Singapore Stroke Registry
Annual Report 2015

National Registry of Diseases Office
(NRDO)

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Acknowledgement

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TABLE OF CONTENTS

1. GLOSSARY

AF	Atrial Fibrillation
ASR	Age-Standardised Incidence Rate
CT	Computed Tomography
LOS	Length Of Stay
HIDS	Hospital In-patient Discharge Summary
MHA	Ministry of Home Affairs
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
TIA	Transient Ischaemic Attack
MediClaims	System of patient's Medisave and MediShield claims

2. EXECUTIVE SUMMARY

A total of 67,289 episodes of stroke occurring among Singapore residents aged 15 years and above were admitted to public hospitals in the period 2005-2015. Of these, 37,901 (56.3%) occurred in males while the other 29,388 (43.7%) cases occurred in females. Ischaemic stroke made up the majority of stroke cases (81% of all cases of stroke), while haemorrhagic stroke made up the remaining 19%.

There were increasing trends observed in all the groups during the period 2005-2015: the number of cases rose from

- 448 to 639 for haemorrhagic stroke among the females,
- 503 to 807 for haemorrhagic stroke among the males,
- 2,039 to 2,487 for ischaemic stroke among the females and
- 2,419 to 3,407 for ischaemic stroke among the males.

For those aged 15 years and above, the age-standardised incidence rates for ischaemic stroke declined from 183.6 to 161.4 per 100,000 for males between 2005 and 2015, , and from 123.2 to 93.9 per 100,000 for females during the same period. For haemorrhagic stroke, the age-standardised incidence rates for males and females had remained fairly stable from 2005 to 2015. Males had consistently higher incidence rates of stroke, for both ischaemic and haemorrhagic stroke, compared to females.

From 2005-2015, among the three main ethnic groups, the age-standardised incidence rate of stroke was highest among the Malays. The Malays were the only ethnic group to experience an overall increase in the age-standardised incidence rate of stroke over this period, from 217.6 to 251.3 per 100,000, compared to the overall decreases observed in the trends for the Chinese (from 176.8 to 149.3 per 100,000) and Indians (from 181.6 to 151.7 per 100,000). The overall age-standardised incidence rate of stroke had also decreased from 183.6 to 160.2 per 100,000 during this period.

The age-specific incidence rates of stroke increased with age. For the specific age bands, the overall trends showed that while there was a general increase for the stroke incidence rates for the younger age bands (for those in the 25-54 years age bands) for the period 2005 – 2015, a general decrease was observed in the stroke incidence rates for the older age bands (55 years and over) during the same period. The only exception found was for Malays - a general increase for the stroke incidence rates was observed for all the age bands (starting from those aged 25 years and above).

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There was an overall decrease in the age-standardised incidence rates of recurrent stroke. This was mainly due to the overall decline in the rates of ischaemic stroke, which made up the majority of stroke cases. This decline was observed in both males (from 55.8 to 39.9 per 100,000) and females aged 15 years and above (from 36.2 to 22.2 per 100,000) for the period 2005 to 2015. The incidence of haemorrhagic stroke, on the other hand, remained relatively

stable – from 8.5 to 9.9 per 100,000 for males, and from 6.5 to 4.9 per 100,000 for females during this period.

For patients aged 15 years and above, the age-standardised mortality rates for stroke showed an overall downward trend – from 21.1 to 16.6 per 100,000 from 2005 to 2015. For ischaemic and haemorrhagic strokes in both genders, a general downward trend was observed during this period – for ischaemic stroke: from 12.8 to 9.7 per 100,000 for males, and from 9.8 to 7.8 per 100,000 for females; and for haemorrhagic stroke: from 10.3 to 8.6 per 100,000 for males, and from 8.9 to 6.3 per 100,000 for females.

Among the three main ethnic groups, the Malays consistently had the highest age-standardised mortality rates of stroke. In 2015, the age-standardised mortality rate of stroke among the Malays was 26.9 per 100,000 compared to 15.8 and 12.8 per 100,000 for the Chinese and Indians respectively.

As with age-specific incidence rates, the age-specific mortality rates increased with age. For the specific age bands, the overall trends showed that while mortality from stroke among the younger age groups remained relatively stable across the period 2005-2015, a general decrease was observed in the mortality rates for the older age bands (55 years and over). For the Malays, the mortality rates were almost always higher than those of the Chinese and Indians for every age bands after the age of 55 years, and the mortality rates were also higher compared to the overall mortality rates for stroke for the Singapore population as a whole.

A total number of 1,364 patients who had stroke in the year 2014 died from all causes within one year after admission. Of these, 32%, 53.7%, 69.9%, and 82.3% of deaths (cumulative) occurred at less than 7 days, 30 days, 90 days, and 6 months post-stroke respectively.

A total number of 729 stroke patients who had stroke in the year 2014 died due to stroke only within one year after admission. Of these, 51.3%, 77.6%, 88.9%, and 95.2% of deaths (cumulative) occurred at less than 7 days, 30 days, 90 days, and 6 months post-stroke respectively.

The mortality rate within 7 days admission was 18.3% for haemorrhagic stroke, 3.7% for ischaemic stroke and 58.3% for stroke of unknown subtype.

Hypertension, hyperlipidemia, and diabetes mellitus were the top three risk factors identified amongst stroke patients. Indian stroke patients had the highest proportion of risk factors compared to the other ethnicities, with the exception of atrial fibrillation.

Relating to ischaemic stroke treatment, the majority (about three-quarters) of stroke patients received antiplatelet only as treatment. The percentage of patients with history of atrial fibrillation or patients with newly diagnosed atrial fibrillation who were given anticoagulants has remained stable in the period 2005-2013, but increased to 48.0% in 2014 and 61.9% in 2015. The proportion of patients receiving thrombolysis treatment has increased from 0.5% in 2005 to 6.5% in 2015.

Relating to the length of stay, among hemorrhagic stroke patients, the length of stay was about one week longer than that among ischaemic stroke patients.

From the hospitals, 49.2% of stroke patients were discharged to their homes, 10.1% were transferred to community hospitals and 18.8% were sent for rehabilitation in acute hospitals, 3.4% to nursing homes, 0.1% to other hospitals for stroke management and 7.5% to other hospitals for management of disease conditions other than stroke.

In terms of audit parameters, urinary tract infection was the most common complication during hospitalisation. The proportion of stroke patients who had their CT or MRI brain scans done within 24 hours of admission was 93.0%.

3. INTRODUCTION

A stroke occurs when blood supply to part of the brain is interrupted, resulting in damage to the brain. Bodily functions that are normally controlled by the affected part of the brain will be implicated. A stroke is potentially life-threatening and early recognition of symptoms and timely medical attention is crucial.

There are two types of stroke: ischaemic and haemorrhagic. Ischaemic stroke is more common and occurs when there is a blockage caused by a blood clot in an artery supplying blood to a part of the brain. Haemorrhagic stroke occurs when an artery in the brain bursts and results in an intracerebral (parenchymal) harmorrhage, or less commonly, the artery bursts into the space surrounding the brain (subarachnoid haemorrhage)[1].

From 2012 to 2014, stroke and other cerebrovascular diseases were the 10th most common cause of hospitalization, accounting for 1.8% - 1.9% of hospital discharges each year[2]. In this period, stroke and other cerebrovascular diseases were the 4th leading cause of death after cancer, heart and hypertensive illnesses, and lung and respiratory diseases, accounting for 8.4% - 9.3% of all deaths each year[3,4]. Common risk factors for stroke include hypertension (high blood pressure), hyperlipidemia (high cholesterol), diabetes mellitus, heart disease, and overweight and obesity[5]. These risk factors can be reduced through appropriate lifestyle modifications such as having a healthy diet and engaging in regular physical activity.

[1] Singapore National Stroke Association. What is Stroke? [Retrieved 17 July 2017]; available from: www.snsa.org.ag/what-is-stroke
[2] Ministry of Health, Singapore. Top 10 Conditions of Hospitalisation. [Retrieved 24 July 2017]; available from: www.moh.gov.sg/content/moh_web/home/statistics/Health_Facts_Singapore/Top_10_Conditions_of_Hospitalisation.html
[3] Immigration and Checkpoints Authority, Singapore. Report on Registration of Births and Deaths 2013
[4] Immigration and Checkpoints Authority, Singapore. Report on Registration of Births and Deaths 2014
[5] Ministry of Health, Singapore. Stroke [Retrieved 17 July 2017]; available from: https://www.healthhub.sg/a-z/diseases-and-conditions/87/stroke

4. METHODOLOGY

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

The Singapore Stroke Registry was set up in 2002 to obtain epidemiological and clinical data on stroke cases diagnosed in Singapore from all public hospitals. This report was based on the data collected for the year 2015.

Data sources

The source of data was mainly from the MediClaims listing. Case finding was supplemented by the Hospital In-patient Discharge Summary (HIDS) review and from the death registry at the Ministry of Home Affairs (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 then generated from the master list. Case notes were then traced from the Medical Record Offices 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.

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. Stroke episodes that occurred within the year 2015 were recorded.

Data analysis

Population denominators were derived using the Department of Statistics' mid-year population estimates. Crude rates were computed using these denominators. Segi World Population was used for direct standardisation to calculate age-standardised rates. The 2015 population was used as the denominator to calculate incidence and mortality rates. 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 stroke mortality in this report covered deaths as at 31 October 2016 among patients who had stroke in the year 2014 and 2015; including in-hospital deaths and outside of hospital deaths.

Singapore residents

Citizens and permanent residents

Age-Standardised Incidence Rate

The age-standardised incidence rate was used to age-standardise incidence against the age structure of Singapore's population as at the 2010 Census. This metric was used to compare the incidence rates in Singapore over time.

5. FINDINGS

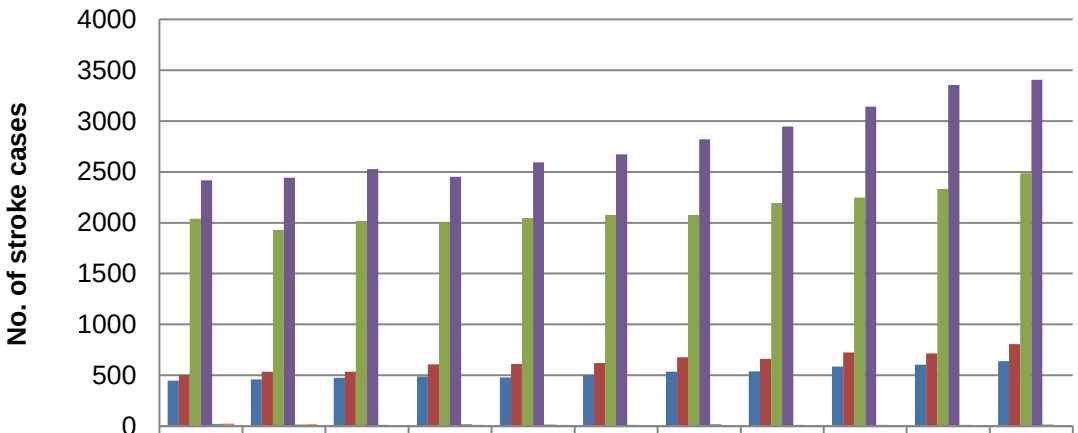
5.1 Incidence of Stroke Admitted to Public Hospitals, 2005-2015

A total of 67,289 cases of stroke occurred among Singapore residents in the period 2005-2015. Of these, 37,901 (56.3%) occurred in males while the other 29,388 (43.7%) cases occurred in females. Ischaemic stroke made up the majority of stroke cases (81% of all cases of stroke), while haemorrhagic stroke made up the remaining 19%.

The number of cases of stroke increased every year from 2005-2015. Increasing trends were observed in all the groups during the period 2005-2015. The number of cases rose from

- 448 to 639 for haemorrhagic stroke among the females,
- 503 to 807 for haemorrhagic stroke among the males,
- 2,039 to 2,487 for ischaemic stroke among the females and
- 2,419 to 3,407 for ischaemic stroke among the males **(Figure 5.1.1).**

FIGURE 5.1.1: Number of Stroke (First-Ever and Recurrent) Cases among Singapore Residents aged above 15 Years Admitted to Public Hospitals by Gender and Type of Stroke, 2005-2015



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Haemorrhagic Female	448	460	474	488	478	504	535	540	587	606	639
Haemorrhagic Male	503	534	535	609	612	621	678	662	723	715	807
Ischaemic Female	2039	1931	2018	2004	2047	2077	2079	2195	2249	2332	2487
Ischaemic Male	2419	2442	2527	2451	2594	2672	2821	2945	3142	3355	3407
Unknown Female	23	15	13	18	17	13	19	14	12	12	15
Unknown Male	24	18	11	13	12	3	11	11	7	8	9

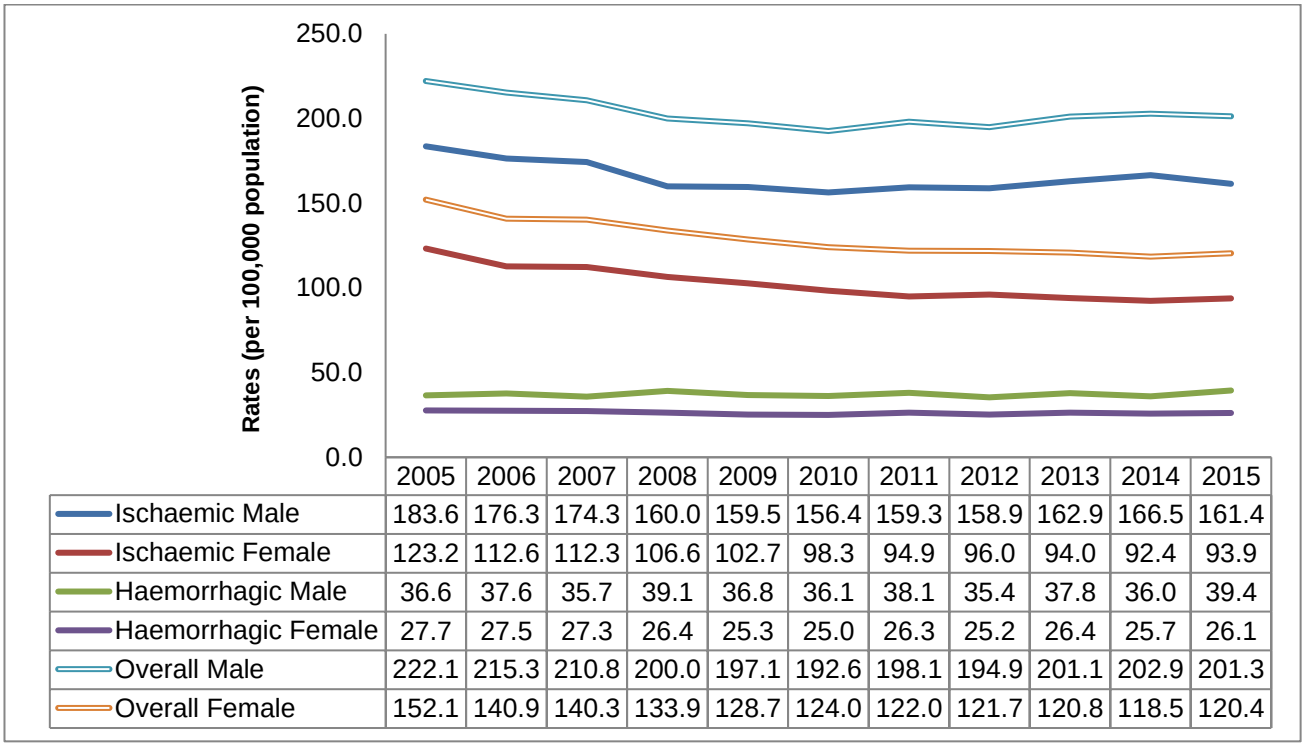
During the period 2005-2015, there was an overall decrease in the age-standardised incidence rates (ASR) of stroke – from 222.1 to 201.3 per 100,000 for males, and from 152.1 to 120.4 per 100,000 for females during this time period (**Figure 5.1.2**). Males had consistently higher incidence rates of stroke, for both ischaemic and haemorrhagic stroke, compared to females.

The ASR for ischaemic stroke declined from 183.6 per 100,000 in 2005 to 156.4 per 100,000 in 2010, before increasing to 161.4 per 100,000 in 2015 for males. It decreased from 123.2 per 100,000 in 2005 to 93.9 per 100,000 in 2015 for females. This corresponds to the

decreasing national prevalence of hypertension (from 27.3% in 1998 to 23.5% in 2010), hyperlipidemia (from 25.4% in 1998 to 17.4% in 2010) and smoking (from 15.2% in 1998 to 14.3% in 2010) in Singapore residents aged 18-69 years, which was cited from National Health Survey[6].

From 2005-2015, the Malays had the highest ASR of stroke among the three main ethnic groups. In 2015, the ASR of stroke among those aged 15 and above for the Malays was 251.3 per 100,000 compared to 149.3 and 151.7 per 100,000 for Chinese and Indians respectively. From 2005-2015, while the ASR of stroke among Chinese and Indians aged 15 and above had experienced an overall decrease (from 176.8 to 149.3, and 181.6 to 151.7 per 100,000 respectively), whereas that for the Malays saw an overall increase, from 217.6 to 251.3 per 100,000 **(Figure 5.1.3)**.

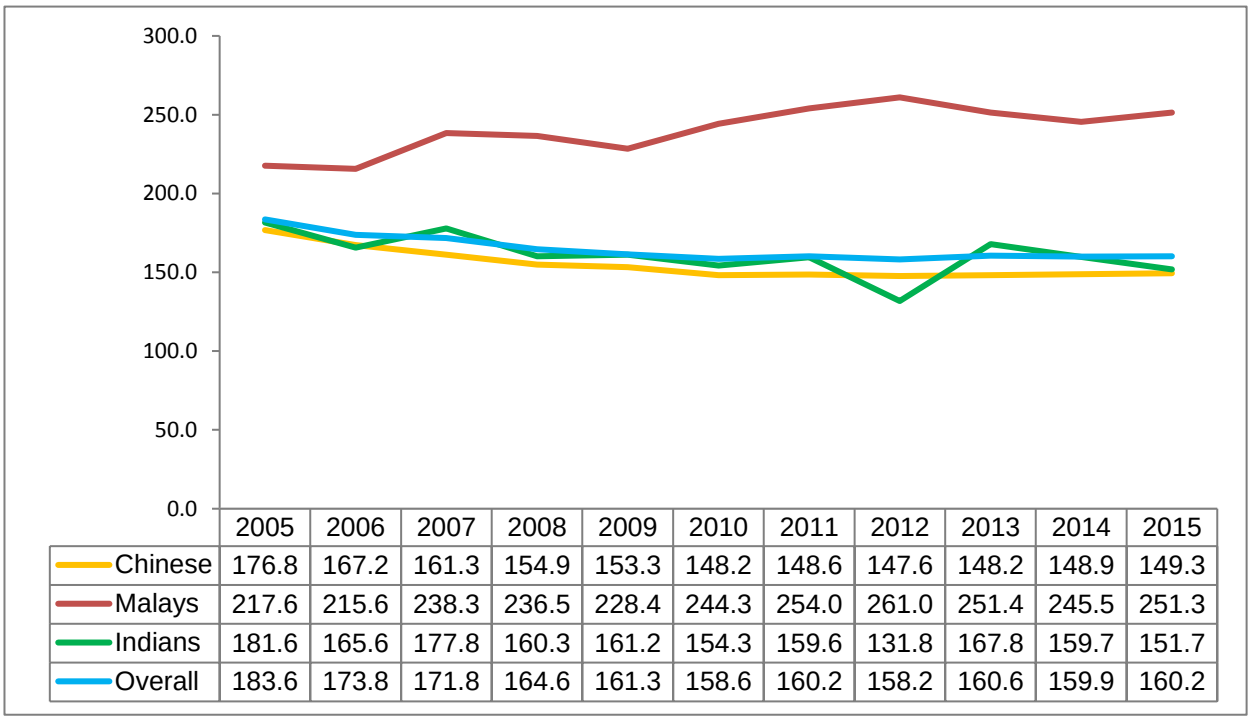
FIGURE 5.1.2: Age-Standardised Incidence Rate of Stroke (First-Ever and Recurrent) among Singapore Residents aged above 15 Years Admitted to Public Hospitals by Gender and Type of Stroke, 2005-2015



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ischaemic Male	183.6	176.3	174.3	160.0	159.5	156.4	159.3	158.9	162.9	166.5	161.4
Ischaemic Female	123.2	112.6	112.3	106.6	102.7	98.3	94.9	96.0	94.0	92.4	93.9
Haemorrhagic Male	36.6	37.6	35.7	39.1	36.8	36.1	38.1	35.4	37.8	36.0	39.4
Haemorrhagic Female	27.7	27.5	27.3	26.4	25.3	25.0	26.3	25.2	26.4	25.7	26.1
Overall Male	222.1	215.3	210.8	200.0	197.1	192.6	198.1	194.9	201.1	202.9	201.3
Overall Female	152.1	140.9	140.3	133.9	128.7	124.0	122.0	121.7	120.8	118.5	120.4

[6] Ministry of Health, Singapore. National Health Survey 2010.

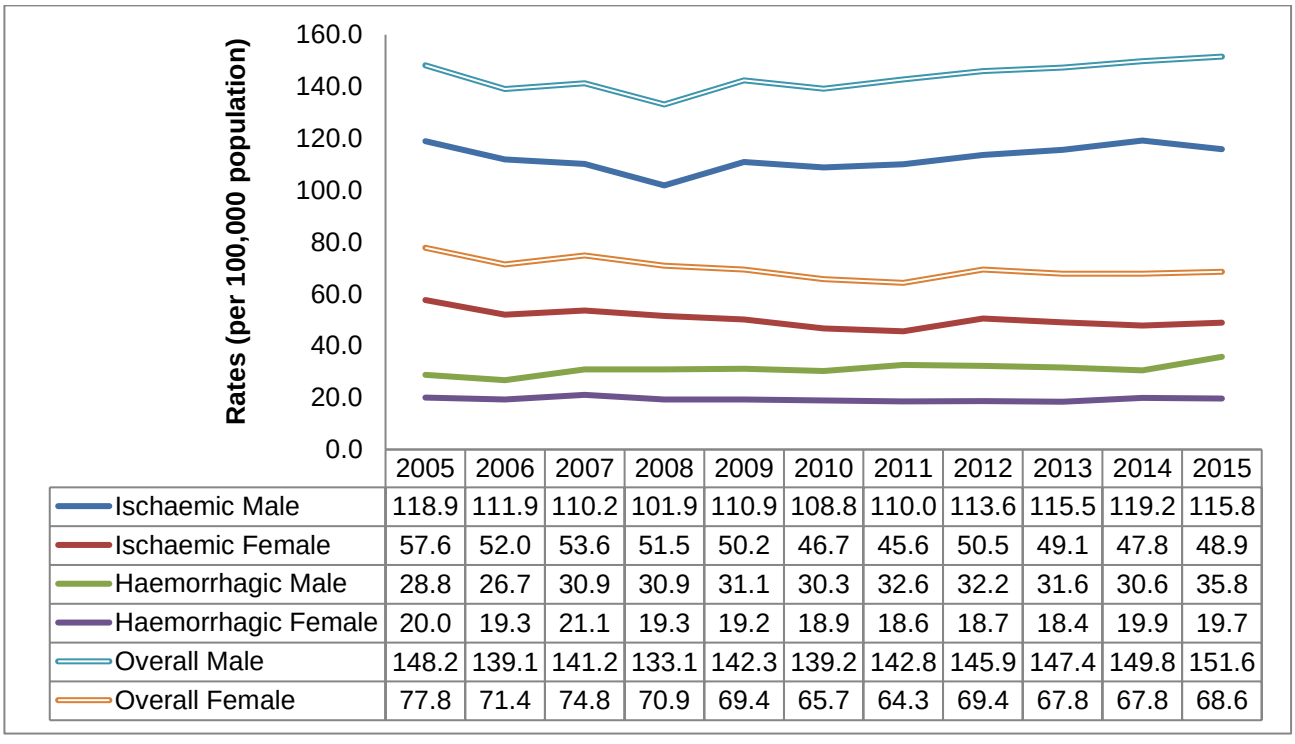
FIGURE 5.1.3: Age-Standardised Incidence Rate of Stroke (First-Ever and Recurrent) among Singapore Residents aged above 15 Years Admitted to Public Hospitals by Ethnicity , 2005-2015



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Chinese	176.8	167.2	161.3	154.9	153.3	148.2	148.6	147.6	148.2	148.9	149.3
Malays	217.6	215.6	238.3	236.5	228.4	244.3	254.0	261.0	251.4	245.5	251.3
Indians	181.6	165.6	177.8	160.3	161.2	154.3	159.6	131.8	167.8	159.7	151.7
Overall	183.6	173.8	171.8	164.6	161.3	158.6	160.2	158.2	160.6	159.9	160.2

From 2010 to 2015, an increase in ASR of stroke was observed among the males aged 25-64 years – from 148.2 to 151.6 per 100,000 during this period. In the same period, ASR of stroke declined among the females aged 25-64 years – from 77.8 to 68.6 per 100,000 (**Figure 5.1.4**).

FIGURE 5.1.4: Age-Standardised Incidence Rate of Stroke (First-Ever and Recurrent) among Singapore Residents aged 25-64 Years Admitted to Public Hospitals, 2005-2015

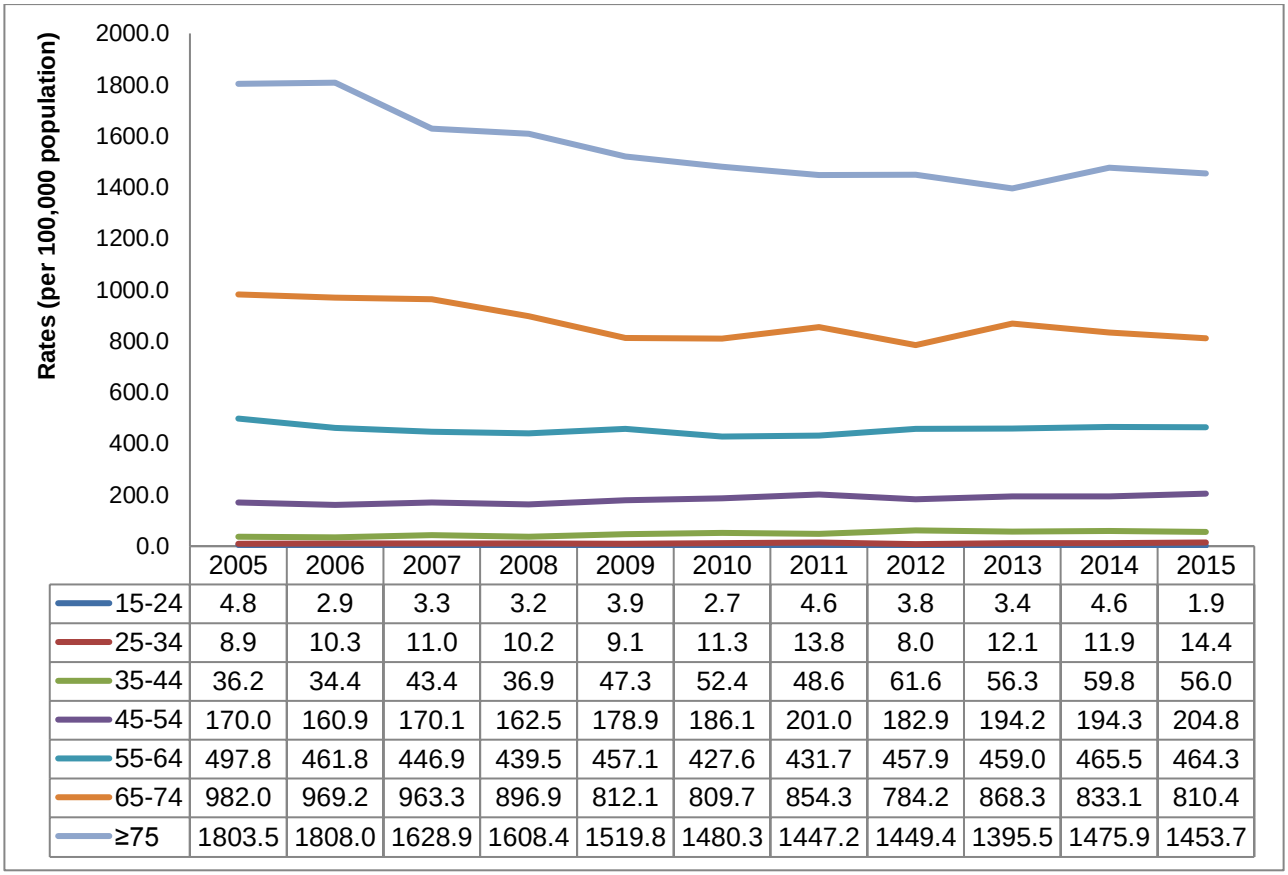


	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ischaemic Male	118.9	111.9	110.2	101.9	110.9	108.8	110.0	113.6	115.5	119.2	115.8
Ischaemic Female	57.6	52.0	53.6	51.5	50.2	46.7	45.6	50.5	49.1	47.8	48.9
Haemorrhagic Male	28.8	26.7	30.9	30.9	31.1	30.3	32.6	32.2	31.6	30.6	35.8
Haemorrhagic Female	20.0	19.3	21.1	19.3	19.2	18.9	18.6	18.7	18.4	19.9	19.7
Overall Male	148.2	139.1	141.2	133.1	142.3	139.2	142.8	145.9	147.4	149.8	151.6
Overall Female	77.8	71.4	74.8	70.9	69.4	65.7	64.3	69.4	67.8	67.8	68.6

The age-specific incidence rate increased with age. For the specific age bands, the overall trends showed that while there was a general increase for the stroke incidence rates for the younger age bands (for those in the 25-54 years age bands) for the period 2005 – 2015, a general decrease was observed in the stroke incidence rates for the older age bands (55 years and over) during the same period. The only exception found was for Malays - a general increase for the stroke incidence rates was observed for all the age bands (starting from those aged 25 years and above) **(Figures 5.1.5 and 5.1.6).**

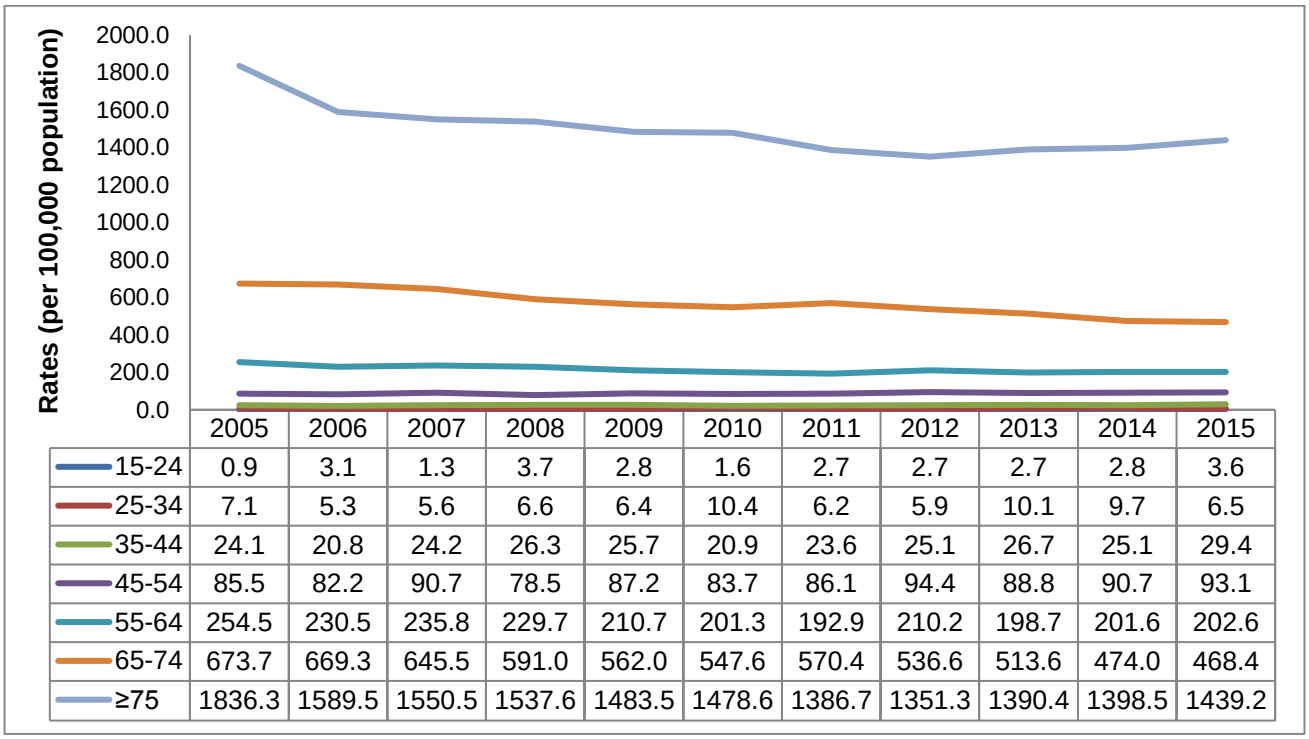
FIGURE 5.1.5: Age-Specific Incidence Rates of Stroke (First-Ever and Recurrent) among Singapore Residents aged above 15 Years Admitted to Public Hospitals by Gender, 2005-2015

a) Males



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	4.8	2.9	3.3	3.2	3.9	2.7	4.6	3.8	3.4	4.6	1.9
25-34	8.9	10.3	11.0	10.2	9.1	11.3	13.8	8.0	12.1	11.9	14.4
35-44	36.2	34.4	43.4	36.9	47.3	52.4	48.6	61.6	56.3	59.8	56.0
45-54	170.0	160.9	170.1	162.5	178.9	186.1	201.0	182.9	194.2	194.3	204.8
55-64	497.8	461.8	446.9	439.5	457.1	427.6	431.7	457.9	459.0	465.5	464.3
65-74	982.0	969.2	963.3	896.9	812.1	809.7	854.3	784.2	868.3	833.1	810.4
≥75	1803.5	1808.0	1628.9	1608.4	1519.8	1480.3	1447.2	1449.4	1395.5	1475.9	1453.7

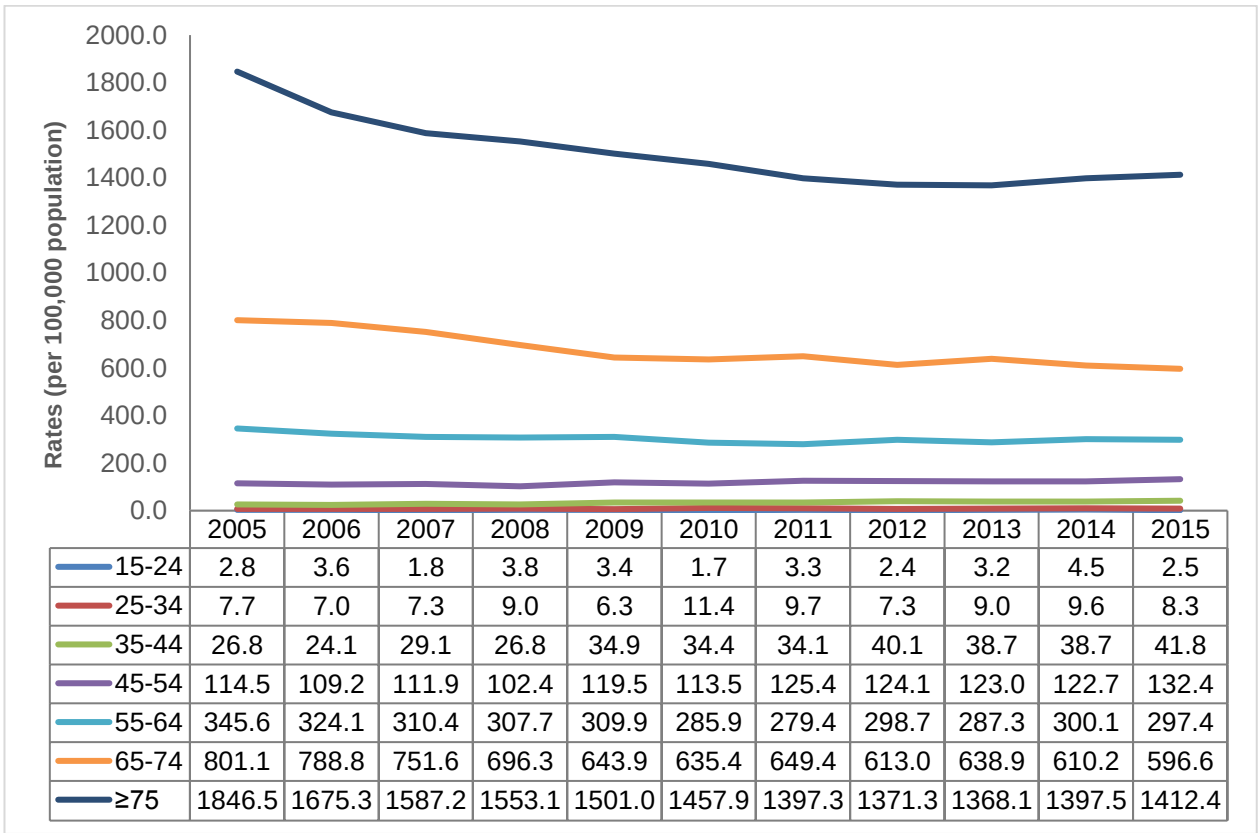
b) Females



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	0.9	3.1	1.3	3.7	2.8	1.6	2.7	2.7	2.7	2.8	3.6
25-34	7.1	5.3	5.6	6.6	6.4	10.4	6.2	5.9	10.1	9.7	6.5
35-44	24.1	20.8	24.2	26.3	25.7	20.9	23.6	25.1	26.7	25.1	29.4
45-54	85.5	82.2	90.7	78.5	87.2	83.7	86.1	94.4	88.8	90.7	93.1
55-64	254.5	230.5	235.8	229.7	210.7	201.3	192.9	210.2	198.7	201.6	202.6
65-74	673.7	669.3	645.5	591.0	562.0	547.6	570.4	536.6	513.6	474.0	468.4
≥75	1836.3	1589.5	1550.5	1537.6	1483.5	1478.6	1386.7	1351.3	1390.4	1398.5	1439.2

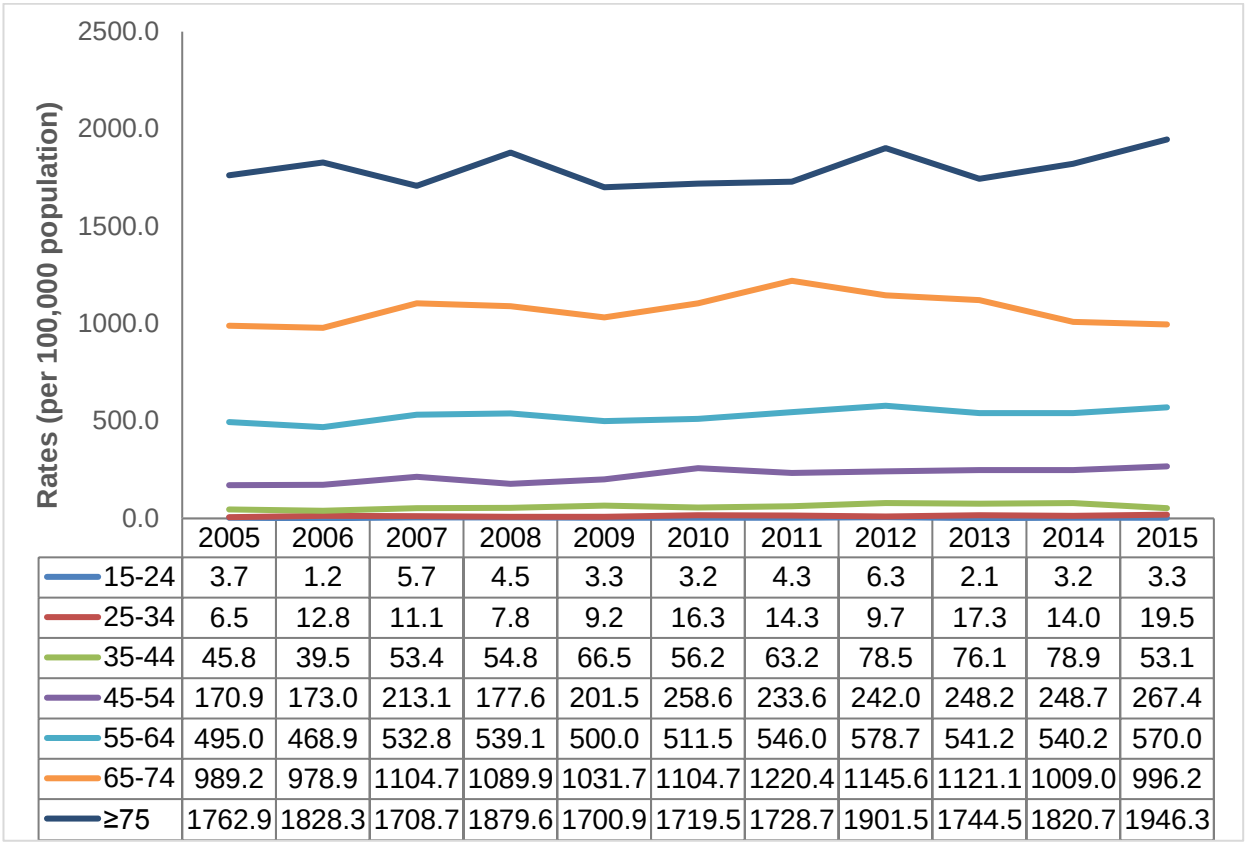
FIGURE 5.1.6: Age-Specific Incidence Rates of Stroke among Singapore Residents (First-Ever and Recurrent) aged above 15 Years Admitted to Public Hospitals by Ethnicity, 2005-2015

a) Chinese



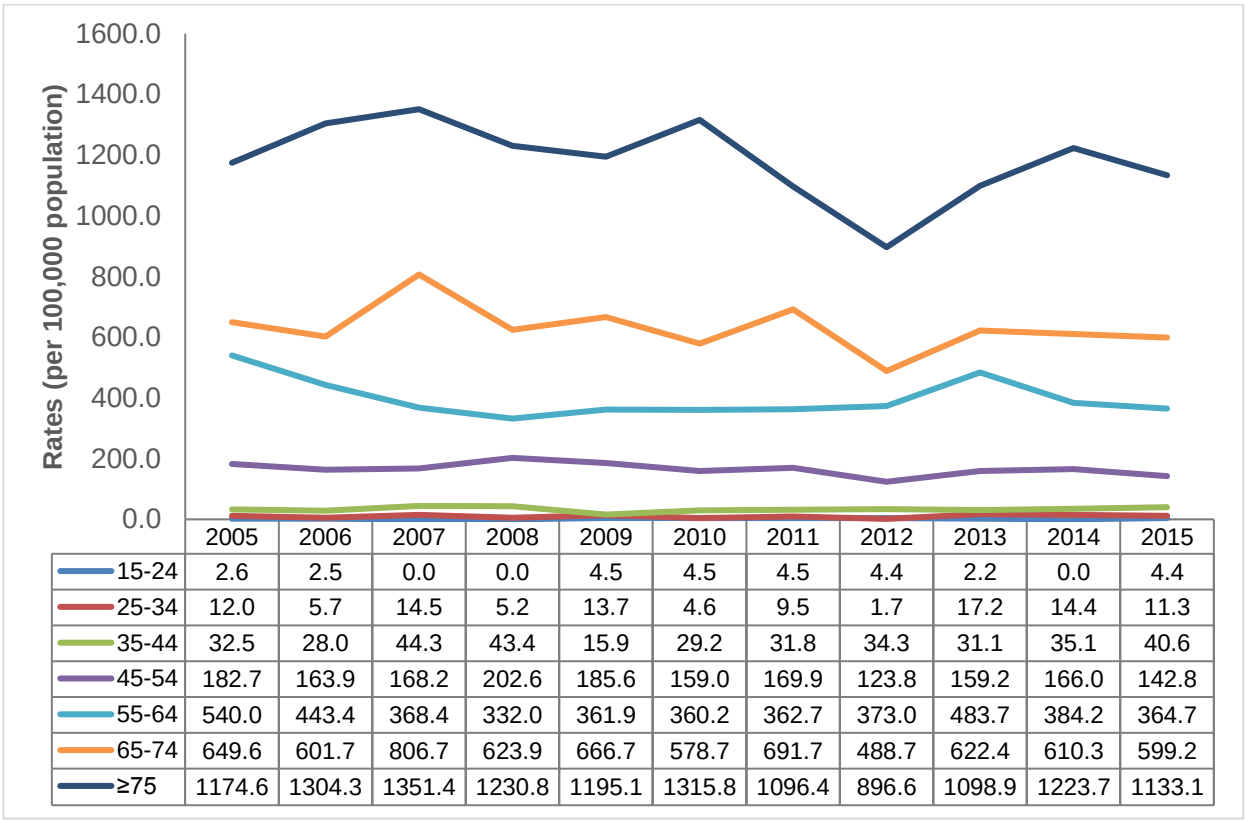
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	2.8	3.6	1.8	3.8	3.4	1.7	3.3	2.4	3.2	4.5	2.5
25-34	7.7	7.0	7.3	9.0	6.3	11.4	9.7	7.3	9.0	9.6	8.3
35-44	26.8	24.1	29.1	26.8	34.9	34.4	34.1	40.1	38.7	38.7	41.8
45-54	114.5	109.2	111.9	102.4	119.5	113.5	125.4	124.1	123.0	122.7	132.4
55-64	345.6	324.1	310.4	307.7	309.9	285.9	279.4	298.7	287.3	300.1	297.4
65-74	801.1	788.8	751.6	696.3	643.9	635.4	649.4	613.0	638.9	610.2	596.6
≥75	1846.5	1675.3	1587.2	1553.1	1501.0	1457.9	1397.3	1371.3	1368.1	1397.5	1412.4

b) Malays



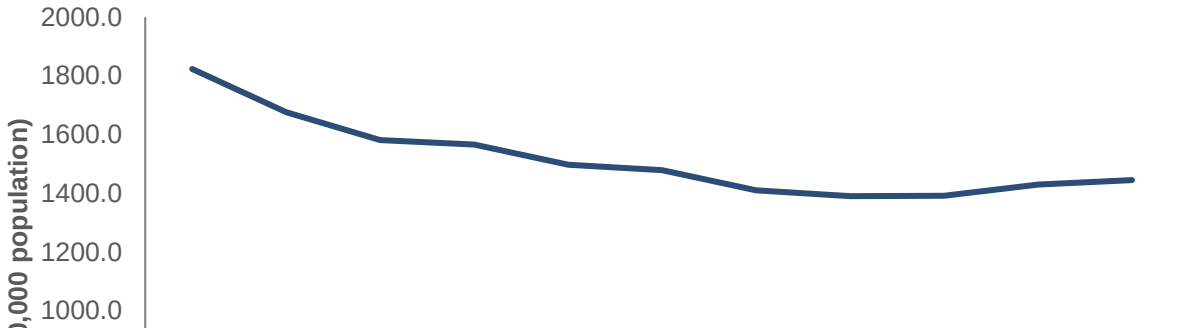
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	3.7	1.2	5.7	4.5	3.3	3.2	4.3	6.3	2.1	3.2	3.3
25-34	6.5	12.8	11.1	7.8	9.2	16.3	14.3	9.7	17.3	14.0	19.5
35-44	45.8	39.5	53.4	54.8	66.5	56.2	63.2	78.5	76.1	78.9	53.1
45-54	170.9	173.0	213.1	177.6	201.5	258.6	233.6	242.0	248.2	248.7	267.4
55-64	495.0	468.9	532.8	539.1	500.0	511.5	546.0	578.7	541.2	540.2	570.0
65-74	989.2	978.9	1104.7	1089.9	1031.7	1104.7	1220.4	1145.6	1121.1	1009.0	996.2
≥75	1762.9	1828.3	1708.7	1879.6	1700.9	1719.5	1728.7	1901.5	1744.5	1820.7	1946.3

c) Indians



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	2.6	2.5	0.0	0.0	4.5	4.5	4.5	4.4	2.2	0.0	4.4
25-34	12.0	5.7	14.5	5.2	13.7	4.6	9.5	1.7	17.2	14.4	11.3
35-44	32.5	28.0	44.3	43.4	15.9	29.2	31.8	34.3	31.1	35.1	40.6
45-54	182.7	163.9	168.2	202.6	185.6	159.0	169.9	123.8	159.2	166.0	142.8
55-64	540.0	443.4	368.4	332.0	361.9	360.2	362.7	373.0	483.7	384.2	364.7
65-74	649.6	601.7	806.7	623.9	666.7	578.7	691.7	488.7	622.4	610.3	599.2
≥75	1174.6	1304.3	1351.4	1230.8	1195.1	1315.8	1096.4	896.6	1098.9	1223.7	1133.1

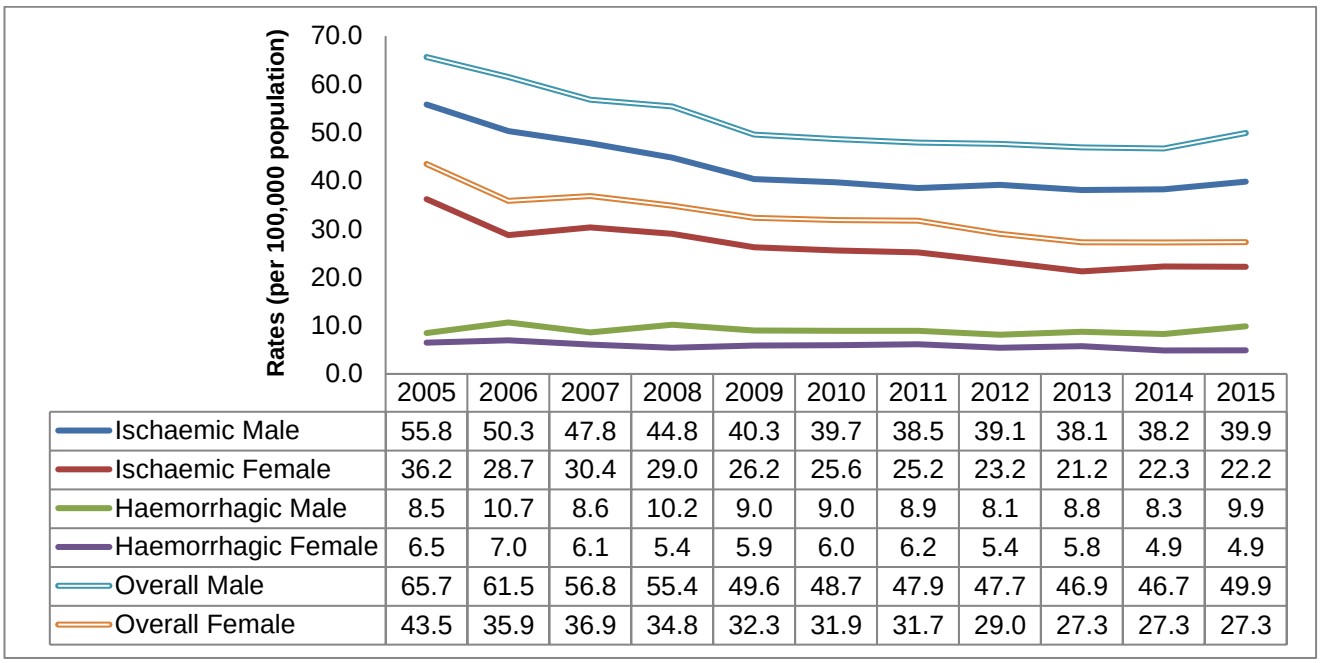
d) Overall



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	2.9	3.0	2.3	3.5	3.4	2.2	3.7	3.2	3.1	3.7	2.8
25-34	7.9	7.7	8.2	8.3	7.7	10.9	9.8	6.9	11.0	10.8	10.3
35-44	30.1	27.5	33.7	31.5	36.3	36.4	35.8	42.9	41.1	41.9	42.2
45-54	128.2	121.9	130.8	120.9	133.4	135.4	144.0	138.9	141.7	142.5	148.7
55-64	374.8	345.1	340.6	334.0	333.5	314.1	311.8	333.7	328.5	333.3	333.3
65-74	818.1	809.7	794.2	734.4	679.6	671.1	704.3	653.7	681.6	645.1	632.2
≥75	1823.4	1676.3	1581.6	1565.8	1498.0	1479.2	1410.8	1390.6	1392.4	1429.8	1445.1

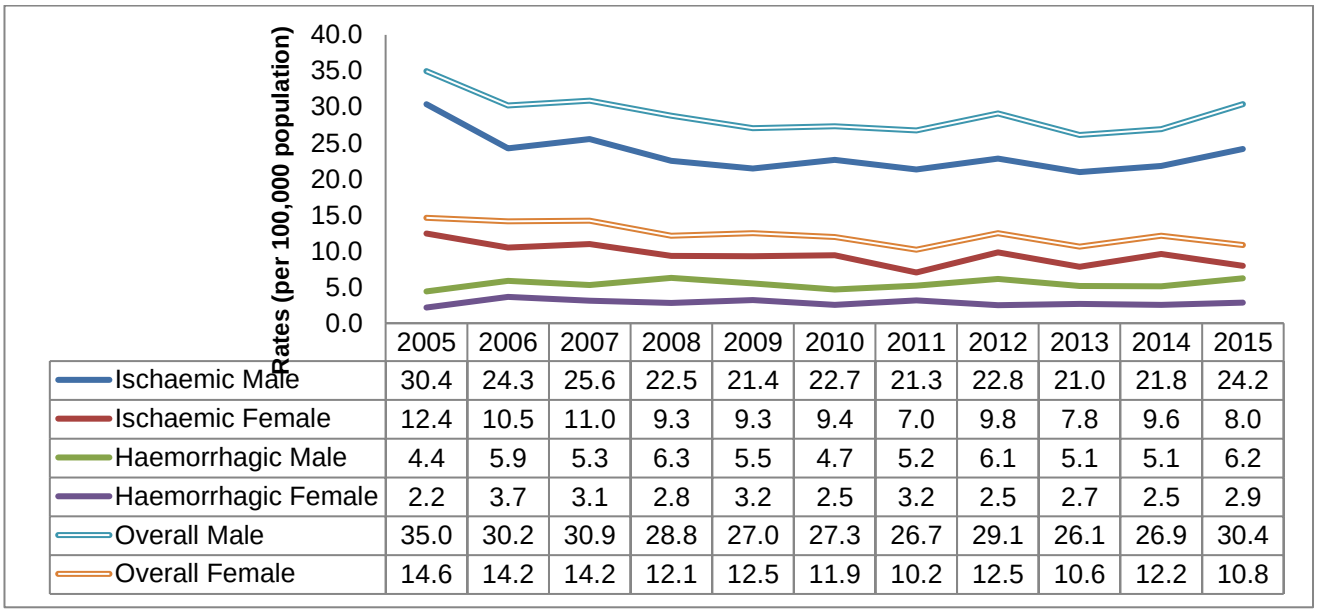
There was an overall decrease in the ASR of recurrent stroke. This was mainly due to the overall decline in the ASR of ischaemic stroke, which made up the majority of stroke cases. This decline was observed in both males (from 55.8 to 39.9 per 100,000) and females aged 15 years and above (from 36.2 to 22.2 per 100,000) for the period 2005 to 2015. The incidence of haemorrhagic stroke, on the other hand, remained relatively stable – from 8.5 to 9.9 per 100,000 for males, and from 6.5 to 4.9 per 100,000 for females during this period **(Figure 5.1.7)**. However, fluctuations were observed in the time trends for recurrent stroke when only those aged between 25-64 years were taken into account, although an overall decline was still observed **(Figure 5.1.8)**.

FIGURE 5.1.7: Age-Standardised Incidence Rate of Stroke (Recurrent only) among Singapore Residents aged above 15 Years Admitted to Public Hospitals, 2005-2015



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ischaemic Male	55.8	50.3	47.8	44.8	40.3	39.7	38.5	39.1	38.1	38.2	39.9
Ischaemic Female	36.2	28.7	30.4	29.0	26.2	25.6	25.2	23.2	21.2	22.3	22.2
Haemorrhagic Male	8.5	10.7	8.6	10.2	9.0	9.0	8.9	8.1	8.8	8.3	9.9
Haemorrhagic Female	6.5	7.0	6.1	5.4	5.9	6.0	6.2	5.4	5.8	4.9	4.9
Overall Male	65.7	61.5	56.8	55.4	49.6	48.7	47.9	47.7	46.9	46.7	49.9
Overall Female	43.5	35.9	36.9	34.8	32.3	31.9	31.7	29.0	27.3	27.3	27.3

FIGURE 5.1.8: Age-Standardised Incidence Rate of Stroke (Recurrent only) among Singapore Residents aged 25-64 Years Admitted to Public Hospitals, 2005-2015



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ischaemic Male	30.4	24.3	25.6	22.5	21.4	22.7	21.3	22.8	21.0	21.8	24.2
Ischaemic Female	12.4	10.5	11.0	9.3	9.3	9.4	7.0	9.8	7.8	9.6	8.0
Haemorrhagic Male	4.4	5.9	5.3	6.3	5.5	4.7	5.2	6.1	5.1	5.1	6.2
Haemorrhagic Female	2.2	3.7	3.1	2.8	3.2	2.5	3.2	2.5	2.7	2.5	2.9
Overall Male	35.0	30.2	30.9	28.8	27.0	27.3	26.7	29.1	26.1	26.9	30.4
Overall Female	14.6	14.2	14.2	12.1	12.5	11.9	10.2	12.5	10.6	12.2	10.8

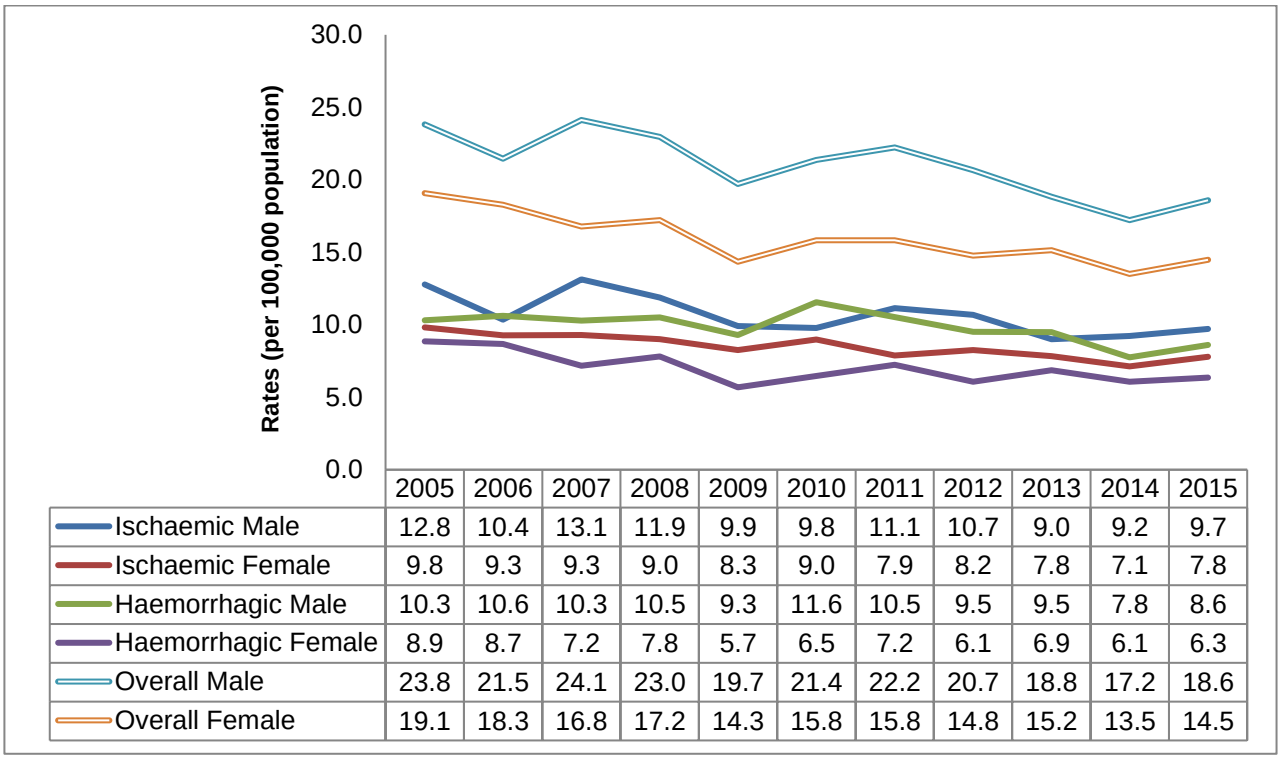
5.2 Mortality Trends from Stroke during Hospitalisation, 2005-2015

For patients aged 15 years and above, the age-standardised mortality rates for stroke showed an overall downward trend – from 21.1 to 16.6 per 100,000 from 2005 to 2015. For ischaemic and haemorrhagic strokes in both genders, a general downward trend was observed during this period – for ischaemic stroke: from 12.8 to 9.7 per 100,000 for males, and from 9.8 to 7.8 per 100,000 for females; and for haemorrhagic stroke: from 10.3 to 8.6 per 100,000 for males, and from 8.9 to 6.3 per 100,000 for females **(Figures 5.2.1 and 5.2.2).**

Among the three main ethnic groups, the Malays consistently had the highest age-standardised mortality rates of stroke. In 2015, the age-standardised mortality rate of stroke among the Malays was 26.9 per 100,000 compared to 15.8 and 12.8 per 100,000 for the Chinese and Indians respectively. **(Figure 5.2.2)**. The same overall pattern of decline was also observed when only those aged 25-64 years were included **(Figures 5.2.3 and 5.2.4)**.

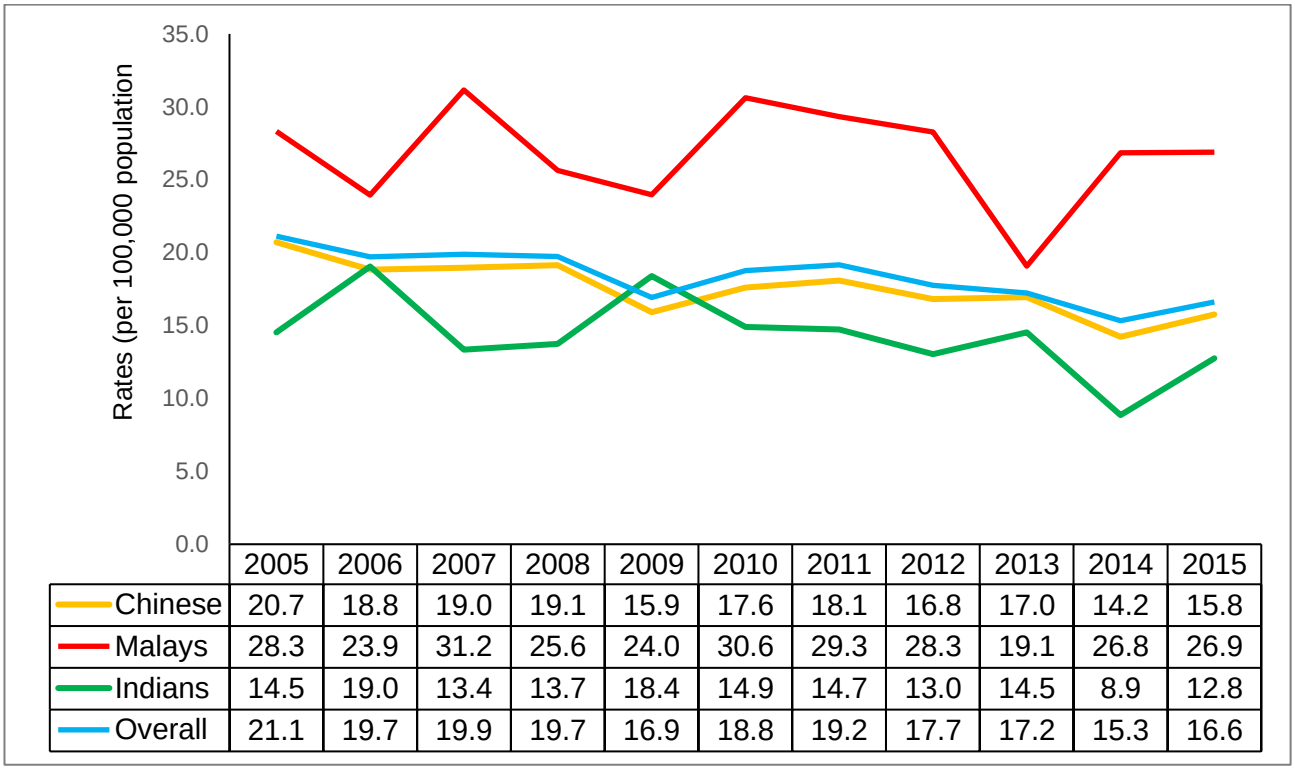
As with the age-specific incidence rates, the age-specific mortality rates increased with age. For the specific age bands, the overall trends showed that while mortality from stroke among the younger age groups remained relatively stable across the period 2005-2015, a general decrease was observed in the mortality rates for the older age bands (55 years and over) during the same period. For the Malays, the mortality rates were almost always higher than those of the Chinese and Indians for every age bands after the age of 55 years, and the mortality rates were also higher compared to the overall mortality rates from stroke of the Singapore population as a whole, for the time period particularly after the year 2007 **(Figure 5.2.5 and 5.2.6)**.

FIGURE 5.2.1: Age-Standardised Mortality Rate of Stroke (First-Ever and Recurrent) among Singapore Residents aged above 15 Years Admitted to Public Hospitals by Gender, 2005-2015



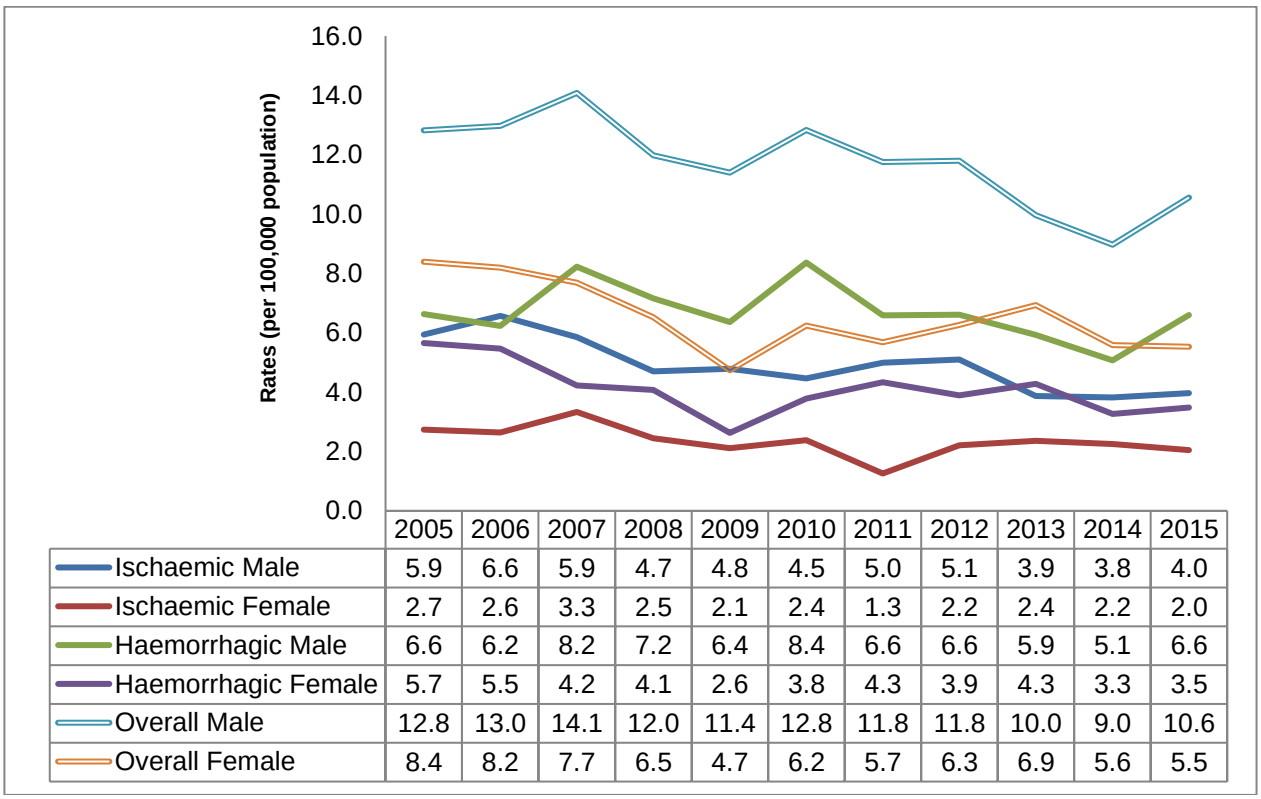
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ischaemic Male	12.8	10.4	13.1	11.9	9.9	9.8	11.1	10.7	9.0	9.2	9.7
Ischaemic Female	9.8	9.3	9.3	9.0	8.3	9.0	7.9	8.2	7.8	7.1	7.8
Haemorrhagic Male	10.3	10.6	10.3	10.5	9.3	11.6	10.5	9.5	9.5	7.8	8.6
Haemorrhagic Female	8.9	8.7	7.2	7.8	5.7	6.5	7.2	6.1	6.9	6.1	6.3
Overall Male	23.8	21.5	24.1	23.0	19.7	21.4	22.2	20.7	18.8	17.2	18.6
Overall Female	19.1	18.3	16.8	17.2	14.3	15.8	15.8	14.8	15.2	13.5	14.5

FIGURE 5.2.2: Age-Standardised Mortality Rate of Stroke (First-Ever and Recurrent) among Singapore Residents aged above 15 Years Admitted to Public Hospitals by Ethnicity, 2005-2015



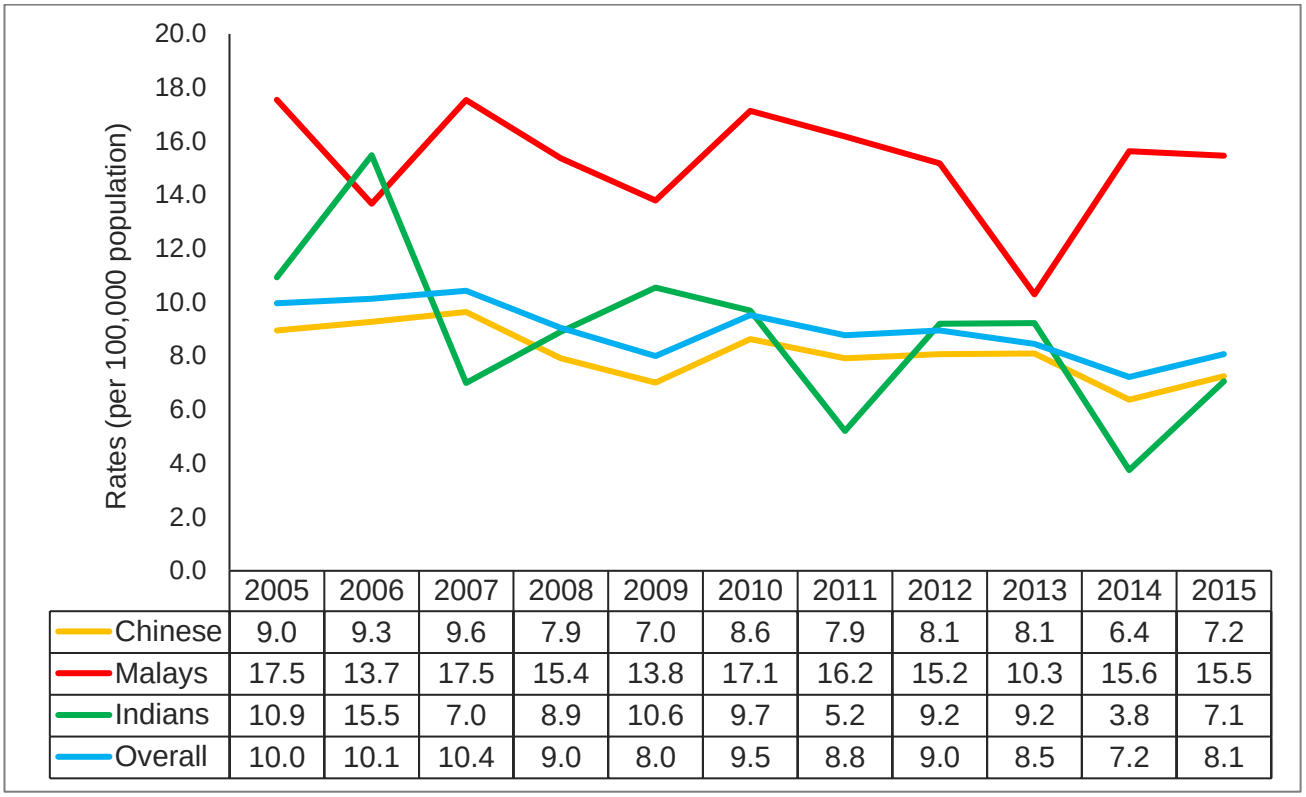
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Chinese	20.7	18.8	19.0	19.1	15.9	17.6	18.1	16.8	17.0	14.2	15.8
Malays	28.3	23.9	31.2	25.6	24.0	30.6	29.3	28.3	19.1	26.8	26.9
Indians	14.5	19.0	13.4	13.7	18.4	14.9	14.7	13.0	14.5	8.9	12.8
Overall	21.1	19.7	19.9	19.7	16.9	18.8	19.2	17.7	17.2	15.3	16.6

FIGURE 5.2.3: Age-Standardised Mortality Rates of Stroke (First-Ever and Recurrent) among Singapore Residents aged 25-64 Years Admitted to Public Hospitals, 2005-2015



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ischaemic Male	5.9	6.6	5.9	4.7	4.8	4.5	5.0	5.1	3.9	3.8	4.0
Ischaemic Female	2.7	2.6	3.3	2.5	2.1	2.4	1.3	2.2	2.4	2.2	2.0
Haemorrhagic Male	6.6	6.2	8.2	7.2	6.4	8.4	6.6	6.6	5.9	5.1	6.6
Haemorrhagic Female	5.7	5.5	4.2	4.1	2.6	3.8	4.3	3.9	4.3	3.3	3.5
Overall Male	12.8	13.0	14.1	12.0	11.4	12.8	11.8	11.8	10.0	9.0	10.6
Overall Female	8.4	8.2	7.7	6.5	4.7	6.2	5.7	6.3	6.9	5.6	5.5

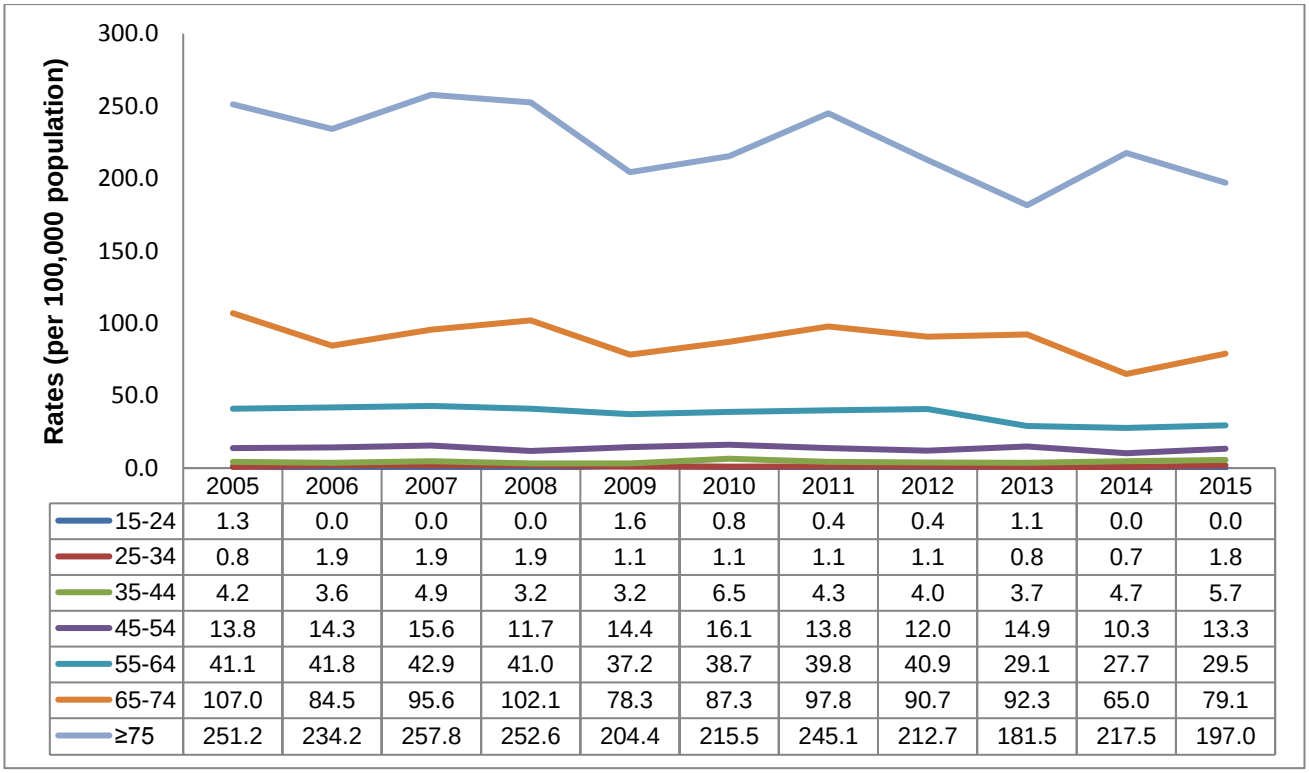
FIGURE 5.2.4: Age-Standardised Mortality Rates of Stroke (First-Ever and Recurrent) among Singapore Residents aged 25-64 Years Admitted to Public Hospitals by Ethnicity, 2005-2015



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Chinese	9.0	9.3	9.6	7.9	7.0	8.6	7.9	8.1	8.1	6.4	7.2
Malays	17.5	13.7	17.5	15.4	13.8	17.1	16.2	15.2	10.3	15.6	15.5
Indians	10.9	15.5	7.0	8.9	10.6	9.7	5.2	9.2	9.2	3.8	7.1
Overall	10.0	10.1	10.4	9.0	8.0	9.5	8.8	9.0	8.5	7.2	8.1

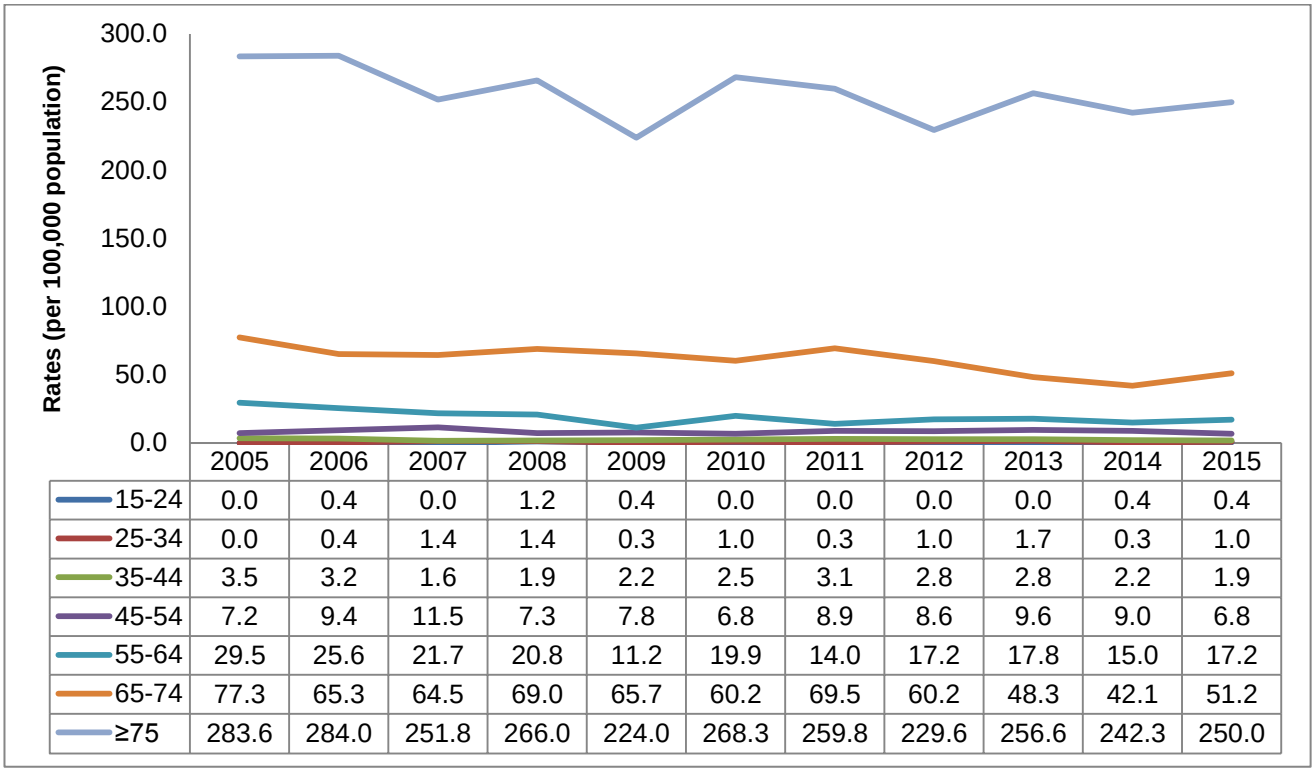
FIGURE 5.2.5: Age-Specific Mortality Rates of Stroke (First-Ever and Recurrent) among Singapore Residents aged above 15 Years Admitted to Public Hospitals by Gender, 2005-2015

a) Males



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	1.3	0.0	0.0	0.0	1.6	0.8	0.4	0.4	1.1	0.0	0.0
25-34	0.8	1.9	1.9	1.9	1.1	1.1	1.1	1.1	0.8	0.7	1.8
35-44	4.2	3.6	4.9	3.2	3.2	6.5	4.3	4.0	3.7	4.7	5.7
45-54	13.8	14.3	15.6	11.7	14.4	16.1	13.8	12.0	14.9	10.3	13.3
55-64	41.1	41.8	42.9	41.0	37.2	38.7	39.8	40.9	29.1	27.7	29.5
65-74	107.0	84.5	95.6	102.1	78.3	87.3	97.8	90.7	92.3	65.0	79.1
≥75	251.2	234.2	257.8	252.6	204.4	215.5	245.1	212.7	181.5	217.5	197.0

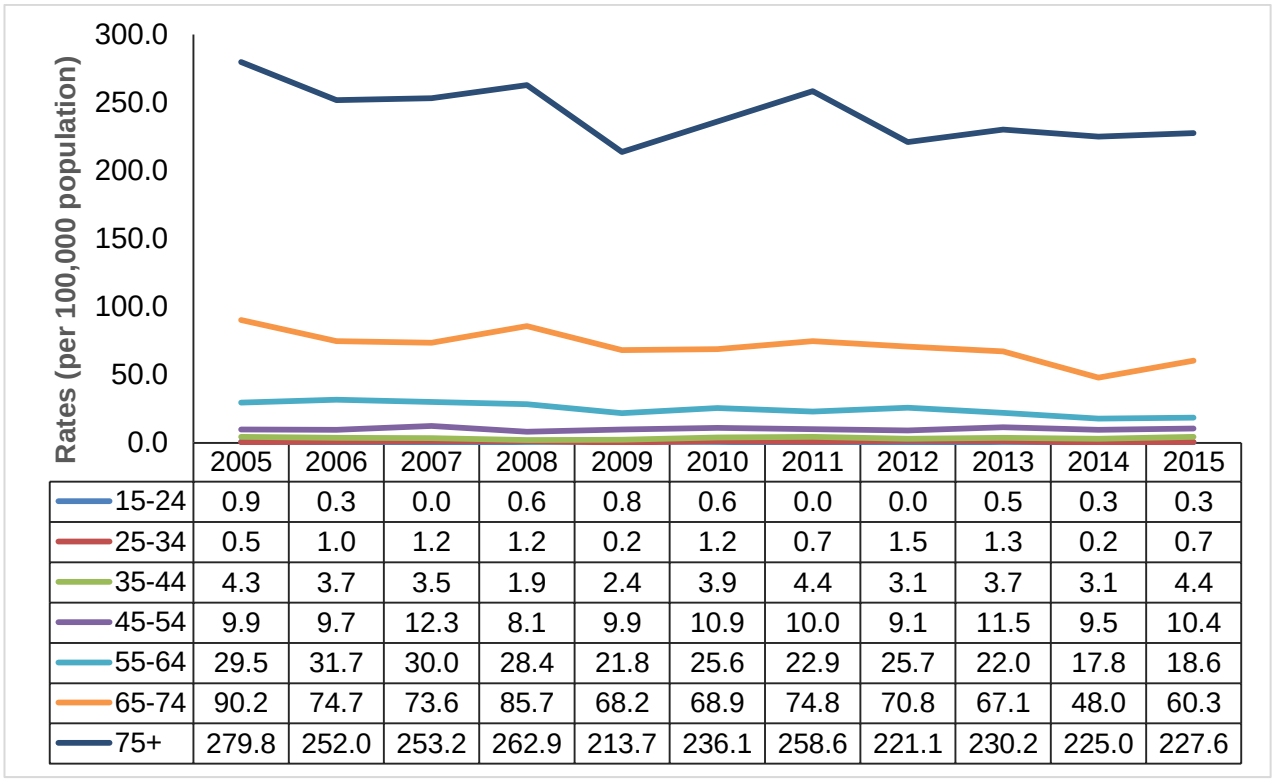
b) Females



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	0.0	0.4	0.0	1.2	0.4	0.0	0.0	0.0	0.0	0.4	0.4
25-34	0.0	0.4	1.4	1.4	0.3	1.0	0.3	1.0	1.7	0.3	1.0
35-44	3.5	3.2	1.6	1.9	2.2	2.5	3.1	2.8	2.8	2.2	1.9
45-54	7.2	9.4	11.5	7.3	7.8	6.8	8.9	8.6	9.6	9.0	6.8
55-64	29.5	25.6	21.7	20.8	11.2	19.9	14.0	17.2	17.8	15.0	17.2
65-74	77.3	65.3	64.5	69.0	65.7	60.2	69.5	60.2	48.3	42.1	51.2
≥75	283.6	284.0	251.8	266.0	224.0	268.3	259.8	229.6	256.6	242.3	250.0

FIGURE 5.2.6: Age-Specific Mortality Rates of Stroke (First-Ever and Recurrent) among Singapore Residents aged above 15 Years Admitted to Public Hospitals by Ethnicity, 2005-2015

a) Chinese



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	0.9	0.3	0.0	0.6	0.8	0.6	0.0	0.0	0.5	0.3	0.3
25-34	0.5	1.0	1.2	1.2	0.2	1.2	0.7	1.5	1.3	0.2	0.7
35-44	4.3	3.7	3.5	1.9	2.4	3.9	4.4	3.1	3.7	3.1	4.4
45-54	9.9	9.7	12.3	8.1	9.9	10.9	10.0	9.1	11.5	9.5	10.4
55-64	29.5	31.7	30.0	28.4	21.8	25.6	22.9	25.7	22.0	17.8	18.6
65-74	90.2	74.7	73.6	85.7	68.2	68.9	74.8	70.8	67.1	48.0	60.3
75+	279.8	252.0	253.2	262.9	213.7	236.1	258.6	221.1	230.2	225.0	227.6

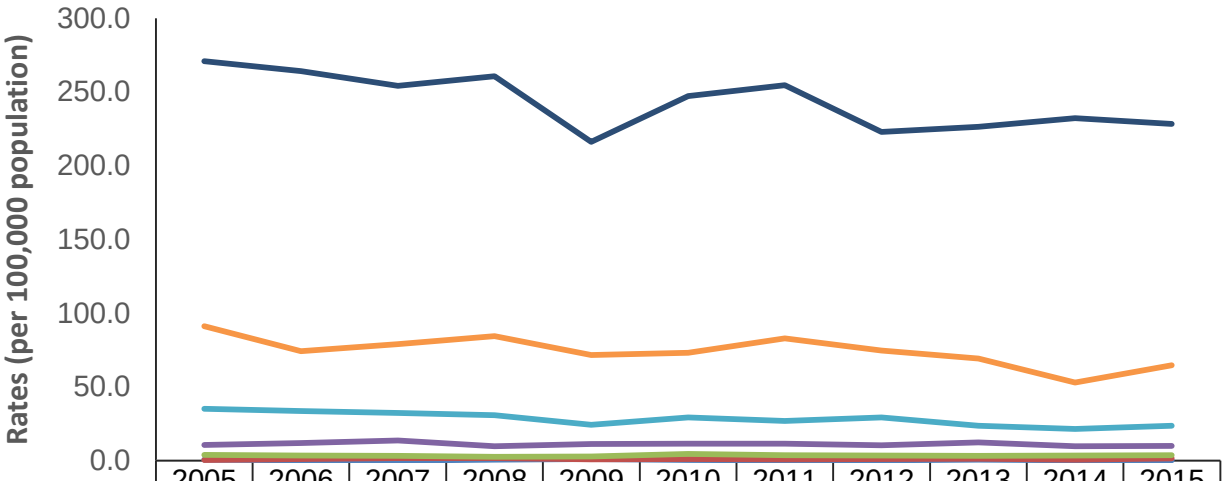
b) Malays

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	0.0	0.0	0.0	1.1	0.0	0.0	1.1	0.0	1.1	0.0	0.0
25-34	0.0	3.2	1.6	3.1	1.5	1.5	0.0	0.0	0.0	2.5	6.1
35-44	3.6	4.9	3.8	3.9	5.4	9.8	2.9	3.1	3.2	9.7	3.2
45-54	7.4	23.9	24.1	16.7	17.4	13.4	17.9	20.1	17.8	12.1	13.7
55-64	83.1	31.1	57.0	52.1	42.9	60.7	62.0	53.1	28.7	52.3	52.7
65-74	129.7	57.9	136.1	100.5	100.5	125.2	134.4	126.2	85.2	105.1	109.4
75+	257.7	373.7	339.8	277.8	265.0	358.2	302.3	318.2	204.4	311.5	306.6

c) Indians

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	0.0	0.0	0.0	0.0	4.5	0.0	0.0	2.2	0.0	0.0	0.0
25-34	0.0	0.0	5.4	1.7	3.1	0.0	1.6	0.0	3.4	0.0	0.0
35-44	1.8	0.0	0.0	3.3	1.6	4.6	0.0	6.0	0.0	1.5	0.0
45-54	17.3	18.7	9.0	12.9	18.6	14.1	9.8	3.8	7.5	5.5	5.5
55-64	35.0	61.3	17.5	24.3	26.1	28.3	13.1	37.6	35.6	11.3	32.2
65-74	51.3	42.4	67.2	42.7	75.0	34.0	108.3	52.6	55.9	25.7	65.3
75+	127.0	202.9	135.1	166.7	170.7	211.0	120.5	92.0	153.8	156.9	118.2

d) Overall



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
15-24	0.7	0.2	0.0	0.6	1.0	0.4	0.2	0.2	0.6	0.2	0.2
25-34	0.4	1.1	1.6	1.6	0.7	1.1	0.7	1.1	1.3	0.5	1.4
35-44	3.9	3.4	3.2	2.6	2.7	4.4	3.7	3.4	3.2	3.4	3.7
45-54	10.5	11.9	13.6	9.7	11.3	11.5	11.4	10.3	12.2	9.6	10.0
55-64	35.2	33.6	32.3	30.8	24.2	29.3	26.9	29.2	23.6	21.4	23.5
65-74	91.2	74.3	79.0	84.5	71.6	73.0	82.9	74.6	69.2	53.0	64.5
75+	270.9	264.2	254.2	260.7	216.2	247.3	254.6	222.8	226.3	232.3	228.4

5.3 Mortality after Stroke Onset, 2014 & 2015

A total number of 1,364 stroke patients, who had stroke in the year 2014, died from all causes within one year after admission. Of these, 32%, 53.7%, 69.9%, and 82.3% of deaths (cumulative) occurred at less than 7 days, 30 days, 90 days, and 6 months post-stroke, respectively **(Table 5.3.1)**.

A total number of 729 stroke patients, who had stroke in the year 2014, died due to stroke only within one year after admission. Of these, 51.3%, 77.6%, 88.9%, and 95.2% of deaths (cumulative) occurred at less than 7 days, 30 days, 90 days, and 6 months post-stroke respectively **(Table 5.3.1)**.

TABLE 5.3.1: Cumulative Frequencies of All Cause Mortalities and Stroke Mortalities at Various Time-periods after Stroke Onset, 2014

Time period after stroke onset	Cumulative frequency (%) of all cause mortalities	Cumulative frequency (%) of mortalities due to stroke
< 7 days	436 (32.0%)	374 (51.3%)
< 30 days	733 (53.7%)	566 (77.6%)
< 90 days	953 (69.9%)	648 (88.9%)
6 months post stroke	1,123 (82.3%)	694 (95.2%)
1 year post stroke	1,364 (100.0%)	729 (100.0%)

The mortality rate within 7 days of admission was 18.3% for haemorrhagic stroke, 3.7% for ischaemic stroke and 58.3% for stroke of unknown subtype. Majority of patients with haemorrhagic stroke died within 6 days of admission, whereas most patients with ischaemic stroke died after 90 days or more **(Table 5.3.2)**.

TABLE 5.3.2: Proportion (%) of Cases Died by Stroke Aetiology at Various Time Periods after Admission, 2015

	0-6 days	7-29 days	30-89 days	>=90 days
Haemorrhagic	18.3	6.3	2.3	5.0
Ischaemic	3.7	4.4	3.9	8.2
Unknown	58.3	20.8	12.5	0.0

5.4 Ethnic Differences in Risk Factors, 2015

Across the board, regardless of ethnicity, hypertension, hyperlipidemia, and diabetes mellitus were the top three risk factors identified amongst stroke patients. Most of these risk factors can be addressed through appropriate lifestyle modifications such as the adoption of a healthy diet, physical activity participation and smoke-free lifestyle.

Notably, the proportion of patients with risk factors associated with stroke were found to be highest among Indians compared to the other ethnic groups, with the exception of atrial fibrillation (Table 5.5.1).

TABLE 5.4.1: Distribution of Proportion of Risk Factors in Stroke patients by Ethnic Groups, 2015

Risk Factor	Chinese (%)	Malay (%)	Indian (%)	Other (%)
History of Diabetes Mellitus	33.1	44.8	57.5	32.2
Blood sugar>=10mmol/l on admission	24.3	34.8	40.1	23.5
History of Ischaemic Heart Disease	19.7	24.3	34.6	24.4
History of Smoking	35.1	39.8	41.0	40.0
History of Hyperlipidaemia	61.0	62.9	71.2	60.9
History of Atrial Fibrillation	15.7	11.9	8.4	13.9
History of Hypertension	76.8	78.4	80.9	75.7
History of Peripheral vascular diseases	3.3	3.2	6.7	3.5
History of Transient Ischeamic Attack	4.4	3.0	4.9	4.4

5.5 Ischaemic Stroke Treatment, 2005-2015

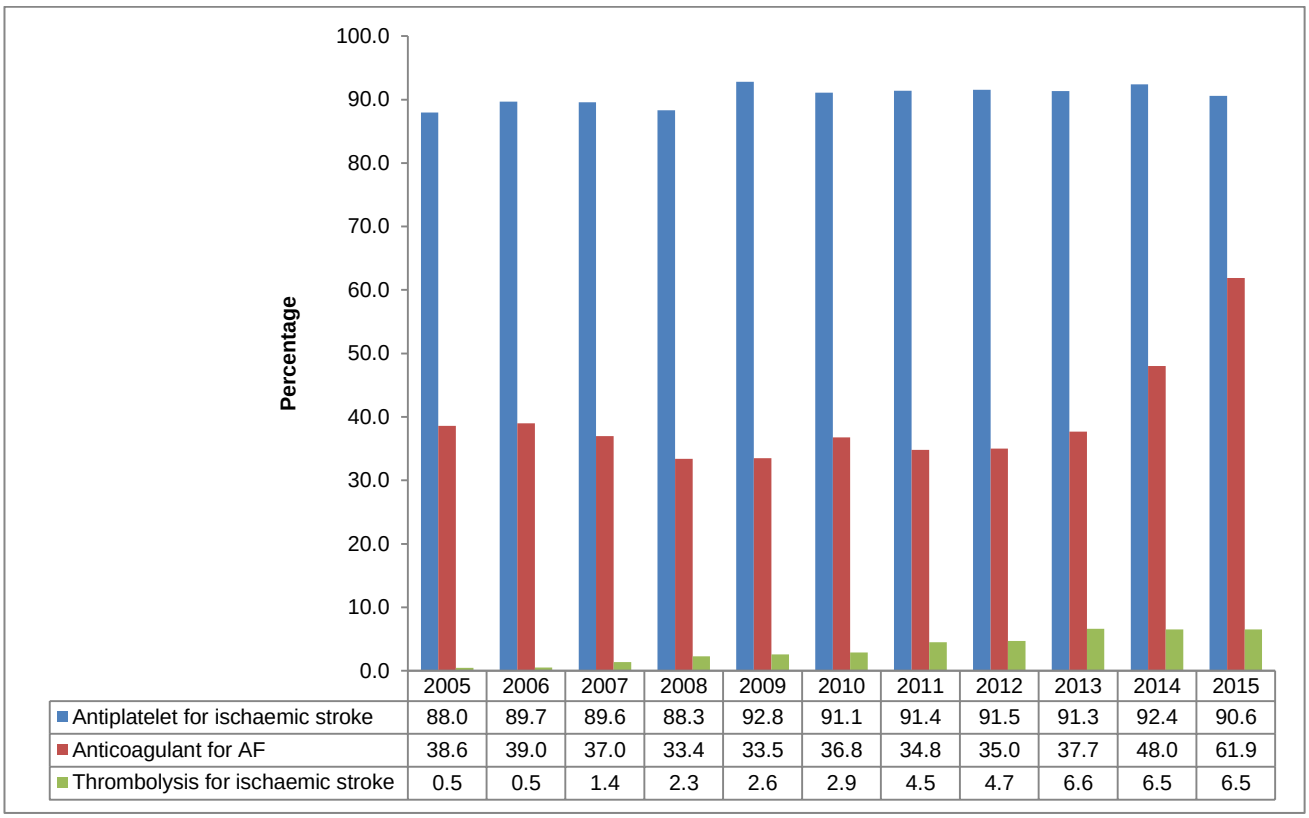
For both first-ever and recurrent stroke patients, the majority (about three-quarters) received antiplatelet only as treatment for ischaemic stroke **(Table 5.6.1)**. The percentage of patients with history of atrial fibrillation or patients with newly diagnosed atrial fibrillation, who were given anticoagulants has remained stable from 2005 to 2013, but increased to 48.0% in 2014 and 61.9% in 2015. The proportion of patients receiving thrombolysis treatment has increased from 0.5% in 2005 to 6.5% in 2015 **(Figure 5.6.1)**.

TABLE 5.5.1: Antiplatelet, Anticoagulant Treatment for Ischaemic Stroke, 2015

Ischaemic Stroke	1st ever stroke (%)	Recurrent stroke (%)	Overall (%)
Antiplatelet only	78.6	75.1	77.8
Anticoagulant only	2.6	5.5	3.3
Antiplatelet & Anticoagulant	13.4	13.6	13.5

Note: exclude those with contraindication

FIGURE 5.5.1: Antiplatelet, Anticoagulant, Thrombolysis Treatment for Ischaemic Stroke, 2005-2015



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Antiplatelet for ischaemic stroke	88.0	89.7	89.6	88.3	92.8	91.1	91.4	91.5	91.3	92.4	90.6
Anticoagulant for AF	38.6	39.0	37.0	33.4	33.5	36.8	34.8	35.0	37.7	48.0	61.9
Thrombolysis for ischaemic stroke	0.5	0.5	1.4	2.3	2.6	2.9	4.5	4.7	6.6	6.5	6.5

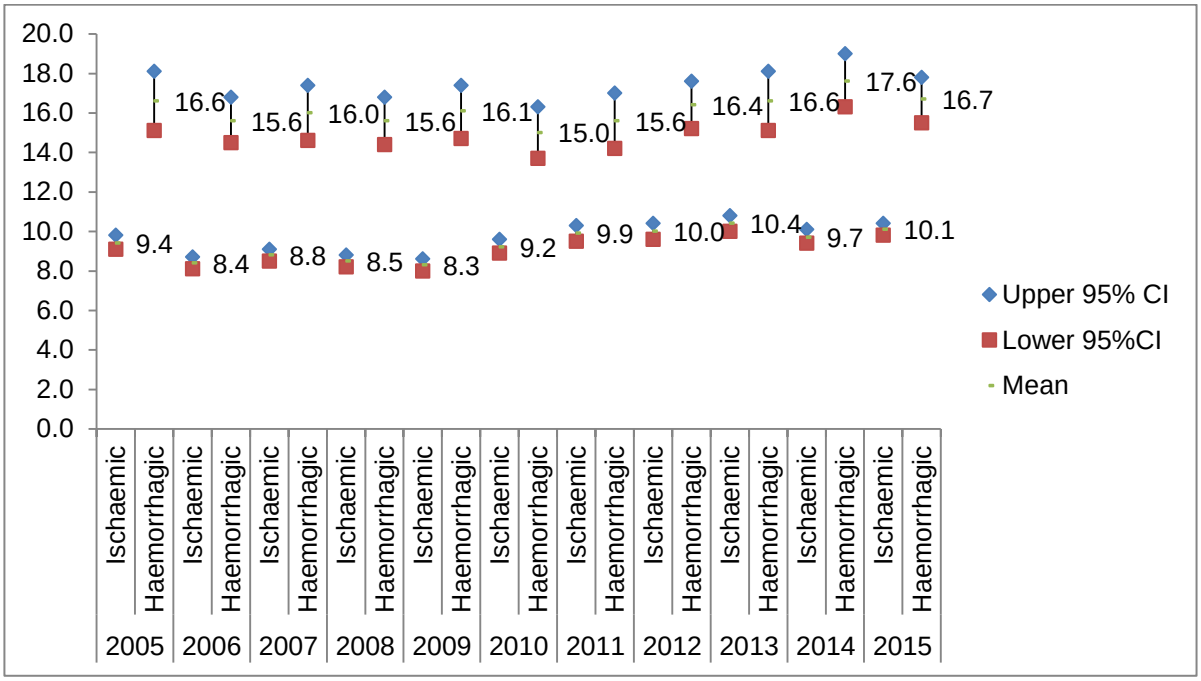
Note: Excludes patients with contraindications for antiplatelet and anticoagulant. Note that from July 2014, the list of possible reasons for patients being contraindicated for antiplatelet and anticoagulant was extended. This list is required for field staff to input into the database and to classify if a patient was contraindicated for antiplatelet and anticoagulant.

5.6 Length of Hospital Stay and Discharge Information, 2005-2015

The length of stay among haemorrhagic stroke patients was about one week longer than that among ischaemic stroke patients **(Figure 5.6.1)**. This was likely because haemorrhagic stroke tended to be more serious than ischaemic stroke, thus warranting a longer stay in hospital.

From the hospitals, 49.2% of stroke patients were discharged to their homes, 10.1% were transferred to community hospitals and 18.8% were sent for rehabilitation in acute hospitals, 3.4% to nursing homes, 0.1% to other hospitals for stroke management and 7.5% to other hospitals for management of disease conditions other than stroke. Stroke patients who were transferred from restructured hospitals to the rehabilitation unit residing in other hospitals were included in the category 'rehabilitation in acute hospitals', such as from Tan Tock Seng Hospital to Ang Mo Kio Community Hospital, Singapore General Hospital to Bright Vision Hospital, and National University Hospital to West Point Hospital.

FIGURE 5.6.1: Length of Hospital Stay (Days), 95%CI (Lower, Mean, Upper) 2005-2015



5.7 Audit Parameters (Timing for Neuro-imaging, In-hospital Events, Stroke Pathway), 2015

The following indicators were used by MOH as audit parameters: timing for neuro-imaging, development of in-hospital events (complications), and stroke episodes management using stroke care pathways.

A total of 85.5% of the stroke patients had their CT brain scan done during hospitalisation.
78.7% had CT scans done within 24 hours of admission.
66.7% had undergone MRI brain scan during hospitalisation.
93.0% had CT or MRI brain scan done within 24 hours of their admission to the hospitals.

ECG was done in 97.7% of admissions.

64.6% of stroke episodes were managed using stroke care pathways during their hospitalisation.

18.0 % of stroke episodes had developed at least one in-patient event (complications) during their hospitalisation.

The common in-patient events (complications) developed during the hospitalisation were urinary tract infection (9.6%), pneumonia (7.3%), septicaemia (1.4%), deep vein thrombosis (0.4%), angina/acute myocardial infarction (2.0%), pulmonary embolism (0.2%) and recurrent stroke within 28 days (0.8%).