Singapore Stroke Registry
Annual Report 2017

National Registry of Diseases Office

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Acknowledgement

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1. GLOSSARY

AF	Atrial Fibrillation/Flutter
ASIR	Age-Standardised Incidence Rate
ASMR	Age-Standardised Mortality Rate
CFR	Case Fatality Rate
CI	Confidence Interval
CIR	Crude Incidence Rate
CMR	Crude Mortality Rate
CT	Computed Tomography
ED	Emergency Department
EMR	Electronic Medical Record
HIDS	Hospital In-patient Discharge Summary
HPB	Health Promotion Board
HS	Haemorrhagic Stroke
ICD	International Classification of Diseases
IQR	Interquartile Range
IS	Ischaemic Stroke
LOS	Length of Stay
MediClaims	System of Patient's Medisave and MediShield claims
MHA	Ministry of Home Affairs
MOH	Ministry of Health
MONICA	Monitoring Trends and Determinants in Cardiovascular Disease, World Health Organisation
MRI	Magnetic Resonance Imaging
NRDO	National Registry of Diseases Office
NRIC	National Registration Identity Card
SSR	Singapore Stroke Registry

2. EXECUTIVE SUMMARY

In 2017, there were 7,741 stroke cases admitted to Singapore public hospitals (about 21 per day). Of these stroke cases, 57.7% occurred among men and the mean age at stroke admission was 65.8 years old; while 42.3% occurred among women and the mean age at stroke admission was 72.0 years old. 79.9% of the stroke cases were ischaemic stroke (IS) and 20.0% were haemorrhagic stroke (HS), with the remaining 0.1% being stroke with unknown aetiology. The Malays had the highest crude incidence rate (CIR) (281.3 per 100,000 population) and were the youngest at the admission of stroke (mean age at admission: 64.4 years old). This is followed by the Chinese (230.3 per 100,000 population) with a mean age at stroke admission of 69.6 years; and Indians (184.3 per 100,000 population) with a mean age at stroke admission of 65.0 years.

From 2008 to 2017, there was an overall increase in CIR, from 187.9 to 229.6 per 100,000 population ($p<0.001$). However, the age-standardised incidence rate (ASIR) declined from 164.6 to 156.4 per 100,000 population during this period ($p<0.05$). The mean age at stroke admission increased slightly from 68.0 years in 2008 to 68.4 years in 2017.

In 2017, there were 759 deaths due to stroke, an increase from 698 in 2008. Of these deaths, 46.0% occurred among men with a mean age of 70.5 years and 54.0% among women with a mean age of 78.0 years. Split by stroke sub-type, 48.1% of the stroke deaths were due to IS, 50.9% due to HS, and 1% due to stroke with unknown aetiology. The Malays had the highest crude mortality rate (CMR) (25.1 per 100,000 population) and were the youngest at death due to stroke (mean age at stroke death: 71.9 years). This is followed by the Chinese (23.6 per 100,000 population) with a mean age of death due to stroke at 75.2 years, and Indians (14.4 per 100,000 population) with a mean age of death due to stroke at 73.2 years.

The CMR fluctuated between 20.5 and 26.8 per 100,000 population during 2008-2017. The age-standardised mortality rate (ASMR) showed an overall downward trend since 2011 - from 20.8 per 100,000 population in 2011 to 14.1 per 100,000 population in 2017 ($p<0.01$).

Of all the stroke patients in 2017, 7.9% (614 patients) died of stroke within 30 days from admission. Compared to 2008 (573 patients, 10.3%), the 30-day case fatality rate (CFR) decreased significantly ($p<0.05$). In 2017, CFR was greater for women (10.2%) as compared to men (6.3%). The Chinese (8.3%) and the Malays (7.5%) had higher CFRs than the Indians (5.4%). In 2017, the CFR for HS (23.3%) was nearly 6 times that for IS (4.0%).

In 2017, the top 5 risk factors found in stroke patients were hyperlipidaemia (83.9%), hypertension (82.9%), ischaemic heart disease (45.7%), diabetes mellitus (41.0%), and smoking (36.4%). The top 5 risk factors found among IS patients in 2017 were hypertension (82.1%), hyperlipidaemia (59.8%), ischaemic heart disease (39.7%), smoking (28.8%), and diabetes mellitus (27.9%); while the top 5 risk factors found among HS patients in 2017 were hyperlipidaemia (90.0%), hypertension (83.1%), ischaemic heart disease (46.9%), diabetes mellitus (44.2%), and smoking (38.2%).

3. INTRODUCTION

Cerebrovascular diseases, including stroke, were the 9th most common condition of hospitalisation in 2016[1], the 4th most common principal cause of death (accounting for 6.3% of total deaths) in 2017[2], and the leading contributor to the burden of disease in Singapore[3,4].

Globally, stroke was the 3rd leading causes of death (contributing 6 million deaths)[5] and disease burden (contributing 132 million disability-adjusted life-years)[6] in 2017. The recent publication from the Global Burden of Disease, Injuries, and Risk Factors (GBD) Study forecasted that stroke will likely continue to be one of the leading three causes of death in 2040 worldwide[7].

Stroke occurs when the blood supply to the brain is interrupted or reduced, which results in cell death in the brain and impaired neurological function. Ischaemic stroke is the most common stroke and is caused by blocked artery. Haemorrhagic stroke is caused by the leaking or bursting of a blood vessel. As delayed treatment can lead to irreversible brain damage or death, timely treatment is an important factor for the treatment of acute stroke.

Risk factors such as hypertension and hyperlipidaemia make one susceptible to the onset of stroke, but these factors are preventable with a healthy lifestyle. A recent study suggested that unhealthy lifestyle was associated with a 66% increased risk of stroke compared with people with healthy lifestyle (including not smoking, healthy diet, normal body mass index, and regular physical exercise)[8]. Therefore, the primary prevention of stroke should be firmly focused on lifestyle modification, as well as management of blood pressure, blood sugar and blood cholesterol levels[9].

Stroke is a debilitating disease, whereby stroke survivors typically suffer from some form of post-stroke disability, compromising their quality of life. It imposes substantial financial and psychological burden on the patients and their caregivers[10,11,12]. With

[1] Ministry of Health, Statistics, Singapore Health Facts, Top 10 Conditions of Hospitalisation (accessed on Jan 2019)
[2] Principal Causes of Death. Ministry of Health, Singapore (accessed on Jan 2019)
[3] Singapore Burden of Diseases Study 2010. Ministry of Health, Singapore.
[4] Institute for Health Metrics and Evaluation www.healthdata.org/singapore (accessed on Jan 2019)
[5] GBD 2017 Cause of Death Collaborators. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1990-2017: a systematic analysis for global burden of disease study 2017. The Lancet. 2018; 392:1736-88
[6] GBD 2017 DALYs and HALE Collaborators. Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990-2017: a systematic analysis for global burden of disease study 2017. The Lancet. 2018; 392:1859-922
[7] Foreman KJ et al. Forecasting life expectancy, years of life lost, and all-cause and cause-specific mortality for 250 causes of death: reference and alternative scenarios for 2016-40 for 195 countries and territories. The Lancet. 2018; 392:2052-90
[8] Rutten-Jacobs LC et al. Genetic risk, incident stroke, and the benefits of adhering to a healthy lifestyle: cohort study of 306473 UK Biobank participants. BMJ. 2018; 363:k4168
[9] Pandian JD et al. Prevention of stroke: a global perspective. Lancet 2018; 392:1269-78
[10] Ng CS et al. Direct medical cost of stroke in Singapore. Int J Stroke. 2015; 10:75-82
[11] Tyagi et al. Healthcare utilization and cost trajectories post-stroke: role of caregiver and stroke factors. BMC Health Service Research. 2018; 18:881
[12] Malhotra R et al. Short-term trajectories of depressive symptoms in stroke survivors and their family caregivers. J Stroke Cerebrovasc Dis. 2016; 25(1):172-181

Singapore's rapidly ageing population, coupled with the high prevalence of risk factors associated with stroke in the community, the burden of stroke is expected to increase dramatically in the years to come, posing challenges to the healthcare system and society[13].

This report is intended to provide epidemiological and clinical data on stroke cases among Singapore residents aged 15 years and above, admitted into Singapore public hospitals from 2008 to 2017.

[13] Venketasubramanian N and Chen CL. Burden of stroke in Singapore. Int J Stroke. 2008; 3(1): 51-4

4. METHODOLOGY

The National Registry of Diseases Office (NRDO) collects and analyses epidemiological data to support national disease management plans, policy formulation and programme planning.

The Singapore Stroke Registry (SSR) was set up in 2002 to obtain epidemiological and clinical data on stroke cases diagnosed in all public healthcare institutions in Singapore.

Data sources

The SSR receives stroke case notifications from:

1. All public healthcare institutions via the Hospital In-patient Discharge Summary (HIDS),
2. Ministry of Health (MOH) via the MediClaims list, and
3. Death Registry from the Ministry of Home Affairs (MHA) via the death lists.

The source of data was mainly from the MediClaims listing. Case finding was supplemented by the HIDS listing and from the death registry at the MHA. Name lists from MediClaims, HIDS and MHA were merged using the National Registration Identity Card (NRIC) number to obtain the master patient list. The patient lists for the respective hospitals were generated from the master list. Case notes were then traced from the Medical Record Offices (MRO) at the respective hospitals and the cases were verified by the registry coordinators from NRDO. Once the cases were verified, data was captured electronically into registry forms which were later uploaded and transferred into the database in the National Registry of Diseases System. Cases that were diagnosed and also those who died at emergency departments of the various hospitals were included in the report.

Stroke cases occurring among Singapore residents (i.e. citizens and permanent residents of Singapore) aged 15 years and above were included in the analysis. The data and analysis covered all public hospitals in Singapore, namely Alexandra Hospital (AH), Changi General Hospital (CGH), Khoo Teck Puat Hospital (KTPH), KK Women's & Children's Hospital (KKH), National University Hospital (NUH), Singapore General Hospital (SGH) and Tan Tock Seng Hospital (TTSH). Data from private hospitals was not included in the analysis.

The vital status of all patients registered in the SSR were updated till 31 Aug 2018 by matching the patients' NRIC with the death information imported from the MHA.

ICD codes

Cases extracted from MediClaims, HIDS and MHA were coded based on the International Classification of Diseases 9th Revision (ICD-9) Clinical Modification. It covered ICD–9 codes: 430, 431, 432, 433, 434, 436 and 437 and ICD-10 codes from I60 to I69 while excluding 432.1 (Subdural haemorrhage), 435 (Transient cerebral Ischaemia) and 438 (Late effects of cerebrovascular disease) for ICD-9, and I62.0 (Nontraumatic subdural haemorrhage), I62.1 (Nontraumatic extradural haemorrhage), G45 (Transient cerebral ischemic attacks and related syndromes) and I69 (Sequelae of cerebrovascular disease) for ICD-10.

The MONICA (Monitoring Trends and Determinants in Cardiovascular Disease, World Health Organisation) criteria were used for episode management. Recurrence of stroke after 28 days of the preceding recorded stroke episode was counted as another episode.

Incidence rate

The crude incidence rates (CIRs) were computed by taking the number of stroke episodes that occurred in each year, divided by Singapore resident population in the same year obtained from the Singapore Department of Statistics mid-year population estimates[14]. Age-standardised incidence rates (ASIRs) were calculated using the direct method with the Segi World population, which was listed on the World Health Organisation website[15], as the standardisation weights.

Mortality rate

The crude mortality rates (CMRs) were computed by taking the number of deaths with stroke as the primary cause of death occurring in each year, divided by the number of Singapore residents in the same year[14]. Age-standardised mortality rates (ASMRs) were calculated using the direct method with the Segi World population as the standardisation weights[15].

30-day case fatality rate

The 30-day case fatality rates (CFRs) were computed by taking the number of deaths with stroke as the primary cause of death that occurred within 30 days upon stroke admission, regardless of whether the death occurred within or outside the hospital in each year, divided by the number of stroke episodes in the same year. This indicator reflects the stroke severity, the timeliness in care delivery, the effectiveness of stroke treatment and post-stroke care.

95% confidence intervals and p-values for trend

95% confidence intervals (CIs) were calculated to estimate the range that would contain the true population value of incidence or mortality rates at 95% level of confidence. P-values based on average annual percentage change over years were computed to test whether the change in trend was significant.

[14] Department of Statistics Singapore. SingStat Table Builder, Population and Population Structure, Annual Population, Singapore Residents by age group, ethnic group and sex.

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

5. FINDINGS

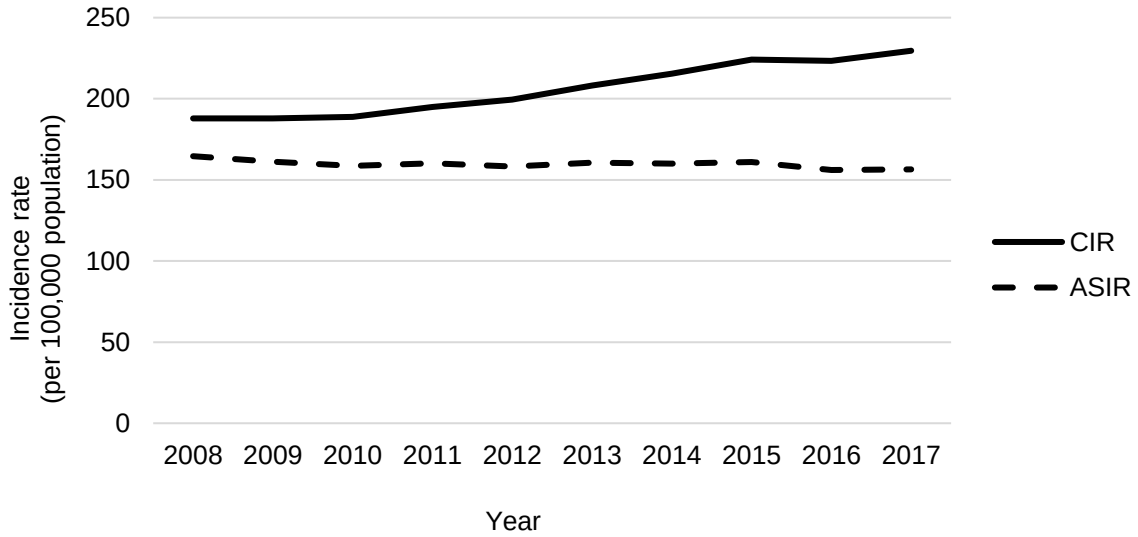
5.1 Incidence of Stroke

Over the years, the number of stroke episodes increased from 5,583 episodes in 2008 to 7,741 episodes in 2017 (Table 5.1.1). Similarly, the crude incidence rate (CIR) increased significantly from 187.9 to 229.6 per 100,000 population from 2008 to 2017 ($p<0.001$). This increase was mainly driven by the effect of Singapore's ageing population, since the age-standardised incidence rate (ASIR) decreased from 164.6 to 156.4 per 100,000 population from 2008 to 2017 ($p<0.05$) (Table 5.1.1 and Figure 5.1.1).

Table 5.1.1: Incidence Number and Rate of Stroke (per 100,000 population), 2008-2017

Year	No.	CIR	95% CI	ASIR	95% CI
2008	5583	187.9	183.0-192.8	164.6	160.2-169.0
2009	5760	187.9	183.0-192.8	161.3	157.1-165.5
2010	5890	188.9	184.1-193.7	158.6	154.5-162.7
2011	6143	194.9	190.0-199.8	160.2	156.1-164.3
2012	6367	199.5	194.6-204.4	158.2	154.3-162.1
2013	6720	208.1	203.1-213.1	160.6	156.7-164.5
2014	7029	215.4	210.4-220.4	160.0	156.2-163.8
2015	7399	224.2	219.1-229.3	161.0	157.3-164.7
2016	7455	223.4	218.3-228.5	156.1	152.5-159.7
2017	7741	229.6	224.5-234.7	156.4	152.8-160.0
P for trend		p<0.001		p=0.023	

Figure 5.1.1: Incidence Rate of Stroke (per 100,000 population), 2008-2017



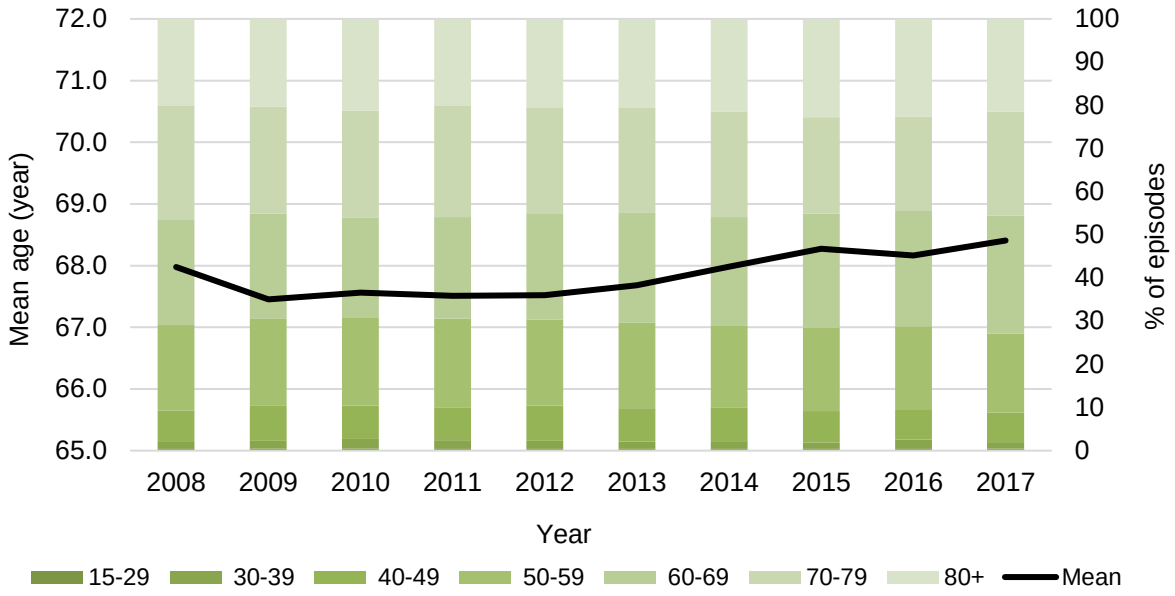
The average age at stroke admission was 68.4 years in 2017. Before 2012, the highest proportion of stroke patients at admission was among those aged 70-79 years. Since 2012, the highest proportion of stroke patients at admission was amongst those aged 60-69 years (Table 5.1.2 and Figure 5.1.2).

Table 5.1.2: Age Distribution (%) and Mean Age (year) at Stroke Admission, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	68.0	31	0.6	91	1.6	394	7.1
2009	67.5	31	0.5	106	1.8	475	8.2
2010	67.6	30	0.5	129	2.2	455	7.7
2011	67.5	34	0.6	109	1.8	463	7.5
2012	67.5	24	0.4	123	1.9	518	8.1
2013	67.7	30	0.4	117	1.7	518	7.7
2014	68.0	31	0.4	128	1.8	542	7.7
2015	68.3	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	114	1.5	523	6.8

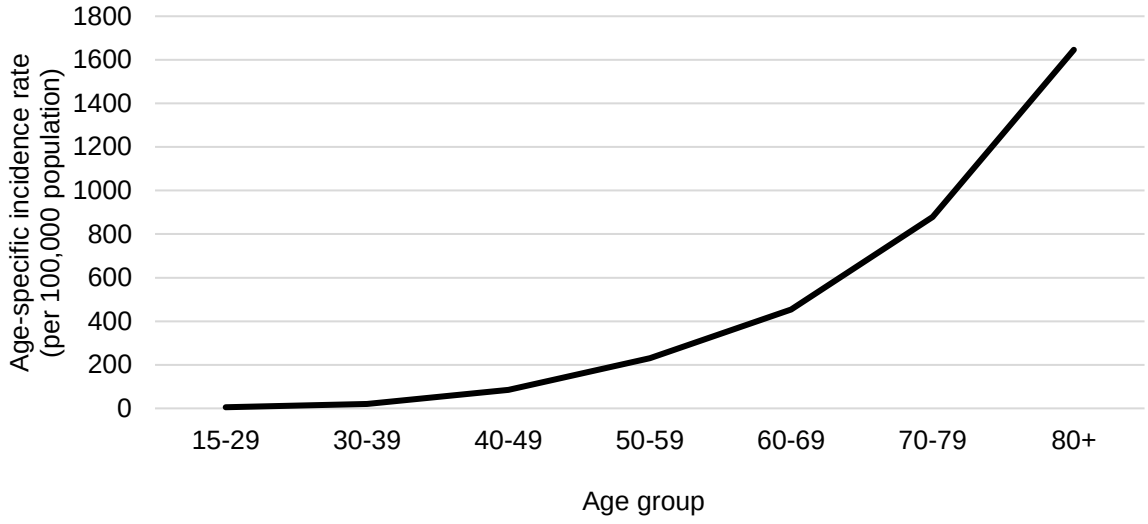
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	1107	19.8	1357	24.3	1483	26.6	1120	20.1
2009	1150	20.0	1405	24.4	1426	24.8	1167	20.3
2010	1208	20.5	1362	23.1	1457	24.7	1249	21.2
2011	1274	20.7	1445	23.5	1589	25.9	1229	20.0
2012	1273	20.0	1567	24.6	1560	24.5	1302	20.4
2013	1338	19.9	1706	25.4	1631	24.3	1380	20.5
2014	1346	19.1	1761	25.1	1719	24.5	1502	21.4
2015	1426	19.3	1957	26.4	1653	22.3	1677	22.7
2016	1428	19.2	1991	26.7	1622	21.8	1702	22.8
2017	1418	18.3	2119	27.4	1859	24.0	1667	21.5

Figure 5.1.2: Age Distribution (%) and Mean Age (year) at Stroke Admission, 2008-2017



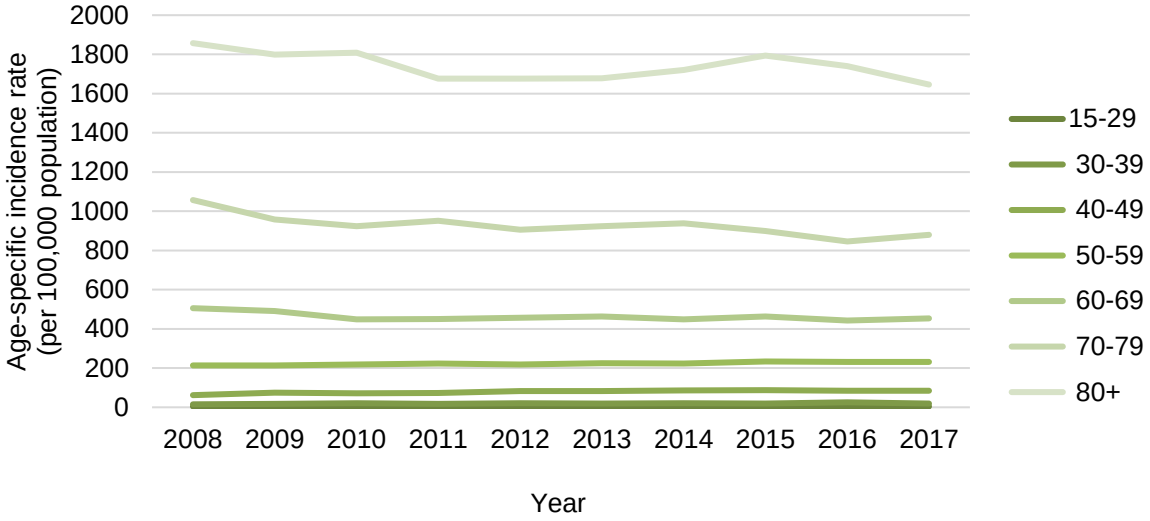
Age is one of the important risk factors for stroke incidence[16]. The age-specific incidence rate increased exponentially with age due to the cumulative effects of ageing on the cerebrovascular system, with the age-specific incidence rates almost doubling or tripling with the progress to the next age band (Figure 5.1.3a and Figure 5.1.3b).

Figure 5.1.3a: Age-Specific Incidence Rate (per 100,000 population) across Age Groups (2017)



[16] Wolf PA et.al. Probability of Stroke: A risk profile from the Framingham study. Stroke 1991 Mar;22(3):312-318

Figure 5.1.3b: Age-Specific Incidence Rate (per 100,000 population) across Years, 2008-2017



Among those in the age groups 60-69 and 70-79 years, the age-specific incidence rates had declined significantly over the years (for those aged 60-69 years: from 505.6 to 454.1 per 100,000 population from 2008 to 2017, p<0.05; for those aged 70-79 years: from 1057 to 879.2 per 100,000 population from 2008 to 2017, p<0.01). However, there was an increasing trend in age-specific incidence rates for the age groups 30-39, 40-49 and 50-59 years (for those aged 30-39 years: from 15.2 to 19.6 per 100,000 population from 2008 to 2017, p<0.05; for those aged 40-49 years: from 62 to 85 per 100,000 population from 2008 to 2017, p<0.01; and for those aged 50-59 years: from 213.5 to 230.8 per 100,000 population from 2008 to 2017, p<0.001) (Table 5.1.3 and Figure 5.1.3b).

Table 5.1.3: Age-Specific Incidence Rate (per 100,000 population), 2008-2017

Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2008	187.9	183.0-192.8	4.1	2.6-5.6	15.2	12.1-18.3	62.0	55.9-68.1
2009	187.9	183.0-192.8	4.0	2.6-5.4	17.2	13.9-20.5	74.7	68.0-81.4
2010	188.9	184.1-193.7	3.8	2.4-5.2	20.8	17.2-24.4	71.9	65.3-78.5
2011	194.9	190.0-199.8	4.4	2.9-5.9	17.8	14.5-21.1	73.4	66.7-80.1
2012	199.5	194.6-204.4	3.1	1.9-4.3	20.2	16.6-23.8	82.3	75.2-89.4
2013	208.1	203.1-213.1	3.9	2.5-5.3	19.4	15.9-22.9	82.4	75.3-89.5
2014	215.4	210.4-220.4	4.0	2.6-5.4	21.5	17.8-25.2	86.8	79.5-94.1
2015	224.2	219.1-229.3	4.1	2.7-5.5	18.9	15.4-22.4	87.4	80.0-94.8
2016	223.4	218.3-228.5	5.4	3.8-7.0	25.4	21.3-29.5	84.8	77.5-92.1
2017	229.6	224.5-234.7	5.2	3.6-6.8	19.6	16.0-23.2	85.0	77.7-92.3
P for trend	p<0.001		p=0.114		p=0.033		p=0.001	
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2008	213.5	200.9-226.1	505.6	478.7-532.5	1057.0	1003.2-1110.8	1857.4	1748.6-1966.2
2009	214.0	201.6-226.4	491.3	465.6-517.0	957.7	908.0-1007.4	1798.2	1695.0-1901.4
2010	218.9	206.6-231.2	448.8	425.0-472.6	923.3	875.9-970.7	1808.0	1707.7-1908.3
2011	224.0	211.7-236.3	450.7	427.5-473.9	952.1	905.3-998.9	1676.7	1583.0-1770.4
2012	218.7	206.7-230.7	457.0	434.4-479.6	906.4	861.4-951.4	1675.7	1584.7-1766.7
2013	225.2	213.1-237.3	463.7	441.7-485.7	924.1	879.3-968.9	1678.8	1590.2-1767.4
2014	222.9	211.0-234.8	448.4	427.5-469.3	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	855.8-942.4	1794.6	1708.7-1880.5
2016	232.1	220.1-244.1	442.6	423.2-462.0	845.9	804.7-887.1	1740.3	1657.6-1823.0
2017	230.8	218.8-242.8	454.1	434.8-473.4	879.2	839.2-919.2	1646.0	1567.0-1725.0
P for trend	p<0.001		p=0.037		p=0.003		p=0.084	

The number of stroke incidence episodes was consistently higher in men as compared to women across the entire study period, although Singapore has a sex ratio close to 1:1[17] (Table 5.1.4). In 2017, the CIR for men was almost 1.4-fold as much as that for women (272.3 per 100,000 population for men vs. 189.2 per 100,000 population for women), and the ASIR was nearly 1.7 times higher for men than women (196.8 per 100,000 population for men vs. 117.4 per 100,000 population for women).

For both genders, the CIR had increased significantly in the past decade (for men: from 210.7 to 272.3 per 100,000 population from 2008 to 2017, p<0.001; for women: from 165.9 to 189.2 per 100,000 population from 2008 to 2017, p<0.001). As for ASIR, while the rates for women had decreased significantly over the years (from 133.4 to 117.4 per 100,000 population from 2008 to 2017, p<0.001), the ASIR for men had remained relative stable during the same period (Table 5.1.4 and Figure 5.1.4).

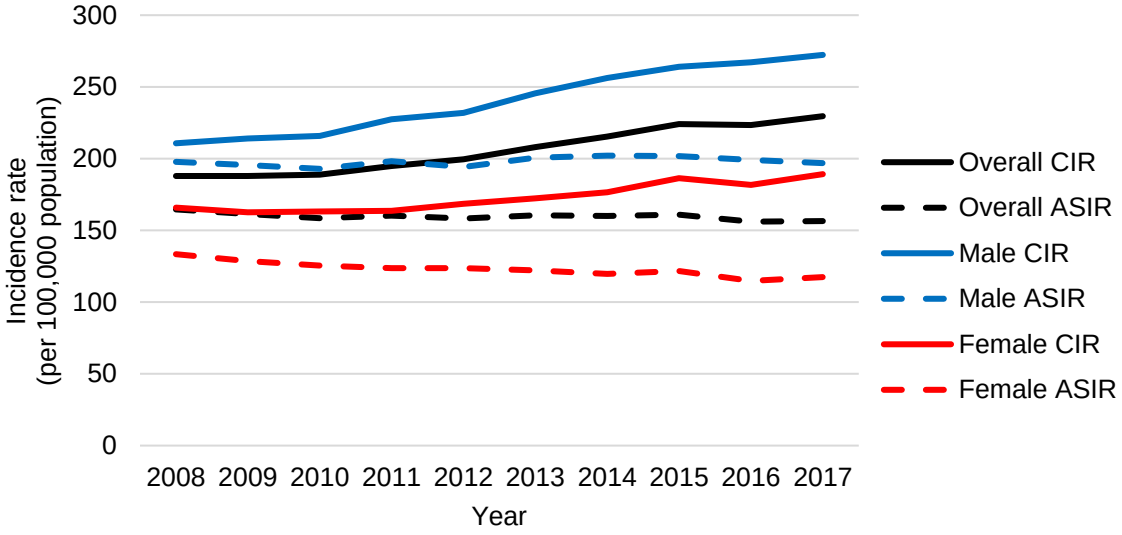
This is due to biological and lifestyle differences between the two genders. Premenopausal women are protected by oestrogens against risk for cerebrovascular diseases such as stroke. Oestrogen has beneficial effects on endothelium and vascular system to dilate blood vessels and promote blood flow, while testosterone has the opposite effects[18]. Moreover, the National Population Health Survey 2016/2017 found that men had higher prevalence of stroke risk factors than women, including hypertension, hyperlipidaemia, overweight (including obesity), diabetes mellitus, cigarette smoking and binge drinking[19]. These lifestyle risk factors can be prevented or managed through adopting healthy lifestyle practices and regular health screening.

Table 5.1.4: Incidence Number and Rate (per 100,000 population) by Gender, 2008-2017

Male						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2008	3073	55.0	210.7	203.3-218.1	197.7	190.7-204.7
2009	3218	55.9	214.1	206.7-221.5	195.5	188.7-202.3
2010	3296	56.0	215.9	208.5-223.3	192.9	186.2-199.6
2011	3510	57.1	227.5	220.0-235.0	198.3	191.7-204.9
2012	3618	56.8	231.8	224.2-239.4	194.3	187.9-200.7
2013	3872	57.6	245.5	237.8-253.2	200.6	194.2-207.0
2014	4079	58.0	256.2	248.3-264.1	202.1	195.9-208.3
2015	4249	57.4	264.0	256.1-271.9	201.8	195.7-207.9
2016	4345	58.3	267.2	259.3-275.1	199.1	193.1-205.1
2017	4467	57.7	272.3	264.3-280.3	196.8	191.0-202.6
P for trend			p<0.001		p=0.172	
Female						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2008	2510	45.0	165.9	159.4-172.4	133.4	128.1-138.7
2009	2542	44.1	162.6	156.3-168.9	128.5	123.4-133.6
2010	2594	44.0	163.1	156.8-169.4	125.4	120.4-130.4
2011	2633	42.9	163.6	157.4-169.8	123.6	118.7-128.5
2012	2749	43.2	168.5	162.2-174.8	123.7	119.0-128.4
2013	2848	42.4	172.4	166.1-178.7	122.1	117.5-126.7
2014	2950	42.0	176.6	170.2-183.0	119.7	115.2-124.2
2015	3150	42.6	186.3	179.8-192.8	121.7	117.3-126.1
2016	3110	41.7	181.7	175.3-188.1	114.8	110.6-119.0
2017	3274	42.3	189.2	182.7-195.7	117.4	113.2-121.6
P for trend			p<0.001		p<0.001	

[17] Statistics Singapore-Population Trends 2017. Singstat.
[18] Krause DN et al. Influence of sex steroid hormones on cerebrovascular function. J Appl Physiol 2006;101:1252-1261
[19] National Population Health Survey 2016/2017. Ministry of Health, Singapore

Figure 5.1.4: Incidence Rate (per 100,000 population) by Gender, 2008-2017



Men suffered from stroke at a younger age than women. In 2017, the average age of stroke admission was 65.8 years for men and 72.0 years for women. In 2017, 63.9% of the male patients were younger than 70 years at stroke admission, while 41.6% of the female patients were in this age group (Table 5.1.5a and Table 5.1.5b).

Table 5.1.5a: Age Distribution (%) and Mean Age (year) at Stroke Admission among Men, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	65.5	16	0.5	55	1.8	253	8.2
2009	64.7	17	0.5	64	2.0	304	9.4
2010	64.6	15	0.5	79	2.4	316	9.6
2011	64.7	20	0.6	75	2.1	301	8.6
2012	64.9	14	0.4	80	2.2	344	9.5
2013	65.0	16	0.4	72	1.9	349	9.0
2014	65.3	18	0.4	76	1.9	375	9.2
2015	65.5	15	0.4	77	1.8	362	8.5
2016	65.4	28	0.6	105	2.4	338	7.8
2017	65.8	19	0.4	72	1.6	349	7.8

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	751	24.4	825	26.8	772	25.1	401	13.0
2009	820	25.5	857	26.6	754	23.4	402	12.5
2010	853	25.9	859	26.1	744	22.6	430	13.0
2011	929	26.5	923	26.3	806	23.0	456	13.0
2012	875	24.2	997	27.6	842	23.3	466	12.9
2013	969	25.0	1094	28.3	878	22.7	494	12.8
2014	942	23.1	1181	29.0	933	22.9	554	13.6
2015	989	23.3	1323	31.1	890	20.9	593	14.0
2016	1018	23.4	1352	31.1	860	19.8	644	14.8
2017	978	21.9	1435	32.1	1010	22.6	604	13.5

Figure 5.1.5a: Age Distribution (%) and Mean Age (year) at Stroke Admission among Men, 2008-2017

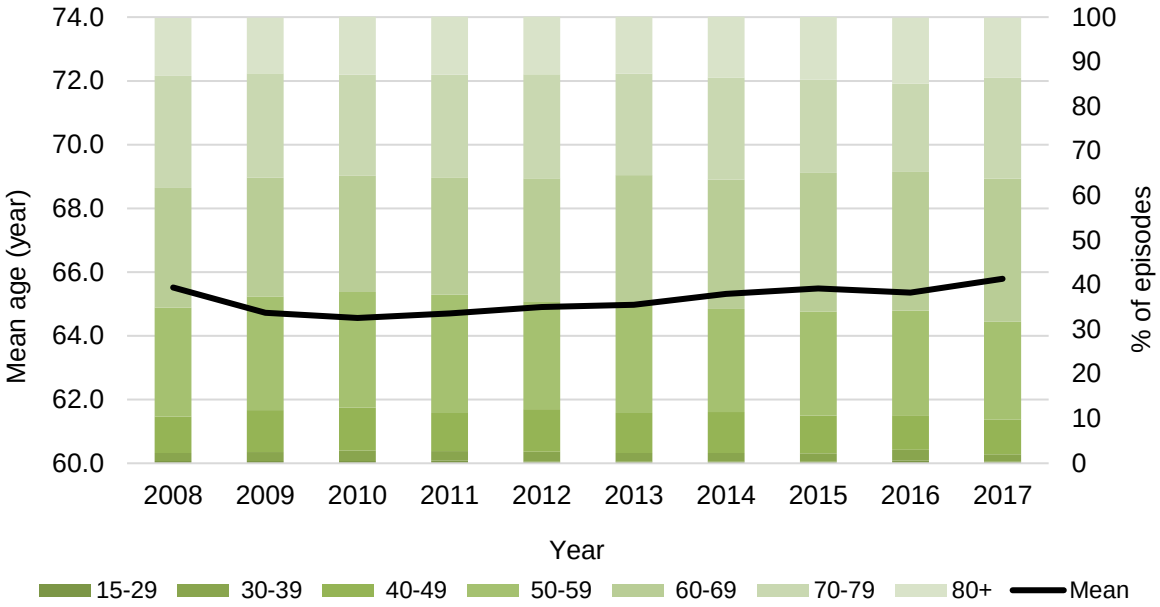


Table 5.1.5b: Age Distribution (%) and Mean Age (year) at Stroke Admission among Women, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	71.0	15	0.6	36	1.4	141	5.6
2009	70.9	14	0.6	42	1.7	171	6.7
2010	71.4	15	0.6	50	1.9	139	5.4
2011	71.3	14	0.5	34	1.3	162	6.2
2012	71.0	10	0.4	43	1.6	174	6.3
2013	71.4	14	0.5	45	1.6	169	5.9
2014	71.7	13	0.4	52	1.8	167	5.7
2015	72.0	17	0.5	35	1.1	180	5.7
2016	72.1	14	0.5	44	1.4	183	5.9
2017	72.0	22	0.7	42	1.3	174	5.3

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	356	14.2	532	21.2	711	28.3	719	28.6
2009	330	13.0	548	21.6	672	26.4	765	30.1
2010	355	13.7	503	19.4	713	27.5	819	31.6
2011	345	13.1	522	19.8	783	29.7	773	29.4
2012	398	14.5	570	20.7	718	26.1	836	30.4
2013	369	13.0	612	21.5	753	26.4	886	31.1
2014	404	13.7	580	19.7	786	26.6	948	32.1
2015	437	13.9	634	20.1	763	24.2	1084	34.4
2016	410	13.2	639	20.5	762	24.5	1058	34.0
2017	440	13.4	684	20.9	849	25.9	1063	32.5

Figure 5.1.5b: Age Distribution (%) and Mean Age (year) at Stroke Admission among Women, 2008-2017

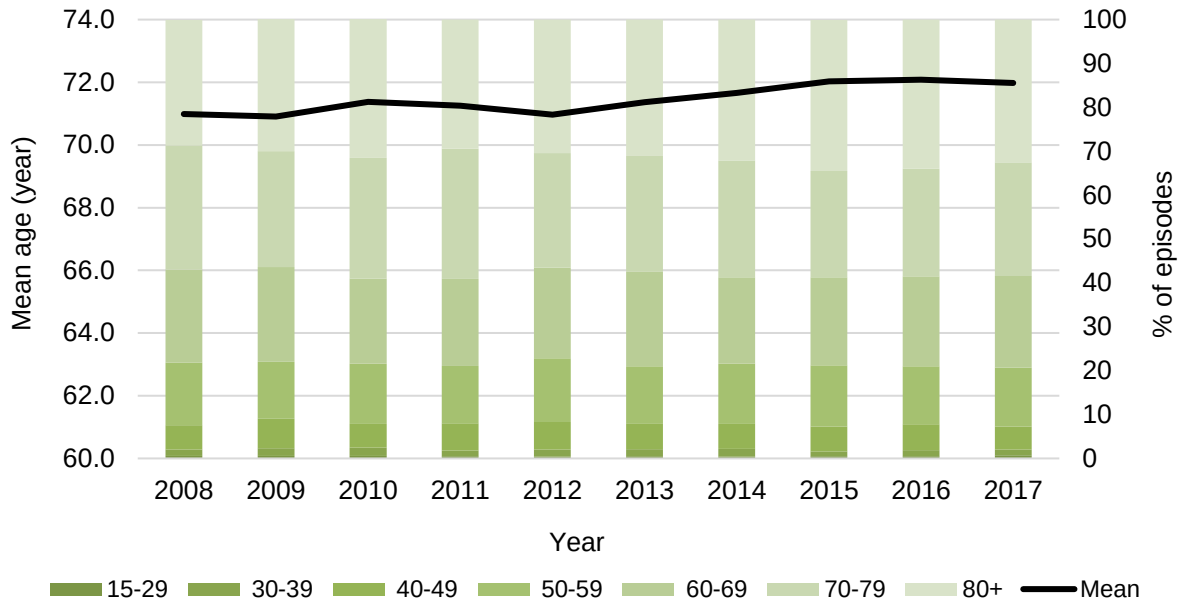
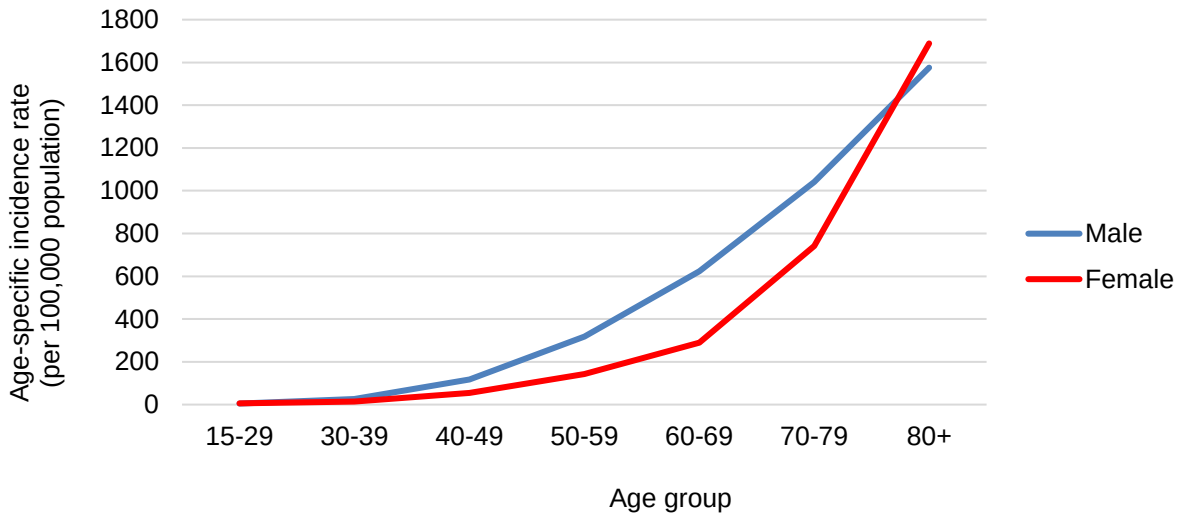


Figure 5.1.6 demonstrates the age-specific incidence rates across the age groups for both genders in 2017. The age-specific incidence rates for women were lower than that for men before 80 years, with the greatest difference found for those in the 60-69 years age band. However, for those aged 80 years and above, women overtook men in terms of age-specific incidence rate, with the rates being 1688.9 per 100,000 population for women and 1575.6 per 100,000 population for men (Figure 5.1.6, Table 5.1.6a, Table 5.1.6b).

Figure 5.1.6: Age-Specific Incidence Rate (per 100,000 population) across Age Groups by Gender (2017)



From 2008 to 2017, the age-specific incidence rates among men increased significantly for most of the age groups below 60 years. They were namely men aged 30-39 years (increased by 38% from 19.0 to 26.2 per 100,000 population from 2008 to 2017, $p<0.05$), 40-49 years (increased by 48% from 79.1 to 116.8 per 100,000 population from 2008 to 2017, $p<0.01$), and 50-59 years (increased by 10% from 288.2 to 317.8 per 100,000 population from 2008 to 2017, $p<0.05$) (Table 5.1.6a). Correspondingly for women, a significant increase was only observed for the age group 40-49 years (increased by 23% from 44.7 to 55.0 per 100,000 population from 2008 to 2017, $p<0.05$) (Table 5.1.6b).

While an increase in age-specific incidence rates was observed among males and females in some of the age groups below 60 years, a decrease in age-specific incidence rate was observed among the older population aged 60 years and above. A significant decline in age-specific incidence rate among men aged 70-79 years (decreased by 15% from 1,223.5 to 1,041.4 per 100,000 population from 2008 to 2017, $p<0.05$) was observed. A similar trend was observed among women for the older age groups: 60-69 years (decreased by 25% from 384.1 to 289 per 100,000 population from 2008 to 2017, $p<0.001$), and 70-79 years (decreased by 19% from 921 to 741.7 per 100,000 population from 2008 to 2017, $p<0.01$) (Table 5.1.6a and Table 5.1.6b).

Table 5.1.6a: Age-Specific Incidence Rate (per 100,000 population) across Years among Men, 2008-2017

Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2008	210.7	203.3-218.1	4.3	2.2-6.4	19.0	14.0-24.0	79.1	69.4-88.8
2009	214.1	206.7-221.5	4.4	2.3-6.5	21.5	16.2-26.8	95.4	84.7-106.1
2010	215.9	208.5-223.3	3.9	1.9-5.9	26.4	20.6-32.2	99.9	88.9-110.9
2011	227.5	220.0-235.0	5.2	2.9-7.5	25.3	19.6-31.0	96.0	85.2-106.8
2012	231.8	224.2-239.4	3.6	1.7-5.5	27.3	21.3-33.3	110.2	98.6-121.8
2013	245.5	237.8-253.2	4.1	2.1-6.1	24.9	19.1-30.7	112.2	100.4-124.0
2014	256.2	248.3-264.1	4.6	2.5-6.7	26.8	20.8-32.8	121.9	109.6-134.2
2015	264.0	256.1-271.9	3.8	1.9-5.7	27.3	21.2-33.4	119.1	106.8-131.4
2016	267.2	259.3-275.1	7.1	4.5-9.7	37.6	30.4-44.8	112.7	100.7-124.7
2017	272.3	264.3-280.3	4.8	2.6-7.0	26.2	20.2-32.2	116.8	104.5-129.1
P for trend	p<0.001		p=0.288		p=0.015		p=0.001	
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2008	288.2	267.6-308.8	635.1	591.8-678.4	1223.5	1137.2-1309.8	1831.1	1651.9-2010.3
2009	303.7	282.9-324.5	616.1	574.9-657.3	1123.7	1043.5-1203.9	1696.2	1530.4-1862.0
2010	307.3	286.7-327.9	579.9	541.1-618.7	1046.4	971.2-1121.6	1709.5	1547.9-1871.1
2011	324.7	303.8-345.6	588.3	550.3-626.3	1071.8	997.8-1145.8	1701.5	1545.3-1857.7
2012	298.6	278.8-318.4	592.7	555.9-629.5	1085.1	1011.8-1158.4	1629.4	1481.5-1777.3
2013	324.5	304.1-344.9	605.4	569.5-641.3	1098.9	1026.2-1171.6	1619.7	1476.9-1762.5
2014	310.8	290.9-330.7	610.3	575.5-645.1	1121.5	1049.5-1193.5	1707.5	1565.3-1849.7
2015	322.9	302.8-343.0	635.0	600.8-669.2	1060.7	991.0-1130.4	1697.5	1560.9-1834.1
2016	330.0	309.7-350.3	610.4	577.9-642.9	981.0	915.4-1046.6	1748.2	1613.2-1883.2
2017	317.8	297.9-337.7	624.1	591.8-656.4	1041.4	977.2-1105.6	1575.6	1449.9-1701.3
P for trend	p=0.024		p=0.550		p=0.028		p=0.131	

Table 5.1.6b: Age-Specific Incidence Rate (per 100,000 population) across Years among Women, 2008-2017

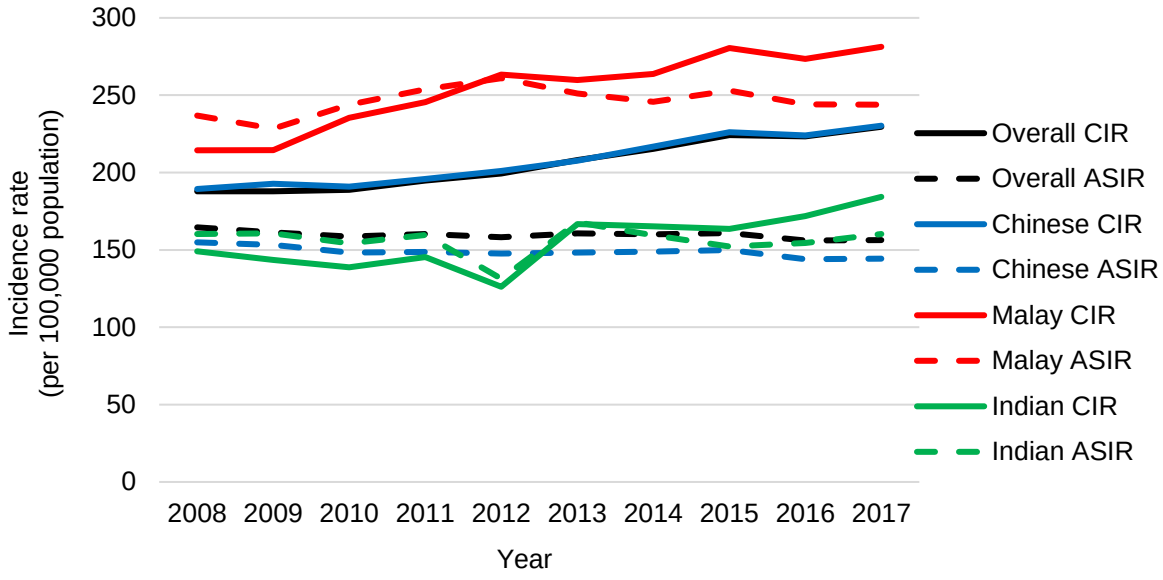
Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2008	165.9	159.4-172.4	4.0	2.0-6.0	11.7	7.9-15.5	44.7	37.3-52.1
2009	162.6	156.3-168.9	3.6	1.7-5.5	13.3	9.3-17.3	54.0	45.9-62.1
2010	163.1	156.8-169.4	3.8	1.9-5.7	15.7	11.4-20.0	43.9	36.6-51.2
2011	163.6	157.4-169.8	3.6	1.7-5.5	10.7	7.1-14.3	51.1	43.2-59.0
2012	168.5	162.2-174.8	2.6	1.0-4.2	13.6	9.5-17.7	54.8	46.7-62.9
2013	172.4	166.1-178.7	3.6	1.7-5.5	14.3	10.1-18.5	53.2	45.2-61.2
2014	176.6	170.2-183.0	3.3	1.5-5.1	16.8	12.2-21.4	52.7	44.7-60.7
2015	186.3	179.8-192.8	4.4	2.3-6.5	11.3	7.6-15.0	56.9	48.6-65.2
2016	181.7	175.3-188.1	3.6	1.7-5.5	14.3	10.1-18.5	58.2	49.8-66.6
2017	189.2	182.7-195.7	5.7	3.3-8.1	13.8	9.6-18.0	55.0	46.8-63.2
P for trend	p<0.001		p=0.301		p=0.532		p=0.017	
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2008	138.0	123.7-152.3	384.1	351.5-416.7	921.0	853.3-988.7	1872.4	1735.5-2009.3
2009	123.5	110.2-136.8	373.0	341.8-404.2	821.5	759.4-883.6	1856.8	1725.2-1988.4
2010	129.5	116.0-143.0	323.7	295.4-352.0	822.4	762.0-882.8	1864.5	1736.8-1992.2
2011	122.0	109.1-134.9	318.9	291.5-346.3	853.9	794.1-913.7	1662.4	1545.2-1779.6
2012	137.6	124.1-151.1	326.3	299.5-353.1	759.8	704.2-815.4	1702.6	1587.2-1818.0
2013	124.9	112.2-137.6	326.9	301.0-352.8	779.5	723.8-835.2	1713.7	1600.9-1826.5
2014	134.3	121.2-147.4	291.2	267.5-314.9	786.6	731.6-841.6	1728.4	1618.4-1838.4
2015	143.8	130.3-157.3	295.5	272.5-318.5	763.5	709.3-817.7	1852.5	1742.2-1962.8
2016	133.7	120.8-146.6	279.8	258.1-301.5	732.1	680.1-784.1	1735.5	1630.9-1840.1
2017	143.4	130.0-156.8	289.0	267.3-310.7	741.7	691.8-791.6	1688.9	1587.4-1790.4
P for trend	p=0.144		p<0.001		p=0.001		p=0.130	

Similar to the general population's ethnic distribution[20], the Chinese accounted for the highest proportion of stroke episodes, followed by the Malays, and the Indians. For all the three main ethnic groups, the number of stroke episodes had increased over the years. The Malays showed the highest increase in the number of stroke episodes, a 1.5-fold increase from 806 to 1,212 episodes from 2008 to 2017, as compared to around 1.4-fold increase for the Chinese (from 4,293 to 5,864 episodes) and the Indians (from 374 to 537 episodes) during this period (Table 5.1.7). Similarly, all three ethnic groups showed significantly increasing trend in terms of CIR during the study period (Chinese: from 189.4 to 230.3 per 100,000 population from 2008 to 2017, $p<0.001$; Malays: from 214.4 to 281.3 per 100,000 population from 2008 to 2017, $p<0.001$; Indians: from 149.1 to 184.3 per 100,000 population from 2008 to 2017, $p<0.05$). (Table 5.1.7).

Of the three main ethnic groups, the Malays had the highest CIR and ASIR in the entire study period. It is noteworthy that while the ASIR among the Malays peaked at 261.0 per 100,000 population in 2012, it had since gradually declined to 243.8 per 100,000 population in 2017. As for the Chinese, a significant decrease in ASIR was observed in the past decade (from 154.9 to 144.4 per 100,000 population from 2008 to 2017, $p<0.01$). The ASIR among the Indians fluctuated between 131.4 and 167.8 per 100,000 population during the same period ($p=0.934$) (Table 5.1.7 and Figure 5.1.7).

This ethnic difference in the stroke incidence might be due to risk factors such as hypertension, hyperlipidaemia, obesity and daily cigarette smoking being most prevalent among the Malays[21].

Figure 5.1.7: Incidence Rate (per 100,000 population) by Ethnicity, 2008-2017



[20] Statistics Singapore-Population Trends 2017. Singstat.
[21] National Health Survey 2010. Ministry of Health, Singapore

Table 5.1.7: Incidence Number and Rate (per 100,000 population) by Ethnicity, 2008-2017

Chinese						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2008	4293	76.9	189.4	183.7-195.1	154.9	150.2-159.6
2009	4473	77.7	192.7	187.1-198.3	153.3	148.8-157.8
2010	4499	76.4	191.0	185.4-196.6	148.2	143.8-152.6
2011	4664	75.9	195.8	190.2-201.4	148.6	144.3-152.9
2012	4850	76.2	201.1	195.4-206.8	147.6	143.4-151.8
2013	5066	75.4	207.7	202.0-213.4	148.3	144.2-152.4
2014	5342	76.0	216.8	211.0-222.6	148.9	144.8-153.0
2015	5637	76.2	226.1	220.2-232.0	150.0	146.0-154.0
2016	5648	75.8	224.1	218.3-229.9	144.0	140.1-147.9
2017	5864	75.8	230.3	224.4-236.2	144.4	140.6-148.2
P for trend			p<0.001		p=0.005	
Malay						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2008	806	14.4	214.4	199.6-229.2	236.9	220.3-253.5
2009	824	14.3	214.5	199.9-229.1	228.4	212.5-244.3
2010	921	15.6	235.4	220.2-250.6	243.9	227.6-260.2
2011	975	15.9	245.5	230.1-260.9	253.8	237.3-270.3
2012	1061	16.7	263.3	247.5-279.1	261.0	244.9-277.1
2013	1062	15.8	259.8	244.2-275.4	251.2	235.8-266.6
2014	1093	15.5	263.7	248.1-279.3	245.7	230.9-260.5
2015	1179	15.9	280.6	264.6-296.6	252.9	238.3-267.5
2016	1164	15.6	273.4	257.7-289.1	244.2	230.0-258.4
2017	1212	15.7	281.3	265.5-297.1	243.8	229.9-257.7
P for trend			p<0.001		p=0.285	
Indian						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2008	374	6.7	149.1	134.0-164.2	160.3	143.6-177.0
2009	385	6.7	143.6	129.3-157.9	160.8	144.3-177.3
2010	379	6.4	138.7	124.7-152.7	154.3	138.3-170.3
2011	401	6.5	145.4	131.2-159.6	159.6	143.4-175.8
2012	352	5.5	126.2	113.0-139.4	131.4	117.3-145.5
2013	469	7.0	166.8	151.7-181.9	167.8	152.3-183.3
2014	469	6.7	165.3	150.3-180.3	159.4	144.7-174.1
2015	468	6.3	163.6	148.8-178.4	152.3	138.3-166.3
2016	496	6.7	171.9	156.8-187.0	154.4	140.7-168.1
2017	537	6.9	184.3	168.7-199.9	160.3	146.6-174.0
P for trend			p=0.014		p=0.934	

In 2017, the average age at stroke admission for the three major ethnic groups was higher for the Chinese (69.6 years) than Malays (64.4 years) and Indians (65 years) respectively. The proportion of stroke patients aged 70 years and above at stroke admission for each of the three major ethnic groups was 49.7% (Chinese), 31.9% (Malays) and 33.1% (Indians) respectively (Table 5.1.8a, Table 5.1.8b and Table 5.1.8c).

Table 5.1.8a: Age Distribution (%) and Mean Age (year) at Stroke Admission among Chinese, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	68.9	25	0.6	63	1.5	251	5.8
2009	68.4	24	0.5	71	1.6	323	7.2
2010	68.6	22	0.5	89	2.0	302	6.7
2011	68.6	23	0.5	74	1.6	294	6.3
2012	68.6	13	0.3	93	1.9	348	7.2
2013	68.8	18	0.4	85	1.7	339	6.7
2014	69.1	22	0.4	83	1.6	370	6.9
2015	69.4	20	0.4	74	1.3	377	6.7
2016	69.5	26	0.5	90	1.6	345	6.1
2017	69.6	23	0.4	71	1.2	357	6.1

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	791	18.4	1064	24.8	1152	26.8	947	22.1
2009	835	18.7	1096	24.5	1142	25.5	982	22.0
2010	832	18.5	1051	23.4	1168	26.0	1035	23.0
2011	885	19.0	1090	23.4	1265	27.1	1033	22.1
2012	877	18.1	1181	24.4	1245	25.7	1093	22.5
2013	913	18.0	1238	24.4	1330	26.3	1143	22.6
2014	904	16.9	1317	24.7	1398	26.2	1248	23.4
2015	952	16.9	1467	26.0	1337	23.7	1410	25.0
2016	956	16.9	1488	26.3	1334	23.6	1409	24.9
2017	934	15.9	1560	26.6	1550	26.4	1369	23.3

Figure 5.1.8a: Age Distribution (%) and Mean Age (year) at Stroke Admission among Chinese, 2008-2017

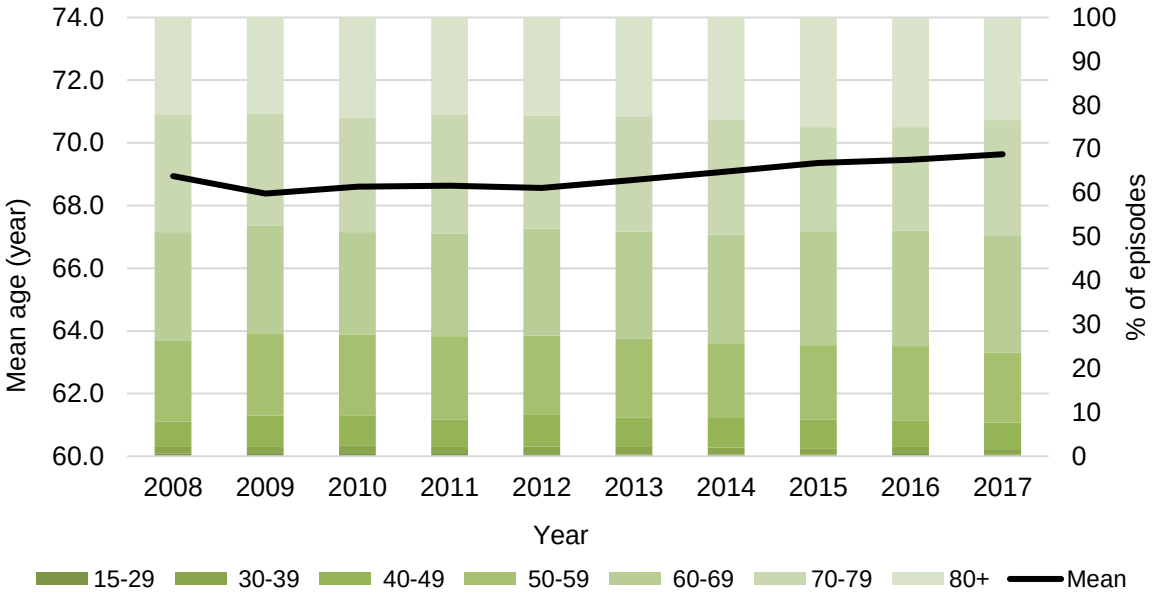


Table 5.1.8b: Age Distribution (%) and Mean Age (year) at Stroke Admission among Malays, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	65.1	5	0.6	16	2.0	84	10.4
2009	64.4	3	0.4	20	2.4	107	13.0
2010	63.8	6	0.7	23	2.5	101	11.0
2011	64.0	8	0.8	18	1.8	104	10.7
2012	64.3	9	0.8	18	1.7	112	10.6
2013	64.4	5	0.5	16	1.5	116	10.9
2014	64.3	6	0.5	28	2.6	105	9.6
2015	64.9	7	0.6	22	1.9	101	8.6
2016	63.7	10	0.9	36	3.1	109	9.4
2017	64.4	14	1.2	29	2.4	98	8.1

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	187	23.2	193	23.9	208	25.8	113	14.0
2009	193	23.4	195	23.7	187	22.7	119	14.4
2010	259	28.1	207	22.5	205	22.3	120	13.0
2011	252	25.8	252	25.8	220	22.6	121	12.4
2012	277	26.1	270	25.4	238	22.4	137	12.9
2013	274	25.8	303	28.5	200	18.8	148	13.9
2014	297	27.2	286	26.2	226	20.7	145	13.3
2015	319	27.1	343	29.1	218	18.5	169	14.3
2016	317	27.2	336	28.9	183	15.7	173	14.9
2017	314	25.9	370	30.5	205	16.9	182	15.0

Figure 5.1.8b: Age Distribution (%) and Mean Age (year) at Stroke Admission among Malays, 2008-2017

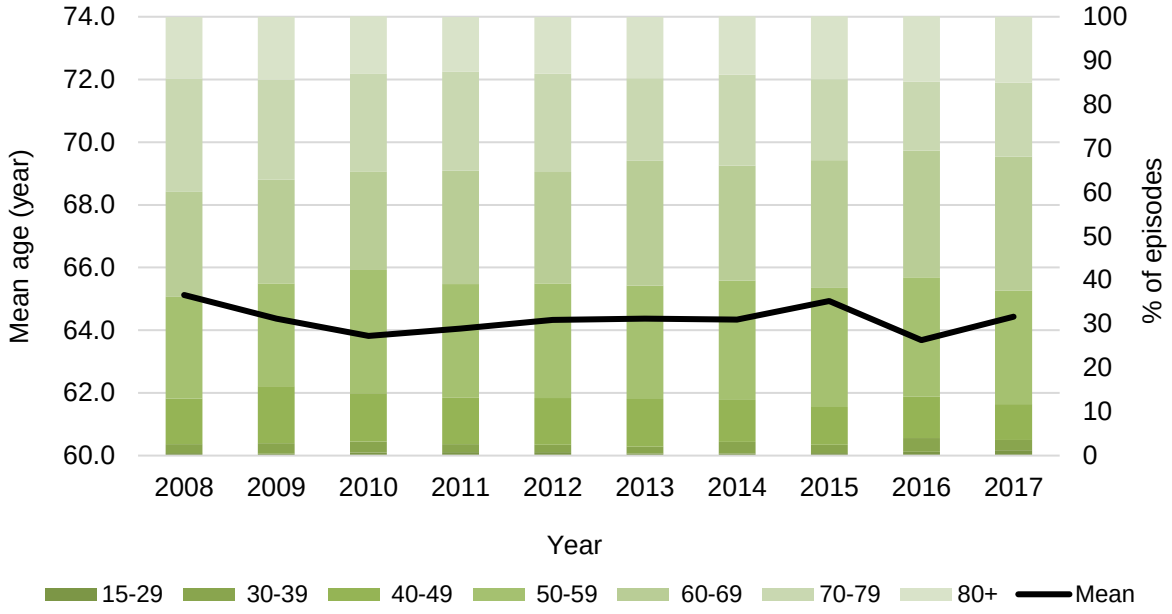
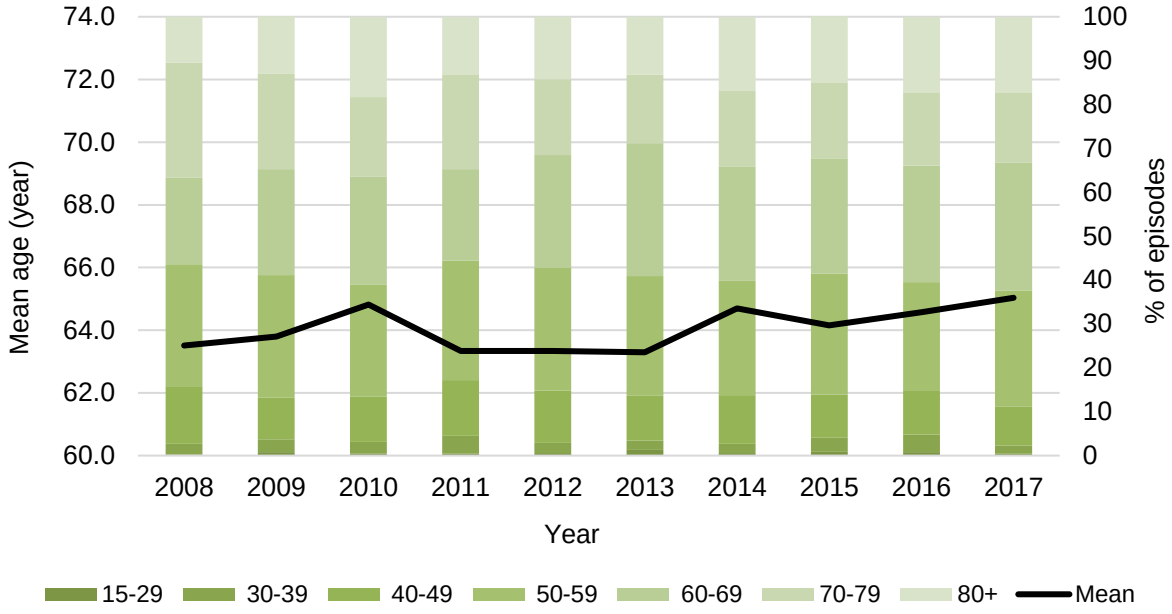


Table 5.1.8c: Age Distribution (%) and Mean Age (year) at Stroke Admission among Indians, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	63.5	1	0.3	9	2.4	49	13.1
2009	63.8	3	0.8	11	2.9	37	9.6
2010	64.8	2	0.5	10	2.6	39	10.3
2011	63.3	2	0.5	16	4.0	51	12.7
2012	63.3	2	0.6	8	2.3	42	11.9
2013	63.3	6	1.3	10	2.1	48	10.2
2014	64.7	3	0.6	10	2.1	52	11.1
2015	64.2	4	0.9	15	3.2	46	9.8
2016	64.6	4	0.8	20	4.0	49	9.9
2017	65.0	2	0.4	10	1.9	48	8.9

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	104	27.8	74	19.8	98	26.2	39	10.4
2009	107	27.8	93	24.2	84	21.8	50	13.0
2010	97	25.6	93	24.5	69	18.2	69	18.2
2011	109	27.2	84	20.9	86	21.4	53	13.2
2012	99	28.1	90	25.6	61	17.3	50	14.2
2013	128	27.3	142	30.3	73	15.6	62	13.2
2014	122	26.0	122	26.0	81	17.3	79	16.8
2015	129	27.6	122	26.1	81	17.3	71	15.2
2016	123	24.8	132	26.6	83	16.7	85	17.1
2017	142	26.4	157	29.2	86	16.0	92	17.1

Figure 5.1.8c: Age Distribution (%) and Mean Age (year) at Stroke Admission among Indians, 2008-2017



Approximately 80% of stroke episodes were Ischaemic stroke (IS) and 20.0% were haemorrhagic stroke (HS). The ASIR of IS was generally about 4-fold that for HS across the years (Table 5.1.9).

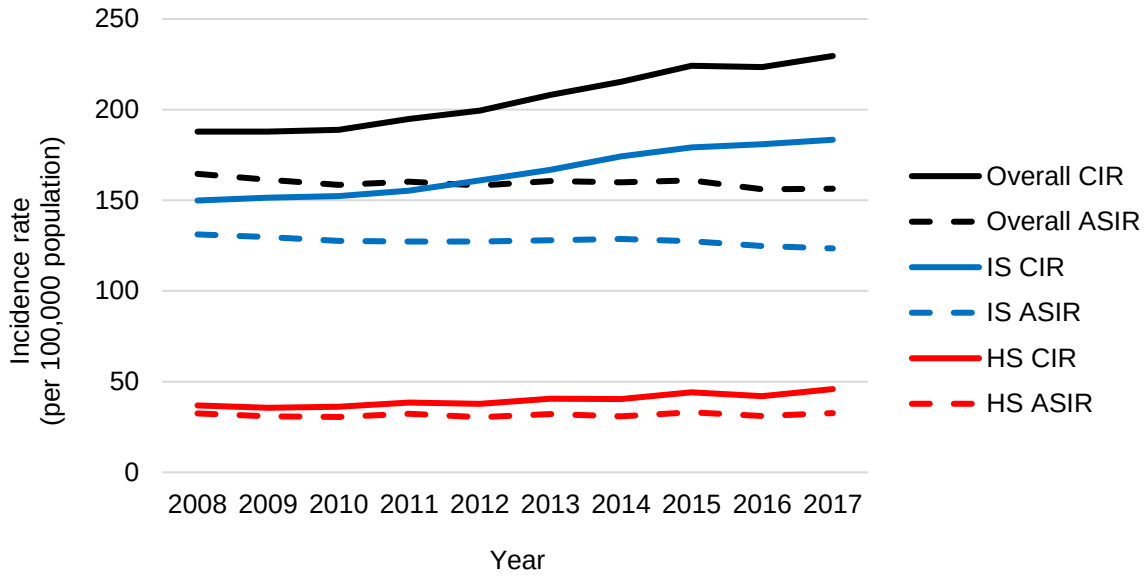
Generally, the number of stroke episodes and CIR for both stroke sub-types had increased over the years. However, the ASIR of IS decreased significantly from 131.2 to 123.5 per 100,000 population from 2008 to 2017 (p<0.01), while the ASIR of HS remained relatively stable, ranging from 30.4 to 33.1 per 100,000 population during the same period (p=0.488) (Table 5.1.9 and Figure 5.1.9).

Table 5.1.9: Incidence Number and Rate (per 100,000 population) by Stroke Sub-type, 2008-2017

Ischaemic stroke*						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2008	4455	79.8	149.9	145.5-154.3	131.2	127.3-135.1
2009	4641	80.6	151.4	147.0-155.8	129.7	125.9-133.5
2010	4749	80.6	152.3	148.0-156.6	127.6	123.9-131.3
2011	4900	79.8	155.4	151.0-159.8	127.2	123.6-130.8
2012	5140	80.7	161.0	156.6-165.4	127.2	123.7-130.7
2013	5391	80.2	166.9	162.4-171.4	127.9	124.4-131.4
2014	5687	80.9	174.3	169.8-178.8	128.7	125.3-132.1
2015	5915	79.9	179.2	174.6-183.8	127.4	124.1-130.7
2016	6037	81.0	180.9	176.3-185.5	124.8	121.6-128.0
2017	6184	79.9	183.4	178.8-188.0	123.5	120.4-126.6
P for trend			p<0.001		p=0.003	
Haemorrhagic stroke*						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2008	1097	19.6	36.9	34.7-39.1	32.5	30.5-34.5
2009	1090	18.9	35.6	33.5-37.7	30.8	28.9-32.7
2010	1125	19.1	36.1	34.0-38.2	30.5	28.7-32.3
2011	1213	19.7	38.5	36.3-40.7	32.3	30.4-34.2
2012	1202	18.9	37.7	35.6-39.8	30.4	28.7-32.1
2013	1310	19.5	40.6	38.4-42.8	32.2	30.4-34.0
2014	1322	18.8	40.5	38.3-42.7	30.9	29.2-32.6
2015	1459	19.7	44.2	41.9-46.5	33.1	31.4-34.8
2016	1402	18.8	42.0	39.8-44.2	31.0	29.3-32.7
2017	1547	20.0	45.9	43.6-48.2	32.7	31.0-34.4
P for trend			p<0.001		p=0.488	

** Stroke is classified as Ischaemic stroke, haemorrhagic stroke, and stroke with unknown aetiology. Stroke cases of unknown aetiology were not listed in the table.*

Figure 5.1.9: Incidence Rate (per 100,000 population) by Stroke Sub-type, 2008-2017



The average age at which Singapore residents was admitted for HS (ranging from 63 to 65 years) was about 4-5 years younger than that for IS (ranging from 68 to 69 years) (Table 5.1.10a and Table 5.1.10b).

In 2017, 37.8% of the HS patients were aged 70 years and above at admission, while 47.4% of the IS patients were in this age group (Table 5.1.10a and Table 5.1.10b).

Table 5.1.10a: Age Distribution (%) and Mean Age (year) at Stroke Admission (Ischaemic Stroke), 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	68.9	14	0.3	46	1.0	268	6.0
2009	68.4	13	0.3	67	1.4	330	7.1
2010	68.4	16	0.3	75	1.6	315	6.6
2011	68.4	16	0.3	67	1.4	311	6.3
2012	68.3	13	0.3	77	1.5	352	6.8
2013	68.5	8	0.1	77	1.4	369	6.8
2014	68.7	20	0.4	77	1.4	365	6.4
2015	69.1	15	0.3	64	1.1	362	6.1
2016	69.1	15	0.2	87	1.4	361	6.0
2017	69.1	17	0.3	72	1.2	354	5.7
Year	**Age 50-59**		**Age 60-69**		**Age 70-79**		**Age 80+**
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
2008	841	18.9	1112	25.0	1234	27.7	940	21.1
2009	868	18.7	1150	24.8	1220	26.3	993	21.4
2010	940	19.8	1115	23.5	1239	26.1	1049	22.1
2011	969	19.8	1171	23.9	1325	27.0	1041	21.2
2012	1001	19.5	1285	25.0	1306	25.4	1106	21.5
2013	1019	18.9	1411	26.2	1346	25.0	1161	21.5
2014	1068	18.8	1452	25.5	1459	25.7	1246	21.9
2015	1080	18.3	1599	27.0	1402	23.7	1393	23.6
2016	1106	18.3	1647	27.3	1380	22.9	1441	23.9
2017	1094	17.7	1714	27.7	1551	25.1	1382	22.3

Figure 5.1.10a: Age Distribution (%) and Mean Age (year) at Stroke Admission (Ischaemic Stroke), 2008-2017

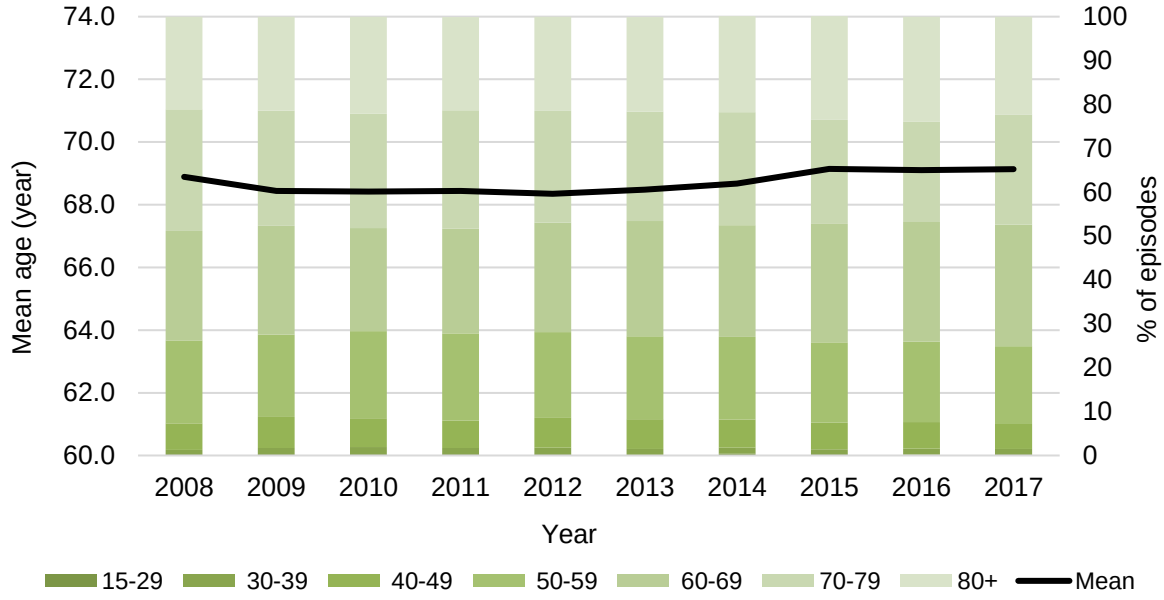
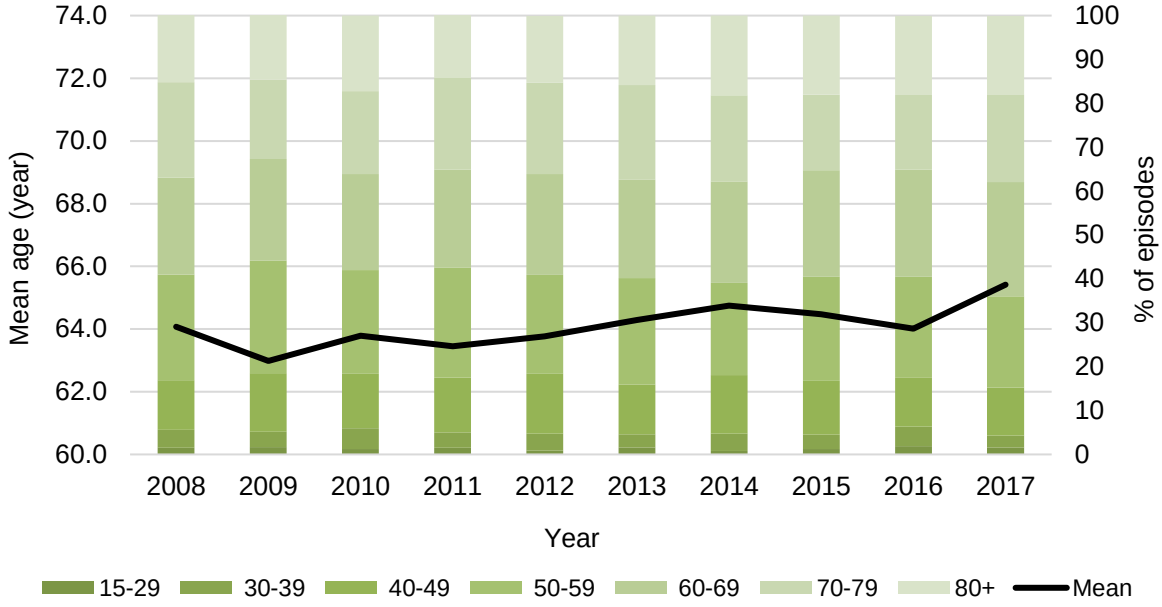


Table 5.1.10b: Age Distribution (%) and Mean Age (year) at Stroke Admission (Haemorrhagic Stroke), 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	64.1	16	1.5	45	4.1	124	11.3
2009	63.0	18	1.7	38	3.5	145	13.3
2010	63.8	14	1.2	54	4.8	140	12.4
2011	63.5	18	1.5	42	3.5	152	12.5
2012	63.8	11	0.9	46	3.8	165	13.7
2013	64.3	21	1.6	39	3.0	148	11.3
2014	64.7	11	0.8	51	3.9	177	13.4
2015	64.5	17	1.2	48	3.3	180	12.3
2016	64.0	27	1.9	62	4.4	158	11.3
2017	65.4	24	1.6	42	2.7	169	10.9

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	264	24.1	242	22.1	238	21.7	168	15.3
2009	280	25.7	252	23.1	197	18.1	160	14.7
2010	265	23.6	246	21.9	213	18.9	193	17.2
2011	305	25.1	270	22.3	253	20.9	173	14.3
2012	270	22.5	277	23.0	250	20.8	183	15.2
2013	318	24.3	294	22.4	283	21.6	207	15.8
2014	277	21.0	306	23.1	259	19.6	241	18.2
2015	346	23.7	354	24.3	251	17.2	263	18.0
2016	321	22.9	342	24.4	239	17.0	253	18.0
2017	322	20.8	404	26.1	307	19.8	279	18.0

Figure 5.1.10b: Age Distribution (%) and Mean Age (year) at Stroke Admission (Haemorrhagic Stroke), 2008-2017



5.2 Mortality of Stroke

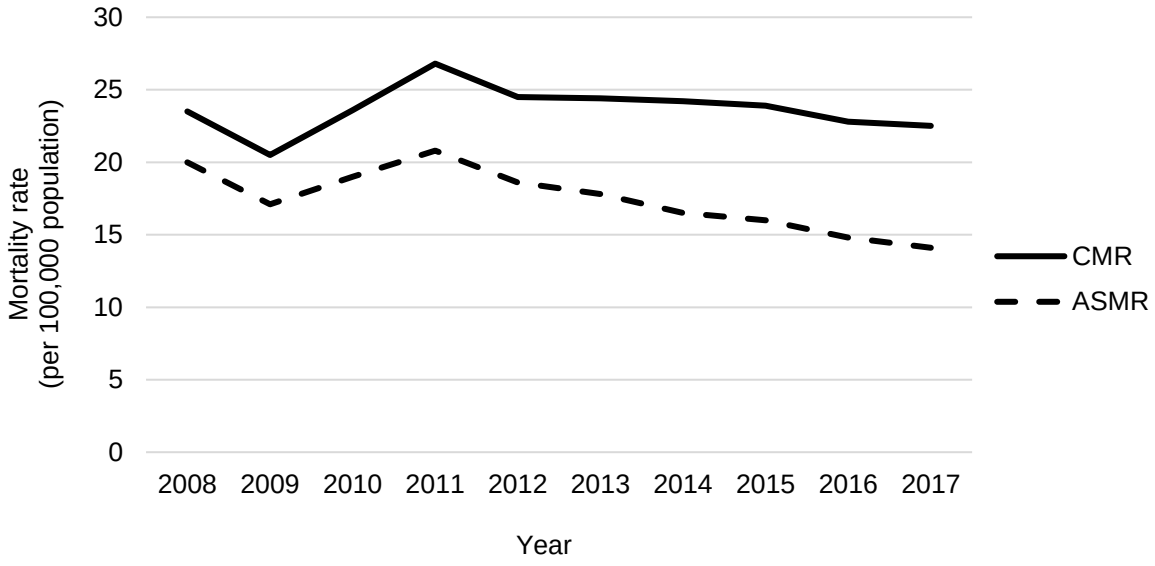
During 2008-2017, the number of deaths due to stroke peaked at 844 in 2011 before decreasing to 759 in 2017 (Table 5.2.1), although stroke incidence continued increasing (Table 5.1.1).

While the crude mortality rate (CMR) remained fairly stable during the past decade, a significant decrease in the age-standardised mortality rate (ASMR) was observed (from 20 to 14.1 per 100,000 population from 2008 to 2017, p<0.01) (Table 5.2.1 and Figure 5.2.1). The improvement observed in the ASMR may be attributed to earlier presentation of stroke patients due to increased awareness, as well as medical advancements in stroke treatment.

Table 5.2.1: Mortality Number and Rate (per 100,000 population) of Stroke, 2008-2017

Year	No.	CMR	95% CI	ASMR	95% CI
2008	698	23.5	21.8-25.2	20.0	18.5-21.5
2009	630	20.5	18.9-22.1	17.1	15.7-18.5
2010	735	23.6	21.9-25.3	19.0	17.6-20.4
2011	844	26.8	25.0-28.6	20.8	19.4-22.2
2012	783	24.5	22.8-26.2	18.6	17.3-19.9
2013	787	24.4	22.7-26.1	17.8	16.5-19.1
2014	790	24.2	22.5-25.9	16.5	15.3-17.7
2015	789	23.9	22.2-25.6	16.0	14.9-17.1
2016	760	22.8	21.2-24.4	14.8	13.7-15.9
2017	759	22.5	20.9-24.1	14.1	13.1-15.1
P for trend		p=0.938		p=0.003	

Figure 5.2.1: Mortality Rate (per 100,000 population) of Stroke, 2008-2017



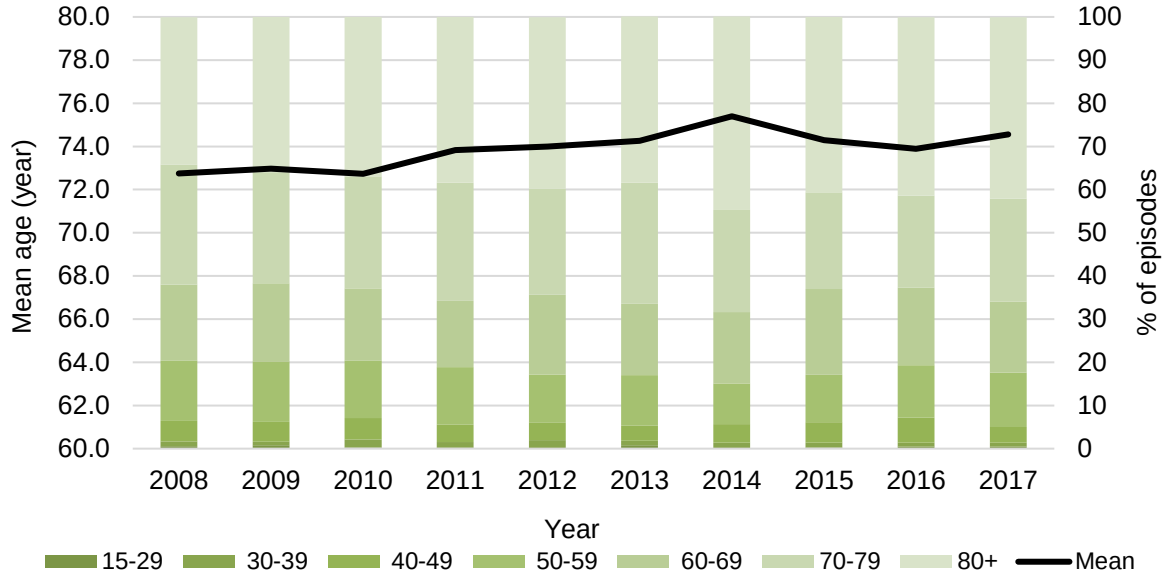
The average age for stroke death increased from 72.7 years old in 2008 to 75.4 years in 2014, but declined subsequently to 74.6 years in 2017. Death due to stroke was observed to increase with age, and the highest proportion of the stroke death occurred in patients aged 80 years or older. Moreover, the proportion of death due to stroke in this oldest age band rose from 34.1% to 42% in the past decade (Table 5.2.2 and Figure 5.2.2).

Table 5.2.2: Age Distribution (%) and Mean Age (year) at Death, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	72.7	4	0.6	8	1.1	33	4.7
2009	73.0	5	0.8	5	0.8	29	4.6
2010	72.7	2	0.3	13	1.8	37	5.0
2011	73.8	2	0.2	11	1.3	34	4.0
2012	74.0	0	0.0	16	2.0	31	4.0
2013	74.3	6	0.8	8	1.0	28	3.6
2014	75.4	1	0.1	10	1.3	34	4.3
2015	74.3	2	0.3	9	1.1	37	4.7
2016	73.9	4	0.5	7	0.9	44	5.8
2017	74.6	4	0.5	7	0.9	27	3.6

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	98	14.0	123	17.6	194	27.8	238	34.1
2009	88	14.0	114	18.1	162	25.7	227	36.0
2010	98	13.3	123	16.7	191	26.0	271	36.9
2011	113	13.4	129	15.3	231	27.4	324	38.4
2012	88	11.2	144	18.4	193	24.6	311	39.7
2013	91	11.6	131	16.6	220	28.0	303	38.5
2014	74	9.4	130	16.5	187	23.7	354	44.8
2015	87	11.0	157	19.9	177	22.4	320	40.6
2016	92	12.1	137	18.0	162	21.3	314	41.3
2017	96	12.6	125	16.5	181	23.8	319	42.0

Figure 5.2.2: Age Distribution (%) and Mean Age (year) at Death, 2008-2017



Consistent with the age-specific incidence rate (Figure 5.1.3a and Figure 5.1.3b), the age-specific mortality rate increased sharply with age, especially for patients aged 70 years and above (Figure 5.2.3a and Figure 5.2.3b).

Figure 5.2.3a: Age-Specific Mortality Rate (per 100,000 population) across Age Groups (2017)

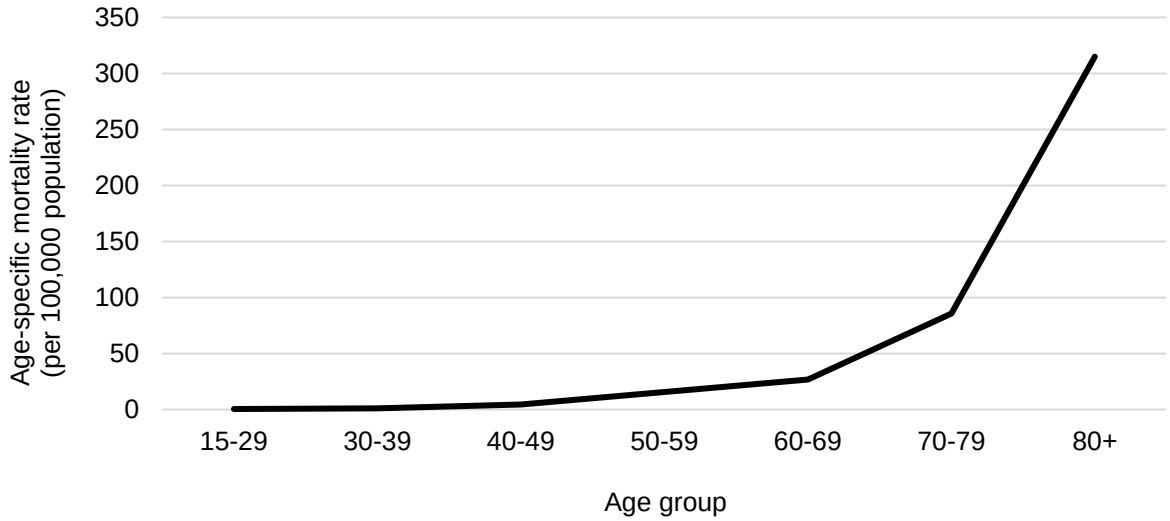
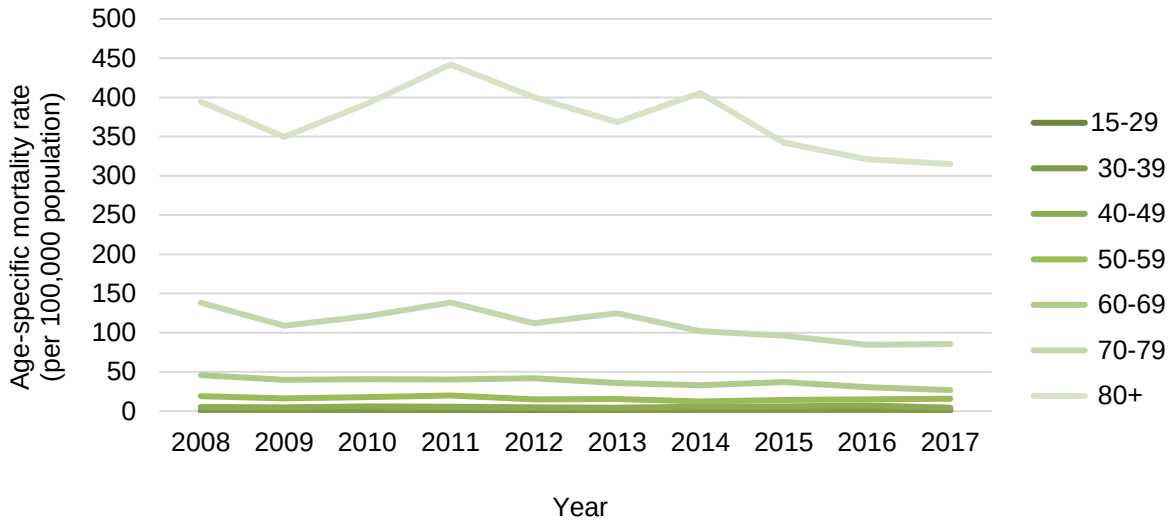


Figure 5.2.3b: Age-Specific Mortality Rate (per 100,000 population) across Years, 2008-2017



From 2008 to 2017, it was observed that the age-specific mortality rates declined significantly for people of several age groups: 50-59 years (decreased by 17% from 18.9 to 15.6 per 100,000 population from 2008 to 2017, p<0.05), 60-69 years (decreased by 41% from 45.8 to 26.8 per 100,000 population from 2008 to 2017, p<0.001) and 70-79 years (decreased by 38% from 138.3 to 85.6 per 100,000 population from 2008 to 2017, p<0.01) (Table 5.2.3).

Table 5.2.3: Age-Specific Mortality Rate (per 100,000 population), 2008-2017

Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2008	23.5	21.8-25.2	0.5	0.0-1.0	1.3	0.4-2.2	5.2	3.4-7.0
2009	20.5	18.9-22.1	0.6	0.0-1.2	0.8	0.1-1.5	4.6	2.9-6.3
2010	23.6	21.9-25.3	0.3	0.0-0.7	2.1	1.0-3.2	5.8	3.9-7.7
2011	26.8	25.0-28.6	0.3	0.0-0.7	1.8	0.7-2.9	5.4	3.6-7.2
2012	24.5	22.8-26.2	0.0	0.0-0.0	2.6	1.3-3.9	4.9	3.2-6.6
2013	24.4	22.7-26.1	0.8	0.2-1.4	1.3	0.4-2.2	4.5	2.9-6.1
2014	24.2	22.5-25.9	0.1	0.0-0.4	1.7	0.7-2.7	5.4	3.6-7.2
2015	23.9	22.2-25.6	0.3	0.0-0.7	1.5	0.5-2.5	6.0	4.1-7.9
2016	22.8	21.2-24.4	0.5	0.0-1.0	1.2	0.3-2.1	7.2	5.1-9.3
2017	22.5	20.9-24.1	0.5	0.0-1.0	1.2	0.3-2.1	4.4	2.7-6.1
P for trend	p=0.938		p=0.752		p=0.948		p=0.564	
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2008	18.9	15.2-22.6	45.8	37.7-53.9	138.3	118.8-157.8	394.7	344.6-444.8
2009	16.4	13.0-19.8	39.9	32.6-47.2	108.8	92.0-125.6	349.8	304.3-395.3
2010	17.8	14.3-21.3	40.5	33.3-47.7	121.0	103.8-138.2	392.3	345.6-439.0
2011	19.9	16.2-23.6	40.2	33.3-47.1	138.4	120.6-156.2	442.0	393.9-490.1
2012	15.1	11.9-18.3	42.0	35.1-48.9	112.1	96.3-127.9	400.3	355.8-444.8
2013	15.3	12.2-18.4	35.6	29.5-41.7	124.6	108.1-141.1	368.6	327.1-410.1
2014	12.3	9.5-15.1	33.1	27.4-38.8	102.1	87.5-116.7	405.5	363.3-447.7
2015	14.3	11.3-17.3	37.1	31.3-42.9	96.3	82.1-110.5	342.4	304.9-379.9
2016	15.0	11.9-18.1	30.5	25.4-35.6	84.5	71.5-97.5	321.1	285.6-356.6
2017	15.6	12.5-18.7	26.8	22.1-31.5	85.6	73.1-98.1	315.0	280.4-349.6
P for trend	p=0.049		p<0.001		p=0.003		p=0.062	

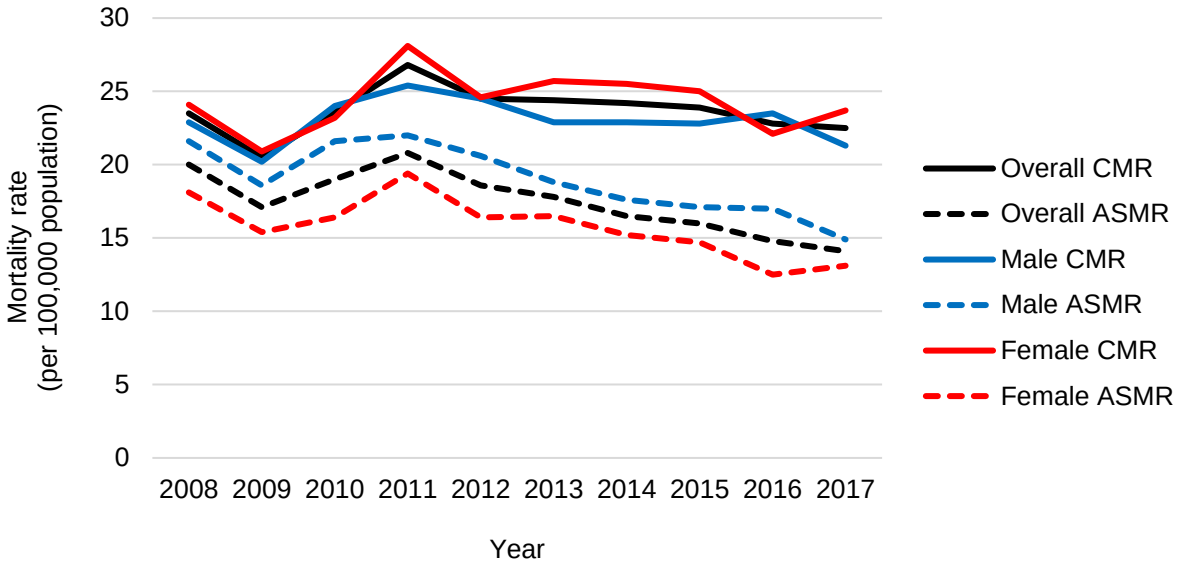
In the past decade, there were consistently more women who died from stroke compared to men, with the exception of year 2016 (Table 5.2.4), although women accounted for less than 45% of stroke incidence during the same time period (Table 5.1.4). This was probably due to women tending to have stroke at an older age (Table 5.1.5a and Table 5.1.5b) and thus were more likely to have underlying significant co-morbidities and more likely to suffer from subsequent complications.

Similar to ASIR, the ASMR was consistently higher for men than for women during 2008-2017 (Table 5.2.4). For both genders, the ASMR decreased significantly over the years (men: from 21.6 to 14.9 per 100,000 population, p<0.01; women: from 18.1 to 13.1 per 100,000 population, p<0.01).

Table 5.2.4: Mortality Number and Rate (per 100,000 population) by Gender, 2008-2017

Male						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2008	334	47.9	22.9	20.4-25.4	21.6	19.3-23.9
2009	304	48.3	20.2	17.9-22.5	18.6	16.5-20.7
2010	366	49.8	24.0	21.5-26.5	21.6	19.4-23.8
2011	392	46.4	25.4	22.9-27.9	22.0	19.8-24.2
2012	382	48.8	24.5	22.0-27.0	20.6	18.5-22.7
2013	362	46.0	22.9	20.5-25.3	18.8	16.8-20.8
2014	364	46.1	22.9	20.6-25.2	17.6	15.8-19.4
2015	367	46.5	22.8	20.5-25.1	17.1	15.3-18.9
2016	382	50.3	23.5	21.1-25.9	17.0	15.3-18.7
2017	349	46.0	21.3	19.1-23.5	14.9	13.3-16.5
P for trend			p=0.862		p=0.002	
Female						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2008	364	52.1	24.1	21.6-26.6	18.1	16.2-20.0
2009	326	51.7	20.9	18.6-23.2	15.4	13.7-17.1
2010	369	50.2	23.2	20.8-25.6	16.4	14.7-18.1
2011	452	53.6	28.1	25.5-30.7	19.4	17.5-21.3
2012	401	51.2	24.6	22.2-27.0	16.4	14.7-18.1
2013	425	54.0	25.7	23.3-28.1	16.5	14.9-18.1
2014	426	53.9	25.5	23.1-27.9	15.2	13.7-16.7
2015	422	53.5	25.0	22.6-27.4	14.7	13.2-16.2
2016	378	49.7	22.1	19.9-24.3	12.5	11.2-13.8
2017	410	54.0	23.7	21.4-26.0	13.1	11.8-14.4
P for trend			p=0.824		p=0.009	

Figure 5.2.4: Mortality Rate (per 100,000 population) by Gender, 2008-2017



The average age of death due to stroke among men was younger than women. In 2017, the average age for death due to stroke for men was 70.5 years, while the average age for women was 78.0 years (Table 5.2.5a and Table 5.2.5b).

In 2017, 75.4% of death due to stroke in female patients occurred among those aged 70 years and above, while 54.8% occurred among male patients in this age group (Table 5.2.5a and Table 5.2.5b). Moreover, for both genders, an increasing proportion of death due to stroke was found to occur in the oldest age band (80 years and above), from 24.0% to 28.4% from 2008 to 2017 for men, and from 43.4% to 53.7% during the same period for women (Table 5.2.5a and Table 5.2.5b).

Table 5.2.5a: Age Distribution (%) and Mean Age (year) at Death among Men, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	69.0	2	0.6	6	1.8	21	6.3
2009	68.9	4	1.3	2	0.7	17	5.6
2010	68.5	2	0.5	9	2.5	27	7.4
2011	70.2	1	0.3	9	2.3	15	3.8
2012	70.6	0	0.0	7	1.8	17	4.5
2013	70.3	2	0.6	5	1.4	15	4.1
2014	71.4	0	0.0	8	2.2	20	5.5
2015	70.0	0	0.0	8	2.2	26	7.1
2016	70.0	2	0.5	5	1.3	27	7.1
2017	70.5	2	0.6	5	1.4	14	4.0

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	64	19.2	72	21.6	89	26.6	80	24.0
2009	68	22.4	64	21.1	74	24.3	75	24.7
2010	66	18.0	80	21.9	95	26.0	87	23.8
2011	80	20.4	75	19.1	103	26.3	109	27.8
2012	57	14.9	94	24.6	102	26.7	105	27.5
2013	61	16.9	78	21.5	115	31.8	86	23.8
2014	47	12.9	87	23.9	90	24.7	112	30.8
2015	50	13.6	102	27.8	86	23.4	95	25.9
2016	64	16.8	85	22.3	92	24.1	107	28.0
2017	60	17.2	77	22.1	92	26.4	99	28.4

Figure 5.2.5a: Age Distribution (%) and Mean Age (year) at Death among Men, 2008-2017

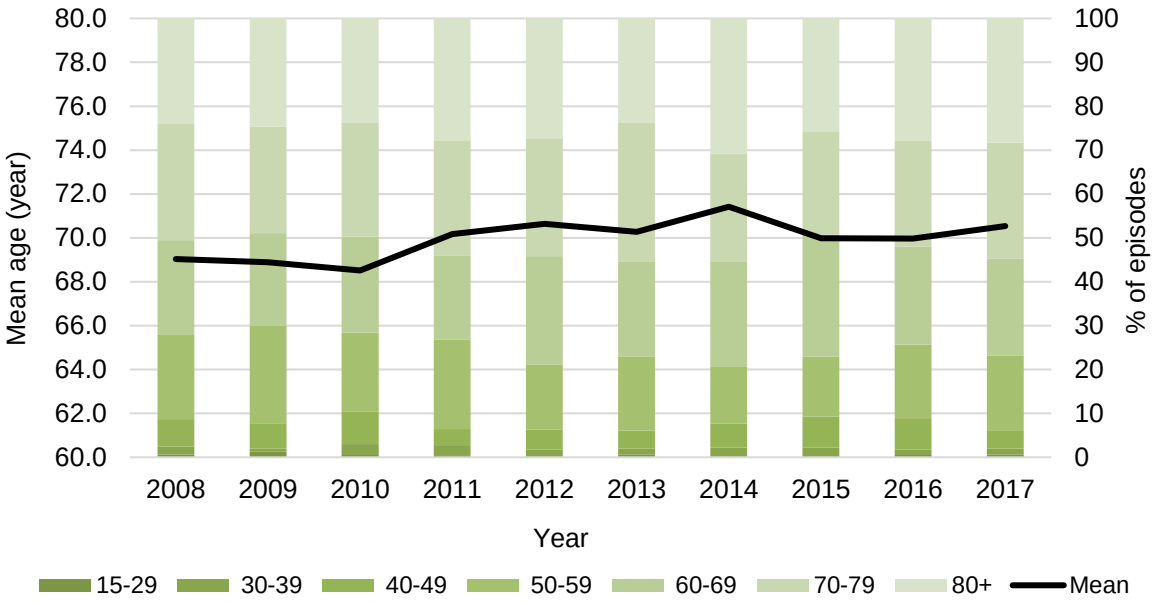


Table 5.2.5b: Age Distribution (%) and Mean Age (year) at Death among Women, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	76.2	2	0.5	2	0.5	12	3.3
2009	76.8	1	0.3	3	0.9	12	3.7
2010	76.9	0	0.0	4	1.1	10	2.7
2011	77.0	1	0.2	2	0.4	19	4.2
2012	77.2	0	0.0	9	2.2	14	3.5
2013	77.7	4	0.9	3	0.7	13	3.1
2014	78.8	1	0.2	2	0.5	14	3.3
2015	78.1	2	0.5	1	0.2	11	2.6
2016	77.9	2	0.5	2	0.5	17	4.5
2017	78.0	2	0.5	2	0.5	13	3.2

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	34	9.3	51	14.0	105	28.8	158	43.4
2009	20	6.1	50	15.3	88	27.0	152	46.6
2010	32	8.7	43	11.7	96	26.0	184	49.9
2011	33	7.3	54	11.9	128	28.3	215	47.6
2012	31	7.7	50	12.5	91	22.7	206	51.4
2013	30	7.1	53	12.5	105	24.7	217	51.1
2014	27	6.3	43	10.1	97	22.8	242	56.8
2015	37	8.8	55	13.0	91	21.6	225	53.3
2016	28	7.4	52	13.8	70	18.5	207	54.8
2017	36	8.8	48	11.7	89	21.7	220	53.7

Figure 5.2.5b: Age Distribution (%) and Mean Age (year) at Death among Women, 2008-2017

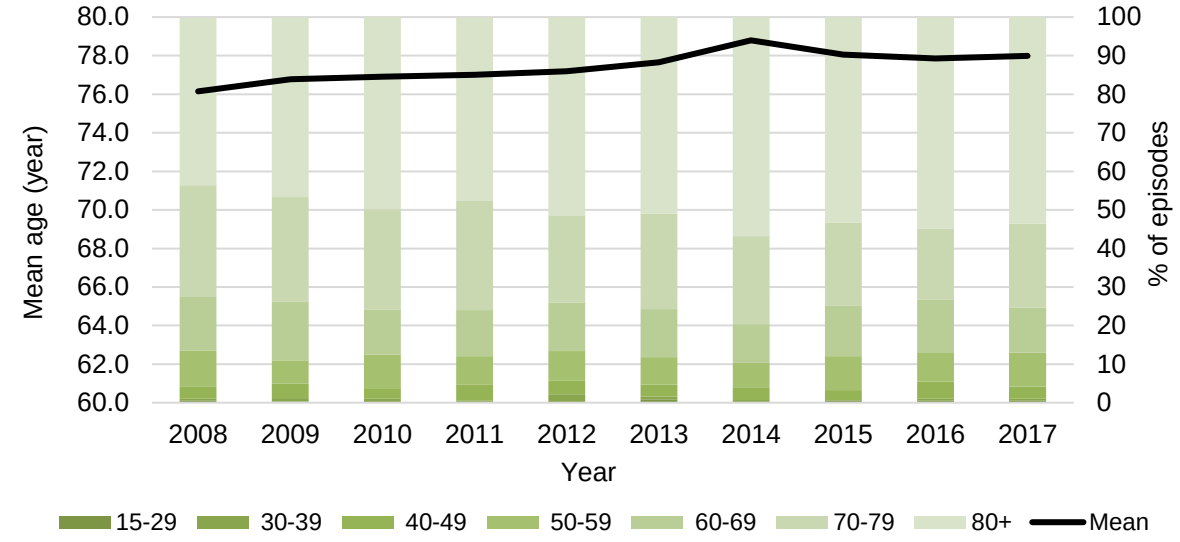
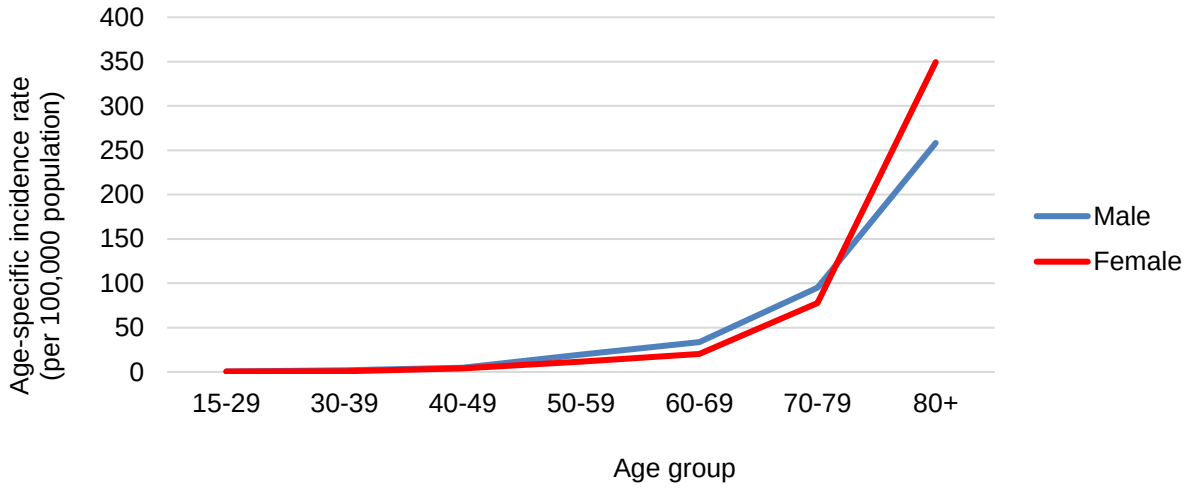


Figure 5.2.6 shows the age-specific mortality rates across the age groups for both genders in 2017. In 2017, the age-specific mortality rates were consistently higher for men compared to women across most of the age groups (30-79 years). However, this gender difference was reversed for the oldest age group of 80 years and above (Figure 5.2.6), with higher age-specific mortality rate among women (349.5 per 100,000 population) than that among men (258.3 per 100,000 population). This is probably due to the fact that this is a wide age band, and on average, women live longer than men in Singapore[22], and as the risk of stroke increases with age, the risk of stroke death is therefore higher for women in the highest age band.

Figure 5.2.6: Age-Specific Mortality Rate (per 100,000 population) across Age Groups by Gender (2017)



[22] Life Expectancy at Birth (1957-2017). Department of Statistics Singapore.

From 2008 to 2017, the age-specific mortality rates declined significantly for older men aged 50 years and above: 50-59 years (decreased by 21% from 24.6 to 19.5 per 100,000 population from 2008 to 2017, p<0.05), 60-69 years (decreased by 40% from 55.4 to 33.5 per 100,000 population from 2008 to 2017, p<0.05), 70-79 years (decreased by 33% from 141.0 to 94.9 per 100,000 population from 2008 to 2017, p<0.05), and 80 years and above (decreased by 29% from 365.3 to 258.3 per 100,000 population from 2008 to 2017, p<0.05). A similar trend was observed for older women aged 60-79 years: 60-69 years (decreased by 45% from 36.8 to 20.3 per 100,000 population from 2008 to 2017, p<0.001), 70-79 years (decreased by 43% from 136.0 to 77.8 per 100,000 population from 2008 to 2017, p<0.01) (Table 5.2.6a and Table 5.2.6b).

Table 5.2.6a: Age-Specific Mortality Rate (per 100,000 population) across Years among Men, 2008-2017

Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2008	22.9	20.4-25.4	0.5	0.0-1.2	2.1	0.4-3.8	6.6	3.8-9.4
2009	20.2	17.9-22.5	1.0	0.0-2.0	0.7	0.0-1.6	5.3	2.8-7.8
2010	24.0	21.5-26.5	0.5	0.0-1.2	3.0	1.0-5.0	8.5	5.3-11.7
2011	25.4	22.9-27.9	0.3	0.0-0.8	3.0	1.0-5.0	4.8	2.4-7.2
2012	24.5	22.0-27.0	0.0	0.0-0.0	2.4	0.6-4.2	5.4	2.8-8.0
2013	22.9	20.5-25.3	0.5	0.0-1.2	1.7	0.2-3.2	4.8	2.4-7.2
2014	22.9	20.6-25.2	0.0	0.0-0.0	2.8	0.8-4.8	6.5	3.6-9.4
2015	22.8	20.5-25.1	0.0	0.0-0.0	2.8	0.8-4.8	8.6	5.3-11.9
2016	23.5	21.1-25.9	0.5	0.0-1.2	1.8	0.2-3.4	9.0	5.6-12.4
2017	21.3	19.1-23.5	0.5	0.0-1.2	1.8	0.2-3.4	4.7	2.2-7.2
P for trend	p=0.862		p=0.643		p=0.617		p=0.770	
Year	**Age 50-59**		**Age 60-69**		**Age 70-79**		**Age 80+**	
	CMR	**95% CI**	**CMR**	**95% CI**	**CMR**	**95% CI**	**CMR**	**95% CI**
2008	24.6	18.6-30.6	55.4	42.6-68.2	141.0	111.7-170.3	365.3	285.3-445.3
2009	25.2	19.2-31.2	46.0	34.7-57.3	110.3	85.2-135.4	316.5	244.9-388.1
2010	23.8	18.1-29.5	54.0	42.2-65.8	133.6	106.7-160.5	345.9	273.2-418.6
2011	28.0	21.9-34.1	47.8	37.0-58.6	137.0	110.5-163.5	406.7	330.3-483.1
2012	19.5	14.4-24.6	55.9	44.6-67.2	131.4	105.9-156.9	367.1	296.9-437.3
2013	20.4	15.3-25.5	43.2	33.6-52.8	143.9	117.6-170.2	282.0	222.4-341.6
2014	15.5	11.1-19.9	45.0	35.6-54.4	108.2	85.8-130.6	345.2	281.3-409.1
2015	16.3	11.8-20.8	49.0	39.5-58.5	102.5	80.8-124.2	271.9	217.2-326.6
2016	20.7	15.6-25.8	38.4	30.2-46.6	104.9	83.5-126.3	290.5	235.5-345.5
2017	19.5	14.6-24.4	33.5	26.0-41.0	94.9	75.5-114.3	258.3	207.4-309.2
P for trend	p=0.029		p=0.012		p=0.024		p=0.026	

Table 5.2.6b: Age-Specific Mortality Rate (per 100,000 population) across Years among Women, 2008-2017

Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2008	24.1	21.6-26.6	0.5	0.0-1.2	0.6	0.0-1.5	3.8	1.6-6.0
2009	20.9	18.6-23.2	0.3	0.0-0.8	0.9	0.0-2.0	3.8	1.7-5.9
2010	23.2	20.8-25.6	0.0	0.0-0.0	1.3	0.1-2.5	3.2	1.2-5.2
2011	28.1	25.5-30.7	0.3	0.0-0.8	0.6	0.0-1.5	6.0	3.3-8.7
2012	24.6	22.2-27.0	0.0	0.0-0.0	2.8	0.9-4.7	4.4	2.1-6.7
2013	25.7	23.3-28.1	1.0	0.0-2.0	1.0	0.0-2.1	4.1	1.9-6.3
2014	25.5	23.1-27.9	0.3	0.0-0.8	0.6	0.0-1.5	4.4	2.1-6.7
2015	25.0	22.6-27.4	0.5	0.0-1.2	0.3	0.0-0.9	3.5	1.4-5.6
2016	22.1	19.9-24.3	0.5	0.0-1.2	0.6	0.0-1.5	5.4	2.8-8.0
2017	23.7	21.4-26.0	0.5	0.0-1.2	0.7	0.0-1.6	4.1	1.9-6.3
P for trend	p=0.824		p=0.532		p=0.395		p=0.484	
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2008	13.2	8.8-17.6	36.8	26.7-46.9	136.0	110.0-162.0	411.5	347.3-475.7
2009	7.5	4.2-10.8	34.0	24.6-43.4	107.6	85.1-130.1	368.9	310.2-427.6
2010	11.7	7.7-15.7	27.7	19.4-36.0	110.7	88.5-132.9	418.9	358.4-479.4
2011	11.7	7.7-15.7	33.0	24.2-41.8	139.6	115.4-163.8	462.4	400.6-524.2
2012	10.7	6.9-14.5	28.6	20.7-36.5	96.3	76.5-116.1	419.6	362.3-476.9
2013	10.2	6.6-13.8	28.3	20.7-35.9	108.7	87.9-129.5	419.7	363.9-475.5
2014	9.0	5.6-12.4	21.6	15.1-28.1	97.1	77.8-116.4	441.2	385.6-496.8
2015	12.2	8.3-16.1	25.6	18.8-32.4	91.1	72.4-109.8	384.5	334.3-434.7
2016	9.1	5.7-12.5	22.8	16.6-29.0	67.3	51.5-83.1	339.6	293.3-385.9
2017	11.7	7.9-15.5	20.3	14.6-26.0	77.8	61.6-94.0	349.5	303.3-395.7
P for trend	p=0.917		p<0.001		p=0.003		p=0.163	

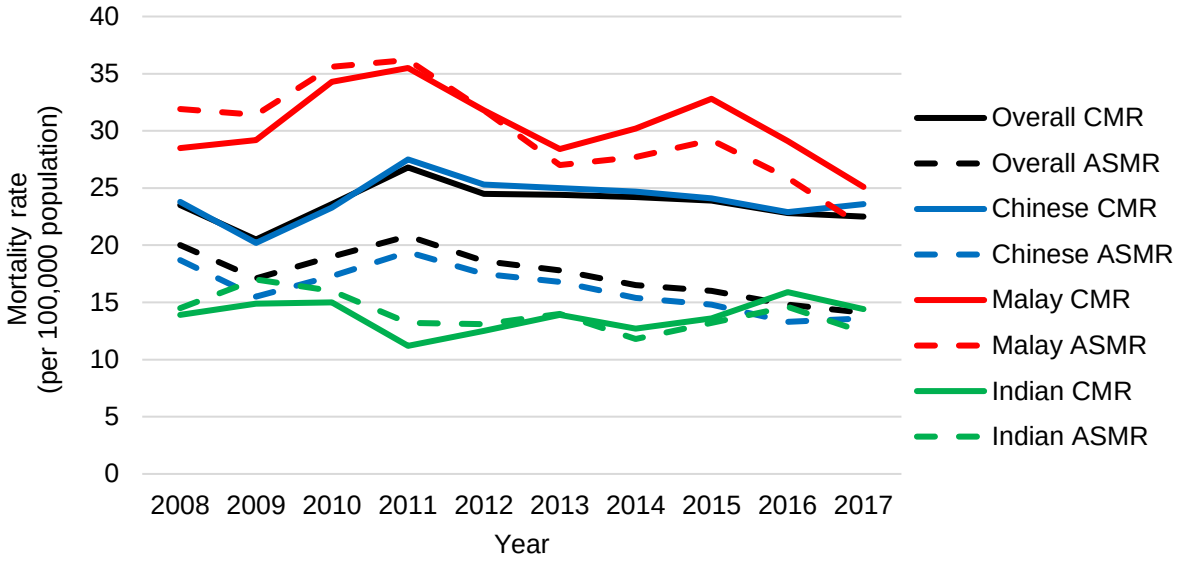
Among the three main ethnic groups, the Malays had the highest CIR and ASIR across the entire study period (Figure 5.1.7), which corresponded to them also having the highest CMR and ASMR (Figure 5.2.7). In 2017, the ASMR for Malays was 21.6 per 100,000 population, followed by Chinese (13.6 per 100,000 population) and then Indians (12.4 per 100,000 population).

The ASMR decreased significantly over the years for the Chinese (from 18.7 to 13.6 per 100,000 from 2008 to 2017, p<0.01) and Malays (from 31.9 to 21.6 per 100,000 during this period, p<0.01), but not significantly for the Indians (p=0.063) (Table 5.2.7 and Figure 5.2.7).

Table 5.2.7: Mortality Number and Rate (per 100,000 population) by Ethnicity, 2008-2017

Chinese						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2008	539	77.2	23.8	21.8-25.8	18.7	17.1-20.3
2009	470	74.6	20.2	18.4-22.0	15.5	14.1-16.9
2010	548	74.6	23.3	21.4-25.2	17.3	15.8-18.8
2011	655	77.6	27.5	25.4-29.6	19.4	17.9-20.9
2012	610	77.9	25.3	23.3-27.3	17.5	16.1-18.9
2013	610	77.5	25.0	23.0-27.0	16.8	15.4-18.2
2014	608	77.0	24.7	22.7-26.7	15.4	14.1-16.7
2015	602	76.3	24.1	22.2-26.0	14.8	13.6-16.0
2016	576	75.8	22.9	21.0-24.8	13.3	12.2-14.4
2017	601	79.2	23.6	21.7-25.5	13.6	12.5-14.7
P for trend			p=0.685		p=0.007	
Malay						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2008	107	15.3	28.5	23.1-33.9	31.9	25.7-38.1
2009	112	17.8	29.2	23.8-34.6	31.4	25.4-37.4
2010	134	18.2	34.3	28.5-40.1	35.6	29.4-41.8
2011	141	16.7	35.5	29.6-41.4	36.2	30.0-42.4
2012	128	16.3	31.8	26.3-37.3	31.8	26.2-37.4
2013	116	14.7	28.4	23.2-33.6	27.0	22.0-32.0
2014	125	15.8	30.2	24.9-35.5	27.7	22.8-32.6
2015	138	17.5	32.8	27.3-38.3	29.2	24.3-34.1
2016	124	16.3	29.1	24.0-34.2	25.9	21.3-30.5
2017	108	14.2	25.1	20.4-29.8	21.6	17.5-25.7
P for trend			p=0.315		p=0.005	
Indian						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2008	35	5.0	13.9	9.3-18.5	14.5	9.6-19.4
2009	40	6.3	14.9	10.3-19.5	17.0	11.6-22.4
2010	41	5.6	15.0	10.4-19.6	16.0	11.0-21.0
2011	31	3.7	11.2	7.2-15.2	13.2	8.4-18.0
2012	35	4.5	12.5	8.3-16.7	13.1	8.6-17.6
2013	39	5.0	13.9	9.5-18.3	14.0	9.5-18.5
2014	36	4.6	12.7	8.6-16.8	11.8	7.9-15.7
2015	39	4.9	13.6	9.3-17.9	13.2	9.0-17.4
2016	46	6.1	15.9	11.3-20.5	14.6	10.3-18.9
2017	42	5.5	14.4	10.0-18.8	12.4	8.6-16.2
P for trend			p=0.706		p=0.063	

Figure 5.2.7: Mortality Rate (per 100,000 population) by Ethnicity, 2008-2017



Compared to the Chinese, the Malays and Indians patients had younger average age of death due to stroke. In 2017, the average age of death due to stroke was 75.2 years for the Chinese, 71.9 years for the Malays, and 73.2 years for the Indians (Table 5.2.8a, Table 5.2.8b and Table 5.2.8c).

In 2017, 41.7% of deaths due to stroke among the Malay patients occurred in those below the age of 70, compared to 42.9% for the Indians, and only 32.0% for the Chinese (Table 5.2.8a, Table 5.2.8b and Table 5.2.8c).

Table 5.2.8a: Age Distribution (%) and Mean Age (year) at Death among Chinese, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	74.2	3	0.6	3	0.6	22	4.1
2009	73.9	3	0.6	2	0.4	22	4.7
2010	73.3	2	0.4	9	1.6	27	4.9
2011	75.3	1	0.2	9	1.4	21	3.2
2012	75.0	0	0.0	13	2.1	22	3.6
2013	74.9	4	0.7	7	1.1	17	2.8
2014	76.2	1	0.2	6	1.0	24	3.9
2015	75.4	2	0.3	4	0.7	32	5.3
2016	75.5	2	0.3	3	0.5	26	4.5
2017	75.2	3	0.5	3	0.5	19	3.2

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	67	12.4	88	16.3	151	28.0	205	38.0
2009	58	12.3	86	18.3	121	25.7	178	37.9
2010	71	13.0	91	16.6	138	25.2	210	38.3
2011	74	11.3	89	13.6	182	27.8	279	42.6
2012	59	9.7	105	17.2	151	24.8	260	42.6
2013	68	11.1	98	16.1	174	28.5	242	39.7
2014	54	8.9	87	14.3	151	24.8	285	46.9
2015	51	8.5	110	18.3	138	22.9	265	44.0
2016	62	10.8	99	17.2	126	21.9	258	44.8
2017	75	12.5	92	15.3	154	25.6	255	42.4

Figure 5.2.8a: Age Distribution (%) and Mean Age (year) at Death among Chinese, 2008-2017

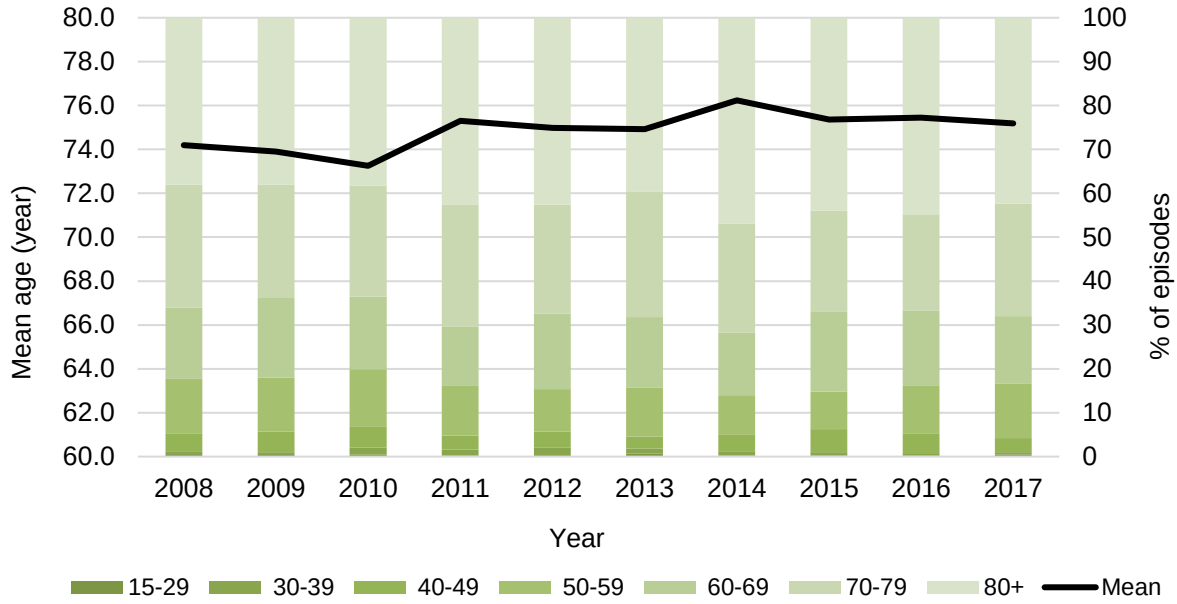


Table 5.2.8b: Age Distribution (%) and Mean Age (year) at Death among Malays, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	68.0	1	0.9	1	0.9	6	5.6
2009	71.3	0	0.0	2	1.8	6	5.4
2010	71.4	0	0.0	3	2.2	6	4.5
2011	68.7	1	0.7	0	0.0	10	7.1
2012	71.7	0	0.0	0	0.0	7	5.5
2013	72.7	0	0.0	0	0.0	8	6.9
2014	71.3	0	0.0	3	2.4	6	4.8
2015	70.0	0	0.0	5	3.6	4	2.9
2016	68.1	1	0.8	4	3.2	13	10.5
2017	71.9	1	0.9	4	3.7	6	5.6

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	24	22.4	25	23.4	28	26.2	22	20.6
2009	19	17.0	19	17.0	31	27.7	35	31.3
2010	19	14.2	24	17.9	40	29.9	42	31.3
2011	28	19.9	32	22.7	40	28.4	30	21.3
2012	19	14.8	28	21.9	35	27.3	39	30.5
2013	15	12.9	21	18.1	31	26.7	41	35.3
2014	18	14.4	30	24.0	26	20.8	42	33.6
2015	27	19.6	34	24.6	32	23.2	36	26.1
2016	22	17.7	25	20.2	22	17.7	37	29.8
2017	13	12.0	21	19.4	17	15.7	46	42.6

Figure 5.2.8b: Age Distribution (%) and Mean Age (year) at Death among Malays, 2008-2017

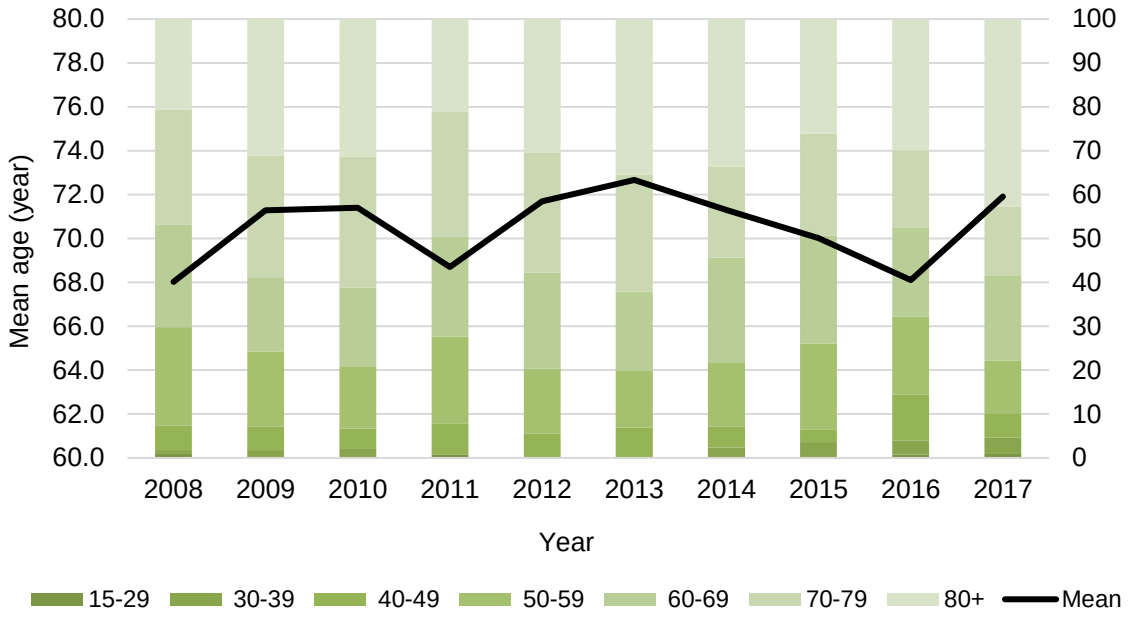
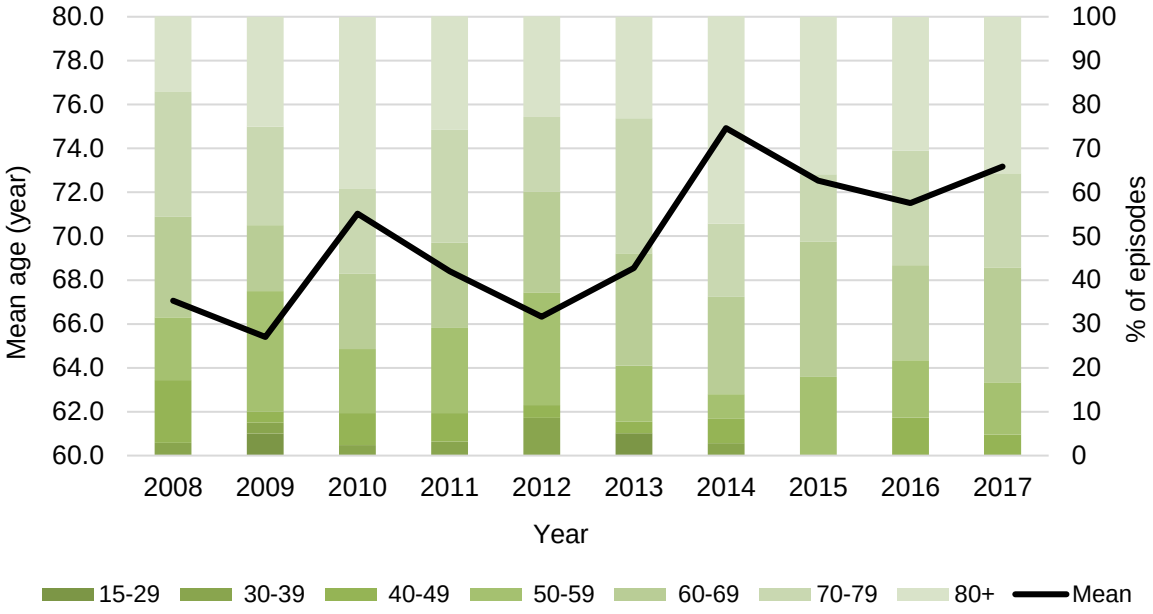


Table 5.2.8c: Age Distribution (%) and Mean Age (year) at Death among Indians, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	67.1	0	0.0	1	2.9	5	14.3
2009	65.4	2	5.0	1	2.5	1	2.5
2010	71.0	0	0.0	1	2.4	3	7.3
2011	68.4	0	0.0	1	3.2	2	6.5
2012	66.3	0	0.0	3	8.6	1	2.9
2013	68.6	2	5.1	0	0.0	1	2.6
2014	74.9	0	0.0	1	2.8	2	5.6
2015	72.5	0	0.0	0	0.0	0	0.0
2016	71.5	0	0.0	0	0.0	4	8.7
2017	73.2	0	0.0	0	0.0	2	4.8

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	5	14.3	8	22.9	10	28.6	6	17.1
2009	11	27.5	6	15.0	9	22.5	10	25.0
2010	6	14.6	7	17.1	8	19.5	16	39.0
2011	6	19.4	6	19.4	8	25.8	8	25.8
2012	9	25.7	8	22.9	6	17.1	8	22.9
2013	5	12.8	10	25.6	12	30.8	9	23.1
2014	2	5.6	8	22.2	6	16.7	17	47.2
2015	7	17.9	12	30.8	6	15.4	14	35.9
2016	6	13.0	10	21.7	12	26.1	14	30.4
2017	5	11.9	11	26.2	9	21.4	15	35.7

Figure 5.2.8c: Age Distribution (%) and Mean Age (year) at Death among Indians, 2008-2017



Before 2017, more patients died from IS than HS every year during the study period (Table 5.2.9), due to the disproportionate higher incidence number of IS than HS (Table 5.1.9). In 2017, however, the number of deaths due to HS (386) outnumbered the number of deaths due to IS (365). Similarly, the CMR and ASMR for IS has been consistently higher than those for HS, with the exception of year 2017.

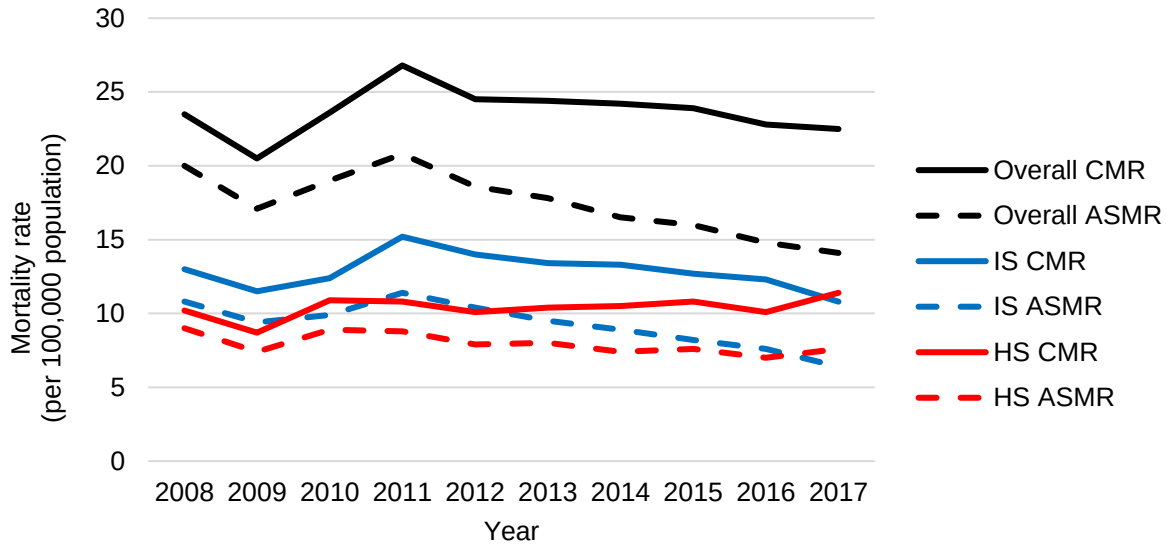
For both stroke sub-types, the ASMR declined significantly from 2008 to 2017 (IS: from 10.8 to 6.4 per 100,000 population, p<0.01; and HS: from 9.0 to 7.6 per 100,000 population, p<0.05) (Table 5.2.9 and Figure 5.2.9).

Table 5.2.9: Mortality Number and Rate (per 100,000 population) by Stroke Sub-type, 2008-2017

Ischaemic stroke*						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2008	385	55.2	13.0	11.7-14.3	10.8	9.7-11.9
2009	354	56.2	11.5	10.3-12.7	9.4	8.4-10.4
2010	388	52.8	12.4	11.2-13.6	9.9	8.9-10.9
2011	479	56.8	15.2	13.8-16.6	11.4	10.4-12.4
2012	447	57.1	14.0	12.7-15.3	10.4	9.4-11.4
2013	434	55.1	13.4	12.1-14.7	9.5	8.6-10.4
2014	434	54.9	13.3	12.0-14.6	8.9	8.1-9.7
2015	420	53.2	12.7	11.5-13.9	8.2	7.4-9.0
2016	412	54.2	12.3	11.1-13.5	7.6	6.9-8.3
2017	365	48.1	10.8	9.7-11.9	6.4	5.7-7.1
P for trend			p=0.419		p=0.003	
Haemorrhagic stroke*						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2008	304	43.6	10.2	9.0-11.4	9.0	8.0-10.0
2009	267	42.4	8.7	7.7-9.7	7.4	6.5-8.3
2010	340	46.3	10.9	9.7-12.1	8.9	7.9-9.9
2011	341	40.4	10.8	9.7-11.9	8.8	7.8-9.8
2012	322	41.1	10.1	9.0-11.2	7.9	7.0-8.8
2013	337	42.8	10.4	9.3-11.5	8.0	7.1-8.9
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	6.2-7.8
2017	386	50.9	11.4	10.3-12.5	7.6	6.8-8.4
P for trend			p=0.149		p=0.033	

** Stroke is classified as Ischaemic stroke, haemorrhagic stroke, and stroke with unknown aetiology. Stroke cases of unknown aetiology were not listed in the table.*

Figure 5.2.9: Mortality Rate (per 100,000 population) by Stroke Sub-type, 2008-2017



From 2008 to 2017, the average age of death due to stroke ranged from 76 to 79 years for IS patients and from 67 to 72 years for HS patients. In 2017, the age difference between death due to IS and HS was 8.3 years, with the average age at IS death being 78.8 years and HS death being 70.5 years.

In 2017, 79.7% of stroke death among the IS patients occurred at 70 years and above, while 52.9% of stroke death among the HS patients occurred in this age group (Table 5.2.10a and Table 5.2.10b).

Table 5.2.10a: Age Distribution (%) and Mean Age (year) at Death for Ischaemic Stroke Patients, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	76.9	0	0.0	1	0.3	5	1.3
2009	76.7	0	0.0	0	0.0	4	1.1
2010	76.7	1	0.3	1	0.3	5	1.3
2011	77.1	0	0.0	0	0.0	9	1.9
2012	77.5	0	0.0	4	0.9	7	1.6
2013	78.1	0	0.0	3	0.7	7	1.6
2014	78.1	0	0.0	4	0.9	6	1.4
2015	78.1	0	0.0	0	0.0	6	1.4
2016	77.8	1	0.2	0	0.0	9	2.2
2017	78.8	1	0.3	2	0.5	2	0.5

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	33	8.6	62	16.1	117	30.4	167	43.4
2009	34	9.6	64	18.1	102	28.8	150	42.4
2010	32	8.2	59	15.2	115	29.6	175	45.1
2011	52	10.9	59	12.3	137	28.6	222	46.3
2012	31	6.9	72	16.1	116	26.0	217	48.5
2013	31	7.1	65	15.0	119	27.4	209	48.2
2014	29	6.7	67	15.4	104	24.0	224	51.6
2015	32	7.6	74	17.6	105	25.0	203	48.3
2016	35	8.5	63	15.3	95	23.1	209	50.7
2017	29	7.9	40	11.0	95	26.0	196	53.7

Figure 5.2.10a: Age Distribution (%) and Mean Age (year) at Death for Ischaemic Stroke Patients, 2008-2017

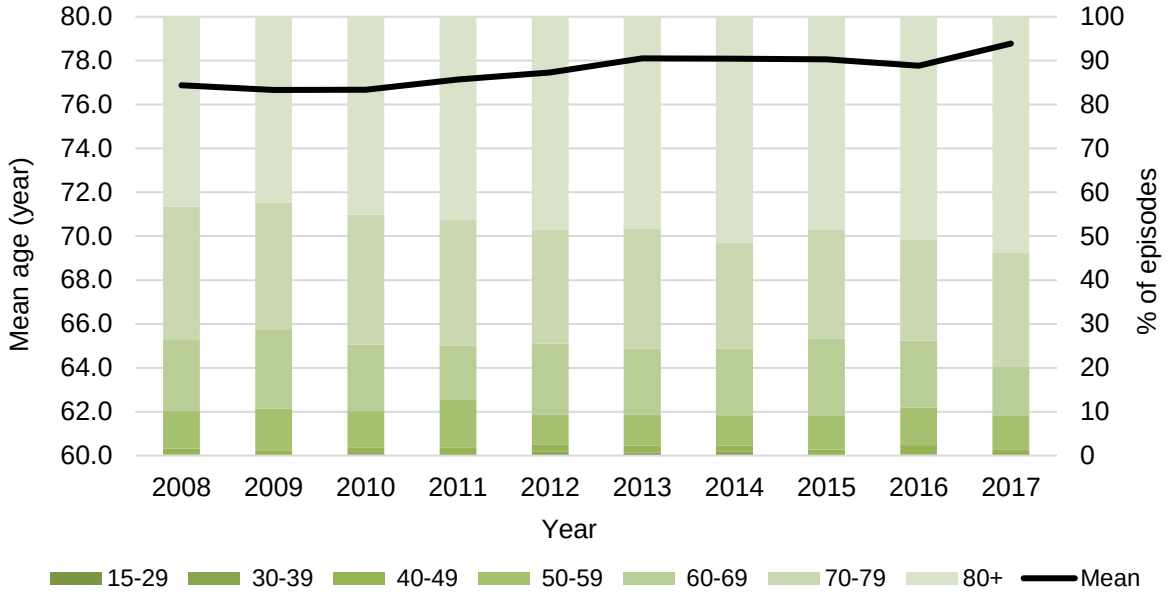
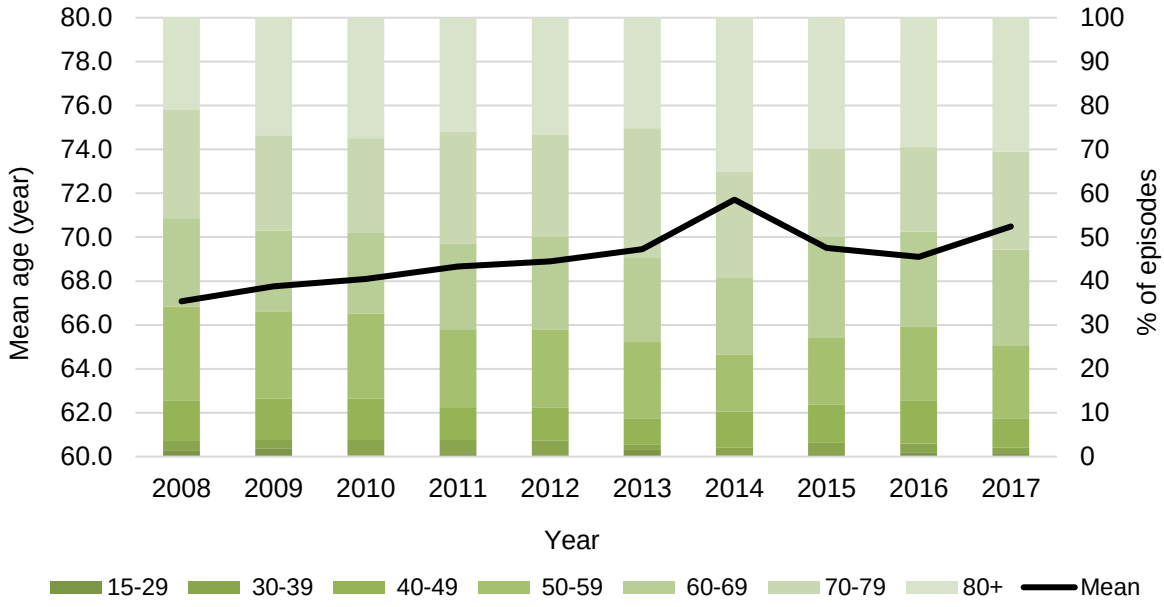


Table 5.2.10b: Age Distribution (%) and Mean Age (year) at Death for Haemorrhagic Stroke Patients, 2008-2017

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2008	67.1	4	1.3	7	2.3	28	9.2
2009	67.8	5	1.9	5	1.9	25	9.4
2010	68.1	1	0.3	12	3.5	32	9.4
2011	68.7	2	0.6	11	3.2	25	7.3
2012	68.9	0	0.0	12	3.7	24	7.5
2013	69.5	5	1.5	4	1.2	20	5.9
2014	71.7	1	0.3	6	1.8	28	8.2
2015	69.5	2	0.6	9	2.5	31	8.7
2016	69.1	3	0.9	7	2.1	33	9.8
2017	70.5	3	0.8	5	1.3	25	6.5

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2008	65	21.4	61	20.1	75	24.7	64	21.1
2009	53	19.9	49	18.4	58	21.7	72	27.0
2010	66	19.4	63	18.5	73	21.5	93	27.4
2011	61	17.9	67	19.6	87	25.5	88	25.8
2012	57	17.7	68	21.1	75	23.3	86	26.7
2013	59	17.5	65	19.3	99	29.4	85	25.2
2014	44	12.9	60	17.5	83	24.3	120	35.1
2015	55	15.4	81	22.8	72	20.2	106	29.8
2016	57	16.9	73	21.6	65	19.2	100	29.6
2017	65	16.8	84	21.8	86	22.3	118	30.6

Figure 5.2.10b: Age Distribution (%) and Mean Age (year) at Death for Haemorrhagic Stroke Patients, 2008-2017



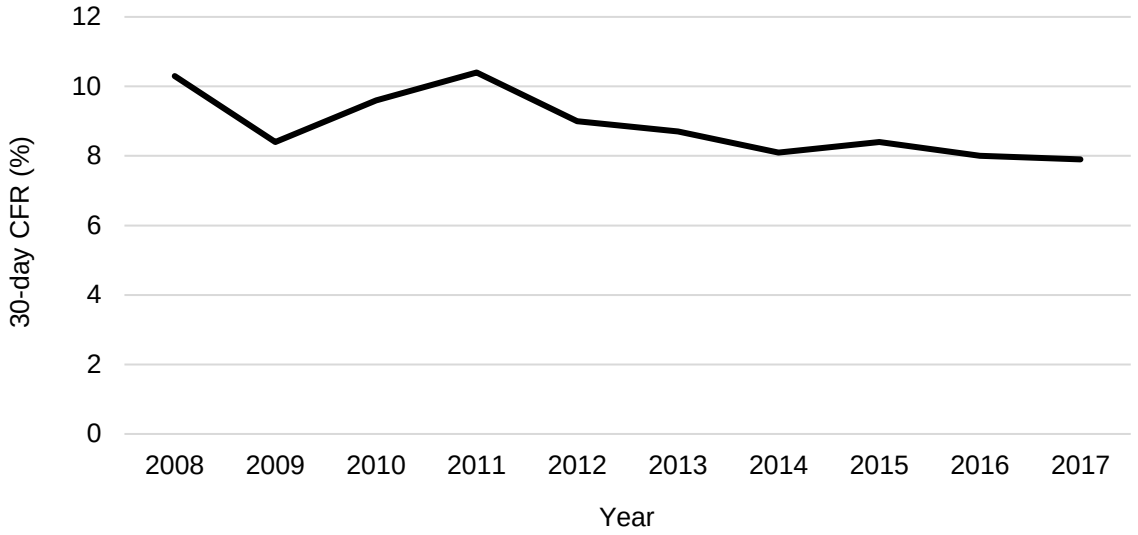
5.3 30-day Case Fatality

The number of deaths due to stroke within 30 days from admission fluctuated between 481 and 638 during the period 2008-2017 (Table 5.3.1). However, there had been a general decline in the 30-day case fatality rate (CFR) since 2011, from 10.4% in 2011 to 7.9% in 2017 ($p<0.05$) (Figure 5.3.1). This falling CFR may be due to better medical management for stroke patients in Singapore's public hospitals, including efficiency in medical service delivery and effectiveness in acute stroke treatment over the years.

Table 5.3.1: 30-day Case Fatality Number and Rate (%), 2008-2017

Year	No.	CFR	95% CI
2008	573	10.3	9.5-11.1
2009	481	8.4	7.7-9.1
2010	566	9.6	8.8-10.4
2011	638	10.4	9.6-11.2
2012	572	9.0	8.3-9.7
2013	583	8.7	8.0-9.4
2014	568	8.1	7.5-8.7
2015	624	8.4	7.8-9.0
2016	595	8.0	7.4-8.6
2017	614	7.9	7.3-8.5
P for trend		p=0.011	

Figure 5.3.1: 30-day Case Fatality Rate (%), 2008-2017



The 30-day CFR for female patients was consistently higher than that for male patients between 2008-2017 (Table 5.3.2), although female patients had lower ASMR during the same study period (Table 5.2.4). This was probably due to the different baseline characteristics between female and male stroke patients, such as age, comorbidities, and stroke severity[23]. The average age for stroke incidence among women was about 5 years older than that among men (Table 5.1.5a and Table 5.1.5b), which might be one of the reasons for the higher CFR observed in women.

In 2017, the 30-day CFR for women was 10.2% and 6.3% for men.

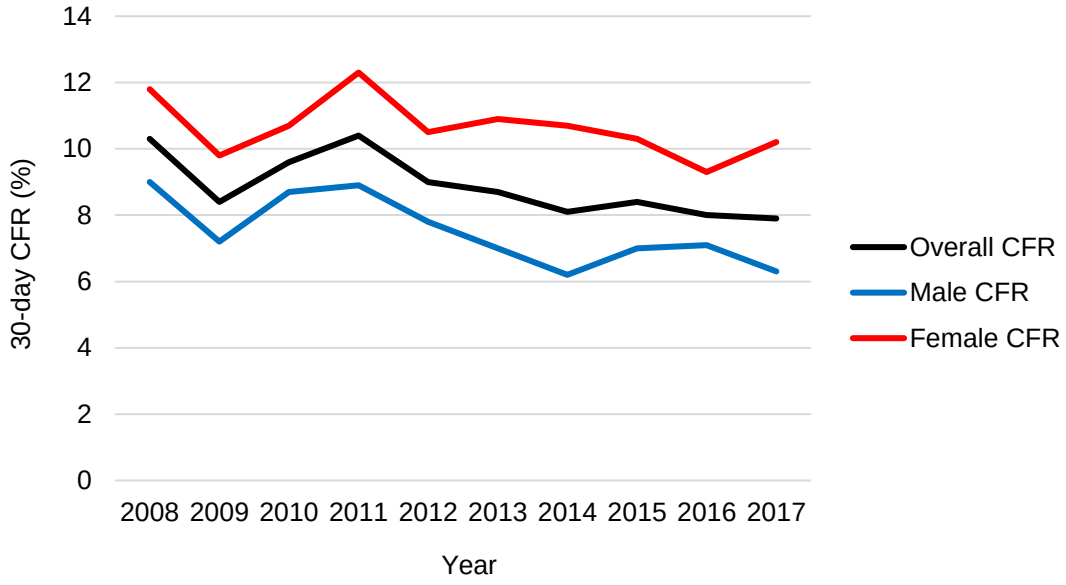
From 2008 to 2017, the 30-day CFR for men significantly decreased, from 9.0% to 6.3% ($p<0.05$). However, this downward trend was not significant for women ($p=0.137$) (Table 5.3.2).

Table 5.3.2: 30-day Case Fatality Number and Rate (%) by Gender, 2008-2017

Male				
Year	**No.**	**%**	**CFR**	**95% CI**
2008	276	48.2	9.0	8.0-10.0
2009	232	48.2	7.2	6.3-8.1
2010	288	50.9	8.7	7.7-9.7
2011	314	49.2	8.9	8.0-9.8
2012	284	49.7	7.8	6.9-8.7
2013	272	46.7	7.0	6.2-7.8
2014	253	44.5	6.2	5.5-6.9
2015	298	47.8	7.0	6.2-7.8
2016	307	51.6	7.1	6.3-7.9
2017	281	45.8	6.3	5.6-7.0
P for trend			p=0.012	
Female				
Year	**No.**	**%**	**CFR**	**95% CI**
2008	297	51.8	11.8	10.5-13.1
2009	249	51.8	9.8	8.6-11.0
2010	278	49.1	10.7	9.5-11.9
2011	324	50.8	12.3	11.0-13.6
2012	288	50.3	10.5	9.4-11.6
2013	311	53.3	10.9	9.8-12.0
2014	315	55.5	10.7	9.6-11.8
2015	326	52.2	10.3	9.2-11.4
2016	288	48.4	9.3	8.3-10.3
2017	333	54.2	10.2	9.2-11.2
P for trend			p=0.137	

[23] Appelros P et al. Sex differences in stroke epidemiology: a systematic review. Stroke 2009 Apr;40(4):1082-1090.

Figure 5.3.2: 30-day Case Fatality Rate (%) by Gender, 2008-2017



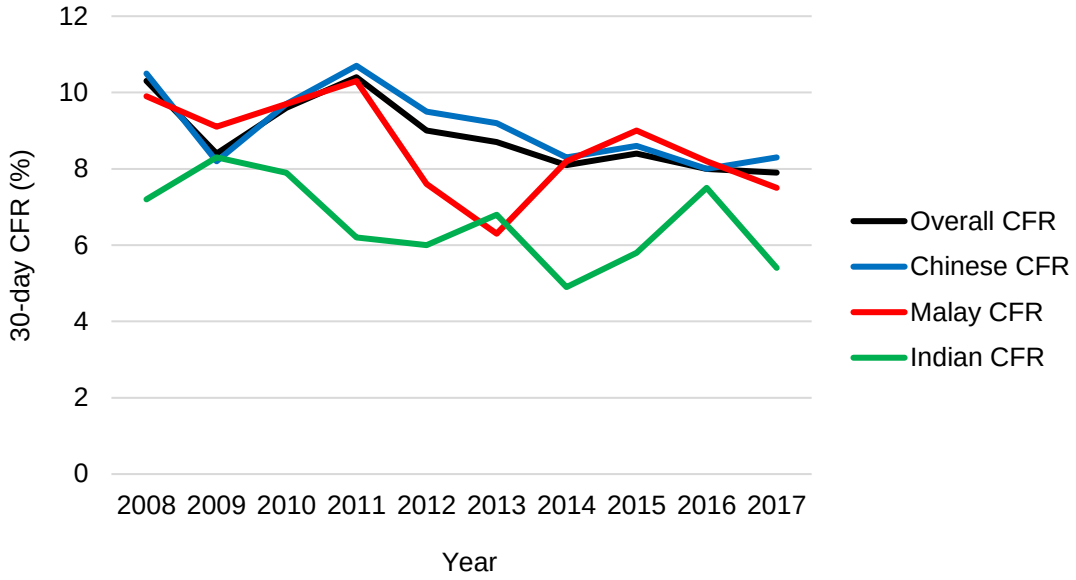
In 2017, the 30-day CFR of Chinese, Malays and Indians was 8.3%, 7.5%, and 5.4% respectively (Table 5.3.3 and Figure 5.3.3).

Among the three main ethnic groups, a significant decrease in 30-day CFR was only observed among the Chinese, from 10.5% in 2008 to 8.3% in 2017 ($p<0.05$).

Table 5.3.3: 30-day Case Fatality Number and Rate (%) by Ethnicity, 2008-2017

Chinese				
Year	**No.**	**%**	**CFR**	**95% CI**
2008	450	78.5	10.5	9.6-11.4
2009	368	76.5	8.2	7.4-9.0
2010	437	77.2	9.7	8.8-10.6
2011	499	78.2	10.7	9.8-11.6
2012	462	80.8	9.5	8.7-10.3
2013	466	79.9	9.2	8.4-10.0
2014	441	77.6	8.3	7.6-9.0
2015	485	77.7	8.6	7.9-9.3
2016	451	75.8	8.0	7.3-8.7
2017	486	79.2	8.3	7.6-9.0
P for trend			p=0.046	
Malay				
Year	**No.**	**%**	**CFR**	**95% CI**
2008	80	14.0	9.9	7.8-12.0
2009	75	15.6	9.1	7.1-11.1
2010	89	15.7	9.7	7.8-11.6
2011	100	15.7	10.3	8.4-12.2
2012	81	14.2	7.6	6.0-9.2
2013	67	11.5	6.3	4.8-7.8
2014	90	15.8	8.2	6.6-9.8
2015	106	17.0	9.0	7.4-10.6
2016	95	16.0	8.2	6.6-9.8
2017	91	14.8	7.5	6.0-9.0
P for trend			p=0.105	
Indian				
Year	**No.**	**%**	**CFR**	**95% CI**
2008	27	4.7	7.2	4.6-9.8
2009	32	6.7	8.3	5.5-11.1
2010	30	5.3	7.9	5.2-10.6
2011	25	3.9	6.2	3.8-8.6
2012	21	3.7	6.0	3.5-8.5
2013	32	5.5	6.8	4.5-9.1
2014	23	4.0	4.9	2.9-6.9
2015	27	4.3	5.8	3.7-7.9
2016	37	6.2	7.5	5.2-9.8
2017	29	4.7	5.4	3.5-7.3
P for trend			p=0.080	

Figure 5.3.3: 30-day Case Fatality Rate (%) by Ethnicity, 2008-2017



Patients with IS had a much higher chance for survival within 30 days of admission than those who experienced HS. The 30-day CFR among HS was 4-5 fold as high as that for IS (Table 5.3.4). HS is associated with higher stroke severity[24], which leads to higher risk of early mortality, although HS patients had an average younger age at stroke admission compared to IS patients (4-5 years younger) (Table 5.1.10a and Table 5.1.10b).

From 2008 to 2017, the 30-day CFR for IS declined significantly, from 6.4% in 2008 to 4.0% in 2017 (p<0.01). However, the downward trend was not found to be significant for HS (p=0.115) (Table 5.3.4 and Figure 5.3.4).

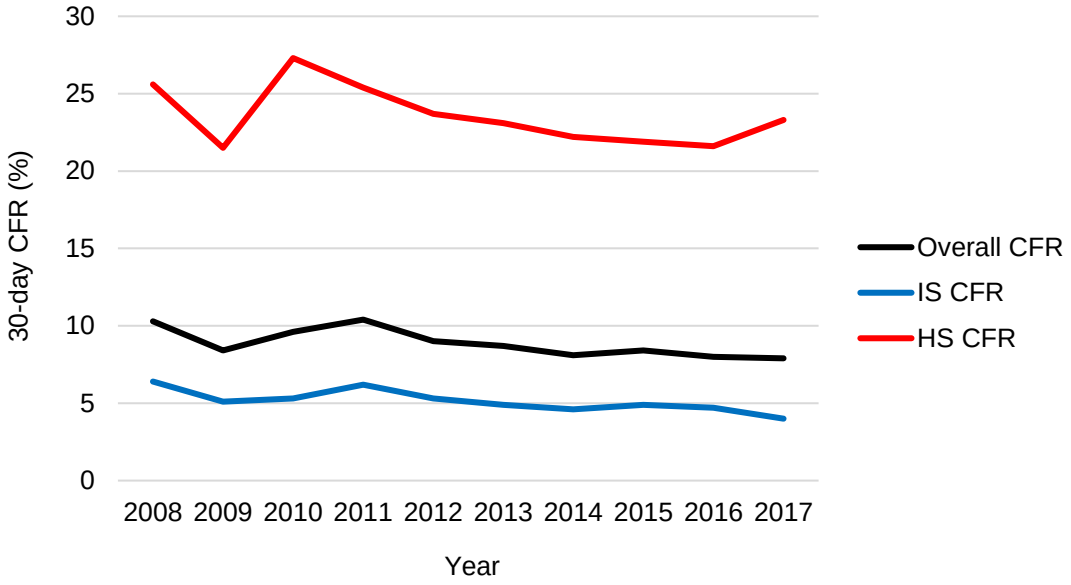
Table 5.3.4: 30-day Case Fatality Number and Rate (%) by Stroke Sub-type, 2008-2017

Ischaemic stroke*				
Year	**No.**	**%**	**CFR**	**95% CI**
2008	283	49.4	6.4	5.7-7.1
2009	238	49.5	5.1	4.5-5.7
2010	254	44.9	5.3	4.7-5.9
2011	306	48.0	6.2	5.5-6.9
2012	273	47.7	5.3	4.7-5.9
2013	265	45.5	4.9	4.3-5.5
2014	260	45.8	4.6	4.1-5.1
2015	291	46.6	4.9	4.3-5.5
2016	282	47.4	4.7	4.2-5.2
2017	246	40.1	4.0	3.5-4.5
P for trend			p=0.004	
Haemorrhagic stroke*				
Year	**No.**	**%**	**CFR**	**95% CI**
2008	281	49.0	25.6	23.0-28.2
2009	234	48.6	21.5	19.1-23.9
2010	307	54.2	27.3	24.7-29.9
2011	308	48.3	25.4	23.0-27.8
2012	285	49.8	23.7	21.3-26.1
2013	302	51.8	23.1	20.8-25.4
2014	294	51.8	22.2	20.0-24.4
2015	320	51.3	21.9	19.8-24.0
2016	303	50.9	21.6	19.4-23.8
2017	361	58.8	23.3	21.2-25.4
P for trend			p=0.115	

** Stroke is classified as Ischaemic stroke, haemorrhagic stroke, and stroke with unknown aetiology. Stroke cases of unknown aetiology were not listed in the table.*

[24]Andersen KK et al. Haemorrhagic and ischaemic strokes compared: stroke severity, mortality, and risk factors. Stroke 2009 Jun; 40(6):2068-2072

Figure 5.3.4: 30-day Case Fatality Rate (%) by Stroke Sub-type, 2008-2017



5.4 Risk Factors

Hypertension, hyperlipidaemia, ischaemic heart disease, diabetes mellitus and smoking were the top 5 risk factors found in stroke patients (Table 5.4.1 and Figure 5.4.1). Most of these 5 factors are lifestyle risk factors which can be prevented or managed through adopting healthy lifestyle practices, attending regular health screening as recommended, and optimization of chronic disease management.

Since 2008, the majority of stroke patients were found to have hypertension or hyperlipidaemia (more than 80%), and no improvement in trend was observed during this period. About 2 in 5 stroke patients had diabetes mellitus and this trend was consistently observed in the past decade. A positive point noted is that the proportion of the patients who smoked gradually decreased from 40.1% in 2008 to 36.4% in 2017 ($p<0.01$). Going beyond the top 5 risk factors, an increase in the proportion of the patients with Atrial Fibrillation/Flutter (AF) was observed, from 16.9% to 20.5% in the past decade ($p<0.001$).

Table 5.4.1: Risk Factors (%), 2008-2017

Risk Factor (%)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	P for trend
Hypertension*	83.0	82.7	81.8	82.1	82.6	81.8	83.9	83.2	82.8	82.9	p=0.365
Hyperlipidaemia*	80.9	82.6	83.2	83.0	84.0	84.8	83.7	82.4	83.5	83.9	p=0.098
Ischaemic Heart Disease	45.4	44.5	45.9	46.2	44.0	42.5	40.5	42.1	47.5	45.7	p=0.723
Diabetes Mellitus*	42.6	42.4	42.7	42.9	41.4	40.8	40.8	40.4	42.9	41.0	p=0.107
Smoking*	40.1	38.8	38.9	39.9	39.8	39.7	37.3	37.9	37.3	36.4	p=0.006
Atrial Fibrillation/Flutter*	16.9	15.4	16.9	18.7	19.3	20.0	19.5	21.1	20.5	20.5	p<0.001
Transient Ischaemic Attack	16.1	13.7	12.0	13.8	13.4	11.5	12.4	13.3	16.1	14.5	p=0.919
Peripheral Vascular Disease	12.6	12.1	11.0	11.8	9.4	9.5	8.2	11.0	13.2	11.5	p=0.660
Valvular Heart Disease	11.2	9.1	7.7	9.5	8.5	9.6	7.4	8.0	9.9	12.6	p=0.713

**For risk factors including hypertension, hyperlipidaemia, diabetes mellitus and AF, patients were defined as having the risk factor if they had history of the above diseases or if they were diagnosed with above diseases at admission. Patients are considered to be smokers if they were current or ex-smokers at admission.*

Figure 5.4.1: Top 5 Risk Factors (%), 2008-2017

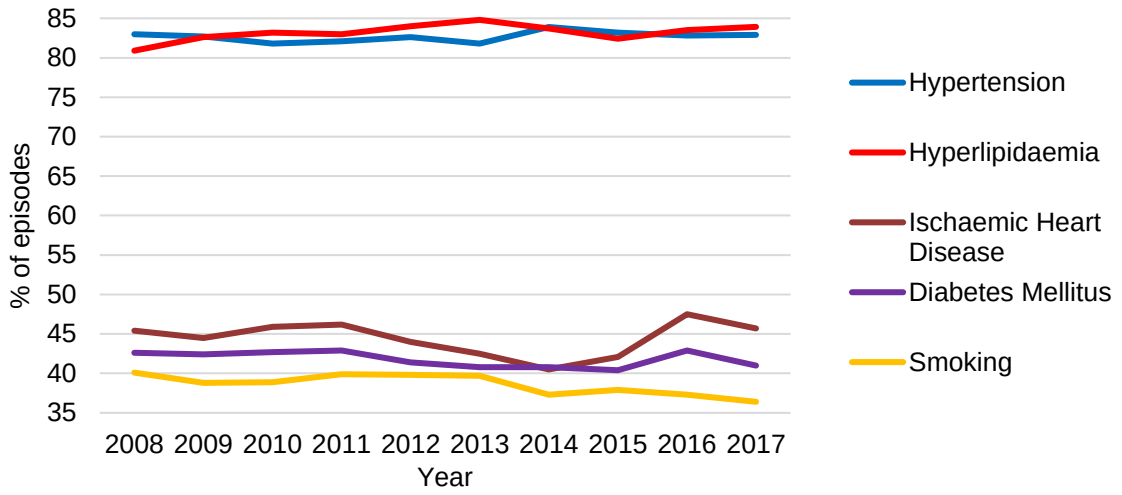


Table 5.4.2 shows the proportion of risk factors among male and female stroke patients in 2017. In terms of risk factors, the gender pattern was found to be fairly similar with some exceptions seen for smoking and AF. In 2017, 57.2% of the male stroke patients were smokers, whereas only 7.7% of the female stroke patients were smokers. The proportion for AF among the female stroke patients was 25.8%, much higher than that among the male stroke patients (16.7%).

Table 5.4.2: Risk Factors (%) by Gender (2017)

Risk Factor (%)	Men	Women
Hypertension	82.0	84.0
Hyperlipidaemia	84.7	82.8
Ischaemic Heart Disease	46.8	44.0
Diabetes Mellitus	40.6	41.4
Smoking	57.2	7.7
Atrial Fibrillation/Flutter	16.7	25.8
Transient Ischaemic Attack	14.6	14.4
Peripheral Vascular Disease	9.9	13.9
Valvular Heart Disease	9.2	17.6

Table 5.4.3 shows the ethnic differences in the proportion of risk factors among stroke patients in 2017. Notably, in 2017, of the 9 risk factors monitored, the Indian stroke patients were found to have the highest proportion for 6 of them - hyperlipidaemia (89.8%), ischaemic heart disease (63.4%), diabetes mellitus (65.4%), transient ischaemic attack (16.3%), peripheral vascular disease (28.6%) and valvular heart disease (14.9%). The Malay stroke patients had the highest proportion for hypertension (85.2%) and smoking (42.8%). The Chinese stroke patients had the highest proportion for AF (21.7%). Despite having higher proportions of multiple risk factors, Indian stroke patients did not have higher mortality and 30-day CFR compared to Chinese and Malay stroke patients (Table 5.2.7 and Table 5.3.3).

Table 5.4.3: Risk Factors (%) by Ethnicity (2017)

Risk Factor (%)	Chinese	Malay	Indian
Hypertension	82.3	85.2	83.6
Hyperlipidaemia	83.0	86.1	89.8
Ischaemic Heart Disease	43.7	46.5	63.4
Diabetes Mellitus	36.9	49.8	65.4
Smoking	34.5	42.8	41.8
Atrial Fibrillation/Flutter	21.7	18.9	11.5
Transient Ischaemic Attack	15.0	11.9	16.3
Peripheral Vascular Disease	9.5	13.8	28.6
Valvular Heart Disease	12.6	12.9	14.9

Table 5.4.4 shows the proportion of risk factors among IS and HS patients in 2017. In 2017, the top 5 risk factors found among IS patients were hypertension (82.1%), hyperlipidaemia (59.8%), ischaemic heart disease (39.7%), smoking (28.8%), and diabetes mellitus (27.9%); while the top 5 risk factors found among HS patients were hyperlipidaemia (90.0%), hypertension (83.1%), ischaemic heart disease (46.9%), diabetes mellitus (44.2%), and smoking (38.2%).

Table 5.4.4: Risk Factors (%) by Stroke Sub-type (2017)

Risk Factor (%)	Ischaemic stroke	Haemorrhagic stroke
Hypertension	82.1	83.1
Hyperlipidaemia	59.8	90.0
Ischaemic Heart Disease	39.7	46.9
Diabetes Mellitus	27.9	44.2
Smoking	28.8	38.2
Atrial Fibrillation/Flutter	12.0	22.7
Transient Ischaemic Attack	8.5	15.9
Peripheral Vascular Disease	5.4	12.9
Valvular Heart Disease	7.4	14.3

6. CONCLUSION

Cerebrovascular diseases including stroke, were the 9th most common condition of hospitalisation[25], the 4th most common principal cause of death[26], and the leading contributor to the burden of disease in Singapore[27].

With the population ageing rapidly in Singapore, stroke incidence is likely to increase, leading to a huge cost burden to society and individuals (both patients and caregivers). While advancements in medical treatment of stroke have reduced mortality due to stroke, survivors of stroke tend to have significant disabilities. Therefore, an effective stroke preventive strategy plays an important role in reducing the socio-economic burden of stroke.

Hypertension, hyperlipidaemia, diabetes mellitus, and smoking are the leading risk factors for stroke. The National Population Health Survey 2016/2017 has shown that the prevalence of hypertension and hyperlipidaemia has increased while the prevalence of diabetes mellitus has remained relatively stable. An encouraging observation is that an improvement was seen in terms of the prevalence of daily smoking[28]. Reduction in stroke incidence can be achieved if the uptake and maintenance of healthy lifestyle practices in the population can be increased and the screening and follow-up rates for chronic diseases can be increased.

[25] Ministry of Health, Statistics, Singapore Health Facts, Top 10 Conditions of Hospitalisation (accessed on Jan 2019).
[26] Principal Causes of Death. Ministry of Health, Singapore (accessed on Jan 2019).
[27] Singapore Burden of Diseases Study 2010. Ministry of Health, Singapore.
[28] National Population Health Survey 2016/2017. Ministry of Health, Singapore.