Singapore Stroke Registry
Annual Report 2016

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 2016, there were 7,413 stroke cases admitted to Singapore public hospitals (about 20 per day). Of these stroke cases, 58.2% were men with a mean age of 65.4 years old and 41.8% women with a mean age of 72.1 years old. 81.1% of the stroke cases were ischaemic stroke (IS) and 18.7% were haemorrhagic stroke (HS). Malays had the highest crude incidence rate (CIR) (272.6 per 100,000 population) and were the youngest at the admission of stroke (mean age at admission: 63.7 years old). This is followed by the Chinese (222.7 per 100,000 population) with a mean age at stroke admission of 69.5 years; and Indians (170.9 per 100,000 population) with a mean age at stroke admission of 64.6 years.

From 2007 to 2016, there was an overall increase in CIR, from 192.0 to 222.1 per 100,000 population ($p<0.001$). However, the age-standardised incidence rate (ASIR) declined from 171.8 per 100,000 population in 2007 to 155.2 per 100,000 population in 2016 ($p<0.05$). The mean age at stroke admission increased slightly from 67.7 years in 2007 to 68.2 years in 2016.

In 2016, there were 759 deaths due to stroke, an increase from 670 in 2007. Of these deaths, 50.2% occurred among men with a mean age of 70.0 years and 49.8% women with a mean age of 77.9 years. Split by stroke sub-type, 54.3% of the stroke deaths were due to IS and 44.4% were due to HS. The CMR and ASMR for IS were consistently higher than those for HS. In 2016, the CMR for IS and HS were 12.3 and 10.1 per 100,000 population respectively. The ASMR were 7.6 and 6.9 per 100,000 population respectively. Malays had the highest crude mortality rate (CMR) (28.9 per 100,000 population) and were the youngest at death due to stroke (mean age at stroke death: 68.1 years old). This is followed by the Chinese (22.9 per 100,000 population) with a mean age of death due to stroke at 75.5 years, and Indians (15.9 per 100,000 population) with a mean age of death due to stroke at 71.5 years.

The CMR fluctuated between 20.5 and 26.8 per 100,000 population during 2007-2016 ($p=0.55$). The age-standardised mortality rate (ASMR) showed an overall downward trend since 2011 ($p<0.01$), from 20.8 per 100,000 population in 2011 to 14.7 per 100,000 population in 2016.

Of all the stroke patients in 2016, 8.0% (594 patients) died of stroke within 30 days from admission. Compared to 2007 (550 patients, 9.9%), this 30-day case fatality rate (CFR) decreased significantly ($p<0.05$). In 2016, CFR was greater for women (9.3%) as compared to men (7.1%). Malays (8.1%) and Chinese (8.0%) had higher CFR than Indians (7.5%). In 2016, CFR for HS (21.8%), was almost 5 times that for IS (4.7%).

In 2016, the top 5 risk factors found in stroke patients were hyperlipidaemia (83.5%), hypertension (82.8%), ischaemic heart disease (47.5%), diabetes mellitus (43.0%), and smoking (37.3%). The top 5 risk factors found among IS patients in 2016 were hyperlipidaemia (90.1%), hypertension (83.1%), ischaemic heart disease (48.3%), diabetes mellitus (46.4%) and smoking (39.1%); while the top 5 risk factors found among HS patients in 2016 were hypertension (81.9%), hyperlipidaemia (55.2%), ischaemic heart disease (42.3%), smoking (28.6%), and diabetes mellitus (28.1%).

2. INTRODUCTION

Cerebrovascular diseases including stroke, were the 9th most common condition of hospitalisation[1], the 4th most common principal cause of death[2] , and the leading contributor to the burden of disease in Singapore[3].

Stroke occurs when the blood supply to the brain is interrupted or reduced, which results in cell death in 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. Risk factors such as hypertension and hyperlipidaemia make one susceptible to the onset of stroke, but these factors are preventable with a healthy lifestyle. As delayed treatment can lead to irreversible brain damage, timely treatment is an important factor for the treatment of acute stroke.

Stroke is a debilitating disease, whereby patients typically suffered from some form of post-stroke disability, compromising their quality of life, as well as that of their caregivers. The share of total burden of disease from cardiovascular diseases including stroke, was the largest among all diseases in Singapore, according to the Singapore Burden of Disease Study done by the Ministry of Health in 2010[3]. With Singapore's rapidly ageing population, coupled with the high prevalence of stroke risk factors 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[4].

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 2007 to 2016.

[1] Ministry of Health, Statistics, Singapore Health Facts, Top 10 Conditions of Hospitalisation (accessed on Dec 2017)
[2] Principal Causes of Death. Ministry of Health, Singapore (accessed on Dec 2017)
[3] Singapore Burden of Diseases Study 2010. Ministry of Health, Singapore.
[4] Venketasubramanian N and Chen CL. Burden of stroke in Singapore. Int J Stroke. 2008; 3(1): 51-4

3. 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 HIDS listing and from the death registry at the MHA. Name lists from MediClaims, HIDS and MHA were merged using the 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. 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 only covered 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 Dec 2016 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[5]. 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[6], 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[5]. Age standardised mortality rates (ASMRs) were calculated using the direct method with the Segi World population as the standardisation weights[6].

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 severity in stroke, 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.

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

[6] 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

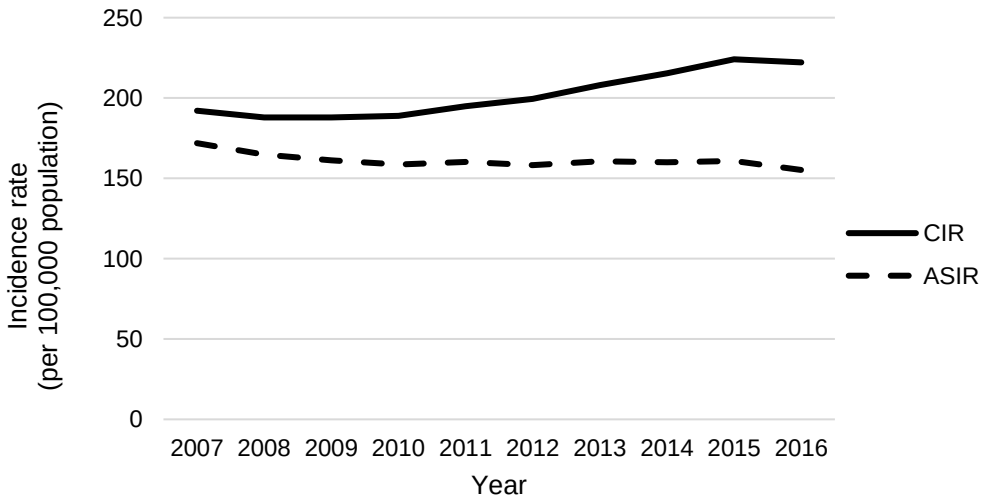
5.1 Incidence of Stroke

Over the years, the number of stroke episodes increased from 5,578 episodes in 2007 to 7,413 episodes in 2016 (Table 5.1.1). Similarly, the crude incidence rate (CIR) increased significantly from 192.0 per 100,000 population in 2007 to 222.1 per 100,000 population in 2016 ($p<0.001$). This increase was mainly driven by the effect of Singapore's ageing population, since the age-standardised incidence rate (ASIR) decreased from 171.8 per 100,000 population in 2007 to 155.2 per 100,000 population in 2016 ($p<0.05$) (Table 5.1.1 and Figure 5.1.1).

Table 5.1.1: Incidence Number and Rate of Stroke (per 100,000 population), 2007-2016

Year	No.	CIR	95% CI	ASIR	95% CI
2007	5578	192.0	187.0-197.0	171.8	167.2-176.4
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	7395	224.1	219.0-229.2	160.9	157.2-164.6
2016	7413	222.1	217.0-227.2	155.2	151.6-158.8
P for trend		p<0.001		p<0.05	

Figure 5.1.1: Incidence Rate of Stroke (per 100,000 population), 2007-2016



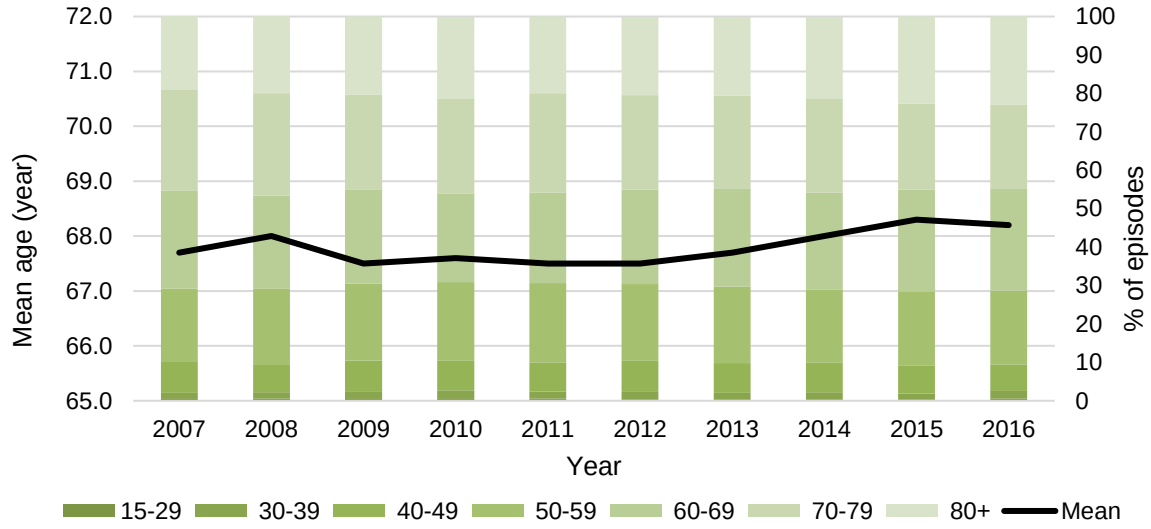
The average age at stroke admission was 68.2 years old in 2016. Before 2012, the highest proportion of stroke patients were aged 70-79 years. Since 2012, the highest proportion of stroke patients was amongst those aged 60-69 years (Table 5.1.2 and Figure 5.1.2).

Table 5.1.2: Age Distribution (%) and Mean Age (year) at Stroke Admission, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	67.7	27	0.5	89	1.6	459	8.2
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	41	0.6	148	2.0	515	6.9

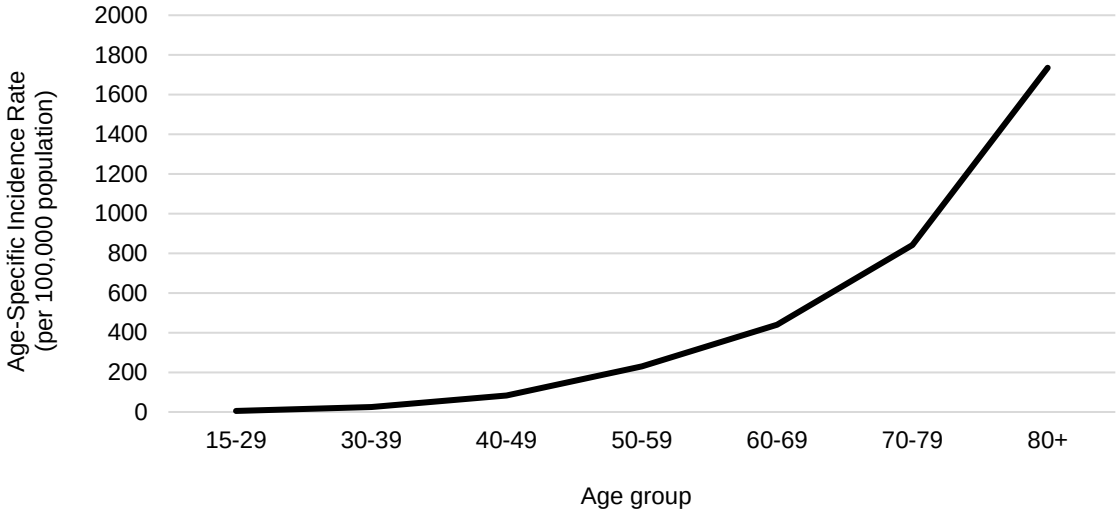
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	1052	18.9	1416	25.4	1465	26.3	1070	19.2
2008	1107	19.8	1357	24.3	1483	26.6	1120	20.1
2009	1150	20.0	1405	24.4	1426	24.8	1167	20.3
2010	1208	20.5	1362	23.1	1457	24.7	1249	21.2
2011	1274	20.7	1447	23.6	1587	25.8	1229	20.0
2012	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	1762	25.1	1718	24.4	1502	21.4
2015	1424	19.3	1957	26.5	1652	22.3	1676	22.7
2016	1418	19.1	1981	26.7	1613	21.8	1697	22.9

Figure 5.1.2: Age Distribution (%) and Mean Age (year) at Stroke Admission, 2007-2016



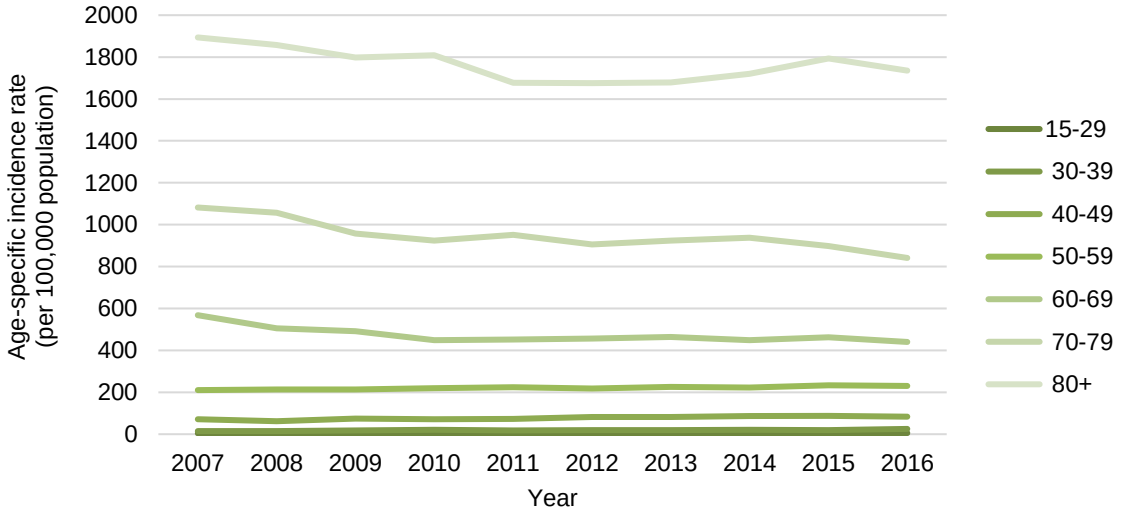
Age is one of the important risk factors for stroke incidence[7]. The age-specific incidence rate increased exponentially with age due to the cumulative effects of ageing on the cerebrovascular system, with the age-specific incidence rate almost doubled or tripled of the next younger age band. (Figure 5.1.3a).

Figure 5.1.3a: Age-Specific Incidence Rate (per 100,000 population) across Age Groups (2016)



[7] 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, 2007-2016



Among those in the age groups 60-69 and 70-79 years, the age-specific incidence rates had declined significantly over the years (p<0.01 for those aged 60-69 years and p<0.001 for those aged 70-79 years). However, there was an increasing trend in age-specific incidence rates for age groups 30-39, 40-49 and 50-59 years (p<0.01) (Table 5.1.3 and Figure 5.1.3b). In 2016, the age-specific incidence rates for age groups older than 40 years dropped slightly compared to the previous year (2015) (Table 5.1.3). More data points in the next few years would be required to observe a more definitive time trend.

Table 5.1.3: Age-Specific Incidence Rate (per 100,000 population), 2007-2016

Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2007	192.0	187.0-197.0	3.7	2.3-5.1	14.9	11.8-18.0	72.1	65.5-78.7
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	224.1	219.0-229.2	4.1	2.7-5.5	18.9	15.4-22.4	87.4	80.0-94.8
2016	222.1	217.0-227.2	5.3	3.7-6.9	25.2	21.1-29.3	83.8	76.6-91.0
P for trend	p<0.001		p=0.25		p<0.01		p<0.01	
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2007	210.4	197.7-223.1	568.0	538.4-597.6	1082.0	1026.6-1137.4	1893.8	1780.3-2007.3
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	451.3	428.0-474.6	950.9	904.1-997.7	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	448.7	427.7-469.7	938.2	893.8-982.6	1720.6	1633.6-1807.6
2015	233.4	221.3-245.5	462.7	442.2-483.2	898.6	855.3-941.9	1793.5	1707.6-1879.4
2016	230.5	218.5-242.5	440.3	420.9-459.7	841.2	800.1-882.3	1735.2	1652.6-1817.8
P for trend	p<0.001		p<0.01		p<0.001		p=0.06	

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[8] (Table 5.1.4). In 2016, the CIR for men was almost 1.5-fold as much as that for women, and the ASIR was 1.7 times higher for men than women.

Generally, for both genders, the number of stroke episodes and CIR increased from 2007 to 2016 ($p<0.001$ for CIR among men, and $p<0.01$ for CIR among women). For women, the ASIR decreased significantly over the years ($p<0.001$), while ASIR for men remained relative stable during the same period (Table 5.1.4 and Figure 5.1.4).

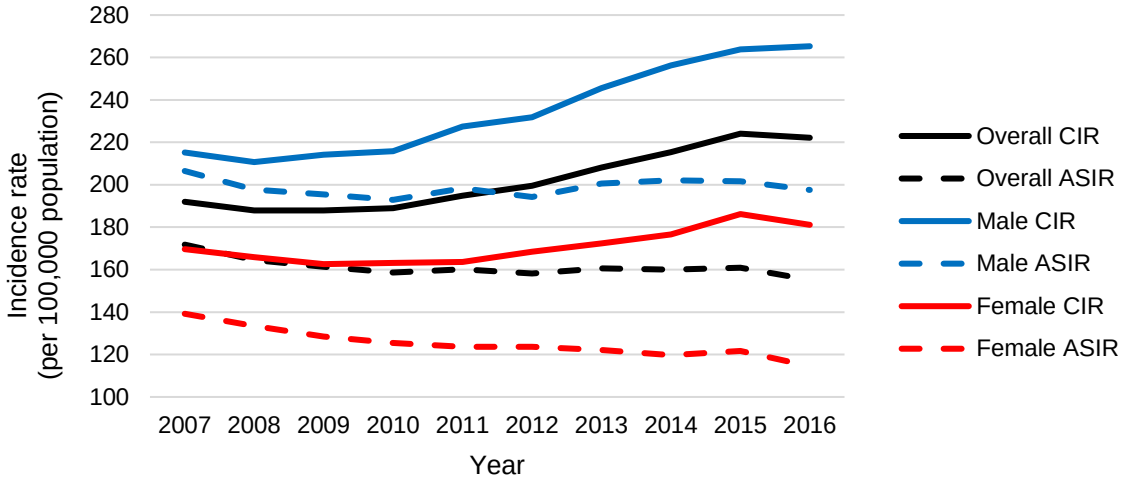
This is due to biological and social difference between the two genders. Premenopausal women are protected by oestrogens against risk for cerebrovascular diseases such as stroke. Oestrogen has beneficial effects on endothelium and vascular system to dilate blood vessels and promote blood flow, while testosterone has the opposite effects[9]. Moreover, the National Health Survey 2010 found that men had higher prevalence of stroke risk factors than women, including hypertension, hyperlipidaemia, obesity, diabetes mellitus and cigarette smoking[10]. 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, 2007-2016

Male						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2007	3072	55.1	215.3	207.7-222.9	206.5	199.2-213.8
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	4246	57.4	263.8	255.9-271.7	201.6	195.5-207.7
2016	4313	58.2	265.3	257.4-273.2	197.5	191.5-203.5
P for trend			p<0.001		p=0.99	
Female						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2007	2506	44.9	169.6	163.0-176.2	139.2	133.6-144.8
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	3149	42.6	186.2	179.7-192.7	121.7	117.3-126.1
2016	3100	41.8	181.1	174.7-187.5	114.5	110.3-118.7
P for trend			p<0.01		p<0.001	

[8] Statistics Singapore-Population Trends 2016. Singstat.
[9] Krause DN et al. Influence of sex steroid hormones on cerebrovascular function. J Appl Physiol 2006;101:1252-1261
[10] National Health Survey 2010. Ministry of Health, Singapore

Figure 5.1.4: Incidence Rate (per 100,000 population) by Gender, 2007-2016



Men suffered from stroke at a younger age than women. In 2016, the average age of stroke admission was 65.4 years for men and 72.1 years for women. In 2016, 34.7% of the male patients were aged 70 years and above at stroke admission, while 58.4% 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, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	65.2	20	0.7	57	1.9	295	9.6
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	27	0.6	104	2.4	333	7.7

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	691	22.5	864	28.1	754	24.5	391	12.7
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	1182	29.0	932	22.8	554	13.6
2015	988	23.3	1323	31.2	889	20.9	592	13.9
2016	1009	23.4	1342	31.1	856	19.8	642	14.9

Figure 5.1.5a: Age Distribution (%) and Mean Age (year) at Stroke Admission among Men, 2007-2016

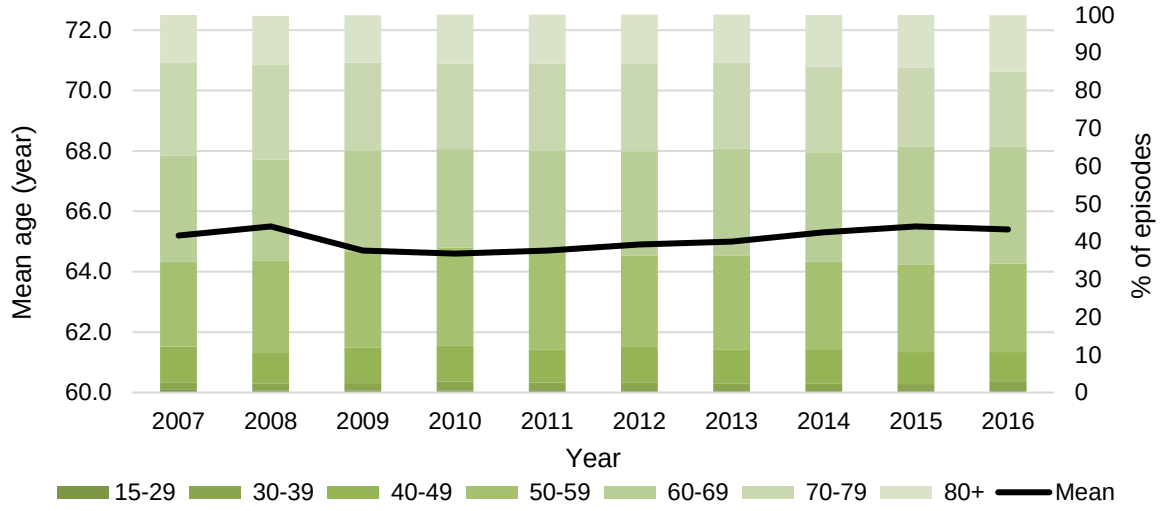


Table 5.1.5b: Age Distribution (%) and Mean Age (year) at Stroke Admission among Women, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	70.7	7	0.3	32	1.3	164	6.5
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	182	5.9

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	361	14.4	552	22.0	711	28.4	679	27.1
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	524	19.9	781	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	436	13.8	634	20.1	763	24.2	1084	34.4
2016	409	13.2	639	20.6	757	24.4	1055	34.0

Figure 5.1.5b: Age Distribution (%) and Mean Age (year) at Stroke Admission among Women, 2007-2016

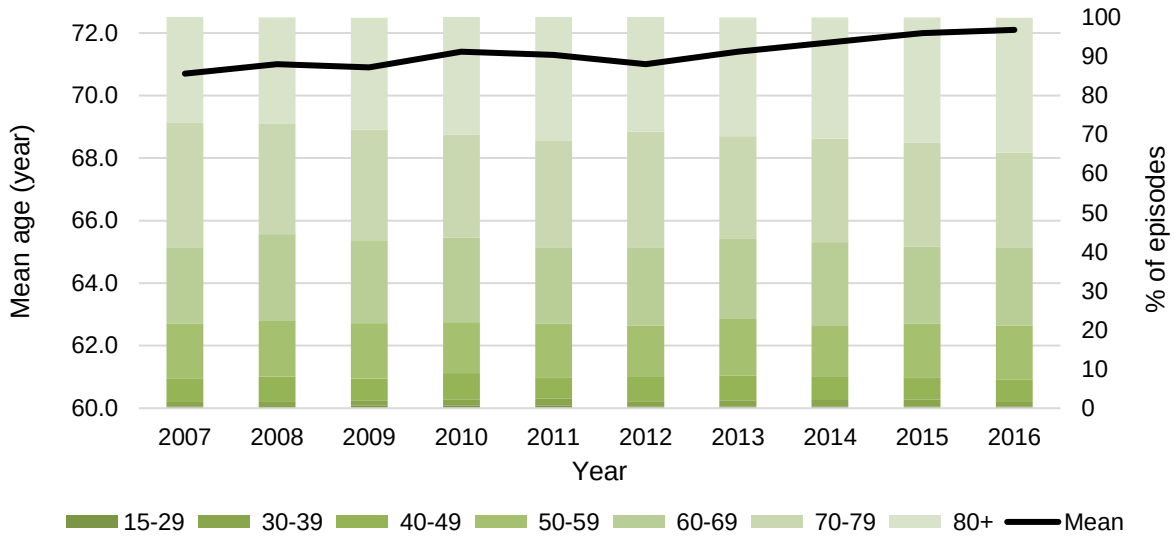
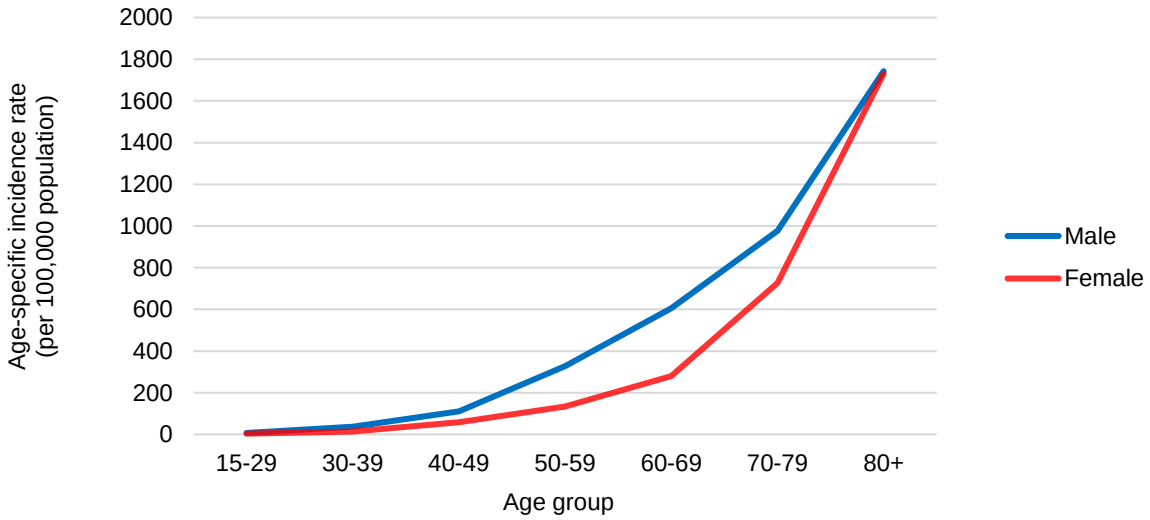


Figure 5.1.6 demonstrates the age-specific incidence rates across age groups for both genders in 2016. The age-specific incidence rates for women were lower than that for men before 80 years old, with the greatest difference for 60-69 years. This gender gap narrowed for age group 80 years and above, with 1,742.8 per 100,000 population for men and 1,730.6 per 100,000 population for women (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 (2016)



From 2007 to 2016, the age-specific incidence rates among men significantly increased for the majority of the male population aged below 60 years. They were namely men aged 30-39 years (increased by almost 2-fold from 19.7 to 37.3 per 100,000 population from 2007 to 2016, p<0.001), 40-49 years (increased by 21% from 92.0 to 111.0 per 100,000 population from 2007 to 2016, p<0.01), and 50-59 years (increased by 19% from 275.2 to 327.0 per 100,000 population from 2007 to 2016, p<0.01) (Table 5.1.6a). Correspondingly, for women, a significant increase was only observed for age group 40-49 years (increased by 11% from 51.9 to 57.8 per 100,000 population from 2007 to 2016, p<0.05) (Table 5.1.6b).

Table 5.1.6a: Age-Specific Incidence Rate (per 100,000 population) across Years among Men, 2007-2016

Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2007	215.3	207.7-222.9	5.5	3.1-7.9	19.7	14.6-24.8	92.0	81.5-102.5
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	263.8	255.9-271.7	3.8	1.9-5.7	27.3	21.2-33.4	119.1	106.8-131.4
2016	265.3	257.4-273.2	6.9	4.3-9.5	37.3	30.1-44.5	111.0	99.1-122.9
P for trend	p<0.001		p=0.76		p<0.001		p<0.01	
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2007	275.2	254.7-295.7	717.0	669.2-764.8	1244.2	1155.4-1333.0	1898.1	1710.0-2086.2
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	610.8	576.0-645.6	1120.3	1048.4-1192.2	1707.5	1565.3-1849.7
2015	322.5	302.4-342.6	635.0	600.8-669.2	1059.5	989.9-1129.1	1694.6	1558.1-1831.1
2016	327.0	306.8-347.2	605.9	573.5-638.3	976.4	911.0-1041.8	1742.8	1608.0-1877.6
P for trend	p<0.01		p=0.21		p<0.01		p=0.09	

While an increase in age-specific incidence rates was observed among males and females aged below 50 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 22% from 1,244.2 to 976.4 per 100,000 population from 2007 to 2016, p<0.01) was observed. A similar trend was observed among women for the age groups: 60-69 years (decreased by 35% from 428.6 to 279.8 per 100,000 population from 2007 to 2016, p<0.001), and 70-79 years (decreased by 23% from 950.5 to 727.3 per 100,000 population from 2007 to 2016, p<0.001) (Table 5.1.6a and Table 5.1.6b).

Table 5.1.6b: Age-Specific Incidence Rate (per 100,000 population) across Years among Women, 2007-2016

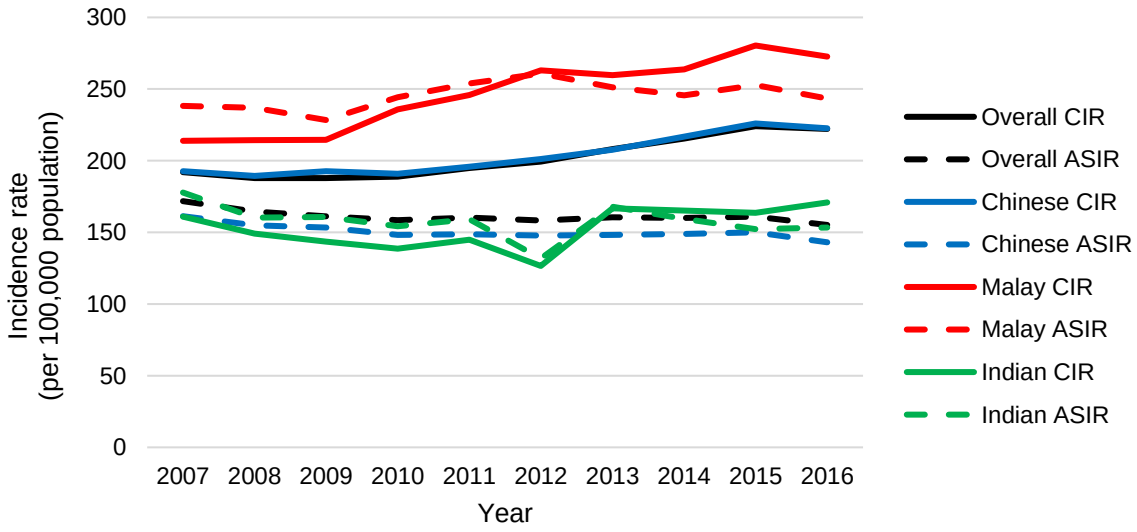
Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2007	169.6	163.0-176.2	1.9	0.5-3.3	10.4	6.8-14.0	51.9	44.0-59.8
2008	165.9	159.4-172.4	4.0	2.0-6.0	11.7	7.9-15.5	44.7	37.3-52.1
2009	162.6	156.3-168.9	3.6	1.7-5.5	13.3	9.3-17.3	54.0	45.9-62.1
2010	163.1	156.8-169.4	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	186.2	179.7-192.7	4.4	2.3-6.5	11.3	7.6-15.0	56.9	48.6-65.2
2016	181.1	174.7-187.5	3.6	1.7-5.5	14.3	10.1-18.5	57.8	49.4-66.2
P for trend	p<0.01		p=0.23		p=0.23		p<0.05	
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CIR	95% CI	CIR	95% CI	CIR	95% CI	CIR	95% CI
2007	145.0	130.0-160.0	428.6	392.8-464.4	950.5	880.6-1020.4	1891.4	1749.1-2033.7
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	320.1	292.7-347.5	851.7	792.0-911.4	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	143.5	130.0-157.0	295.5	272.5-318.5	763.5	709.3-817.7	1852.5	1742.2-1962.8
2016	133.4	120.5-146.3	279.8	258.1-301.5	727.3	675.5-779.1	1730.6	1626.2-1835.0
P for trend	p=0.97		p<0.001		p<0.001		p=0.10	

Similar to the general population's ethnic distribution[11], the stroke episodes were mostly found among Chinese, followed by Malays, then Indians. For all the three main ethnic groups, the number of stroke episodes increased over the years. The Malays showed the highest increase in the number of stroke episodes, a nearly 1.5-fold increase from 787 to 1,161 episodes from 2007 to 2016, as compared to a 1.3-fold increase for the Chinese (from 4,286 to 5,613 episodes) and Indians (from 389 to 493 episodes) during this period (Table 5.1.7).

Of the three main ethnic groups, the Malays had the highest CIR and ASIR in the entire study period. The Malays was also the only group with upward trends found for CIR ($p<0.001$) and ASIR ($p=0.12$) during this period. In terms of ASIR, a significant decrease in ASIR was observed among Chinese, from 161.3 per 100,000 population in 2007 to 143.1 per 100,000 population in 2016 ($p<0.01$). While, a similar downward trend in terms of ASIR was seen among the Indians during this period (from 177.8 to 153.4 per 100,000 population), this was not found to be significant ($p=0.26$) (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 Malays[12].

Figure 5.1.7: Incidence Rate (per 100,000 population) by Ethnicity, 2007-2016



[11] Statistics Singapore-Population Trends 2016. Singstat.
[12] National Health Survey 2010. Ministry of Health, Singapore

Table 5.1.7: Incidence Number and Rate (per 100,000 population) by Ethnicity, 2007-2016

Chinese						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2007	4286	76.8	192.7	186.9-198.5	161.3	156.4-166.2
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	147.7	143.5-151.9
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	5634	76.2	226.0	220.1-231.9	150.0	146.0-154.0
2016	5613	75.7	222.7	216.9-228.5	143.1	139.2-147.0
P for trend			p<0.001		p<0.01	
Malay						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2007	787	14.1	213.9	199.0-228.8	238.3	221.4-255.2
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	922	15.7	235.7	220.5-250.9	244.4	228.1-260.7
2011	976	15.9	245.8	230.4-261.2	254.0	237.5-270.5
2012	1060	16.6	263.0	247.2-278.8	260.8	244.7-276.9
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	1178	15.9	280.4	264.4-296.4	252.8	238.2-267.4
2016	1161	15.7	272.6	256.9-288.3	243.5	229.3-257.7
P for trend			p<0.001		p=0.12	
Indian						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2007	389	7.0	161.0	145.0-177.0	177.8	159.7-195.9
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	400	6.5	145.0	130.8-159.2	159.3	143.1-175.5
2012	353	5.5	126.6	113.4-139.8	131.8	117.7-145.9
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	493	6.7	170.9	155.8-186.0	153.4	139.7-167.1
P for trend			p=0.21		p=0.26	

The average age at stroke admission among Malays and Indians were similar, about 64 years for Malays and about 63 years for Indians. As for the Chinese, the average age at stroke admission was older (about 69 years old). For the Chinese, the average age at admission increased slightly since 2009, from 68.4 to 69.5 years (Figure 5.1.8a). However, this increasing trend was not observed among Malays and Indians (Figure 5.1.8b and Figure 5.1.8c).

In 2016, the proportion of stroke patients aged 70 years and above at stroke admission for each of the three major ethnic groups was 48.6% (Chinese), 30.7% (Malays) and 33.8% (Indians) respectively.

Table 5.1.8a: Age Distribution (%) and Mean Age (year) at Stroke Admission among Chinese, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	68.7	16	0.4	65	1.5	304	7.1
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	378	6.7
2016	69.5	25	0.4	89	1.6	341	6.1

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	743	17.3	1104	25.8	1138	26.6	916	21.4
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	1091	23.4	1264	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	950	16.9	1467	26.0	1336	23.7	1409	25.0
2016	949	16.9	1480	26.4	1325	23.6	1404	25.0

Figure 5.1.8a: Age Distribution (%) and Mean Age (year) at Stroke Admission among Chinese, 2007-2016

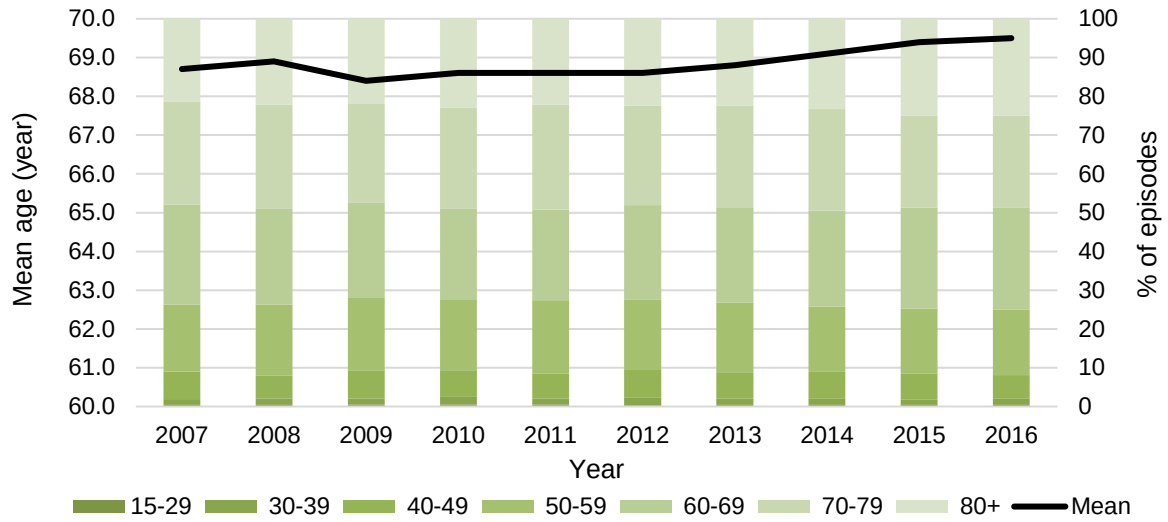


Table 5.1.8b: Age Distribution (%) and Mean Age (year) at Stroke Admission among Malays, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	64.1	8	1.0	9	1.1	93	11.8
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	100	8.5
2016	63.7	10	0.9	36	3.1	109	9.4

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	185	23.5	195	24.8	221	28.1	76	9.7
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	206	22.3	120	13.0
2011	252	25.8	254	26.0	219	22.4	121	12.4
2012	277	26.1	269	25.4	238	22.5	137	12.9
2013	274	25.8	303	28.5	200	18.8	148	13.9
2014	297	27.2	287	26.3	225	20.6	145	13.3
2015	319	27.1	343	29.1	218	18.5	169	14.3
2016	315	27.1	334	28.8	184	15.8	173	14.9

Figure 5.1.8b: Age Distribution (%) and Mean Age (year) at Stroke Admission among Malays, 2007-2016

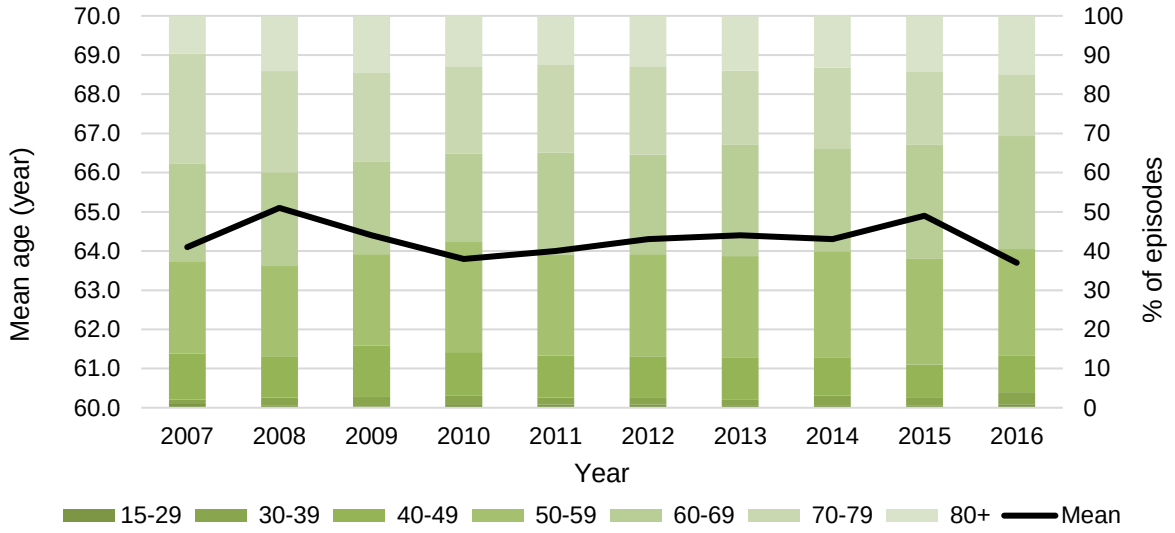
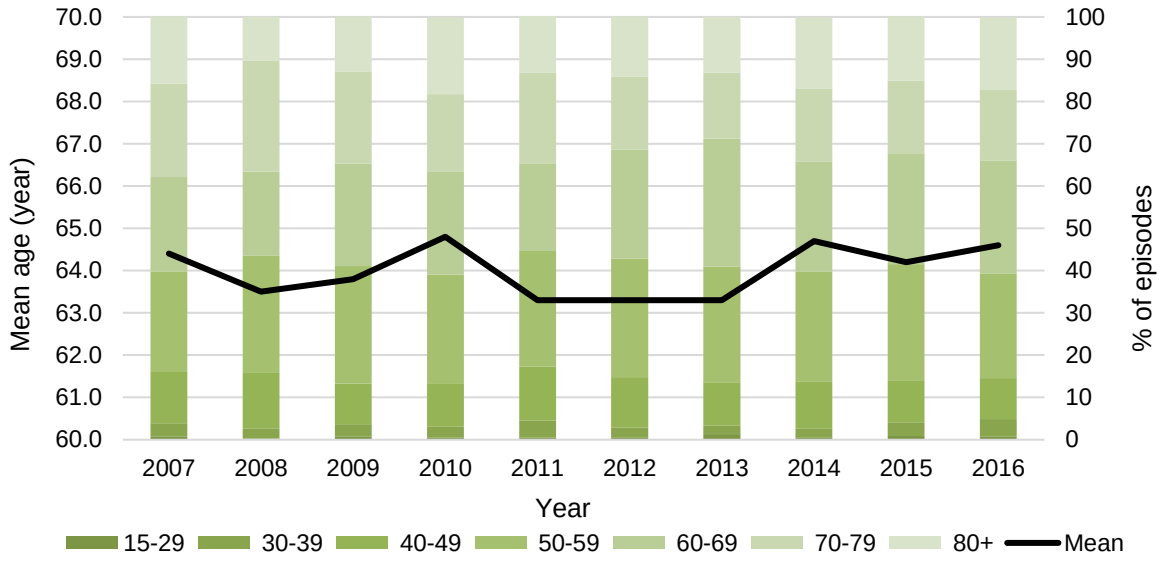


Table 5.1.8c: Age Distribution (%) and Mean Age (year) at Stroke Admission among Indians, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	64.4	3	0.8	12	3.1	47	12.1
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	12.8
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	4.1	48	9.7

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	92	23.7	87	22.4	86	22.1	62	15.9
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	27.3	83	20.8	86	21.5	53	13.3
2012	99	28.0	91	25.8	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	122	24.7	132	26.8	82	16.6	85	17.2

Figure 5.1.8c: Age Distribution (%) and Mean Age (year) at Stroke Admission among Indians, 2007-2016



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

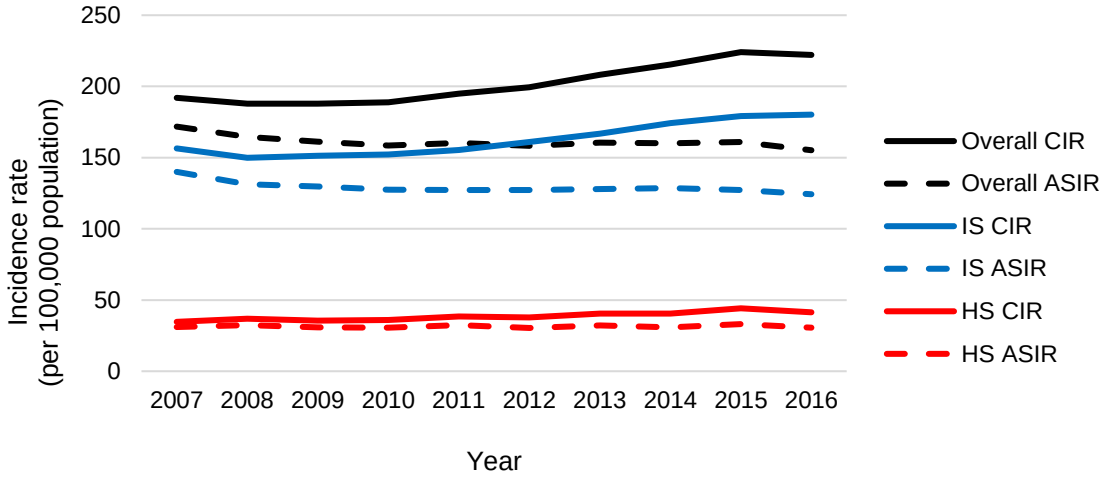
Generally, the number of stroke episodes and CIR for both stroke sub-types had increased over the years. However, the ASIR of IS decreased significantly from 140.0 per 100,000 population in 2007 to 124.3 per 100,000 population in 2016 ($p<0.05$), while the ASIR of HS fluctuated between 30.4 and 33.1 per 100,000 population during the same period (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, 2007-2016

Ischaemic stroke*						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2007	4545	81.5	156.5	152.0-161.0	140.0	135.9-144.1
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	5912	79.9	179.1	174.5-183.7	127.3	124.0-130.6
2016	6014	81.1	180.2	175.6-184.8	124.3	121.1-127.5
P for trend			p<0.001		p<0.05	
Haemorrhagic stroke*						
Year	**No.**	**%**	**CIR**	**95% CI**	**ASIR**	**95% CI**
2007	1009	18.1	34.7	32.6-36.8	31.1	29.2-33.0
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	1458	19.7	44.2	41.9-46.5	33.1	31.4-34.8
2016	1383	18.7	41.4	39.2-43.6	30.6	28.9-32.3
P for trend			p<0.001		p=0.87	

** 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, 2007-2016



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

In 2016, 35.3% of the HS patients were aged 70 years and above at admission, while 46.7% 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), 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	68.6	15	0.3	59	1.3	314	6.9
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	358	6.0

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	801	17.6	1181	26.0	1256	27.6	919	20.2
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	1173	23.9	1323	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	1453	25.5	1458	25.6	1246	21.9
2015	1078	18.2	1599	27.0	1401	23.7	1393	23.6
2016	1102	18.3	1641	27.3	1374	22.8	1437	23.9

Figure 5.1.10a: Age Distribution (%) and Mean Age (year) at Stroke Admission (Ischaemic Stroke), 2007-2016

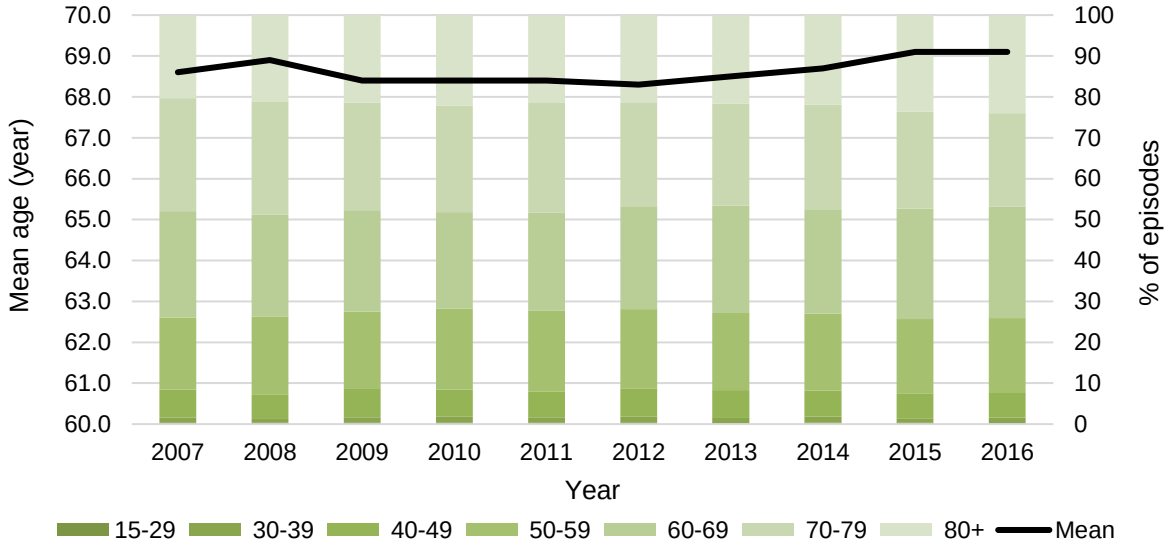
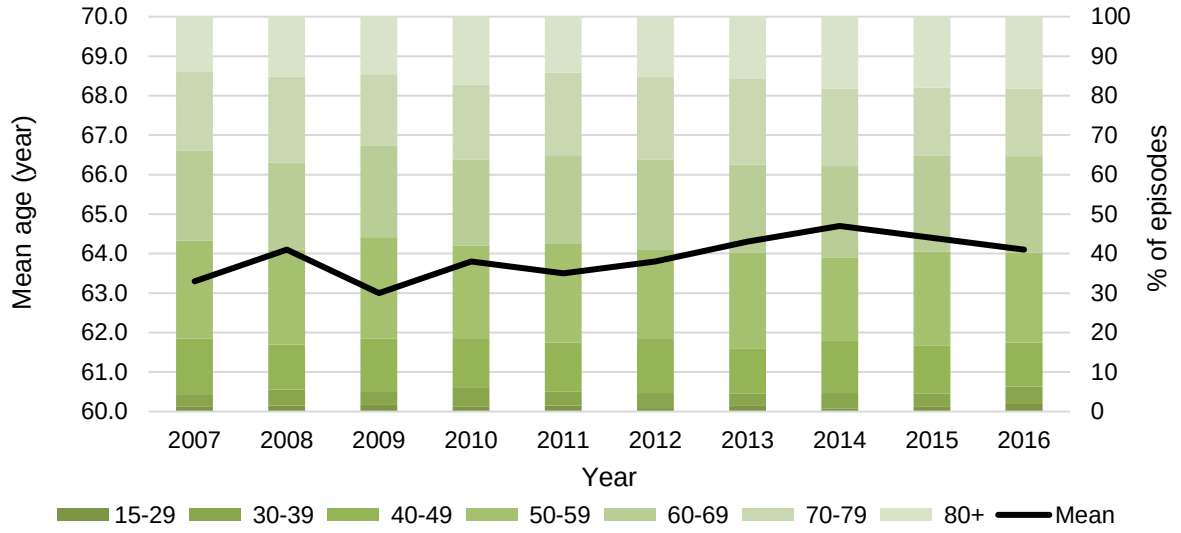


Table 5.1.10b: Age Distribution (%) and Mean Age (year) at Stroke Admission (Haemorrhagic Stroke), 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	63.3	12	1.2	30	3.0	144	14.3
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	64.4	17	1.2	48	3.3	180	12.3
2016	64.1	26	1.9	61	4.4	155	11.2

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	250	24.8	230	22.8	203	20.1	140	13.9
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	262	18.0
2016	315	22.8	338	24.4	236	17.1	252	18.2

Figure 5.1.10b: Age Distribution (%) and Mean Age (year) at Stroke Admission (Haemorrhagic Stroke), 2007-2016



5.2 Mortality of Stroke

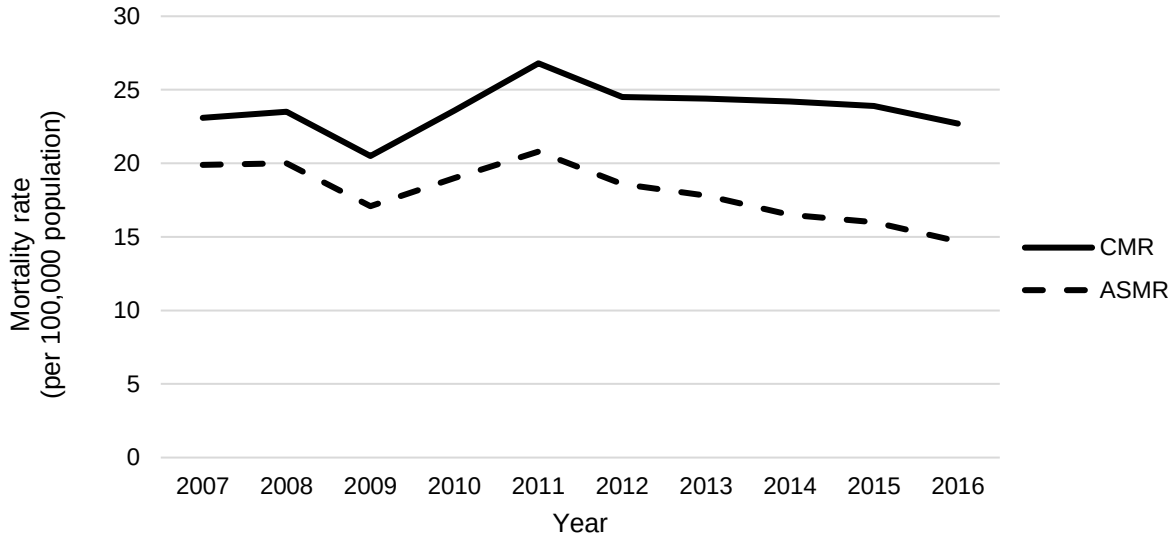
During 2007-2016, the number of deaths due to stroke peaked at 844 in 2011 before decreasing to 759 in 2016. Similarly, the crude mortality rate (CMR) peaked in 2011 at 26.8 per 100,000 population and then decreased to 22.7 per 100,000 population in 2016 (Table 5.2.1).

Correspondingly, the age-standardised mortality rate (ASMR) peaked at 20.8 per 100,000 population in 2011 and then gradually declined to 14.7 per 100,000 population in 2016 (Table 5.2.1 and Figure 5.2.1) ($p<0.01$). This falling stroke mortality in the recent years was possibly attributed to the timely recognition of stroke symptoms and improved stroke treatment.

Table 5.2.1: Mortality Number and Rate (per 100,000 population) of Stroke, 2007-2016

Year	No.	CMR	95% CI	ASMR	95% CI
2007	670	23.1	21.4-24.8	19.9	18.4-21.4
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	759	22.7	21.1-24.3	14.7	13.6-15.8
P for trend		p=0.55		p<0.01	

Figure 5.2.1: Mortality Rate (per 100,000 population) of Stroke, 2007-2016



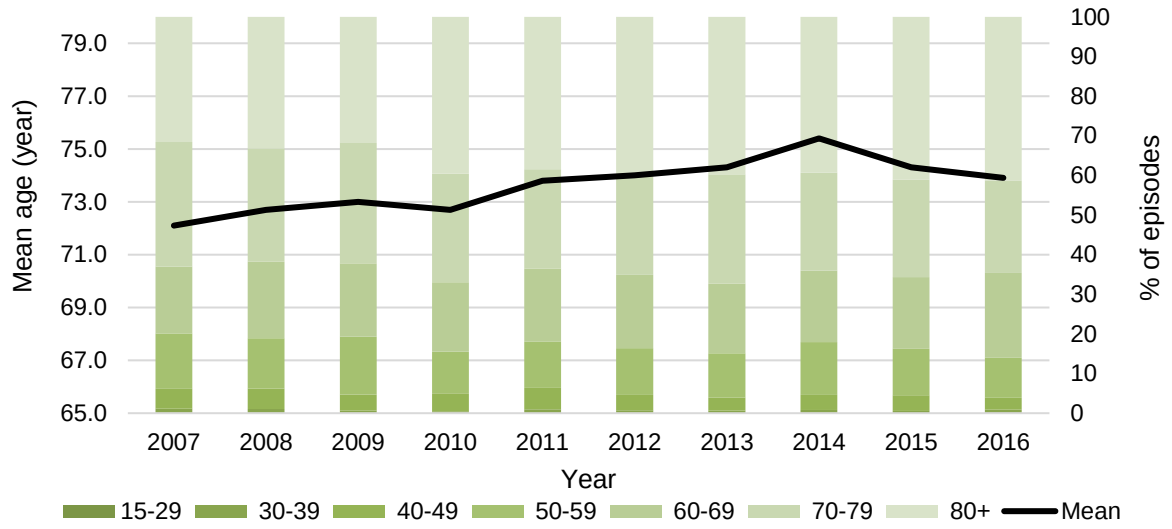
The average age for stroke death increased from 72.1 years old in 2007 to 75.4 years in 2014 but declined subsequently to 73.9 years in 2016. The highest proportion of the stroke death occurred in patients aged 80 years or older. Moreover, this proportion rose from 32.4% in 2007 to 41.4% in 2016, while the proportion aged 70-79 years old dropped from 28.8% in 2007 to 21.3% in 2016 (Table 5.2.2 and Figure 5.2.2).

Table 5.2.2: Age Distribution (%) and Mean Age (year) at Death, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	72.1	2	0.3	6	0.9	45	6.7
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

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	85	12.7	122	18.2	193	28.8	217	32.4
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	136	17.9	162	21.3	314	41.4

Figure 5.2.2: Age Distribution (%) and Mean Age (year) at Death, 2007-2016



Consistent with the age-specific incidence rate, the age-specific mortality rate increased sharply with age, especially for people 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 (2016)

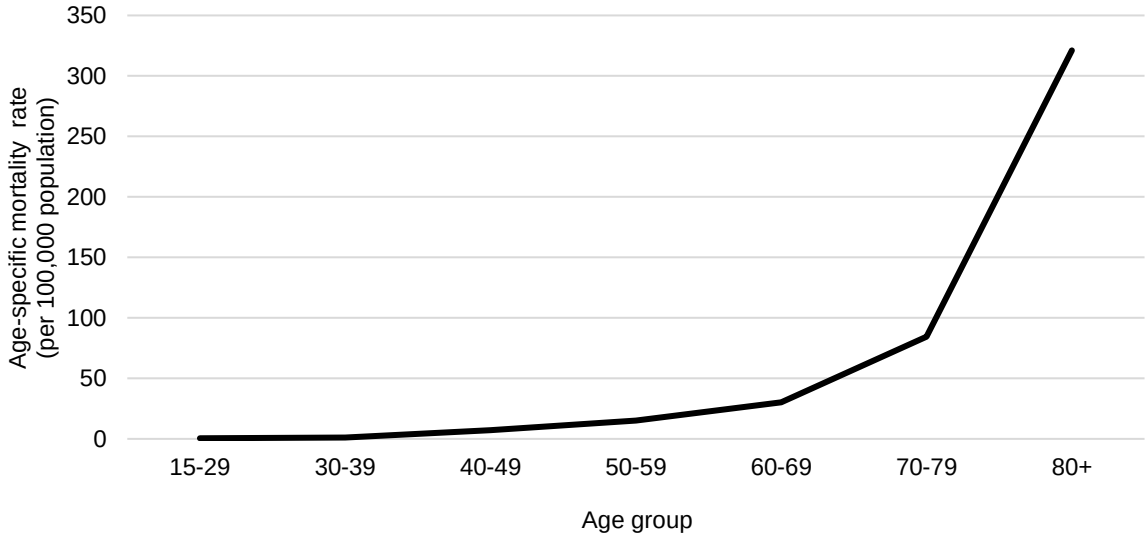
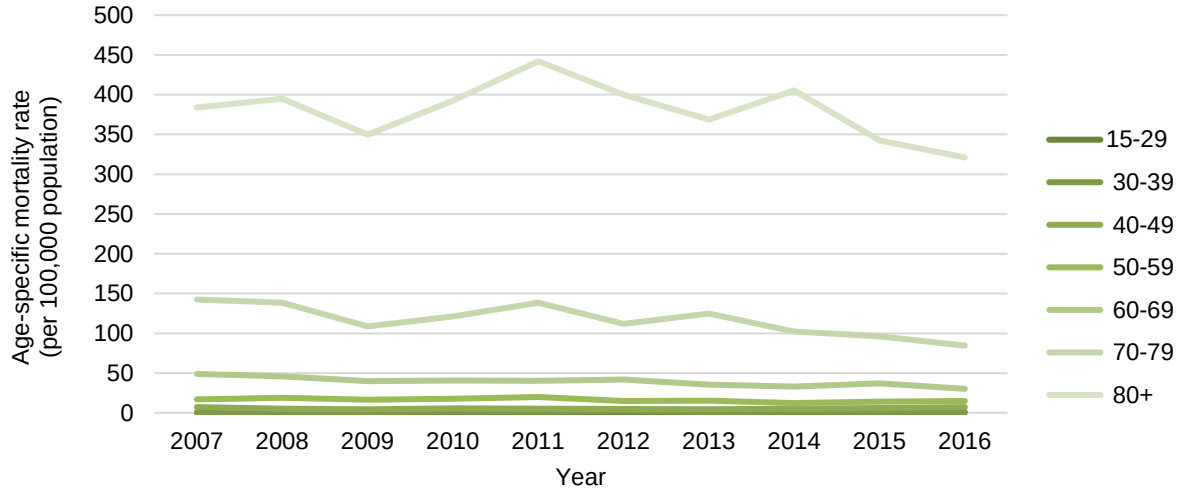


Figure 5.2.3b: Age-Specific Mortality Rate (per 100,000 population) across Years, 2007-2016



From 2007 to 2016, it was observed that the age-specific mortality rates declined significantly for people of several age groups: 50-59 years (decreased by 12% from 17.0 to 15.0 per 100,000 population from 2007 to 2016, p<0.05), 60-69 years (decreased by 38% from 48.9 to 30.2 per 100,000 population from 2007 to 2016, p<0.001) and 70-79 years (decreased by 41% from 142.5 to 84.5 per 100,000 population from 2007 to 2016, p<0.01) (Table 5.2.3).

Table 5.2.3: Age-Specific Mortality Rate (per 100,000 population), 2007-2016

Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2007	23.1	21.4-24.8	0.3	0.0-0.7	1.0	0.2-1.8	7.1	5.0-9.2
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	22.7	21.1-24.3	0.5	0.0-1.0	1.2	0.3-2.1	7.2	5.1-9.3
P for trend	p=0.55		p=0.69		p=0.43		p=0.74	
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2007	17.0	13.4-20.6	48.9	40.2-57.6	142.5	122.4-162.6	384.1	333.0-435.2
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	30.2	25.1-35.3	84.5	71.5-97.5	321.1	285.6-356.6
P for trend	p<0.05		p<0.001		p<0.01		p=0.23	

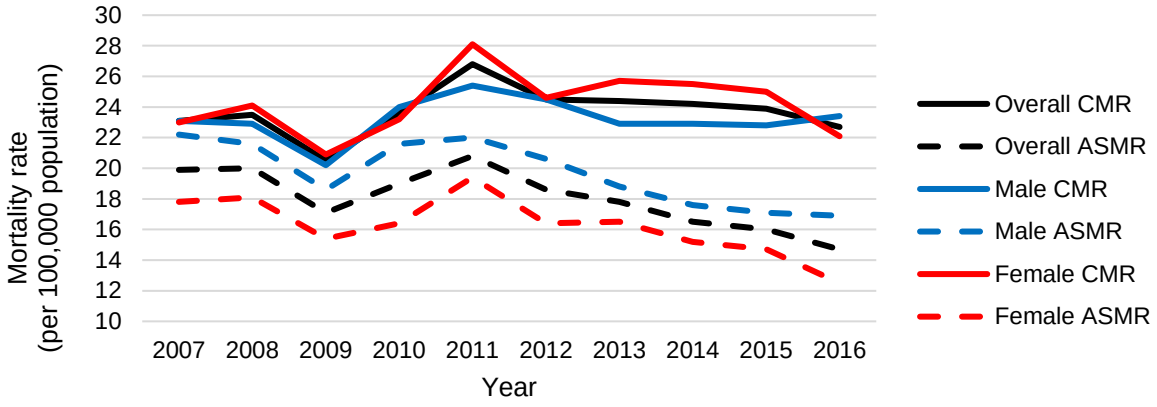
Every year, more women than men died from stroke during 2007-2016 (with exception of year 2016) (Table 5.2.4), although women accounted for less than 45% of stroke incidence during the same time period (Table 5.1.4). This was due to the fact that women tended to have stroke at an older age (Table 5.1.5a and Table 5.1.5b) and thus were likely to have more co-morbidities accompanying the onset of stroke.

Similar to ASIR, the ASMR was consistently higher for men than for women during 2007-2016 (Table 5.2.4). For both genders, the ASMR decreased significantly over the years (from 22.2 to 16.9 per 100,000 population, p<0.01 for men; from 17.8 to 12.5 per 100,000 population, p<0.05 for women).

Table 5.2.4: Mortality Number and Rate (per 100,000 population) by Gender, 2007-2016

Male						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2007	330	49.3	23.1	20.6-25.6	22.2	19.8-24.6
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	381	50.2	23.4	21.0-25.8	16.9	15.2-18.6
P for trend			p=0.65		p<0.01	
Female						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2007	340	50.7	23.0	20.6-25.4	17.8	15.9-19.7
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	49.8	22.1	19.9-24.3	12.5	11.2-13.8
P for trend			p=0.52		p<0.05	

Figure 5.2.4: Mortality Rate (per 100,000 population) by Gender, 2007-2016



The average age of death due to stroke among men was much younger than women. In 2016, the average age for death due to stroke for men was 70.0 years, while the average age for women was 77.9 years (Table 5.2.5a and Table 5.2.5b).

In 2016, 73.3% of death due to stroke in female patients occurred among those aged 70 years and above, while 52.2% occurred among male patients in this age group (Table 5.2.5a and Table 5.2.5b). Moreover, an increasing proportion of death due to stroke was found to occur for female patients in the oldest age band (80 years and above), from 39.4% in 2007 to 54.8% in 2016 (Table 5.2.5a and Table 5.2.5b).

Table 5.2.5a: Age Distribution (%) and Mean Age (year) at Death among Men, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	69.9	1	0.3	2	0.6	25	7.6
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

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	50	15.2	81	24.5	88	26.7	83	25.2
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	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	84	22.0	92	24.1	107	28.1

Figure 5.2.5a: Age Distribution (%) and Mean Age (year) at Death among Men, 2007-2016

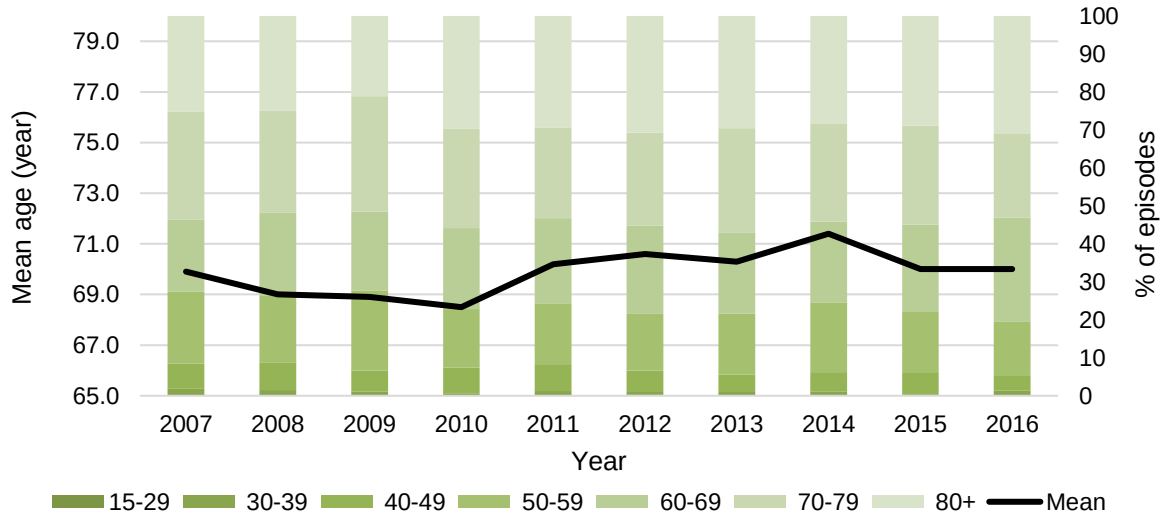


Table 5.2.5b: Age Distribution (%) and Mean Age (year) at Death among Women, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	74.2	1	0.3	4	1.2	20	5.9
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

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	35	10.3	41	12.1	105	30.9	134	39.4
2008	34	9.3	51	14.0	105	28.8	158	43.4
2009	20	6.1	50	15.3	88	27	152	46.6
2010	32	8.7	43	11.7	96	26	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

Figure 5.2.5b: Age Distribution (%) and Mean Age (year) at Death among Women, 2007-2016

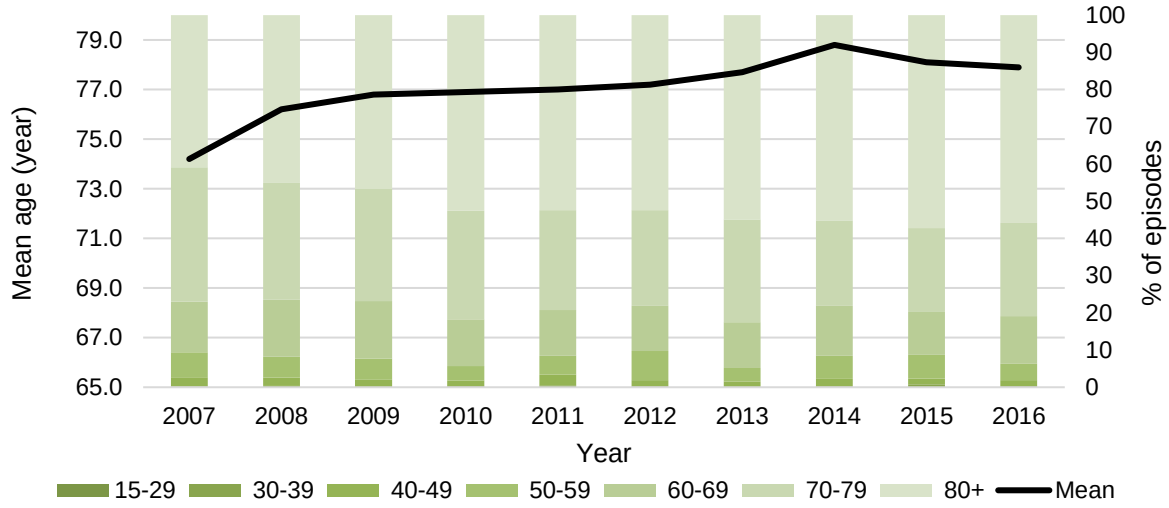
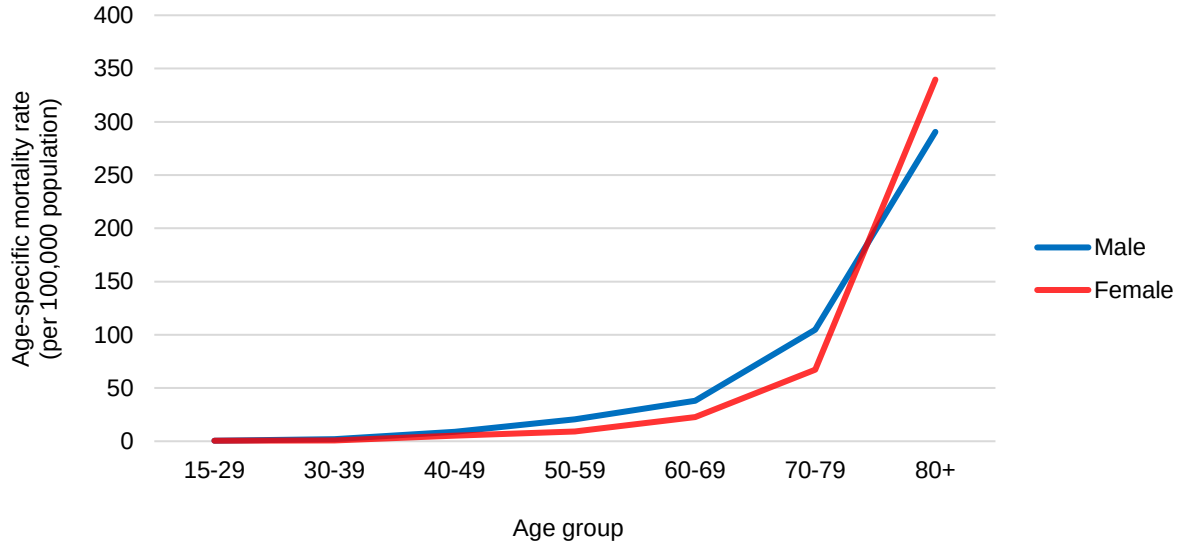


Figure 5.2.6 demonstrates the age-specific mortality rates across age groups for both genders in 2016.

In 2016, the age-specific mortality rates were consistently higher for men compared to women across age groups (30-79 years old). However, this gender difference was reversed in the age group 80 years and above (Figure 5.2.6). This is due to the fact that on average, women live longer than men in Singapore[13], and as the risk of stroke increases with age, the risk of stroke and stroke death is therefore higher for women in the higher age bands.

Figure 5.2.6: Age-Specific Mortality Rate (per 100,000 population) across Age Groups by Gender (2016)



[13] Life Expectancy at Birth (1957-2016). Department of Statistics Singapore.

From 2007 to 2016, the age-specific mortality rates declined significantly for older men: 60-69 years (decreased by 44% from 67.2 to 37.9 per 100,000 population from 2007 to 2016, p<0.05), 70-79 years (decreased by 28% from 145.2 to 104.9 per 100,000 population from 2007 to 2016, p<0.05), and 80 years and above (decreased by 28% from 402.9 to 290.5 per 100,000 population from 2007 to 2016, p<0.05). A similar trend was observed for older women: 60-69 years (decreased by 28% from 31.8 to 22.8 per 100,000 population from 2007 to 2016, p<0.001), 70-79 years (decreased by 52% from 140.4 to 67.3 per 100,000 population from 2007 to 2016, p<0.001), but was not significant for age group 80 years and above (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, 2007-2016

Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2007	23.1	20.6-25.6	0.3	0.0-0.8	0.7	0.0-1.7	7.8	4.7-10.9
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	23.4	21.0-25.8	0.5	0.0-1.2	1.8	0.2-3.4	9.0	5.6-12.4
P for trend	p=0.65		p=0.88		p=0.13		p=0.60	
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2007	19.9	14.4-25.4	67.2	52.6-81.8	145.2	114.9-175.5	402.9	316.2-489.6
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	37.9	29.8-46.0	104.9	83.5-126.3	290.5	235.5-345.5
P for trend	p=0.09		p<0.05		p<0.05		p<0.05	

Table 5.2.6b: Age-Specific Mortality Rate (per 100,000 population) across Years among Women, 2007-2016

Year	Overall		Age 15-29		Age 30-39		Age 40-49	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2007	23.0	20.6-25.4	0.3	0.0-0.8	1.3	0.0-2.6	6.3	3.5-9.1
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
P for trend	p=0.52		p=0.37		p=0.26		p=0.86	
Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	CMR	95% CI	CMR	95% CI	CMR	95% CI	CMR	95% CI
2007	14.1	9.4-18.8	31.8	22.1-41.5	140.4	113.5-167.3	373.3	310.1-436.5
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
P for trend	p=0.27		p<0.001		p<0.001		p=0.78	

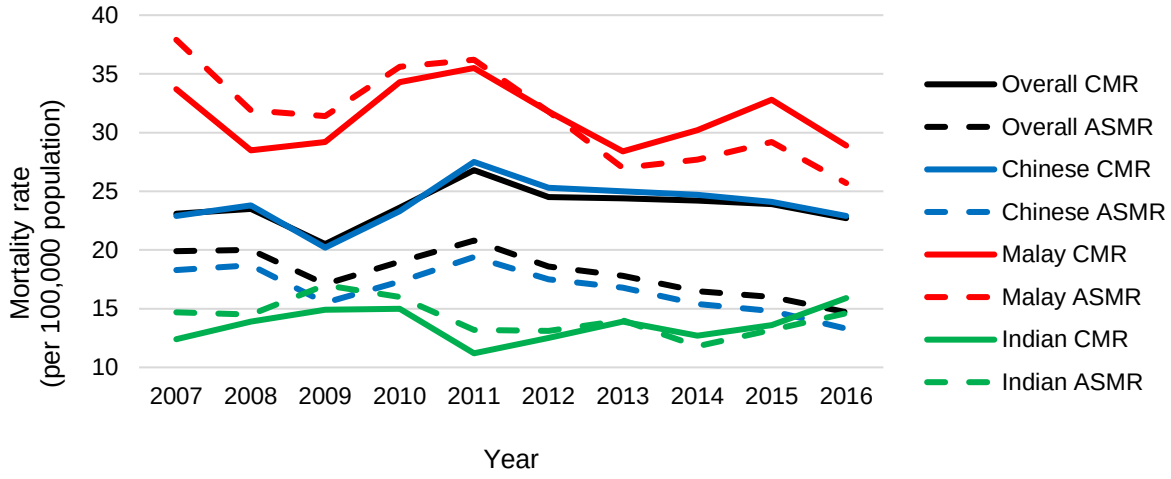
Among the three main ethnic groups, the Malays had the highest CMR and ASMR across the entire study period (Figure 5.2.7), which corresponded to them also having the highest CIR and ASIR (Figure 5.1.7). In 2016, the ASMR for Malays was 25.7 per 100,000 population, followed by Indians (14.6 per 100,000 population) and then Chinese (13.3 per 100,000 population).

The ASMR decreased significantly over the years for the Chinese (from 18.3 to 13.3 per 100,000 from 2007 to 2016, $p<0.05$) and Malays (from 37.9 to 25.7 per 100,000 during this period, $p<0.01$), but not for the Indians (Table 5.2.7 and Figure 5.2.7).

Table 5.2.7: Mortality Number and Rate (per 100,000 population) by Ethnicity, 2007-2016

Chinese						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2007	509	76.0	22.9	20.9-24.9	18.3	16.7-19.9
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	75.9	22.9	21.0-24.8	13.3	12.2-14.4
P for trend			p=0.44		p<0.05	
Malay						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2007	124	18.5	33.7	27.8-39.6	37.9	31.1-44.7
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	123	16.2	28.9	23.8-34.0	25.7	21.1-30.3
P for trend			p=0.58		p<0.01	
Indian						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2007	30	4.5	12.4	8.0-16.8	14.7	9.3-20.1
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
P for trend			p=0.58		p=0.13	

Figure 5.2.7: Mortality Rate (per 100,000 population) by Ethnicity, 2007-2016



Compared to the Chinese, the Malays and Indians patients had younger average age of death due to stroke. In 2016, the average age of death due to stroke was 75.5 years for the Chinese, 68.1 years for the Malays, and 71.5 years for the Indians (Table 5.2.8a, Table 5.2.8b and Table 5.2.8c).

In 2016, 66.7% of deaths due to stroke among the Chinese patients occurred in those aged 70 years and above. The corresponding proportion was 48.0% for the Malay patients and 56.5% for the Indian patients (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, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	72.8	1	0.2	3	0.6	36	7.1
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

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	62	12.2	91	17.9	133	26.1	183	36.0
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

Figure 5.2.8a: Age Distribution (%) and Mean Age (year) at Death among Chinese, 2007-2016

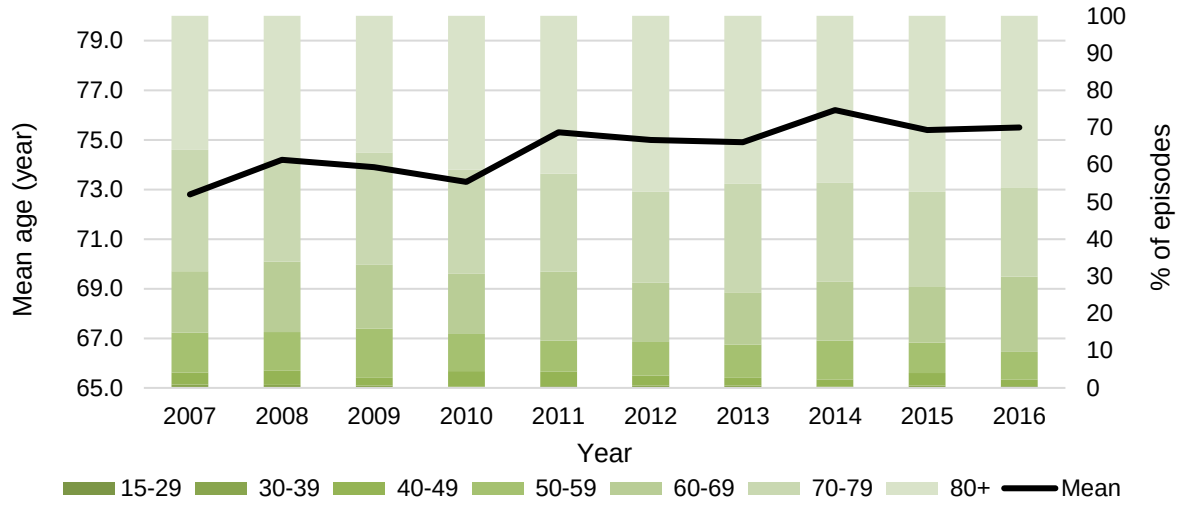


Table 5.2.8b: Age Distribution (%) and Mean Age (year) at Death among Malays, 2007-2016

Year	Average Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	70.7	0	0.0	2	1.6	6	4.8
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	3.3	13	10.6

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	15	12.1	25	20.2	49	39.5	27	21.8
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	17.9	24	19.5	22	17.9	37	30.1

Figure 5.2.8b: Age Distribution (%) and Mean Age (year) at Death among Malays, 2007-2016

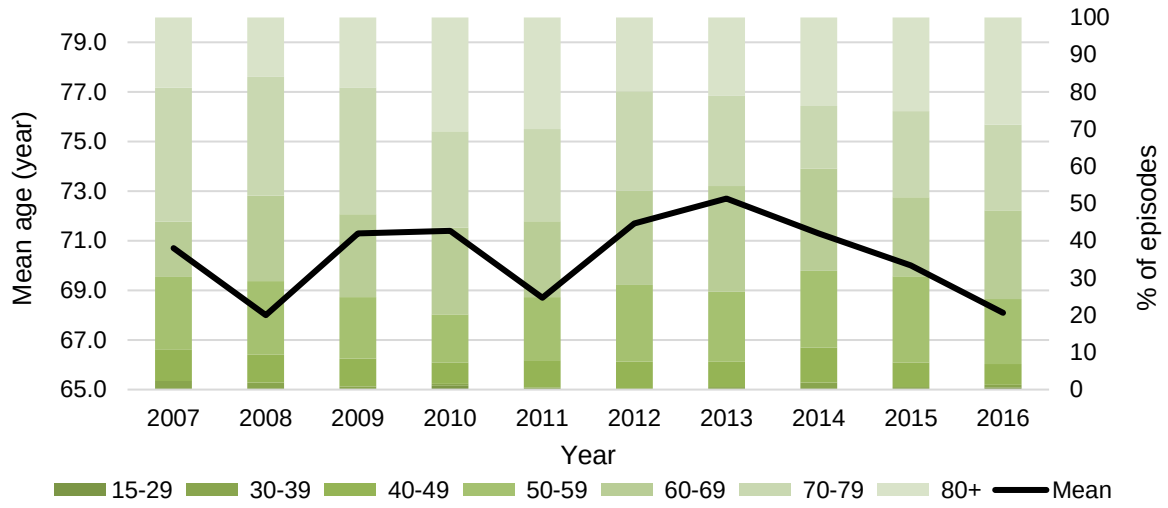
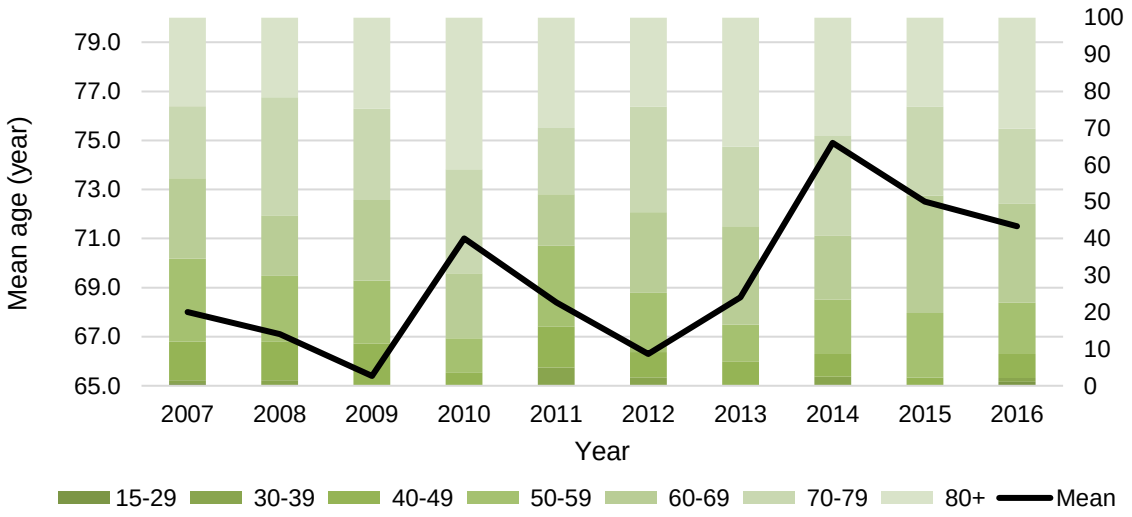


Table 5.2.8c: Age Distribution (%) and Mean Age (year) at Death among Indians, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	68.0	1	3.3	1	3.3	1	3.3
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

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	6	20.0	6	20.0	9	30.0	6	20.0
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

Figure 5.2.8c: Age Distribution (%) and Mean Age (year) at Death among Indians, 2007-2016



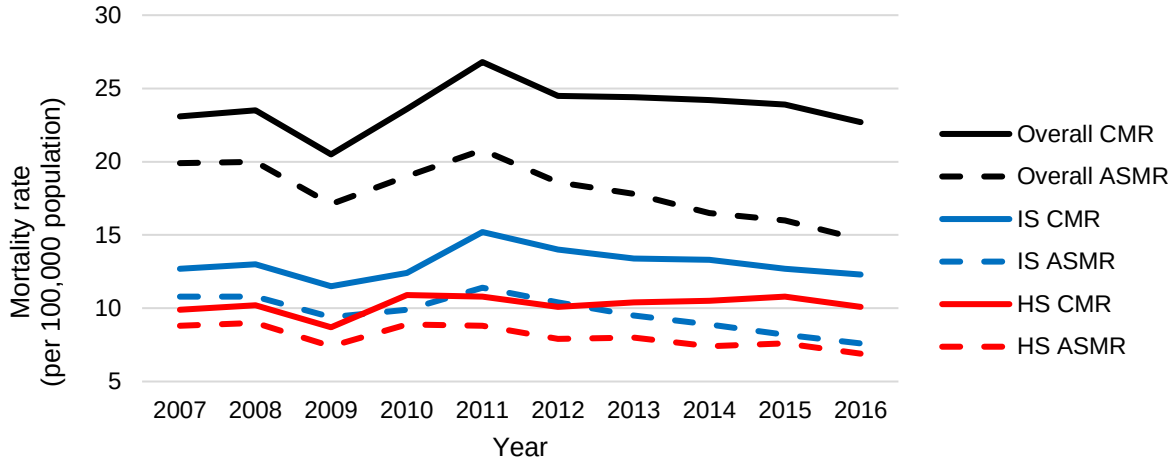
More patients died from IS than HS every year during 2007-2016 (Table 5.2.9), due to the disproportionate higher incidence number of IS than HS (Table 5.1.9). Similarly, the CMR and ASMR for IS were consistently higher than those for HS during this period. For both stroke sub-types, the ASMR declined significantly from 2007 to 2016 (from 10.8 to 7.6 per 100,000 population, p<0.01 for IS; and from 8.8 to 6.9 per 100,000 population, p<0.05 for HS) (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, 2007-2016

Ischaemic stroke*						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2007	369	55.1	12.7	11.4-14.0	10.8	9.7-11.9
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	54.3	12.3	11.1-13.5	7.6	6.9-8.3
P for trend			p=0.78		p<0.01	
Haemorrhagic stroke*						
Year	**No.**	**%**	**CMR**	**95% CI**	**ASMR**	**95% CI**
2007	289	43.1	9.9	8.8-11.0	8.8	7.8-9.8
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	337	44.4	10.1	9.0-11.2	6.9	6.1-7.7
P for trend			p=0.30		p<0.05	

** 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, 2007-2016



From 2007 to 2016, the average age of death due to stroke ranged from 75 to 78 years for IS patients and it ranged from 67 to 72 years for HS patients. The age difference between death due to IS and HS ranged between 6-10 years during 2007-2016. In 2016, the average age at IS death was 77.8 years and HS death was 69.1 years.

In 2016, 73.8% of stroke death among the IS patients occurred at 70 years and above, while 49.0% 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, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	75.6	0	0.0	2	0.5	6	1.6
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

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	35	9.5	61	16.5	121	32.8	144	39.0
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

Figure 5.2.10a: Age Distribution (%) and Mean Age (year) at Death for Ischaemic Stroke Patients, 2006-2017

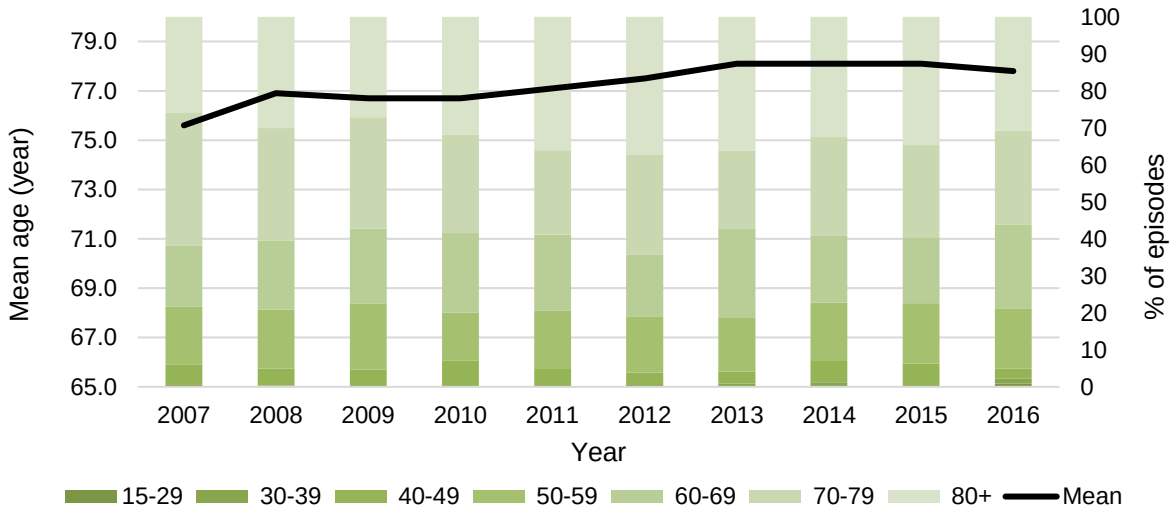
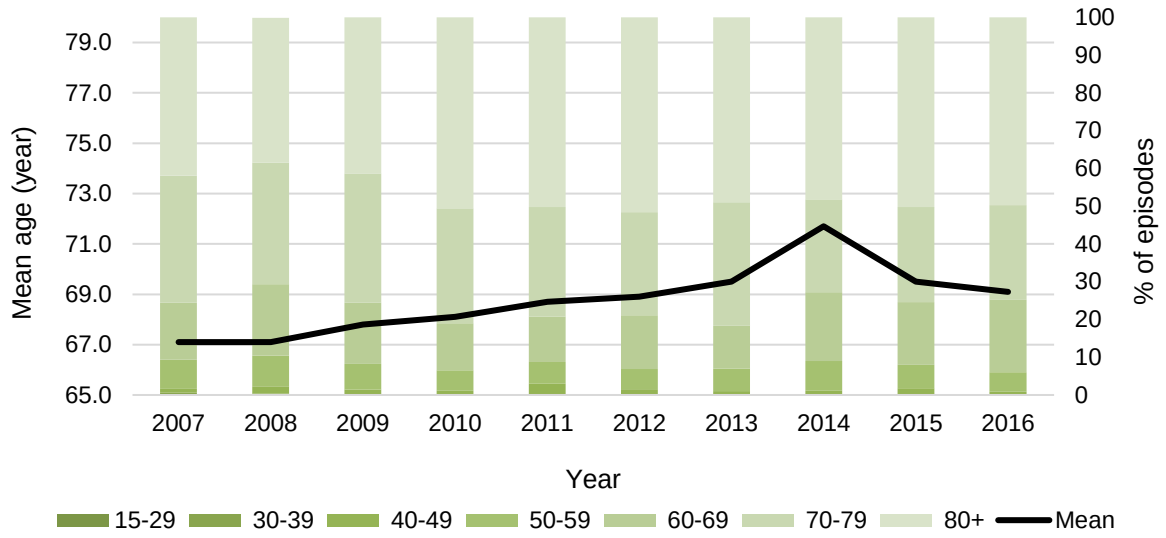


Table 5.2.10b: Age Distribution (%) and Mean Age (year) at Death for Haemorrhagic Stroke Patients, 2007-2016

Year	Mean Age	Age 15-29		Age 30-39		Age 40-49	
		No.	%	No.	%	No.	%
2007	67.1	2	0.7	4	1.4	39	13.5
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

Year	Age 50-59		Age 60-69		Age 70-79		Age 80+	
	No.	%	No.	%	No.	%	No.	%
2007	50	17.3	59	20.4	69	23.9	66	22.8
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	72	21.4	65	19.3	100	29.7

Figure 5.2.10b: Age Distribution (%) and Mean Age (year) at Death for Haemorrhagic Stroke Patients, 2007-2016



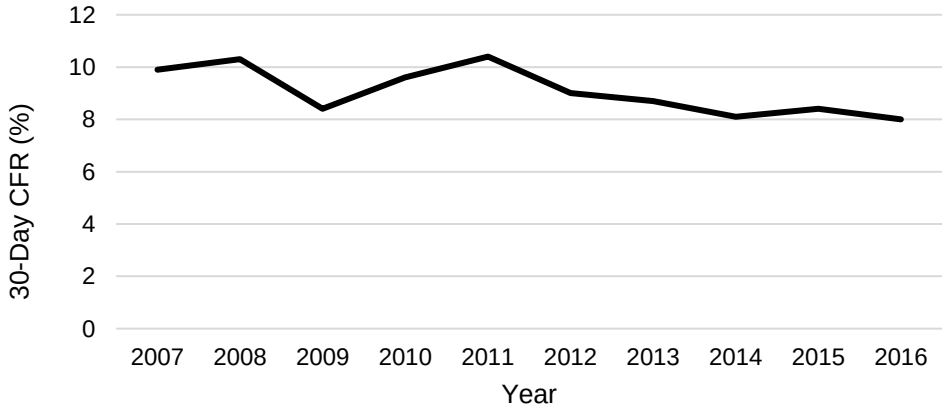
5.3 30-Day Case Fatality

The number of deaths due to stroke within 30 days from admission fluctuated between 481 and 638 during the period 2007-2016 (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 8.0% in 2016 ($p<0.05$) (Figure 5.3.1). This falling CFR may be due to better medical management for stroke patients in Singapore 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 (%), 2007-2016

Year	No.	CFR	95% CI
2007	550	9.9	9.1-10.7
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	594	8.0	7.4-8.6
P for trend		p<0.05	

Figure 5.3.1: 30-Day Case Fatality Rate (%), 2007-2016



The 30-day CFR for female patients was consistently higher than that for male patients between 2007-2016 (Table 5.3.2), although female patients had lower ASMR during the same study period (Table 5.2.4). This was due to the different baseline characteristics between female and male stroke patients, such as age, comorbidities, and severity[14]. 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 2016, the 30-day CFR for women was 9.3% and 7.1% for men.

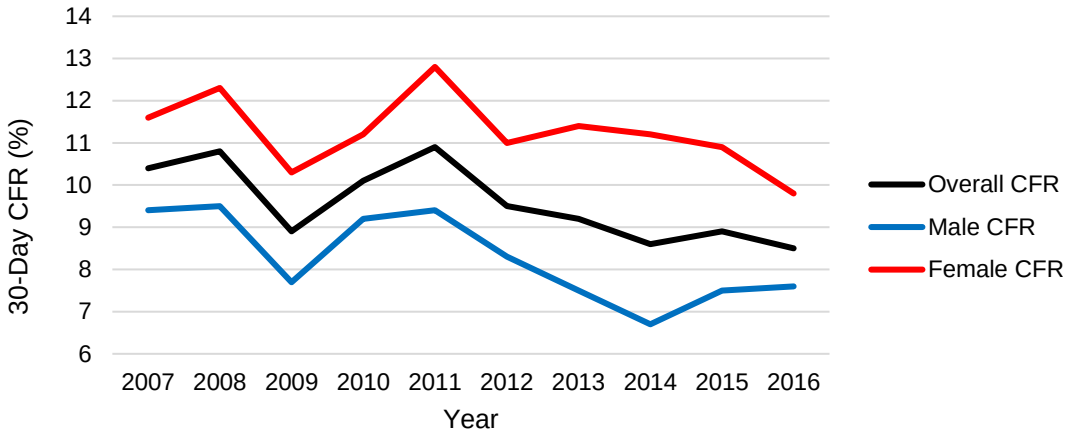
From 2007 to 2016, the 30-day CFR for men significantly decreased, from 8.9% to 7.1% ($p<0.05$). A downward trend was also observed for women, with the 30-day CFR decreasing from 11.1% to 9.3% during this period ($p=0.16$).

Table 5.3.2: 30-Day Case Fatality Number and Rate (%) by Gender, 2007-2016

Male				
Year	**No.**	**%**	**CFR**	**95% CI**
2007	272	49.5	8.9	7.9-9.9
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	306	51.5	7.1	6.3-7.9
P for trend			p<0.05	
Female				
Year	**No.**	**%**	**CFR**	**95% CI**
2007	278	50.5	11.1	9.9-12.3
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	10.4	9.3-11.5
2016	288	48.5	9.3	8.3-10.3
P for trend			p=0.16	

[14] 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, 2007-2016



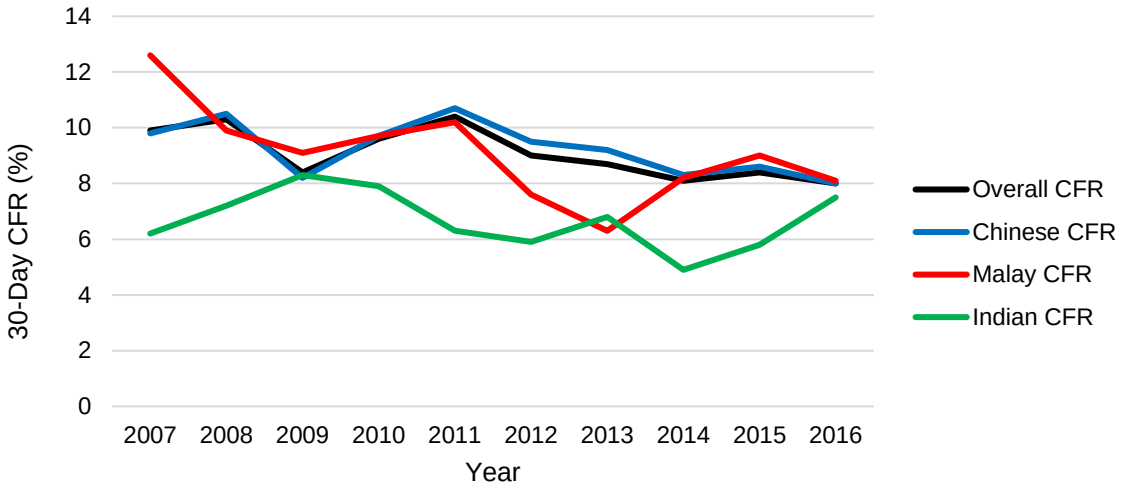
In 2016, the 30-day CFR of Chinese, Malays and Indians was 8.0%, 8.1%, and 7.5% respectively (Table 5.3.3 and Figure 5.3.3).

Among the three main ethnic groups, a significant decrease in 30-day CFR was only observed among the Malays, from 12.6% in 2007 to 8.1% in 2016 ($p<0.05$).

Table 5.3.3: 30-Day Case Fatality Number and Rate (%) by Ethnicity, 2007-2016

Chinese				
Year	**No.**	**%**	**CFR**	**95% CI**
2007	420	76.4	9.8	8.9-10.7
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	75.9	8.0	7.3-8.7
P for trend			p=0.06	
Malay				
Year	**No.**	**%**	**CFR**	**95% CI**
2007	99	18.0	12.6	10.3-14.9
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	10.2	8.3-12.1
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	94	15.8	8.1	6.5-9.7
P for trend			p<0.05	
Indian				
Year	**No.**	**%**	**CFR**	**95% CI**
2007	24	4.4	6.2	3.8-8.6
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	6.3	3.9-8.7
2012	21	3.7	5.9	3.4-8.4
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
P for trend			p=0.34	

Figure 5.3.3: 30-Day Case Fatality Rate (%) by Ethnicity, 2007-2016



Patients who suffered 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[15], 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).

Overall, the 30-day CFR for both stroke sub-types declined significantly, for IS from 6.2% in 2007 to 4.7% in 2016 ($p<0.01$) and for HS from 25.6% in 2007 to 21.8% in 2016 ($p<0.05$) (Table 5.3.4 and Figure 5.3.4).

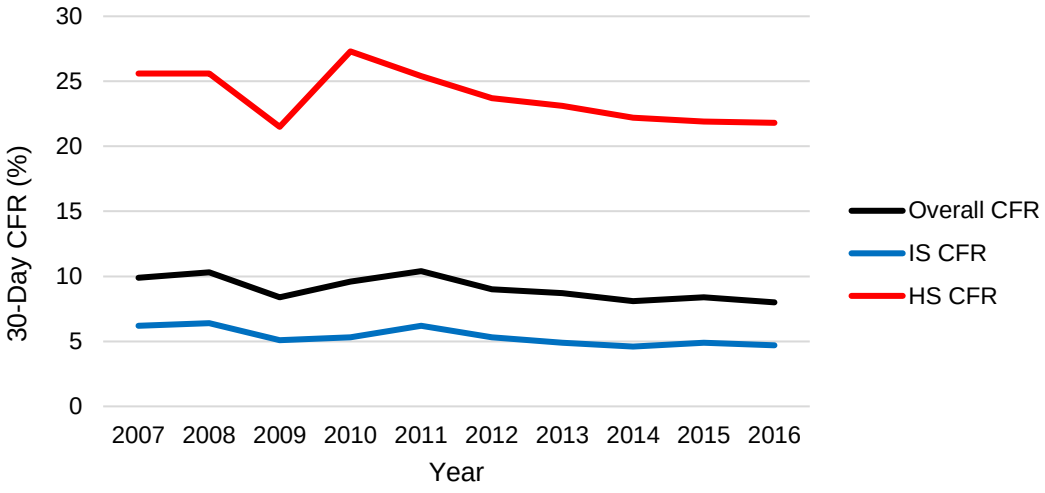
Table 5.3.4: 30-Day Case Fatality Number and Rate (%) by Stroke Sub-type, 2007-2016

Ischaemic stroke*				
Year	**No.**	**%**	**CFR**	**95% CI**
2007	280	50.9	6.2	5.5-6.9
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	47.5	4.7	4.2-5.2
P for trend			p<0.01	
Haemorrhagic stroke*				
Year	**No.**	**%**	**CFR**	**95% CI**
2007	258	46.9	25.6	22.9-28.3
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	302	50.8	21.8	19.6-24.0
P for trend			p<0.05	

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

[15]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, 2007-2016



5.4 Risk Factors

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

Since 2007, the proportion of the stroke patients with hyperlipidaemia increased gradually from 77.7% in 2007 to 83.5% in 2016 ($p<0.05$). Similarly, an increase in the proportion of the patients with Atrial Fibrillation/Flutter (AF), from 16% to 20.6%, was observed over the years ($p<0.001$). The proportion of the patients who smoked gradually decreased from 39.7% in 2007 to 37.3% in 2016 ($p<0.05$).

Table 5.4.1: Risk Factors (%), 2007-2016

Risk Factor (%)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	P for trend
Hypertension*	81.5	83.0	82.7	81.8	82.1	82.6	81.8	83.9	83.2	82.8	p=0.16
Hyperlipidaemia*	77.7	80.9	82.6	83.2	83.0	84.0	84.8	83.7	82.4	83.5	p<0.05
Ischaemic Heart Disease	45.3	45.4	44.5	45.9	46.2	44.0	42.5	40.5	42.1	47.5	p=0.37
Diabetes Mellitus*	43.6	42.6	42.4	42.7	42.9	41.4	40.8	40.8	40.4	43.0	p=0.07
Smoking*	39.7	40.1	38.8	38.9	39.9	39.8	39.7	37.3	37.9	37.3	p<0.05
Atrial Fibrillation/Flutter*	16.0	16.9	15.4	16.9	18.7	19.3	20.0	19.5	21.1	20.6	p<0.001
Transient Ischaemic Attack	14.9	16.1	13.7	12.0	13.8	13.4	11.5	12.4	13.3	16.0	p=0.55
Peripheral Vascular Disease	11.4	12.6	12.1	11.0	11.8	9.4	9.5	8.2	11.0	13.2	p=0.44
Valvular Heart Disease	12.3	11.2	9.1	7.7	9.5	8.5	9.6	7.4	8.0	10.0	p=0.11

**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 (%), 2007-2016

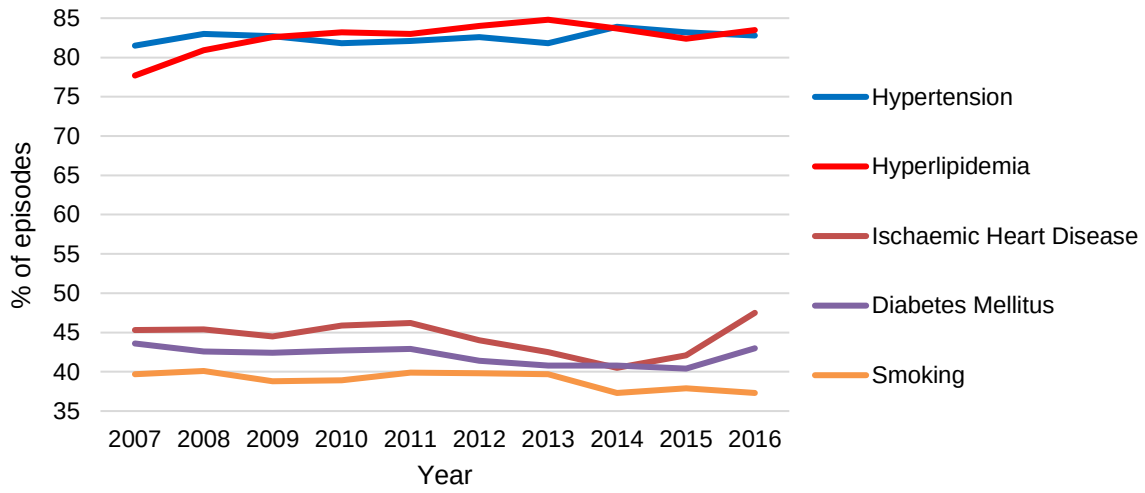


Table 5.4.2 demonstrates the ethnic differences in the proportion of risk factors among stroke patients in 2016.

Notably, in 2016, of the 9 risk factors monitored, Indian stroke patients were found to have the highest proportion for 6 of them - hyperlipidaemia (89.2%), ischaemic heart disease (65.8%), diabetes mellitus (63.3%), transient ischaemic attack (20.3%), peripheral vascular disease (24.2%) and valvular heart disease (11.5%). Malay stroke patients had the highest proportion for hypertension (83.2%) and smoking (45.9%). Chinese stroke patients had the highest proportion for AF (21.8%). Despite having higher proportions of multiple risk factors, Indian stroke patients did not have higher mortality and 30-day case fatality than Chinese and Malay stroke patients. This implied that stroke was likely to be well managed among the Indian patients.

Table 5.4.2: Risk Factors (%) by Ethnicity (2016)

Risk Factor (%)	Chinese	Malay	Indian
Hypertension	82.9	83.2	83.0
Hyperlipidaemia	82.6	85.4	89.2
Ischaemic Heart Disease	44.6	51.5	65.8
Diabetes Mellitus	38.5	54.9	63.3
Smoking	35.5	45.9	39.3
Atrial Fibrillation/Flutter	21.8	18.3	11.8
Transient Ischaemic Attack	15.7	15.7	20.3
Peripheral Vascular Disease	11.2	17.7	24.2
Valvular Heart Disease	10.6	6.4	11.5

Table 5.4.3 demonstrates the proportion of risk factors among male and female stroke patients in 2016.

In 2016, 57.9% of the male stroke patients were smoking, whereas only 8.5% of the female stroke patients were smoking. The proportion for AF among the female stroke patients was 25.9%, much higher than that among the male stroke patients (16.8%).

Table 5.4.3: Risk Factors (%) by Gender (2016)

Risk Factor (%)	Men	Women
Hypertension	81.7	84.4
Hyperlipidaemia	84.7	81.8
Ischaemic Heart Disease	48.5	45.8
Diabetes Mellitus	42.6	43.5
Smoking	57.9	8.5
Atrial Fibrillation/Flutter	16.8	25.9
Transient Ischaemic Attack	16.0	16.1
Peripheral Vascular Disease	12.8	13.7
Valvular Heart Disease	8.3	12.6

Table 5.4.4 demonstrates the proportion of risk factors among IS and HS patients in 2016.

In 2016, the top 5 risk factors found among IS patients were hyperlipidaemia (90.1%), hypertension (83.1%), ischaemic heart disease (48.3%), diabetes mellitus (46.4%) and smoking (39.1%); while the top 5 risk factors found among HS patients were hypertension (81.9%), hyperlipidaemia (55.2%), ischaemic heart disease (42.3%), smoking (28.6%), and diabetes mellitus (28.1%).

Table 5.4.4: Risk Factors (%) by Stroke Sub-type (2016)

Risk Factor (%)	Ischaemic stroke	Haemorrhagic stroke
Hypertension	83.1	81.9
Hyperlipidaemia	90.1	55.2
Ischaemic Heart Disease	48.3	42.3
Diabetes Mellitus	46.4	28.1
Smoking	39.1	28.6
Atrial Fibrillation/Flutter	22.8	11.1
Transient Ischaemic Attack	17.3	9.6
Peripheral Vascular Disease	14.2	7.8
Valvular Heart Disease	10.7	6.7

6. CONCLUSION

Cerebrovascular diseases including stroke, were the 9th most common condition of hospitalisation[16], the 4th most common principal cause of death[17], and the leading contributor to the burden of disease in Singapore[18].

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). Effective stroke preventive strategy can reduce this socio-economic burden of stroke.

Hypertension, hyperlipidaemia, diabetes mellitus, and smoking are the leading risk factors for stroke. While declining trends in the prevalence of hypertension and hyperlipidaemia were observed, an upward climb was seen in the trends for diabetes mellitus and daily smoking prevalence[19]. 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.

[16] Ministry of Health, Statistics, Singapore Health Facts, Top 10 Conditions of Hospitalisation (accessed on Dec 2017).
[17] Principal Causes of Death. Ministry of Health, Singapore (accessed on Dec 2017).
[18] Singapore Burden of Diseases Study 2010. Ministry of Health, Singapore.
[19] National Health Survey 2010. Ministry of Health, Singapore.