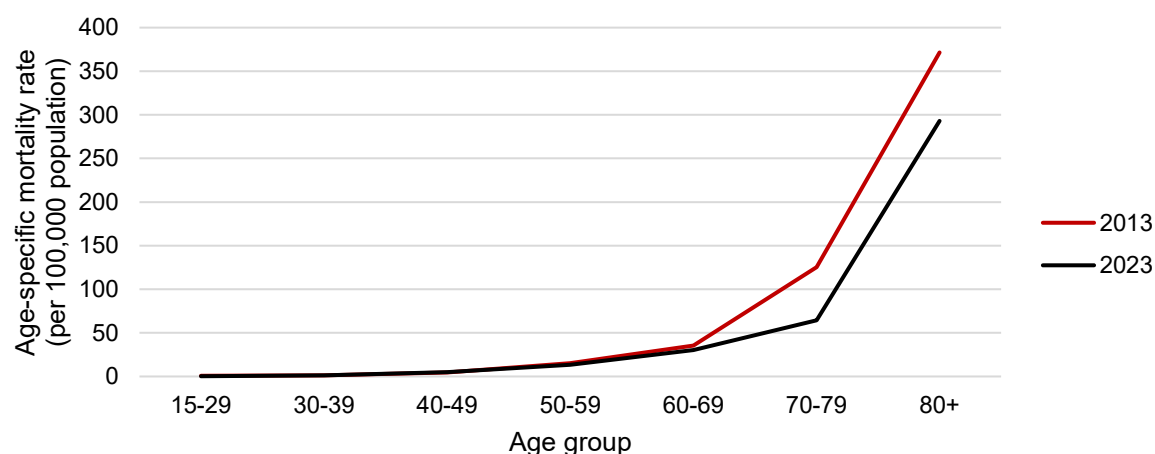


Figure 5.2.3b: Age-specific mortality rate of stroke (per 100,000 population) across years

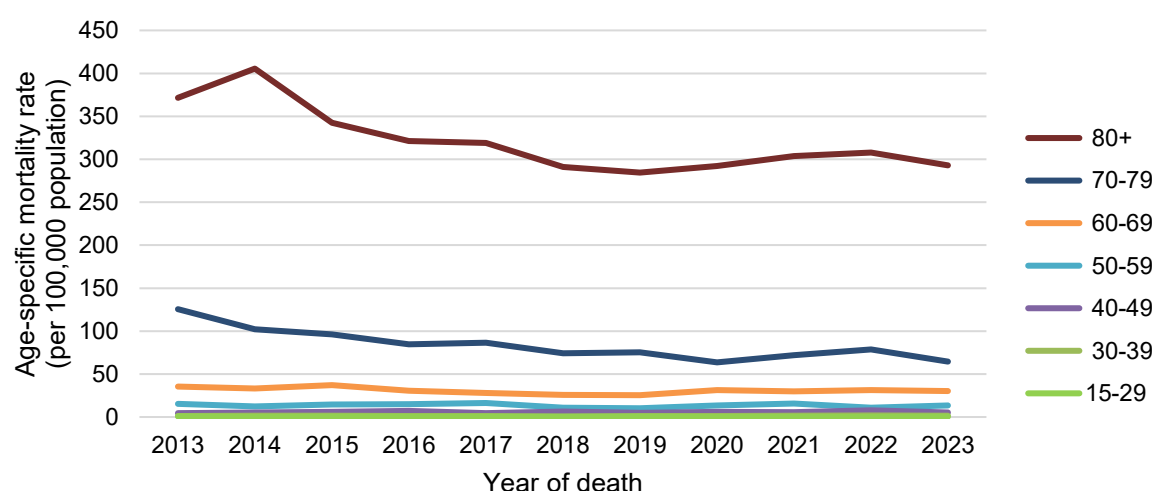


Table 5.2.3: Age-specific mortality rate of stroke (per 100,000 population)

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
2013	24.5	22.8-26.2	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	22.3-25.6	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	20-23.1	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	25.2-28.6	0.1	0.0-0.4	1.8	0.7-2.9	7.8	5.6-10.0
2023	25.4	23.7-27	0.3	0.0-0.7	1.4	0.5-2.4	5.1	3.3-6.8
P for trend	0.308	-	0.168	-	0.957	-	0.430	-
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
2013	15.3	12.2-18.5	35.6	29.5-41.7	125.5	109.0-142.0	371.5	329.8-413.2
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	14.4	11.4-17.4	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	307.7	278.2-337.2
2023	13.3	10.4-16.2	30.4	25.8-35.0	64.6	55.8-73.4	293.0	264.7-321.4
P for trend	0.361	-	0.174	-	<0.001**	-	0.004**	-

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 from 48% to 55% for most years over 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 among males³⁰. The sex distribution of stroke deaths in Singapore was similar to that of high-income countries, whereby males constituted 45% of stroke deaths in 2023³¹. 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 stroke³².

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 2023, males had an ASMR of 14.5 per 100,000 population, while females had an ASMR of 11.4 per 100,000 population. The ASMRs declined significantly over the years for both sexes (males: $p=0.009$, females: $p=0.012$) (Figure 5.2.4).

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

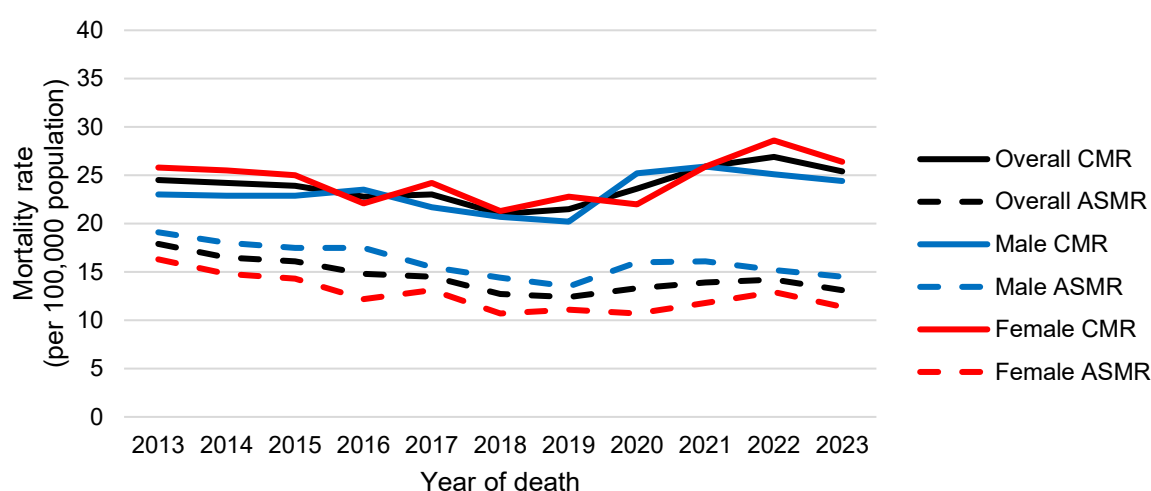
Male						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
2013	363	45.9	23.0	20.6-25.4	19.1	17.2-21.1
2014	364	46.1	22.9	20.5-25.2	18.0	16.1-19.9
2015	368	46.6	22.9	20.5-25.2	17.5	15.7-19.3
2016	382	50.3	23.5	21.1-25.9	17.5	15.7-19.3
2017	356	45.9	21.7	19.4-24	15.5	13.9-17.2
2018	343	47.9	20.7	18.5-22.9	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
2023	420	46.4	24.4	22.0-26.7	14.5	13.0-15.9
P for trend	-	-	0.208	-	0.009**	-
Female						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
2013	427	54.1	25.8	23.4-28.3	16.3	14.7-17.9
2014	426	53.9	25.5	23.1-27.9	14.8	13.3-16.2
2015	422	53.4	25.0	22.6-27.3	14.3	12.9-15.8
2016	378	49.7	22.1	19.9-24.3	12.2	10.9-13.5
2017	419	54.1	24.2	21.9-26.5	13.1	11.8-14.4
2018	373	52.1	21.3	19.2-23.5	10.7	9.6-11.9
2019	403	54.5	22.8	20.6-25.0	11.1	10.0-12.3
2020	392	48.2	22.0	19.9-24.2	10.7	9.5-11.8
2021	453	51.3	25.9	23.5-28.2	11.8	10.6-12.9
2022	514	54.7	28.6	26.1-31.1	12.9	11.7-14.1
2023	486	53.6	26.4	24.0-28.7	11.4	10.3-12.5
P for trend	-	-	0.554	-	0.012*	-

³⁰ Rexrode KM et al. The Impact of Sex and Sex on Stroke. *Circulation Research*. 2022; 130: 512–528.

³¹ Global Burden of Disease Study 2023 (GBD 2023) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2024. <https://vizhub.healthdata.org/gbd-results>. Accessed on 5 December 2025.

³² 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).

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

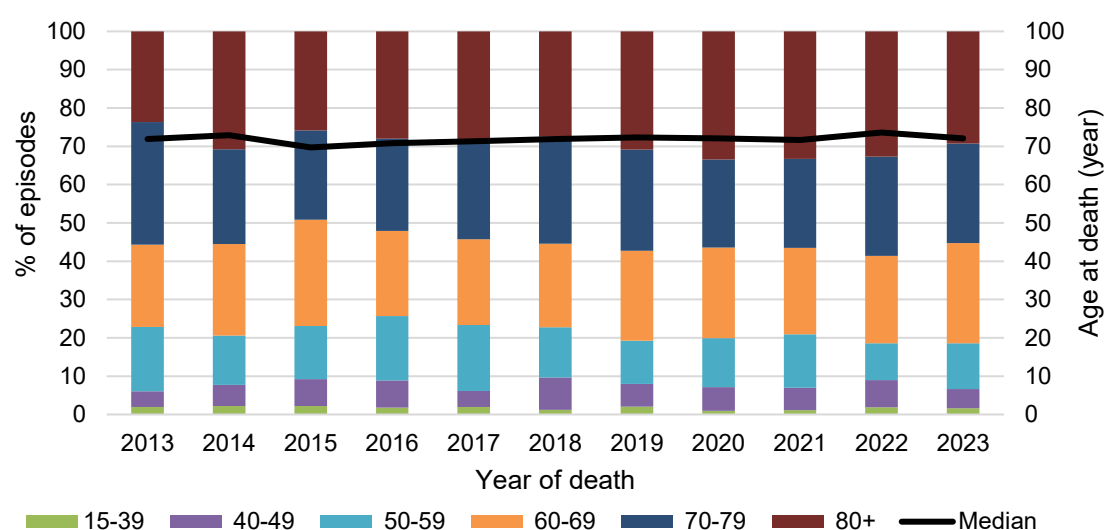


The median age at death due to stroke among males ranged between 69.7 and 73.6 years over the past decade ($p=0.245$) (Table 5.2.5a). In 2023, more than 80% of males who died from stroke were aged 60 years or older, and those aged 80 years or older (29.3%) formed the largest age group among males who died from 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	%
2013	71.9		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
2023	72.1		1	0.2	6	1.4	21	5.0
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2013	61	16.8	78	21.5	116	32.0	86	23.7
2014	47	12.9	87	23.9	90	24.7	112	30.8
2015	51	13.9	102	27.7	86	23.4	95	25.8
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
2023	50	11.9	110	26.2	109	26.0	123	29.3

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



As females had an older median age at onset of stroke compared with males (Tables 5.1.5a and 5.1.5b), they were also found to have an older median age at death – approximately a decade older than that of males. The median age at death due to stroke among females increased from 80.6 years to 83.6 years over the past decade ($p=0.015$) (Table 5.2.5b). In 2023, more than 90% of females who died from stroke were aged 60 years or older; and those aged 80 years or older formed the largest age group among females who died of stroke (59.1%), 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 or older, compared with males in the same age group³³.

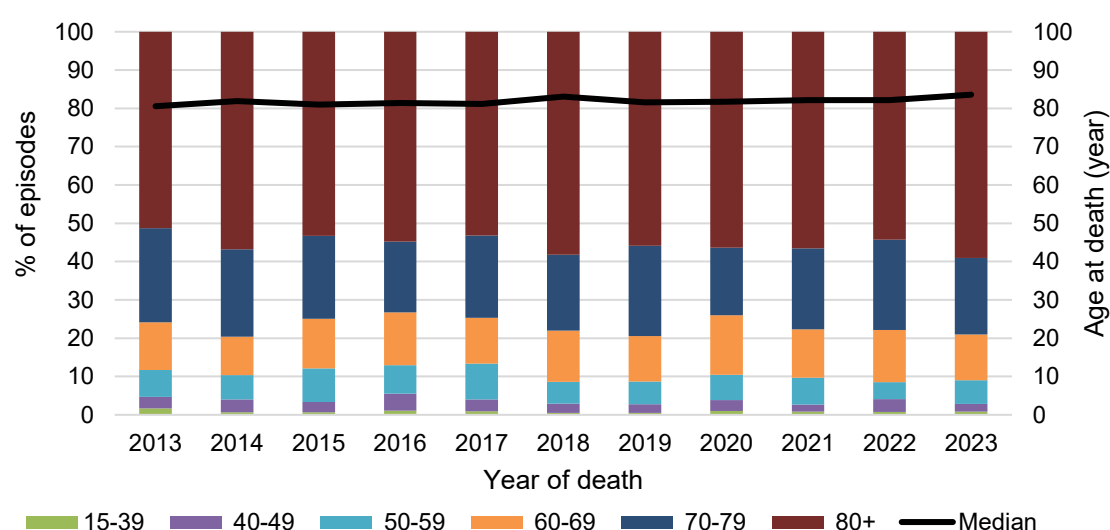
Table 5.2.5b: Age distribution at death of stroke among females

Year of death	Overall	Age 15-29		Age 30-39		Age 40-49	
	Median age	Number	%	Number	%	Number	%
2013	80.6	4	0.9	3	0.7	13	3.0
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	82.2	1	0.2	3	0.6	17	3.3
2023	83.6	1	0.2	3	0.6	10	2.1

³³ 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	%
2013	30	7.0	53	12.4	105	24.6	219	51.3
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	23.5	279	54.3
2023	30	6.2	58	11.9	97	20.0	287	59.1

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

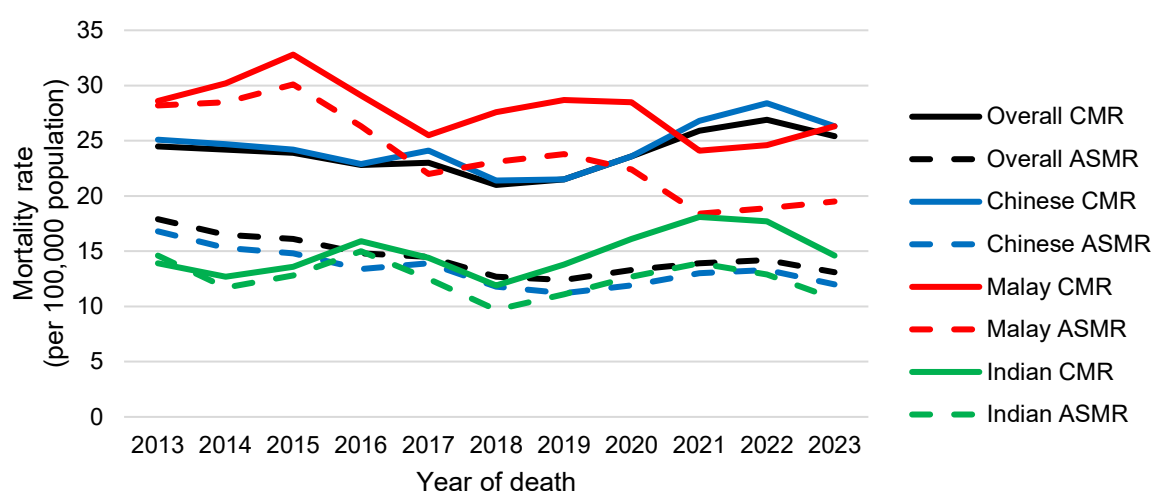


Compared with Chinese and Indians, Malays consistently had higher ASIRs of stroke across the years (Table 5.1.6); similarly, they also consistently had the highest ASMRs (Table 5.2.6). In 2023, the ASMRs of stroke among the Chinese, Malays, and Indians were 12.0, 19.5, and 10.7 per 100,000 population, respectively. The ASMRs showed a significant downward trend over the years for Chinese ($p=0.008$) and Malays ($p<0.001$), but remained relatively unchanged for Indians ($p=0.353$) (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
2013	612	77.5	25.1	23.1-27.1	16.8	15.4-18.2
2014	608	77.0	24.7	22.7-26.6	15.3	14.0-16.5
2015	603	76.3	24.2	22.3-26.1	14.8	13.6-16.1
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	745	79.3	28.4	26.3-30.4	13.3	12.3-14.3
2023	704	77.7	26.3	24.3-28.2	12.0	11.0-12.9
P for trend	-	-	0.279	-	0.008**	-
Malay						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
2013	117	14.8	28.6	23.4-33.8	28.2	22.9-33.4
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	110	11.7	24.6	20.0-29.2	18.9	15.3-22.5
2023	119	13.1	26.3	21.5-31.0	19.5	15.9-23.1
P for trend	-	-	0.020*	-	<0.001**	-
Indian						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
2013	39	4.9	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
2023	46	5.1	14.6	10.4-18.8	10.7	7.6-13.9
P for trend	-	-	0.076	-	0.353	-

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

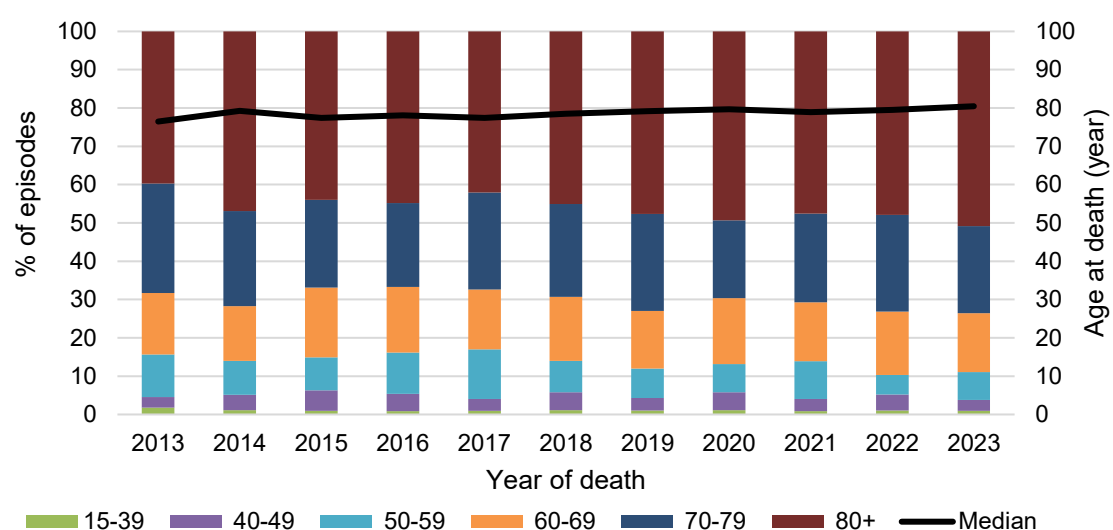


In addition to having the oldest median age at onset of stroke (Tables 5.1.7a to 5.1.7c), the Chinese also had the oldest median age at death, which increased from 76.5 years to 80.5 years over the past decade ($p=0.006$) (Table 5.2.7a). In 2023, almost 90% of stroke deaths among the Chinese occurred among those aged 60 years or older, while those aged 80 years or older constituted the largest age group, comprising 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	%
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	77.4		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
2023	80.5		1	0.1	6	0.9	20	2.8
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2013	68	11.1	98	16.0	175	28.6	243	39.7
2014	54	8.9	87	14.3	151	24.8	285	46.9
2015	52	8.6	110	18.2	138	22.9	265	43.9
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	16.5	188	25.2	357	47.9
2023	51	7.2	108	15.3	160	22.7	358	50.9

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

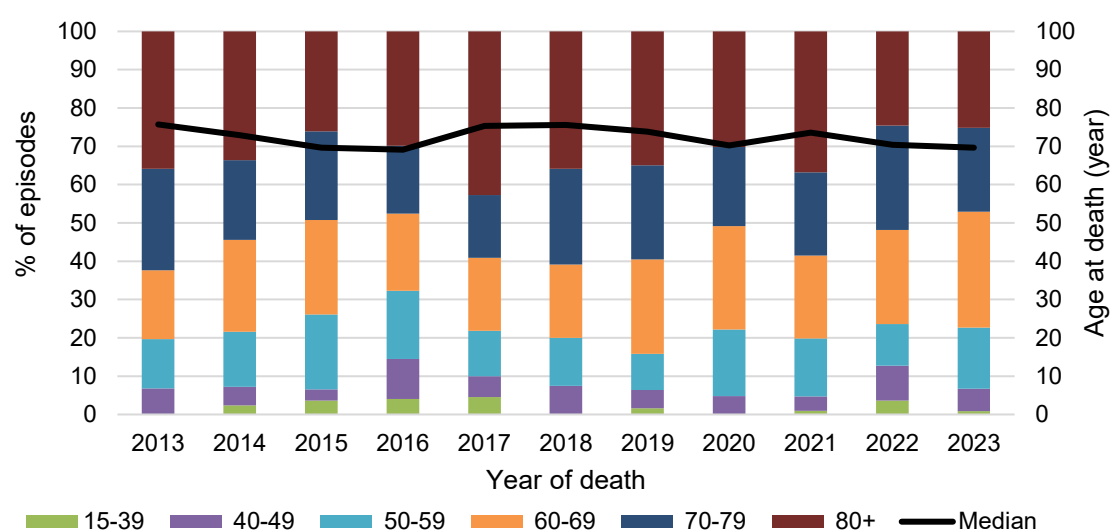


The median age at death due to stroke among Malays ranged between 69.1 and 75.7 years over the past decade ($p=0.347$), on average 6 years younger than that of the Chinese (Table 5.2.7b). In 2023, about 77% stroke deaths among the Malays occurred among those aged 60 years or older. In 2023, those aged 60-69 years formed the largest proportion among all age groups, comprising 30.3% of patients (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	%
2013	75.7		0	0.0	0	0.0	8	6.8
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	70.4		0	0.0	4	3.6	10	9.1
2023	69.7		1	0.8	0	0.0	7	5.9
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2013	15	12.8	21	17.9	31	26.5	42	35.9
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	10.9	27	24.5	30	27.3	27	24.5
2023	19	16.0	36	30.3	26	21.8	30	25.2

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

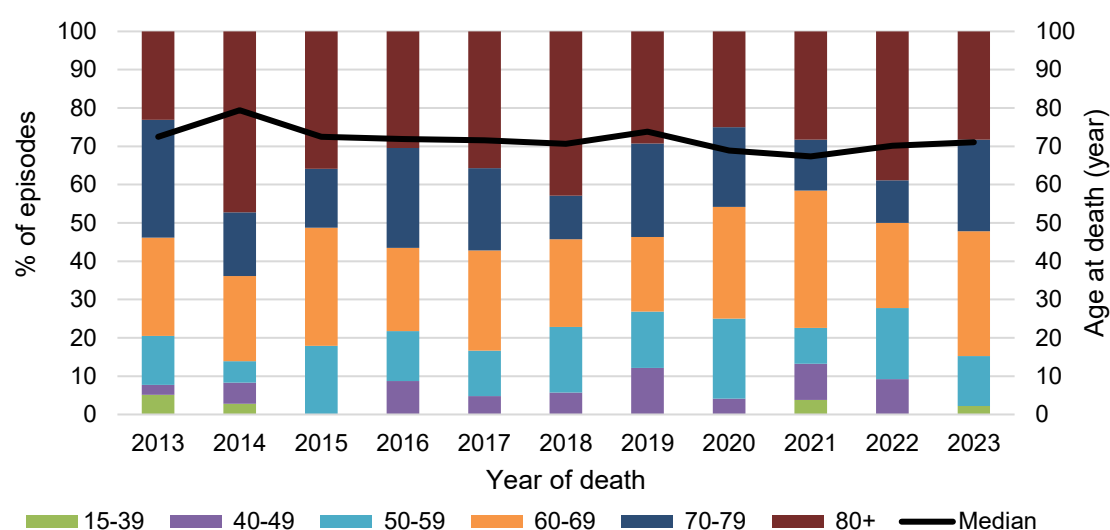


The median age at death due to stroke among Indians ranged between 67.4 and 79.4 years over the past decade ($p=0.041$) (Table 5.2.7c). In 2023, 85% of stroke deaths among Indians occurred among those aged 60 years or older, while those aged 60-69 years (32.6%) comprised the largest age group among Indian 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	%
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
2023	71.1		0	0.0	1	2.2	0	0.0
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2023	6	13.0	15	32.6	11	23.9	13	28.3

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



While there were approximately four times as many IS as HS each year, the disparity between IS and HS in terms of the 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 those of 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 over the years (Table 5.2.8). Since 2020, the ASMRs for IS have been lower than those for HS. Similarly, results from the GBD study revealed that there were approximately equal numbers of IS and HS deaths globally in 2023, as well as similar age-standardised mortality rates. In contrast, IS accounted for 62.9% of all stroke deaths in high-income countries, with a correspondingly higher mortality rate compared with HS; however, in ASEAN countries, the opposite was true, with HS making up 64.1% of all stroke deaths³⁴.

The ASMR of IS declined significantly from 9.6 per 100,000 population in 2013 to 6.1 per 100,000 population in 2023 ($p < 0.001$). However, that for HS remained largely unchanged over the years ($p = 0.466$); in 2023, the ASMR of HS was 7.1 per 100,000 population (Figure 5.2.8). Likewise, a global decreasing trend in mortality for both IS and HS was observed based on findings from the GBD 2023 study; the same pattern was also seen in ASEAN and high-income countries³⁵.

As the percentages in Table 5.2.8 are calculated among all stroke cases, and patients without documentation of IS or HS are not shown, the sum of the percentages for IS and HS does not add up to 100% for each year. Figures for overall CMR and ASMR include cases of unknown etiology.

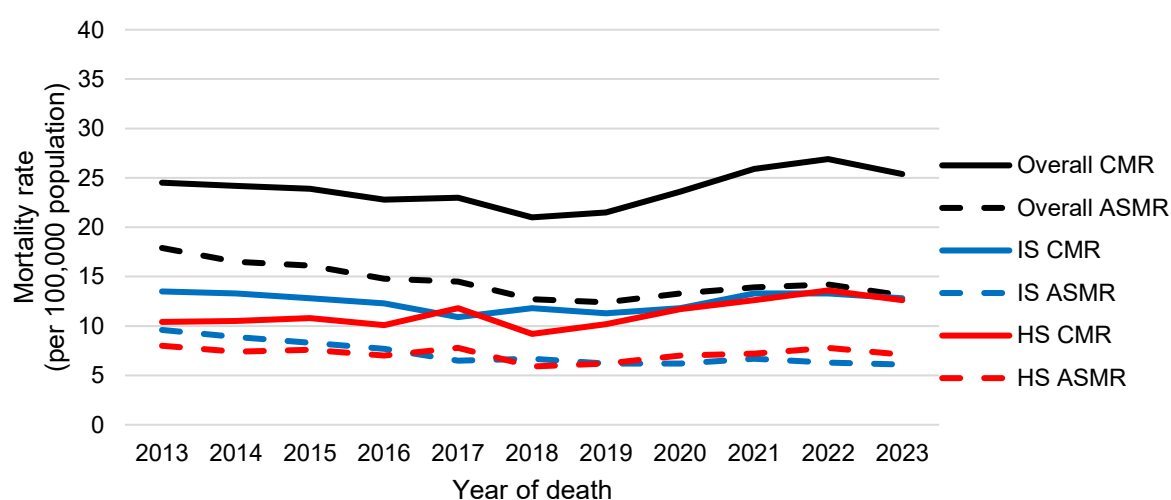
³⁴ Global Burden of Disease Study 2023 (GBD 2023) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2024. <https://vizhub.healthdata.org/gbd-results>. Accessed on 5 December 2025.

³⁵ Ibid.

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

Ischaemic stroke						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
2013	437	55.3	13.5	12.3-14.8	9.6	8.7-10.5
2014	434	54.9	13.3	12.1-14.6	8.9	8.0-9.7
2015	421	53.3	12.8	11.5-14.0	8.3	7.5-9.1
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	463	49.3	13.3	12.1-14.5	6.3	5.7-6.9
2023	457	50.4	12.8	11.6-14.0	6.1	5.5-6.6
P for trend	-	-	0.812	-	<0.001**	-
Haemorrhagic stroke						
Year of death	Number	%	CMR	95% CI	ASMR	95% CI
2013	337	42.7	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
2023	449	49.6	12.6	11.4-13.7	7.1	6.4-7.7
P for trend	-	-	0.025*	-	0.466	-

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



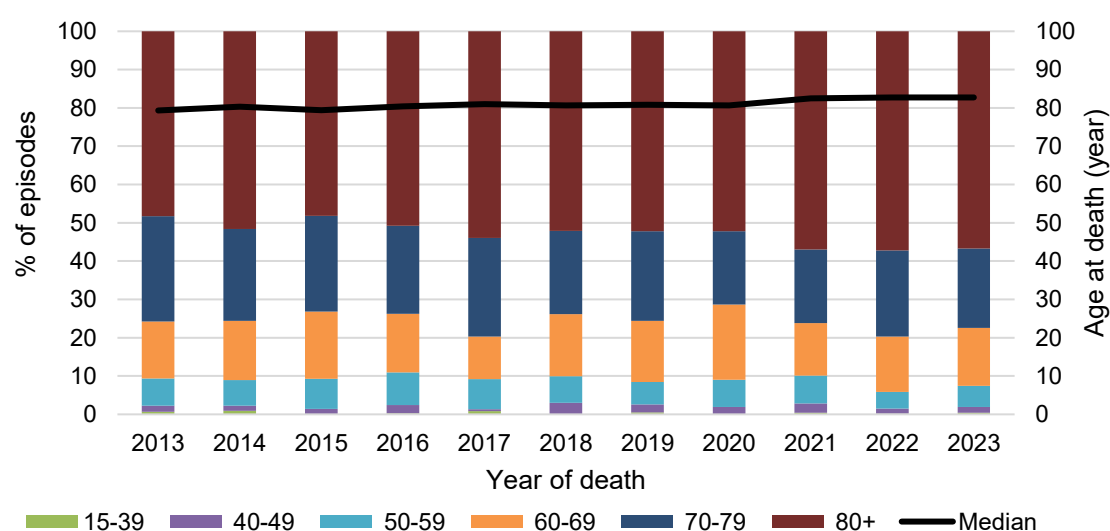
The median age at death due to stroke among IS patients rose from 79.3 years to 82.7 years over the past decade ($p<0.001$), and more than 90% of IS deaths each year occurred among those aged 60 years or older, peaking at 94.2% in 2022 (Table

5.2.9a). In 2023, those aged 80 years or older accounted for the majority of IS patients who died from stroke (56.7%), an increase from 48.3% in 2013 (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	%
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
2023	82.7		0	0.0	2	0.4	7	1.5
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
2013	31	7.1	65	14.9	120	27.5	211	48.3
2014	29	6.7	67	15.4	104	24.0	224	51.6
2015	33	7.8	74	17.6	105	24.9	203	48.2
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	265	57.2
2023	25	5.5	69	15.1	95	20.8	259	56.7

Figure 5.2.9a: Age distribution at death of ischaemic stroke



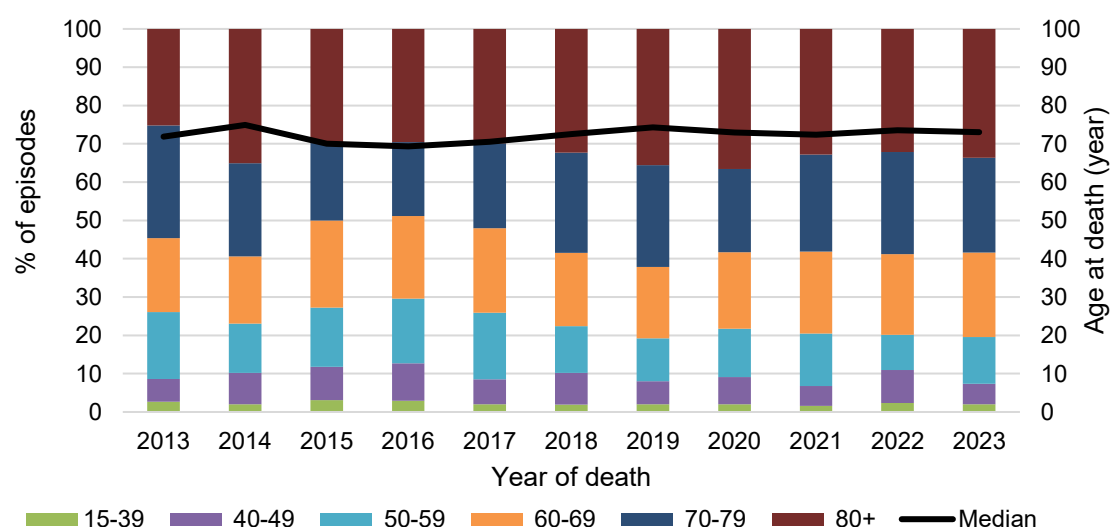
Median age at stroke onset was younger among HS than IS patients (Tables 5.1.9a and 5.1.9b); HS patients were also younger at death. The median age at death due to stroke among HS patients ranged between 69.3 and 74.9 years over the past decade

($p=0.328$), and between 70 and 80% of HS deaths occurred among those aged 60 years or older during this period (Table 5.2.9b). In 2023, those aged 80 years or older formed the largest age group among HS deaths (33.6%), significantly lower than that of IS (56.7%) (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	%
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
2023	73.1		2	0.4	7	1.6	24	5.3
Year of death	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	Number	%	Number	%	Number	%	Number	%
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
2023	55	12.2	99	22.0	111	24.7	151	33.6

Figure 5.2.9b: Age distribution at death of haemorrhagic stroke



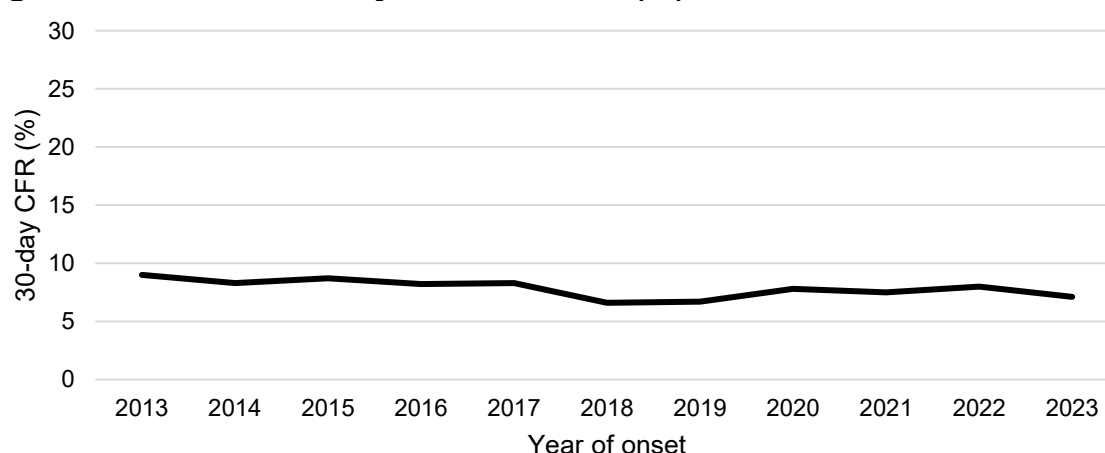
5.3 30-Day Case Fatality

The number of stroke deaths within 30 days of stroke onset increased by about 25%, from 585 in 2013 to 733 in 2023 (Table 5.3.1). This is a less pronounced increase compared with the rise in the number of stroke episodes over the same period (more than 50%) (Table 5.1.1). The positive news is that the 30-day case fatality rate (CFR) declined significantly from 9.0% in 2013 to 7.1% in 2023 ($p=0.043$) (Figure 5.3.1).

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

Year of onset	Number	CFR	95% CI
2013	585	9.0	8.2-9.7
2014	568	8.3	7.6-9.0
2015	625	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	764	8.0	7.4-8.6
2023	733	7.1	6.6-7.6
P for trend	-	0.043*	-

Figure 5.3.1: Case fatality rate of stroke (%)



Similar to the patterns observed 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 those females across the years (Table 5.2.4), the CFRs for males were consistently lower than those for females (Table 5.3.2). In 2023, the CFR was 5.9% for males and 8.7% for females.

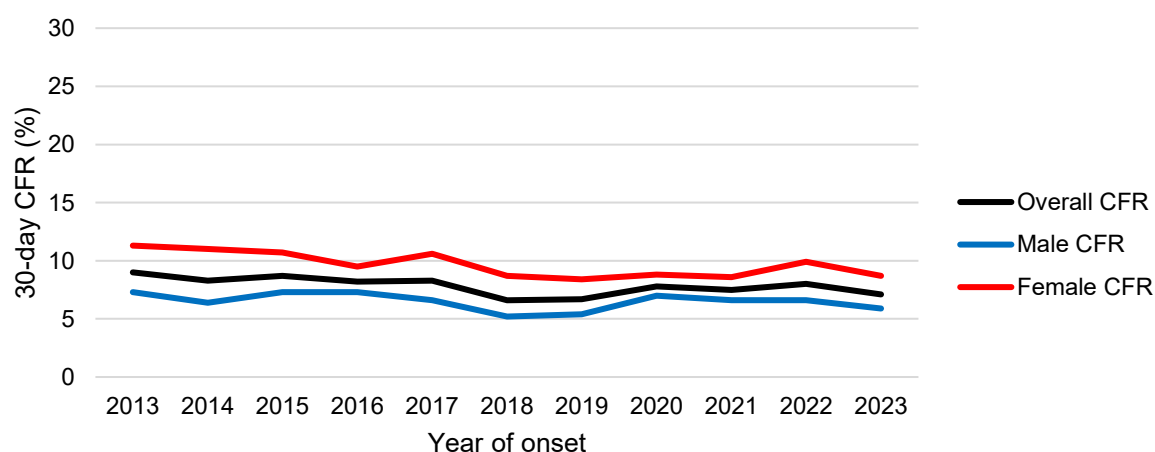
As females tended to have stroke at an older age than males (Tables 5.1.5a and 5.1.5b), they were more likely to have more comorbidities at stroke onset, which may

have contributed to a poorer prognosis³⁶. The CFR declined significantly over the years for females but not males (males: $p=0.237$; females: $p<0.008$) (Figure 5.3.2).

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

Male				
Year of onset	Number	%	CFR	95% CI
2013	272	46.5	7.3	6.4-8.1
2014	253	44.5	6.4	5.6-7.2
2015	299	47.8	7.3	6.5-8.1
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	365	47.8	6.6	5.9-7.3
2023	352	48.0	5.9	5.3-6.6
P for trend	-	-	0.237	-
Female				
Year of onset	Number	%	CFR	95% CI
2013	313	53.5	11.3	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	52.2	9.9	8.9-10.9
2023	381	52.0	8.7	7.8-9.5
P for trend	-	-	0.008**	-

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



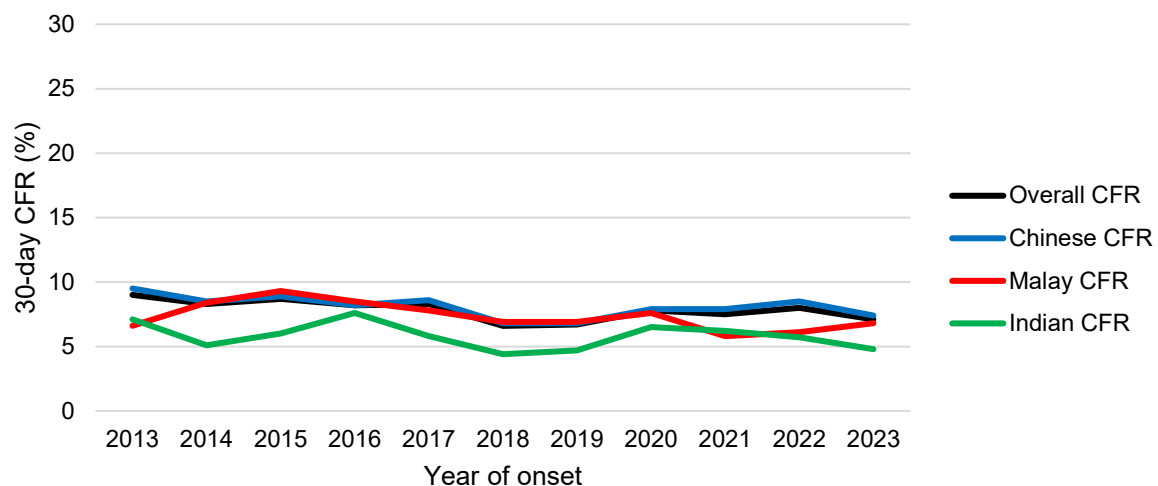
³⁶ Rexrode KM et al. The Impact of Sex and Sex on Stroke. Circulation Research. 2022; 130: 512–528.

Among the ethnic groups, although Malays consistently had the highest ASMRs in the past decade (Table 5.2.6), they did not consistently have the highest CFRs (Table 5.3.3). The Chinese had the highest CFRs for most of the years in the past decade and this was likely due to their older age at stroke onset (Tables 5.1.7a). In 2023, the CFRs were 7.4%, 6.8% and 4.8% for the Chinese, Malays and Indians respectively. There were no significant changes in the CFRs for Chinese ($p=0.084$), Malays ($p=0.053$), and Indians ($p=0.314$) (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
2013	467	79.8	9.5	8.6-10.4
2014	441	77.6	8.5	7.7-9.3
2015	486	77.8	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	613	80.2	8.5	7.9-9.2
2023	572	78.0	7.4	6.8-8.0
P for trend	-	-	0.084	-
Malay				
Year of onset	Number	%	CFR	95% CI
2013	68	11.6	6.6	5.0-8.1
2014	90	15.8	8.4	6.7-10.2
2015	106	17.0	9.3	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	5.5-8.4
2019	92	16.0	6.9	5.5-8.3
2020	101	14.9	7.6	6.1-9.1
2021	80	11.5	5.8	4.5-7.1
2022	85	11.1	6.1	4.8-7.4
2023	98	13.4	6.8	5.5-8.2
P for trend	-	-	0.053	-
Indian				
Year of onset	Number	%	CFR	95% CI
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	7.6	5.2-10.1
2017	30	4.7	5.8	3.7-7.8
2018	24	4.4	4.4	2.6-6.2
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	5.7	3.9-7.5
2023	34	4.6	4.8	3.2-6.4
P for trend	-	-	0.314	-

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 2023, the CFRs were 3.8% and 21.1% for IS and HS, respectively. This is likely because HS is a more severe condition with a 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, where higher scores indicate greater impairment³⁷. Based on available data, the median baseline NIHSS score for IS patients was consistently lower compared with that for HS patients (IS patients: the median NIHSS score remained stable at 4 from 2015 to 2023, while the score for HS patients ranged between 10 and 13 during this period).

Besides greater initial stroke severity, complications associated with HS, such as haematoma expansions, oedema formation and intraventricular haemorrhage, which may lead to elevated intracranial pressure, may also contribute to its higher CFR³⁸.

The CFR declined significantly over the years for IS ($p=0.002$) but not HS ($p=0.617$) patients (Figure 5.3.4).

As the percentages in Table 5.3.4 are calculated among all stroke cases, and patients without documentation of IS or HS are not shown, the sum of the percentages for IS and HS does not add up to 100% for each year. Figures for overall CFR include cases of unknown etiology.

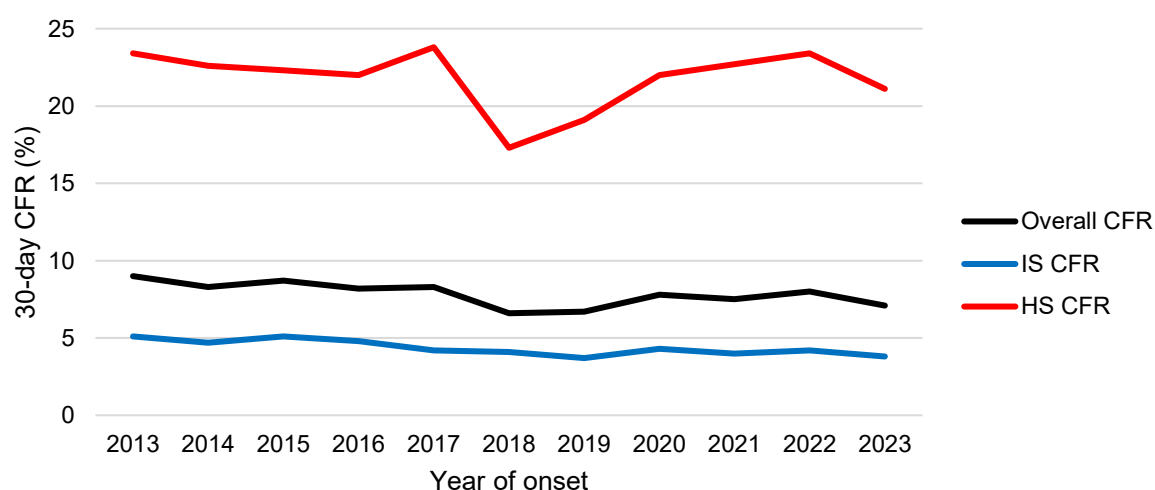
³⁷ NIH Stroke Scale. National Institute of Neurological Disorders and Stroke, the United States. <https://www.ninds.nih.gov/health-information/stroke/assess-and-treat/nih-stroke-scale>. Access on 5 December 2025.

³⁸ 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
2013	267	45.6	5.1	4.5-5.7
2014	260	45.8	4.7	4.1-5.3
2015	292	46.7	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	323	42.3	4.2	3.8-4.7
2023	320	43.7	3.8	3.4-4.2
P for trend	-	-	0.002**	-
Haemorrhagic stroke				
Year of onset	Number	%	CFR	95% CI
2013	302	51.6	23.4	20.8-26.0
2014	294	51.8	22.6	20.0-25.1
2015	320	51.2	22.3	19.9-24.8
2016	303	50.9	22.0	19.5-24.5
2017	377	59.2	23.8	21.4-26.2
2018	269	49.8	17.3	15.3-19.4
2019	313	54.3	19.1	17.0-21.2
2020	371	54.8	22.0	19.8-24.3
2021	394	56.4	22.7	20.5-25.0
2022	441	57.7	23.4	21.3-25.6
2023	413	56.3	21.1	19.1-23.2
P for trend	-	-	0.617	-

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 for cardiovascular disease (CVD), which may lead to stroke³⁹. Globally, high systolic blood pressure was found to be the leading contributor to the burden of stroke worldwide, accounting for 55% of total stroke Disability-Adjusted Life Years (DALYs)⁴⁰. In Singapore, the increasing prevalence of hypertension, high blood cholesterol and high-risk BMI may partly explain the rise in crude incidence of stroke⁴¹. 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)⁴². It has also been found that CVD risk factors 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 CVD, including stroke compared with an individual risk factor alone⁴³.

For this report, hypertension, hyperlipidaemia, diabetes and atrial fibrillation/flutter (AF) were defined as present if there was a history of the condition, or if it was newly diagnosed during the index admission. Smoking included former or current smokers. As patients could have multiple risk factors, the percentages in Figure 5.4.1 do not add up to 100% for each year.

Between 2013 and 2023, hyperlipidaemia and hypertension were consistently the two most common risk factors among stroke patients, with over 80% of patients having each risk factor every year (Figure 5.4.1). In 2023, 85.8% of patients had hyperlipidaemia and 81.4% had hypertension. Diabetes, smoking and AF were also prevalent among stroke patients, with 47.5%, 32.8% and 21.1% of patients having these risk factors respectively in 2023. Over the past decade, the proportion of stroke patients who smoked declined, while the proportion with diabetes increased. The prevalence of the other risk factors remained relatively stable. Given the high prevalence of modifiable risk factors among stroke patients, continued efforts in stroke prevention and risk factor management are important. The S.M.A.R.T.⁴⁴ approach to stroke prevention encourages smoke-free living, healthy meals, an active lifestyle, regular health screening, and taking prescribed medications as prescribed.

³⁹ 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

⁴⁰ Felgin V et al. World Stroke Organization (WSO): Global Stroke Fact Sheet 2022. *International Journal of Stroke*. 2022;(1): 18–29.

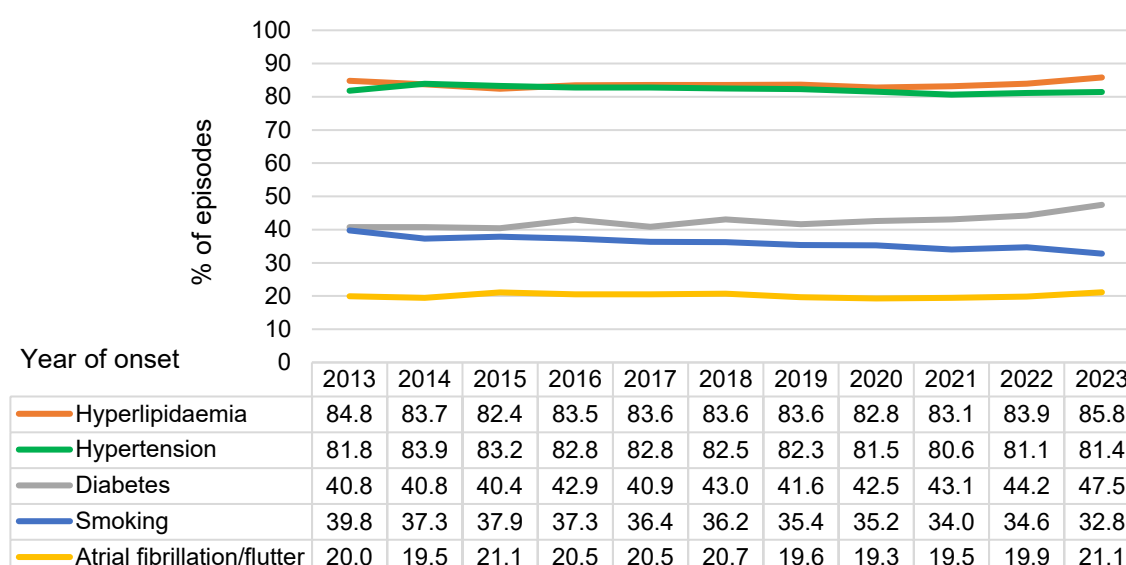
⁴¹ Tan J. et al. Strategies to prevent cardiovascular disease in Singapore: A call to action from Singapore Heart Foundation, Singapore Cardiac Society, and Chapter of Cardiologists of the Academy of Medicine, Singapore. *Ann Acad Med Singap* 2024;53: 23-33

⁴² 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

⁴³ Ibid.

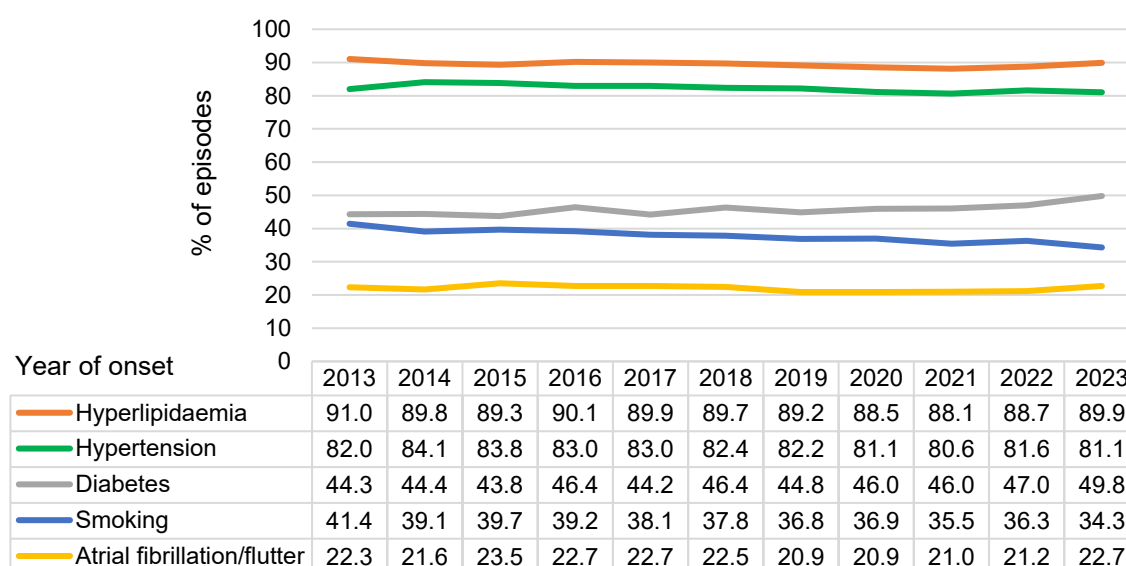
⁴⁴ Be Stroke Smart. <https://www.healthhub.sg/health-conditions/strokeawareness>. Accessed on 26 August 2026.

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



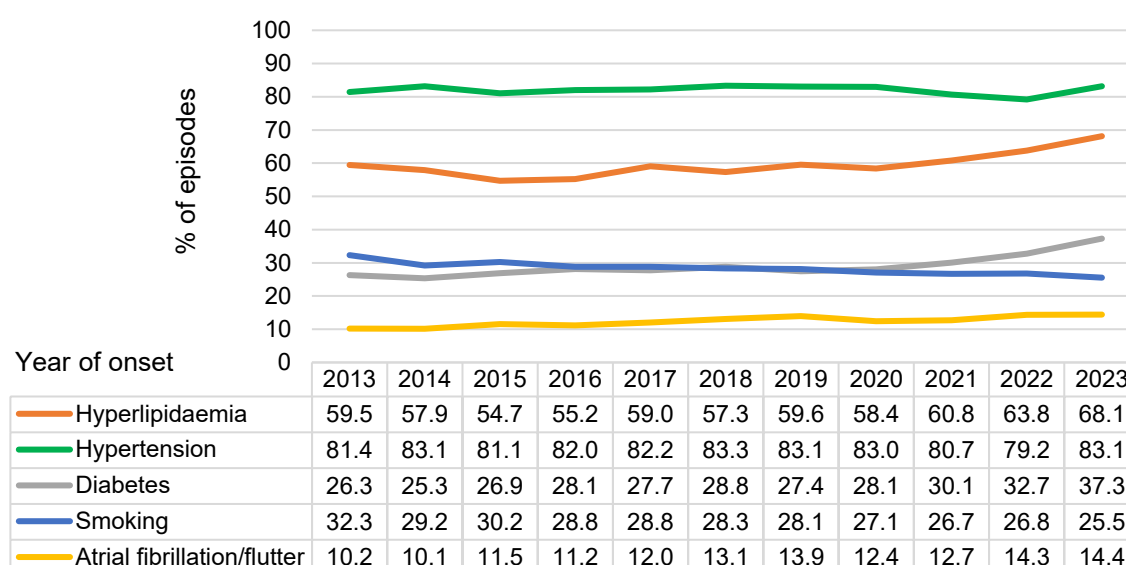
While the proportions of IS and HS patients with hypertension were similar, compared with HS patients, the proportions of IS patients with hyperlipidaemia, diabetes, AF and who smoking were higher (Figures 5.4.2 and 5.4.3). This is in line with findings by Feigin et al. using data from the GBD 2019 study, whereby the 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 subtype⁴⁵.

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



⁴⁵ 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



Additionally, for the latest year (2023), the proportions of patients with various risk factors were further stratified by age group. Hyperlipidaemia, hypertension and diabetes were generally more prevalent among older stroke patients than younger patients (Figure 5.5.4). Hypertension was present in 90.9% of stroke patients aged 80 years and above, compared with 67.0% among those aged 40-49 years.

AF showed a particularly marked increase with age. The prevalence of AF increased from 5.5% among stroke patients aged 40-49 years to 39.5% among those aged 80 years and above, representing an approximately 7.2-fold difference.

In contrast, smoking was more prevalent among stroke patients aged 40-69 years, with more than two-fifths of patients in these age groups being current or former smokers. This was approximately four times higher than that in the general population, based on findings from the NPHS 2023⁴⁶.

The age distribution of risk factors was further stratified by IS and HS patients, and similar patterns to those observed in the overall stroke population were noted (Figure 5.5.5a, Figure 5.5.5b).

Figure 5.5.4: Age distribution of risk factors (%) for patients with stroke onset in 2023

(Darker colours indicate higher proportions for each risk factor)

2023	15-29	30-39	40-49	50-59	60-69	70-79	80+	Overall
Hyperlipidaemia	37.7%	58.2%	76.0%	83.1%	86.3%	89.2%	88.1%	85.8%
Hypertension	20.8%	57.1%	67.0%	74.6%	77.8%	85.4%	90.9%	81.4%
Diabetes	9.4%	28.8%	40.1%	45.9%	47.8%	51.7%	47.0%	47.5%
Smoking	24.4%	38.3%	46.3%	44.6%	41.3%	28.6%	17.8%	32.8%
Atrial fibrillation/flutter	1.9%	0.6%	5.5%	6.7%	13.9%	23.7%	39.5%	21.1%

⁴⁶ National Population Health Survey 2023 Report. Ministry of Health, Singapore. Accessed 2 October 2025.

Figure 5.5.5a: Age distribution of risk factors (%) for IS patients with stroke onset in 2023

2023	15-29	30-39	40-49	50-59	60-69	70-79	80+	IS
Hyperlipidaemia	58.8%	80.0%	86.0%	89.3%	90.6%	91.2%	89.6%	89.9%
Hypertension	26.5%	50.5%	62.6%	73.0%	76.7%	85.3%	90.7%	81.1%
Diabetes	8.8%	34.7%	45.4%	49.9%	49.7%	52.9%	48.6%	49.8%
Smoking	29.0%	44.0%	50.1%	48.4%	43.9%	29.6%	18.0%	34.3%
Atrial fibrillation/flutter	2.9%	1.1%	5.2%	7.8%	14.5%	24.2%	41.8%	22.7%

Figure 5.5.5b: Age distribution of risk factors (%) for HS patients with stroke onset in 2023

2023	15-29	30-39	40-49	50-59	60-69	70-79	80+	HS
Hyperlipidaemia	0.0%	30.7%	51.5%	62.1%	66.3%	77.8%	80.9%	68.1%
Hypertension	10.5%	65.3%	77.6%	79.9%	82.7%	86.1%	91.5%	83.1%
Diabetes	10.5%	21.3%	27.3%	32.6%	39.2%	45.0%	38.9%	37.3%
Smoking	14.3%	30.2%	36.1%	30.7%	28.4%	22.7%	16.8%	25.5%
Atrial fibrillation/flutter	0.0%	0.0%	6.1%	2.8%	10.8%	20.6%	28.1%	14.4%

5.5 Treatment

Early recognition of stroke symptoms and prompt medical attention are important, as some stroke treatments are time-sensitive. The F.A.S.T.⁴⁷ approach – Face drooping, Arm weakness, Speech difficulty, and Time to call for emergency medical assistance – is a simple way to recognise common signs of stroke and emphasises the need to seek medical attention promptly.

There are two main options for reperfusion therapy for IS – intravenous thrombolysis (IVT) and endovascular therapy^{48,49}. The intravenous administration of thrombolytic agents to dissolve blood clots in eligible patients with IS⁵⁰ has been shown in several clinical trials to be beneficial when administered within 4.5 hours of stroke onset^{51,52}. Endovascular therapy involves the use of catheter-guided devices to restore blood flow to occluded (blocked) vessels. Endovascular thrombectomy (EVT), a type of endovascular therapy, currently represents the standard of care for eligible patients with IS due to large vessel occlusion⁵³.

Patients who were enrolled in stroke clinical trials were excluded from the calculation of thrombolytic agents, antiplatelets, and anticoagulants administered. As the administration of thrombolytic agents is time-sensitive, patients who were transferred from another hospital were also excluded from the calculation of thrombolytic agent use.

The proportion of IS patients who received thrombolytic agents remained relatively stable at 5.1% in 2023 (Figures 5.5.1). Meanwhile, the proportion of patients who underwent EVT more than doubled from 2.6% in 2018 to 5.9% in 2023. A meta-analysis of 67 studies conducted in Asia and published after 2010 reported an overall IVT utilisation rate of 9.1% among patients with IS, c with an estimated rate of 6.8% in Southeast Asia⁵⁴.

Antiplatelet therapy is a key component of the management of non-cardioembolic stroke, and most IS patients are started on aspirin (a common type of antiplatelet drug), either as monotherapy or as part of a dual antiplatelet (DAPT) regimen. In patients with atrial fibrillation (AF), anticoagulants are generally preferred over antiplatelet therapy for the secondary prevention of stroke⁵⁵ AF⁵⁶.

⁴⁷ Be Stroke Smart. <https://www.healthhub.sg/health-conditions/strokeawareness>. Accessed on 26 August 2026.

⁴⁸ Hindsholm M. et al. Management and Prognosis of Acute Stroke in Atrial Fibrillation. *J. Clin. Med.* 2023; 12.

⁴⁹ 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).

⁵⁰ Examples of ineligible patients include those on blood thinning medication and those with extensive brain damage, high risk of bleeding and recent bleeding.

⁵¹ 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.

⁵² TPA Therapy. National Library of Medicine, National Center for Biotechnology Information.

<https://www.ncbi.nlm.nih.gov/books/NBK482376/> Accessed on 16 June 2023.

⁵³ 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.

⁵⁴ 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).

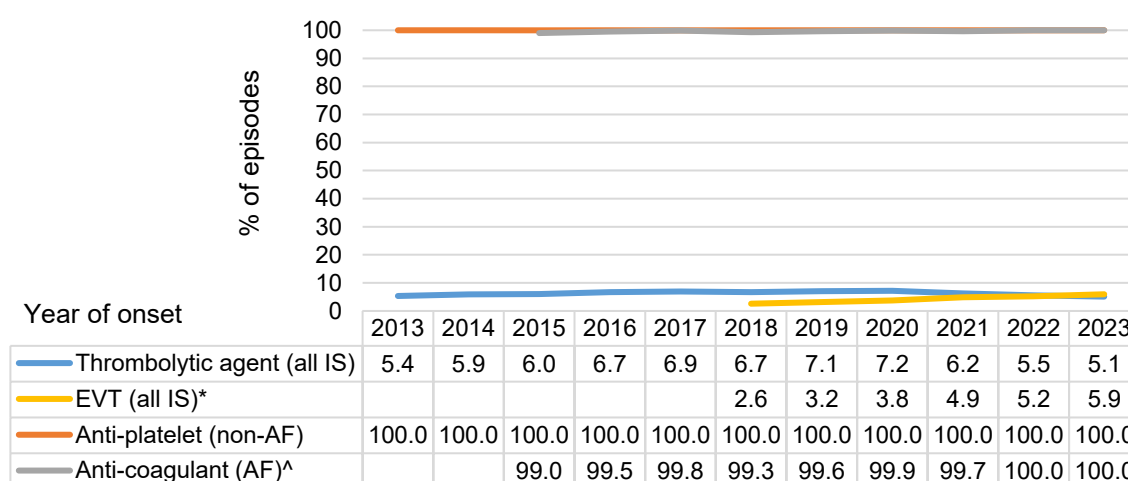
⁵⁵ Coutsoumbas G V. and Di Pasquale G. Ischaemic stroke in the absence of documented atrial fibrillation: is there who could benefit from anticoagulant therapy? *European Heart Journal.* 2022;24: 189–195.

⁵⁶ Altavilla R. et al. Anticoagulation After Stroke in Patients With Atrial Fibrillation. *Stroke.* 2019; 50:2093-2100.

Individuals with documented medical contraindications (such as bleeding disorders or allergies) were excluded from the calculation of antiplatelet and anticoagulant use. From 2015 onwards, patients with other probable reasons for medication omission (such as advanced age or a history of poor medication compliance) were also excluded from the calculation of anticoagulant use. As long as antiplatelets and anticoagulants were administered at any point during the index admission (as a stat dose, regular dose or at discharge), they were counted as prescribed.

After excluding patients with medical contraindications and other probable reasons, both antiplatelet use among eligible IS patients without AF and anticoagulant use among IS patients with AF remained high, at close to 100% each year.

Figure 5.5.1: Treatment (%) among ischaemic stroke patients



* Data collection for EVT started in 2018

^ Complete data on probable reasons for the omission of anticoagulants throughout the entire year has been available from 2015 onwards.

Evidence suggests that, compared with patients treated in general wards during the acute phase of stroke, patients treated in Acute Stroke Units (ASUs) are more likely to survive, have better recovery, and be discharged earlier⁵⁷. More patients treated in ASUs receive therapy, and some start therapy earlier⁵⁸. According to the Sentinel Stroke National Audit Programme in the United Kingdom, patients in ASUs are geographically co-located and managed by a multidisciplinary team in accordance with a well-defined stroke care pathway and continuous monitoring⁵⁹. Admitting patients to ASUs can help ensure that patients get the right care at the right time, in line with the “5Ps” of a stroke unit: caring for stroke patients in one place by professionals with the appropriate perspective and expertise, while allowing hospitals to maximise resources⁶⁰. As HS patients are under-represented in ASUs due to differences in

⁵⁷ Sun Y et al. A systematic review and meta-analysis of acute stroke unit care: What's beyond the statistical significance? British Medical Research Methodology 2013; 13: 132.

⁵⁸ Venketasubramanian N. A Review of the Role of Stroke units in the Modern Day Management of stroke - Implications for Stroke Care in Singapore. Singapore Medical J 1998; 39(2): 82-85

⁵⁹ Sentinel Stroke National Audit Programme (SSNAP), Clinical audit, April 2017 – July 2017, Public Report. Royal College of Physicians, United Kingdom.

⁶⁰ Venketasubramanian N. A Review of the Role of Stroke units in the Modern Day Management of stroke - Implications for Stroke Care in Singapore. Singapore Medical J 1998; 39(2): 82-85

patient care management, they were excluded from the calculation of ASU utilisation. The registry started capturing ASU utilisation in July 2014; hence, complete data for the entire year were available from 2015 onwards.

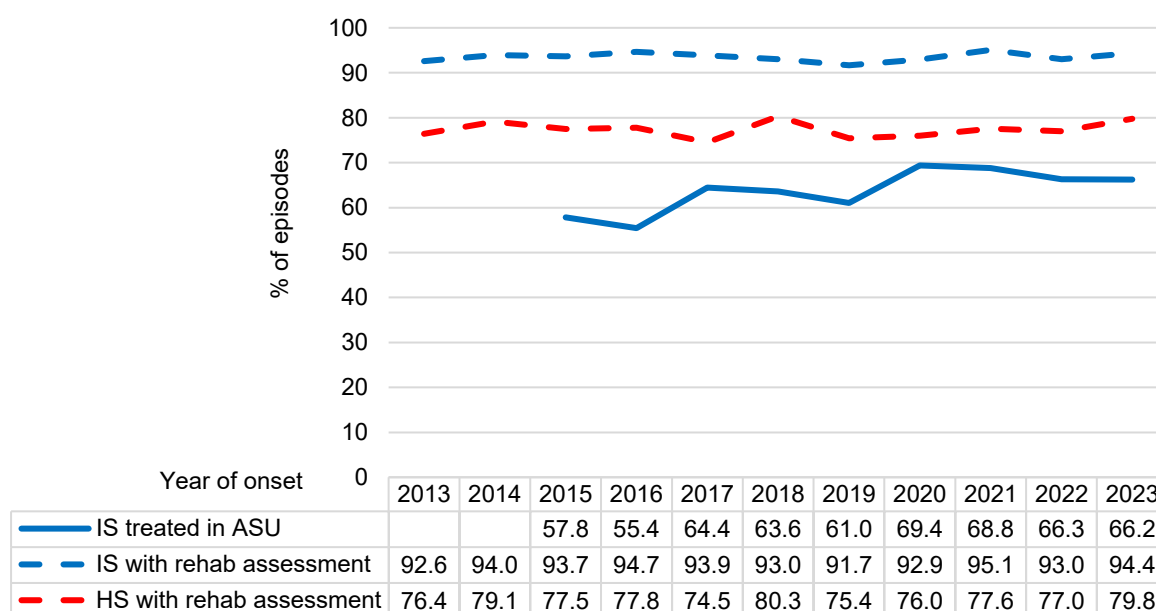
Utilisation of ASUs among IS patients increased from 57.8% in 2015 to 66.2% in 2023 (Figure S2.3). Both all-cause and stroke-specific in-hospital mortality rates were lower among IS patients treated in ASUs (all-cause mortality: 3.6%, stroke-specific mortality: 2.6%) than among those treated in non-ASUs (all-cause mortality: 10.0%; stroke-specific mortality: 5.8%) during the period from 2015 to 2023.

Rehabilitation typically begins as early as clinically feasible and continues after hospital discharge. It involves training in self-care skills, mobility, swallowing and speech. Rehabilitation assessment aims to evaluate functional impact of stroke and to identify interventions that support recovery and independence.

A local study conducted in community hospitals in Singapore reported that older age and earlier rehabilitation were significantly associated with greater short-term functional improvement among ischemic stroke survivors, highlighting the importance of timely rehabilitation to optimize recovery, including among older adults⁶¹.

In Singapore, more than 90% of IS patients underwent rehabilitation assessment annually, while the corresponding proportion among HS patients was lower, ranged from 75% to 80% (Figure S2.3).

Figure 5.5.2: Acute stroke unit utilisation among ischaemic stroke patients and rehabilitation assessment (%) by stroke subtype



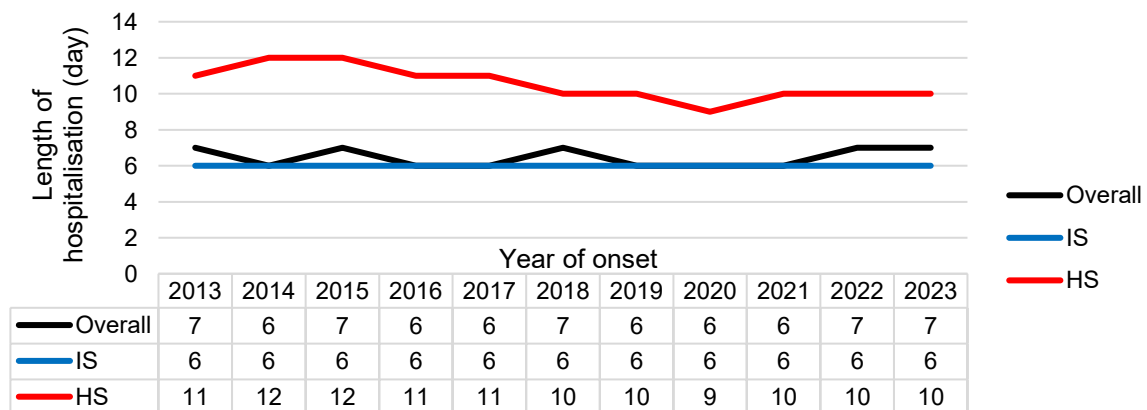
⁶¹ Lai WN et al. Predictors of short-term functional recovery in ischemic stroke rehabilitation at community hospitals in Singapore. *Front. Stroke* 2025; 4:1704636. doi: 10.3389/fstro.2025.1704636.

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 LOS would be abnormally short or long under such scenarios.

The overall median LOS ranged between 6 and 7 days from 2013 to 2023 (Figure 5.6.1). The median LOS for IS patients was considerably shorter, at 6 days, compared with 9-12 days for HS patients. A plausible reason for the longer LOS among HS patients was that they generally had a higher level of impairment, as indicated by their higher median baseline NIHSS score (ranging from 10-13, compared with 4 for IS from 2015 to 2023); hence, a longer duration of acute care was warranted. Furthermore, HS patients are also more susceptible to post-stroke complications, which may result in a prolonged LOS⁶².

Figure 5.6.1: Length of stay (days)



⁶² Pinzon RT & Wijaya VO. Complications as Poor Prognostic Factors in Patients with Haemorrhagic Stroke: A Hospital-Based Stroke Registry. Int J Neurol Neurother 2020, 7:096.

6. CONCLUSION

In 2023, stroke accounted for about 3.3% of Singapore's total burden of ill health and premature death due to diseases, injuries, and risk factors⁶³, and cerebrovascular diseases (including stroke) accounted for 5.6% of deaths locally in 2023. Stroke can significantly impact individuals and their families, as those who have had a stroke may experience difficulties with mobility, activities of daily living, and emotional or behavioural changes⁶⁴.

In Singapore, hyperlipidaemia and hypertension were the two most commonly reported risk factors among stroke patients in 2023 (Figure 5.5.4). Effective management of these and other modifiable risk factors is important for stroke prevention. Internationally, the INTERSTROKE study found that five major modifiable risk factors: hypertension, current smoking, obesity, unhealthy diet, and physical inactivity, accounted for more than 80% of the global risk of all strokes⁶⁵. These findings highlight the importance of managing modifiable cardiovascular risk factors and promoting healthy lifestyle behaviours to reduce the burden of stroke.

Individuals can reduce their 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 screenings and follow-ups, and controlling blood pressure, blood cholesterol and blood glucose levels effectively^{66,67}.

For individuals with symptoms of stroke, seeking medical help promptly plays a crucial role in improving prognosis. For individuals who have survived a stroke, adherence to medication and maintaining a healthy lifestyle can reduce the risk of subsequent cardiovascular events (including recurrent stroke) and premature mortality.

⁶³ Global Burden of Disease Study 2023 (GBD 2023) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2024. <https://vizhub.healthdata.org/gbd-results>. Accessed on 5 December 2025.

⁶⁴ Principal Cause of Death. Ministry of Health. <https://www.moh.gov.sg/others/resources-and-statistics/principal-causes-of-death>. Accessed on 5 December 2025.

⁶⁵ 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.

⁶⁶ Ibid.

⁶⁷ 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.