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Hospitalisation Incidence for Acute Cerebrovascular Disease in Western Australia, 1989 to 1998:

Geographical variations

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EXECUTIVE SUMMARY

Stroke is a major cause of death and long-term disability in WA, yet the incidence remains undetermined across the State. Analysis of linked hospital separation data provides a means to estimate new stroke cases entering the hospital system in a large and geographically dispersed population such as WA.

The incidence of hospitalisation for stroke in WA decreased among males, but remained unchanged among females from 1989 to 1998, with males having the higher incidence over the ten-year period. Rates for first-ever hospitalisation for stroke were highest in the Non-metropolitan areas of the State. A poorer risk factor profile, a larger component of Aboriginal people in the population and distance between a patient's home and hospital are all factors which may influence the rate of first-ever stroke hospitalisation in the Non-metropolitan area. Despite the decrease in the rate of first-ever hospitalisation among the elderly male residents of the Metropolitan area and elderly residents of Non-metropolitan, the rate among the elderly remains well above that of the younger age groups across WA.

The counts of first-ever hospitalisations for stroke were used to determine the incidence of hospitalisation for stroke and its four subtypes – ischaemic cerebrovascular disease (ICD), transient ischaemic attacks (TIA), intracerebral haemorrhage (ICH) and subarachnoid haemorrhage (SAH) – over the period 1989 to 1998 in WA. However, limitations exist in the use of hospital separation data to estimate the true incidence of stroke subtypes due to variations in coding of stroke subtypes, improvements in diagnostic techniques during the study period and acute stroke management practices.

Ischaemic cerebrovascular disease accounted for the largest proportion of first-ever hospitalisations for stroke and consequently the patterns of ICD first-ever hospitalisation were similar to those for all strokes.

Males had a higher hospitalisation incidence for TIA than females, but the differential between the sexes was decreasing due to an increase in the rate among females and a constant male rate. An increase among elderly Metropolitan females accounted for the State female increase, although rates were highest among the Non-metropolitan population. The increase in rate among females is of concern because of the high risk of recurrent stroke and ischaemic heart disease among TIA sufferers.

The number of first-ever hospitalisation was lower for haemorrhagic strokes. However, for ICH the hospitalisation incidence increased over the ten-year period among both elderly males and females. From 1989 to 1998, rates were initially lower among Non-metropolitan residents than among Metropolitan residents, but an increase in the rate among Non-metropolitan residents in latter years resulted in equivalent rates by 1998. In the latter period of the study an increase in the accessibility of appropriate diagnostic services, especially in Non-metropolitan areas, may have resulted in better ascertainment of ICH rather than an increase in true incidence.

Hospitalisation incidence was lowest for SAH than for any other stroke subtype. The rate decreased among both males and females, with females experiencing the highest rates over the ten-year period. Better ascertainment and diagnosis of stroke in recent years has contributed to a decrease in SAH cases. Although the low number of initial hospitalisations for SAH restricted assessment of geographical variation, the rate of Metropolitan females was found to decrease to a level equivalent to that of Metropolitan males.

Changes in the hospitalisation incidence for haemorrhagic stroke through better ascertainment indicate the need for the extension of diagnostic services in Non-metropolitan areas to facilitate early and accurate diagnosis of stroke cases and to optimise the outcome of secondary prevention. Hospitals may already be responding to treatment of patients with symptoms of cerebral ischaemia in increasing numbers, but the prevention of stroke among the increasing number of patients suffering TIAs needs to remain a priority. Best outcomes of stroke treatment are achieved in dedicated stroke units (Stroke Unit Trialists' Collaboration, 1997) and these services are at present concentrated in the Metropolitan area. Costly admissions to hospital for stroke can be reduced by prevention aimed at improving the stroke risk profile of the population and providing appropriate diagnostic and acute treatment services to patients hospitalised for the first time for stroke (Hankey, 2000).

With an increasing proportion of all stroke cases being hospitalised, analysis of linked hospital separation data presents major benefits. It provides a valuable and feasible means of obtaining estimates of stroke incidence for a large and geographically dispersed population not available from local population-based studies. Furthermore, the use of hospital separation data allows the description of hospital utilisation patterns of stroke patients across the State. Comparison of stroke hospitalisation incidence between sub-populations of geographical areas will assist planning of stroke services across the State, which is becoming increasingly important with an ageing population.

1 INTRODUCTION

Acute cerebrovascular disease (stroke) is a major cause of death and long-term disability in most industrialised populations placing a significant burden on the health resources of these communities (Bonita, 1992). In Australia, stroke was the second leading cause of death among females and the third among males during 1998 (AIHW, 2000). In terms of total cost to the Australian health system, stroke ranks eighth among specific causes of illness with a greater proportion of overall cost associated with institutionalisation (AIHW, 2000). Hospitalisation for acute care of stroke is the most costly component, with stroke treatment demanding longer hospital stays than any other cardiovascular condition (AIHW, 2000).

Of all stroke events each year in Australia, 70% are first ever stroke events and 50% occur among people older than 75 years (AIHW, 2000). However, those mildly affected or rapidly fatal are not admitted to hospital and are not included in this report. The Perth Community Stroke Study (PCSS) estimated the crude annual incidence of acute stroke at 1.89 per 1,000 among males and 1.66 among females during 1989–1990 (Anderson et al., 1993). For the same acute stroke events around 70% were estimated to result in hospitalisation with 10% occurring during hospitalisation (Anderson et al., 1994). By 1995–1996 the proportion of stroke cases recorded by the PCSS and admitted to hospital had increased to more than 90% (Jamrozik et al., 2001). The outcomes of these hospitalisations are frequently far from a complete recovery.

Around one-third of people suffering a stroke each year will die within a year (Hankey et al., 2000), and a quarter will remain permanently disabled (Bonita et al., 1994), whilst the remainder will recover sufficiently to live without a disability attributed to stroke. At any time over half of the survivors of stroke require long-term care provided by either an institution or a carer within the home (Bonita et al., 1997).

An appropriate response to a public health issue of this magnitude and severity is dependent upon high quality surveillance of stroke within our community. To date information used to plan and allocate resources for hospital management of stroke in Western Australia has relied on extrapolation from localised community stroke studies based in the Metropolitan area. Although analysis of hospital-based stroke data is unable to accurately estimate the incidence of stroke in Western Australia, this report provides valuable data for the first time on the variation of stroke events across Western Australia. There is a need for information on a Statewide basis which also describes the variation of the burden of stroke among rural and remote as well as metropolitan communities to inform planning and the distribution of primary and secondary prevention strategies. Furthermore, measurement of stroke morbidity and trends is a vital component of any stroke intervention evaluation.

Interventions in the acute stage will depend upon whether the stroke is ischaemic or haemorrhagic. The term stroke in this report is used to describe four subtypes of acute cerebrovascular disease: ischaemic cerebrovascular disease, transient ischaemic attacks, subarachnoid haemorrhage and intracerebral haemorrhage. All of these types of stroke involve dysfunction of at least part of the brain due to disruption of blood flow (too much or too little blood flow).

- Ischaemic cerebrovascular disease (ICD) is the occlusion of blood flow due to arterial blockage caused by narrowing of arteries, clotting, tumours and other causes. This reduction of blood flow in a major artery can then lead to clotting in tributaries proximal to the primary occlusion further affecting tissues in the surrounding area (Stein, 1994).

- Transient ischaemic attack (TIA) also involves the occlusion of blood flow due to arterial blockage, however this is characterised by slightly different symptoms resulting from the process in the artery not being static. In other words there will be fluctuating blood deficits and therefore fluctuating symptoms in the person so affected (Stein, 1994). The symptoms from TIA resolve within 24 hours.

- Subarachnoid haemorrhage (SAH) involves bleeding into the spaces surrounding the brain leading to pressure build-up and can cause death or severe brain damage. If the person survives the initial bleeding, there is a high risk of further bleeding in the following weeks. (Stein, 1994).

- Intracerebral haemorrhage (ICH) involves bleeding directly into parenchyma causing damage to local tissue and surrounding small vessels. This is likely to result in some degree of dysfunction at the site of bleeding, and possibly death depending on the rate at which the haematoma develops (Stein, 1994).

The objective of this report is to provide summary statistics describing trends among the WA population for the first-ever hospitalisation for stroke during the period 1989 to 1998. Summary statistics are presented for all stroke and the four subtypes of acute cerebrovascular stroke by geographical location, gender, year of event and age group.

2 METHODS

Hospital separation data were extracted from the Western Australian Hospital Morbidity Data System (WAHMDS), which is maintained by the Department of Health Western Australia (DOHWA). Linked hospital records were provided by the WA Linked Database (Holman et al., 1999).

Estimates of stroke hospitalisation incidence reported here are based on hospital separation data from 1989 to 1998. The period 1989 to 1998 represents the most recent period that is relatively uninterrupted by major coding changes.

All hospital admissions with a principal diagnosis (major reason for hospitalisation) coded as stroke under the International Classification of Diseases (ICD) 9th Revision (WHO, 1977) were selected. Stroke was defined in terms of four subtypes of acute cerebrovascular disease as follows:

(i) for subarachnoid haemorrhage the ICD9-CM code is 430;
(ii) for intracerebral heamorrhage the ICD9-CM code is 431;
(iii) for ischaemic cerebrovascular disease the ICD9-CM codes are 434 and 436;
(iv) for transient ischaemic attacks the ICD9-CM code is 435.

The definition of ischaemic stroke in this report made no distinction between ischaemic cerebrovascular disease with cerebral infarction, and ischaemic cerebrovascular disease without cerebral infarction. It would be preferable to count only those cases with cerebral infarction. However, only from July 1995 onwards was an additional digit added to the relevant ICD codes, which allowed the identification of cerebral infarction associated with occlusion of pre-cerebral and cerebral arteries. The majority (80%) of cases admitted for occlusion of pre-cerebral arteries (ICD9-CM code 433) had no associated cerebral infarction, whereas over 90% of cases admitted for occlusion of cerebral arteries (ICD9-CM code 434) involved cerebral infarction. Consequently, the use of ICD9-CM codes of 434 and 436 was chosen to define ischaemic cerebrovascular disease.

Having arrived at a definition of hospitalisations related to stroke, it is necessary to determine the first-ever hospitalisation for stroke for each patient. One stroke event may lead to numerous hospitalisations. Treatment may consist of a number of phases each with its own admission and separation, or a patient may be separated from one hospital and admitted to another during a transfer. Transfers were readily identified from the hospital separation records for each patient and deleted. However, admissions for treatment subsequent to a stroke event are not as easily identified. Taking the first record of each patient in the study period would result in an overestimation of stroke hospitalisation incidence as some patients may have been admitted prior to the study period causing a prevalence pooling effect.

Traditionally prevalence pooling has been accounted for by using an appropriate lead-in period to check for prior hospitalisations before counting a particular hospitalisation as a stroke event. The disadvantage of using the lead-in period method is the loss of data equivalent to the lead-in period.

Recently a method for reducing the prevalence pooling effect, which does not involve any loss of data has been reported (Brameld et al., 2001). The method is called 'backcasting' and provides a means of estimating the probability of a prior hospitalisation. These probabilities are then used to give a weight to hospitalisation frequencies such that they more accurately reflect first-ever hospitalisation for stroke.

Age-standardised and age-adjusted rates, standardised rate ratios and trend analyses were all calculated using the Rates Calculator.[1]

Age-standardised and age-adjusted rates were calculated using the direct method (Rothman, 1986). Population figures used as denominators for calculation of rates were obtained from estimates made by the DOHWA, which were derived from estimated resident populations provided by the Australian Bureau of Statistics (ABS). The Australian 1991 population was used as the standard in the direct standardisation process. The time trend analysis of age-standardised and age-adjusted rates used the Poisson regression of age-specific rates, with the year effect averaged over all age groups, to estimate the average change in hospitalisation incidence rates (Clayton & Hills, 1996). The likelihood-ratio chi square test and average annual rate ratios were calculated to establish the nature and significance (at the 95% level) of the trend in rates over time.

Indirect standardisation was used to obtain standardised rate ratios (SRR) in three analyses for all strokes and each stroke subtype. Firstly, the metropolitan age and gender-specific rates were used to calculate the expected numbers of Non-metropolitan hospitalisations in a comparison of the two areas. Secondly, to compare changes over time, within the two areas age and gender-specific rates for the five-year period 1989 to 1993 were used to calculate the expected numbers of hospitalisations for the five-year period 1994 to 1998. Three-year rolling averages were used to smooth out atypical annual fluctuations when analysing age-adjusted rates. Data from the current, prior and following year were used to calculate the rolling average. Finally, indirect standardisation was used to compare the rates of hospitalisation for all stroke and the four subtypes among residents of WA Health Zones (Figure 1) in the 10-year period 1989 to 1998 with that of the State rate using the State gender and age-specific rates.

[1] The Rates Calculator was developed by Dr Jim Codde (Director of Epidemiology and Analytical Services, DOHWA).

Figure 1: Health Zones of Western Australia

3 RESULTS

3.1 ALL STROKE

3.1.1 STATE OVERVIEW

Numbers and age-standardised rates

In Western Australia during 1989 to 1998 there were a total of 12,711 first-ever hospitalisations for stroke among males, and 11,997 among females. This represents an annual average of 1,271 first-ever hospitalisations among males and 1,200 among females (Table 1).

From 1989 to 1998, there was a statistically significant decrease in rate of first-ever hospitalisation for stroke among males. The rate among males decreased by an annual average of 1.6% from 201 (per 100,000 person-years) in 1989 to 172 in 1998. Although the rate among females decreased from 133 per 100,000 in 1989 to 117 in 1998 the change was not statistically significant. Males had a higher rate of first-ever stroke hospitalisation than females (Table 1) and this was consistent over time.

Table 1: Annual average number, age-adjusted rates and percent annual change by gender for first-ever hospitalisation for stroke, Western Australia, 1989 to 1998

	Number	Rate[1,2]		% Annual Change[3]	
Males					
0-44	63	10	(9.5-11.1)	0.7	
45-59	172	125	(119.4-131.2)	-0.9	
60-74	506	639	(620.9-656.0)	-2.2	✡
75+	529	1998	(1944.9-2051.7)	-1.4	✡
Total	1271	186	(182.7-189.2)	-1.6	✡
Females					
0-44	51	8.7	(7.9-9.4)	0.9	
45-59	101	78	(73.0-82.6)	-1.3	
60-74	333	386	(373.3-399.5)	-2.4	✡
75+	714	1599	(1561.8-1635.9)	0.2	
Total	1200	132	(129.2-134.0)	-0.8	

Notes: 1. Rate = age-adjusted rates per 100,000 persons.
2. Figures in parentheses are the 95% confidence intervals for the AAR.
3. The symbols ▲ and ▼ indicate statistically significant increases or decreases in rates respectively.

Age-adjusted rates

The rate of first-ever hospitalisation for stroke increased with age. The annual average rate among males younger than 45 years was 10 per 100,000 person-years compared to 1,998 among males older than 74 years. Among females younger than 45 years the rate was 8.7 compared to 1,599 among females older than 74 years (Table 1).

Males older than 59 years accounted for the decrease in the overall male rate. Among males older than 74 years the rate of first-ever hospitalisation for stroke decreased by an annual average of 1.4% from 2,094 per 100,000 person-years in 1989 to 1,825 in 1998. Over the same period the rate among males aged between 60 and 74 years significantly decreased by an annual average of 2.2% from 692 per 100,000 to 573.

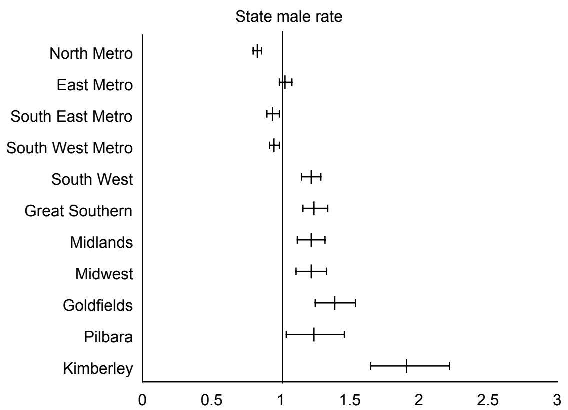
Among females aged between 60 and 74 years, the rate of first-ever hospitalisation for stroke decreased significantly by an annual average of 2.4% from 445 per 100,000 in 1989 to 316 in 1998.

3.1.2 GEOGRAPHIC VARIATION

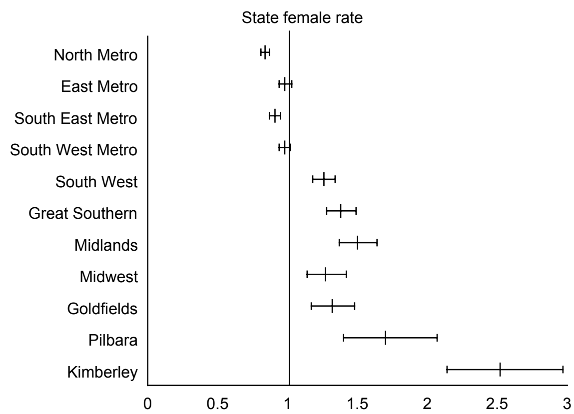
The rate of first-ever stroke hospitalisation varied across the State for the ten-year period, 1989 to 1998. Among both sexes, the rates were significantly higher than the State sex-specific rates for residents of all Non-metropolitan Health Zones. Significantly lower rates than expected based on the State male rate were recorded among male residents of the North Metropolitan, South East Metropolitan and South West Metropolitan Health Zones. Among Metropolitan females the rates were significantly lower than State females for residents of the North Metropolitan and South East Metropolitan Health Zone (Figure 2).

Figure 2: Standardised rate ratios for first-ever stroke hospitalisation by Health Zone and gender, Western Australia, 1989 to 1998

Males



Females



Since there is significant variation between these areas, especially for country residents, further analysis within each health zone was conducted. These analyses can be found in an accompanying supplementary report 'Acute cerebrovascular disease hospitalisation incidence: WA Health Zones, 1989 to 1998', published on the Department of Health website (www.health.wa.gov.au).

Geographic variation for first-ever stroke hospitalisations in Western Australia was analysed by the comparison of number, age-standardised rates, time trends and age-adjusted rates among residents of the Metropolitan area and the Non-metropolitan area.

Numbers and age-standardised rates

In the Metropolitan area during 1989 to 1998 there were a total of 9,144 first-ever stroke hospitalisations among males, and 8,997 among females. This represents an annual average of 914 among males and 900 among females (Table 2).

In the Non-metropolitan area during 1989 to 1998 there were a total of 3,566 first-ever stroke hospitalisations among males, and 3,000 among females. This represents an annual average of 357 first-ever stroke hospitalisations among males and 300 among females (Table 2).

There was a statistically significant decrease in the rate of first-ever stroke hospitalisation among males in the Metropolitan area over time by an annual average of 1.4%. The rate among males decreased from 186 per 100,000 person-years in 1989 to 162 in 1998. The rate among females in 1989 was 122 per 100,000 and remained unchanged with a rate of 110 in 1998. Males had a higher rate than females (Table 2) and this was consistent over the ten-year period.

There was a significant decrease in rates of first-ever stroke hospitalisation over time among males by an annual average of 2.2% and females by an annual average of 1.4% in the Non-metropolitan area (Table 2). The rate among males decreased from 252 per 100,000 in 1989 to 208 in 1998. The female rate was consistently lower than the male rate over the ten-year period and decreased from 182 per 100,000 in 1989 to 144 in 1998 (Table 2). The rates among both male and female residents of the Non-metropolitan area were higher than among their metropolitan counterparts over the ten-year period (Table 2).

Age-adjusted rates

The rate of first-ever stroke hospitalisations in the Metropolitan area increased with age. The annual average rate among males younger than 45 years was 9.5 per 100,000 person-years compared to 1,867 among males older than 74 years. Among females younger than 45 years the rate was 7.0 per 100,000 compared to 1,496 among females older than 74 years (Table 2).

Among Metropolitan males, a statistically significant decrease in the rate among the older age groups accounted for the overall male decrease (Table 2). Males aged 60 to 74 years experienced a decrease in the rate by an annual average of 2.2% from 642 per 100,000 in 1989 to 526 in 1998. Among males older than 74 years, the rate decreased by an annual average of 1.2% from 1,946 per 100,000 in 1989 to 1,696 in 1998.

Only females aged between 60 and 74 years experienced a statistically significant rate decrease from 1989 to 1998 in the Metropolitan area, with the rate decreasing by an annual average of 2.2% from 381 per 100,000 in 1989 to 323 in 1998 (Table 2).

The rate of first-ever stroke hospitalisation in the Non-metropolitan area increased with age. The annual average rate among males younger than 45 years was 13 per 100,000 person-years increasing to 2,475 among males older than 74 years. Among females younger than 45 years the rate was 14 increasing to 2,102 among females older than 74 years (Table 2).

Except for the youngest age group, the rate among all other male age groups in the Non-metropolitan area decreased significantly from 1989 to 1998 (Table 2). From 1989 to 1998 the rate among males aged between 45 and 59 years decreased by an annual average of 3.6% from 205 per 100,000 to 144 and among those aged between 60 and 74 by an annual average of 1.9% from 871 to 741. Among the oldest male age group the rate decreased by an annual average of 2.0% from 2,673 to 2,309. The age-adjusted rates of all age groups of males resident in the Non-metropolitan area were higher than corresponding Metropolitan males.

Although the overall female rate decreased from 1989 to 1998, there was a statistically significant annual increase among the youngest female age group in the Non-metropolitan area over the same period (Table 2). The rate among females younger than 45 years increased by an annual average of 7.6% from 9.3 in 1989 to 18 in 1998. Females younger than 45 years had a similar rate to that among Non-metropolitan males and double the rate of Metropolitan females of the same age over the ten-year period (Table 2). Over the ten-year period the rate among all other female age groups decreased, but remained higher than the corresponding Metropolitan rates. Only the rate among females aged between 60 and 74 years decreased significantly by an annual average of 3.0% from 569 per 100,000 in 1989 to 408 in 1998.

Table 2: Average annual number, age-adjusted rates and percent annual change for first-ever stroke hospitalisation by gender and area, 1989 to 1998

	Male					Female				
	Number	ASR[1,2]		% Annual Change[3]		Number	ASR[1,2]		% Annual Change[3]	
Metro										
0-44	43	9.5	(8.6-10.4)	0.8		32	7.0	(6.2-7.8)	-3.0	
45-59	118	112	(105.7-118.6)	0.5		66	65	(59.8-69.7)	-0.7	
60-74	365	589	(569.9-608)	-2.2	✡	247	353	(339.2-367.1)	-2.2	✡
75+	388	1867	(1808.7-1925.3)	-1.2	✡	555	1496	(1456.3-1535.1)	0.4	
Total	914	172	(168.7-175.8)	-1.4	✡	900	120	(117.7-122.7)	-0.6	
Non-Metro										
0-44	20	13	(10.8-14.3)	0.7		19	14	(11.9-15.8)	7.6	✠
45-59	54	168	(153.4-181.5)	-3.6	✡	35	127	(113.5-140.1)	-1.6	
60-74	141	816	(773.6-858.3)	-1.9	✡	87	528	(493.2-563.2)	-3.0	✡
75+	141	2475	(2347.0-2602.4)	-2.0	✡	159	2102	(1998.8-2204.2)	-1.0	
Total	357	234	(226.4-242.0)	-2.2	✡	300	181	(174.1-187.1)	-1.4	✡

Notes:
1. Rate = age-adjusted rates per 100,000 person-years.
2. Figures in parentheses are 95% confidence intervals of rate.
3. The symbols ▲ and ▼ indicate statistically significant increases or decreases in rates respectively.

Comparison of Non-metropolitan and Metropolitan area

Over the period 1989 to 1998 the rate of first-ever stroke hospitalisation among Non-metropolitan residents was significantly higher than the rate among Metropolitan residents. Among both males and females, rates were significantly higher in the Non-metropolitan area for all years (Table 3).

Table 3: Standardised rate ratio of first-ever stroke hospitalisation among Non-metropolitan residents compared to Metropolitan residents, Western Australia, 1989 to 1998

	Males			Females		
Year	Obs[1]	Exp[2]	SRR[3,4]	Obs[1]	Exp[2]	SRR[3,4]
1989	342	236	1.45 (1.30-1.61)	258	162	1.59 (1.41-1.80)
1990	353	226	1.56 (1.40-1.73)	241	171	1.41 (1.24-1.60)
1991	330	213	1.55 (1.39-1.73)	281	171	1.64 (1.45-1.84)
1992	366	261	1.40 (1.26-1.55)	317	188	1.68 (1.50-1.88)
1993	360	265	1.36 (1.22-1.51)	310	186	1.67 (1.49-1.87)
1994	389	246	1.58 (1.43-1.75)	333	196	1.70 (1.53-1.90)
1995	348	256	1.36 (1.22-1.51)	321	195	1.64 (1.47-1.84)
1996	368	274	1.34 (1.21-1.49)	347	208	1.67 (1.50-1.86)
1997	374	244	1.53 (1.38-1.69)	316	216	1.47 (1.31-1.64)
1998	370	270	1.37 (1.24-1.52)	280	207	1.35 (1.20-1.52)
1989-1998	3600	2489	1.45 (1.40-1.49)	3004	1900	1.58 (1.53-1.64)

Notes:
1. Obs = frequency observed in Non-metropolitan area.
2. Exp = frequencies expected in the Non-metropolitan area if metropolitan rates applied.
3. SRR = standardised rate ratio.
4. Figures in parentheses are 95% confidence intervals of SRR.

3.2 ISCHAEMIC CEREBROVASCULAR DISEASE

3.2.1 STATE OVERVIEW

Numbers and age-standardised rates

In Western Australia during 1989 to 1998 there were a total of 8,163 first-ever hospitalisations for ICD among males, and 7,426 among females. This represents an annual average of 816 among males and 743 among females.

There was a statistically significant decrease in the rate of first-ever hospitalisations for ICD among both sexes from 1989 to 1998. The male rate decreased by an annual average of 3.3% from 142 per 100,000 person-years in 1989 to 105 in 1998, while the rate among females decreased by an annual average of 2.7% from 92 per 100,000 in 1989 to 64 in 1998. Males had a higher rate of first-ever hospitalisations for ICD than females (Table 4) and this was consistent over the ten-year period.

Table 4: Average annual numbers, age-adjusted rates and percent annual change for first-ever hospitalisation for ICD by gender, Western Australia, 1989 to 1998

	Number	Rate[1,2]		% Annual Change[3]	
Males					
0-44	27	4.4	(3.9-4.9)	5.9	✠
45-59	96	70	(65.6-74.4)	-1.9	
60-74	333	420	(406.2-434.6)	-4.3	✡
75+	360	1357	(1312.7-1401.0)	-3.0	✡
Total	816	121	(118.2-123.5)	-3.3	✡
Females					
0-44	19	3.2	(2.8-3.7)	4.2	
45-59	45	35	(31.9-38.4)	-2.6	
60-74	201	232	(222.2-242.6)	-3.8	✡
75+	477	1063	(1032.7-1093.2)	-2.0	✡
Total	743	81	(78.7-82.4)	-2.7	✡

Notes:
1. ASR = age-standardised rates per 100,000 persons.
2. Figures in parentheses are the 95% confidence intervals for the ASR.
3. The symbols ▲ and ▼ indicate statistically significant increases or decreases in rates respectively.

Age-adjusted rates

The rate of first-ever hospitalisation for ICD increased with age. The annual average rate among males younger than 45 years was 4.4 per 100,000 person years, increasing to 1,357 among males older than 74 years. Among females younger than 45 years, the rate was 3.2 increasing to 1,063 among women older than 74 years (Table 4).

Males experienced a statistically significant increase in the rate of first-ever hospitalisation for ICD among the youngest age group. Among males younger than 45 years the rate increased by an annual average of 5.9% from 3.5 per 100,000 person-years in 1989 to 6.2 in 1998. Over the same period the rate decreased by an annual average of 4.3% from 497 per 100,000 to 353 among males aged 60 to 74 years, whilst males older than 74 years experienced a rate decrease by an annual average of 3.0% from 1,496 per 100,000 to 1,130 (Table 4).

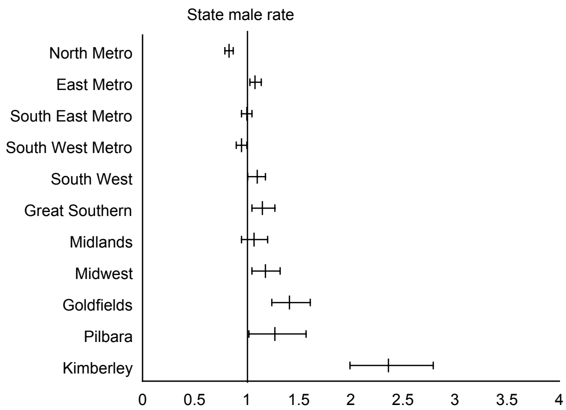
The rates among elderly females decreased over the ten-year period (Table 4). Among females aged between 60 and 74 years the rate decreased by an annual average of 3.8% from 269 per 100,000 person-years in 1989 to 189 in 1998. Over the same period the rate among females older than 74 years decreased by an annual average of 2.0% from 1,147 per 100,000 to 893 in 1998. For each age group the female rate was consistently lower than the rate for males of the same age.

3.2.2 GEOGRAPHIC VARIATION

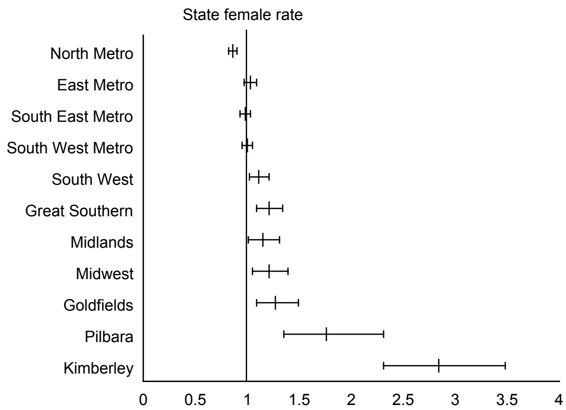
The rate of first-ever hospitalisation for ICD varied across the State for the ten-year period, 1989 to 1998. Among males, rates were significantly higher than the State male rate for residents of all Non-metropolitan Health Zones, except for male residents of the Midlands Health Zone. Only male residents of the North Metropolitan and South West Metropolitan Health Zones had a significantly lower rate than the State male rate. Female residents of the all Non-Metropolitan Health Zones had significantly higher rates than State females, whereas only females residents in the North Metropolitan Health Zone had a rate significantly lower than the State female rate (Figure 3).

Figure 3: Standardised rate ratios for first-ever hospitalisation for ICD by Health Zone and gender, Western Australia, 1989 to 1998

Males



Females



The low numbers of first-ever hospitalisations for ICD across health zones restricted more detailed analysis of variation at the health zone level. The following section outlines geographic variation for ICD events in Western Australia based on results reported for the Metropolitan and the Non-metropolitan areas.

Numbers and age-standardised rates

In the Metropolitan area during 1989 to 1998 there were a total of 6,013 first-ever hospitalisations for ICD among males, and 5,794 among females. This represents an annual average of 601 among males and 579 among females.

In the Non-metropolitan area during 1989 to 1998 there were a total of 2,150 first-ever hospitalisations for ICD among males, and 1,632 among females. This represents an annual average of 215 among males and 163 among females.

From 1989 to 1998, there was a statistically significant decrease in the rate of first-ever hospitalisations for ICD among both sexes of Metropolitan area residents. Among males the rate decreased by an annual average of 3.1% from 132 per 100,000 person-years in 1989 to 100 in 1998, while the rate among females decreased by an annual average of 2.6% from 85 per 100,000 to 62 over the same period. Males had a higher rate of first-ever hospitalisation for ICD than females (Table 5) and this was consistent over the ten-year period.

There also was a statistically significant decrease in rates of first-ever hospitalisations for ICD from 1989 to 1998 among both sexes in the Non-metropolitan area. Among males the rate decreased by an annual average of 3.8% from 176 per 100,000 person-years in 1989 to 124 in 1998, while the rate among females decreased by an annual average of 3.2% from 118 per 100,000 to 75 over the same period. Males had a higher rate of first-ever hospitalisations for ICD than females (Table 5) and this was consistent over time.

Age-adjusted rates

The rate of first-ever hospitalisations for ICD among residents of the Metropolitan area increased with age. The annual average rate among males younger than 45 years was 4.0 per 100,000 person-years, which increased to 1,310 among males older than 74 years. Among females younger than 45 years the rate was 2.6 per 100,000 person-years, which increased to 1,034 among females older than 74 years (Table 5).

Table 5: Average annual number, age-adjusted rate and percent annual change of first-ever hospitalisations for ICD by gender and area, 1989 to 1998

	Males					Females				
	Number	Rate[1,2]		% Annual Change[3]		Number	Rate[1,2]		% Annual Change[3]	
Metro										
0-44	18	4.0	(3.4-4.5)	4.9		12	2.6	(2.1-3.1)	-0.4	
45-59	67	64	(58.8-68.4)	-0.7		29	28	(25.1-31.6)	-1.2	
60-74	244	393	(377.8-409.0)	-4.3	✡	152	218	(206.6-228.5)	-4.4	✡
75+	273	1310	(1261.4-1359.4)	-2.8	✡	386	1034	(1001.4-1066.9)	-2.0	✡
Total	601	115	(111.6-117.5)	-3.1	✡	579	76	(74.2-78.2)	-2.6	✡
Non-Metro										
0-44	9	5.4	(4.3-6.6)	5.5		7	5.2	(4.0-6.4)	12.4	✠
45-59	30	90	(80.1-100.8)	-4.3	✡	16	59	(50.3-68.5)	-4.8	
60-74	90	517	(483.2-550.9)	-4.3	✡	49	298	(271.1-323.8)	-3.8	✡
75+	87	1527	(1425.8-1627.4)	-3.4	✡	91	1194	(1116.2-1271.6)	-2.8	✡
Total	215	143	(136.7-149.0)	-3.8	✡	163	99	(93.9-103.5)	-3.2	✡

Notes: 1. Rate = age-adjusted rates per 100,000 person-years.
2. Figures in parentheses are 95% confidence intervals of rate.
3. The symbols ▲ and ▼ indicate statistically significant increases or decreases in rates respectively.

Elderly Metropolitan males accounted for the decrease in the overall male rate (Table 5). Over the ten-year period, the rate of first-ever hospitalisations for ICD decreased by an annual average of 4.3% from 466 per 100,000 person-years to 326 among males aged 60 to 74 and by an annual average of 2.8% from 1,417 to 1,073 among the oldest male age group.

Female residents of the Metropolitan area 60 years and older experienced a decrease in the rate from 1989 to 1998. Among female residents of the Metropolitan area aged between 60 and 74 years the rate decreased by an annual average of 4.4% from 278 per 100,000 in 1989 to 167 in 1998, whilst among those older than 74 years the rate decreased by an annual average of 2.0% from 1,106 per 100,000 to 850. The age-adjusted rates for all age groups among females were significantly lower than among Non-metropolitan males of the same ages over the ten-year period (Table 5).

The rates of first-ever hospitalisation of ICD among Non-metropolitan residents also increased with age. The annual average rate among males younger than 45 years was 5.4 per 100,000 person-years and increased to 1,527 among males older than 74 years. Among females younger than 45 years the rate was 5.2 per 100,000 and increased to 1,194 among females older than 74 years (Table 5).

The rate of first-ever hospitalisation for ICD decreased significantly from 1989 to 1998 among most male age groups. From 1989 to 1998, among males aged 45 to 59 years the rate decreased from 121 per 100,000 to 76 and among males age 60 to 74 from 607 to 448, with an annual average decline of 4.3% for both age groups. Among males 75 years and older the rate decreased by an annual average of 3.4% from 1,786 in 1989 to 1,343 in 1998.

In contrast to the age-adjusted rates among female residents of the Metropolitan area and males of either area, female residents of the Non-metropolitan area younger than 45 years experienced an increase in rates of first-ever hospitalisation for ICD over the ten-year period (Table 5). Although the annual number of first-ever hospitalisations was low, the rate among females younger than 45 years increased by an annual average of 12.4% from 2.0 in 1989 to 6.2 in 1998.

Similar to the rates of elderly Metropolitan females, the rate of Non-Metropolitan females of the same age decreased significantly from 1989 to 1998 (Table 5). Among females aged between 60 and 74 years the rate decreased by an annual average of 3.8% from 352 per 100,000 to 226 over the ten-year period, while the rate among females older than 74 years decreased by an annual average of 2.8% from 1,252 per 100,000 to 967.

Comparison of Non-metropolitan area and Metropolitan area

Over the period 1989 to 1998 the rate of first-ever hospitalisation for ICD among Non-metropolitan residents was significantly higher than the rate among Metropolitan residents. The number of first-ever hospitalisation for ICD among both male and female residents of the Non-metropolitan area was in excess of that expected if the rate was similar to the Metropolitan area, consistently from 1989 to 1998 (Table 6).

Table 6: Standardised rate ratio of first-ever hospitalisation for ICD among Non-metropolitan residents compared to Metropolitan residents, Western Australia, 1989 to 1998

	Males				Females			
Year	Obs[1]	Exp[2]	SRR[3,4]		Obs[1]	Exp[2]	SRR[3,4]	
1989	232	171	1.36	(1.19-1.55)	165	118	1.41	(1.2-1.64)
1990	217	160	1.36	(1.18-1.55)	140	119	1.18	(1.00-1.40)
1991	213	157	1.36	(1.18-1.55)	160	117	1.38	(1.17-1.61)
1992	225	189	1.19	(1.04-1.36)	169	128	1.32	(1.13-1.54)
1993	218	185	1.18	(1.03-1.35)	160	123	1.30	(1.11-1.52)
1994	203	162	1.25	(1.09-1.44)	175	125	1.39	(1.20-1.62)
1995	208	173	1.20	(1.05-1.38)	164	138	1.19	(1.02-1.39)
1996	208	184	1.13	(0.99-1.30)	185	133	1.39	(1.20-1.61)
1997	209	154	1.36	(1.18-1.56)	169	133	1.27	(1.09-1.48)
1998	216	171	1.26	(1.10-1.44)	145	123	1.18	(1.00-1.39)
1989-1998	2149	1702	1.26	(1.21-1.32)	1632	1259	1.30	(1.23-1.36)

Notes:
1. Obs = frequency observed in Non-metropolitan area.
2. Exp = frequencies expected in the Non-metropolitan area if metropolitan rates applied.
3. SRR = standardised rate ratio.
4. Figures in parentheses are 95% confidence intervals of SRR.

3.3 TRANSIENT ISCHAEMIC ATTACKS

3.3.1 STATE OVERVIEW

Numbers and age-standardised rates
In Western Australia during 1989 to 1998 there were a total of 3,414 first-ever hospitalisations for TIA among males, and 3,275 among females. This represents an annual average of 341 among males and 328 among females.

There was a statistically significant increase in the rate of first-ever hospitalisation for TIA from 1989 to 1998 among females. The rate among females increased by an annual average of 1.3% from 32 per 100,000 person-years in 1989 to 36 in 1998. Despite the increasing rate among females, males had a higher rate of first-ever hospitalisation (Table 7), and this was consistent over time.

Table 7: Annual average number, age-adjusted rates and percent annual change by gender of first-ever hospitalisation for TIA, Western Australia, 1989 to 1998

	Number	Rate[1,2]		% Annual Change[3]	
Males					
0-44	12	1.9	(1.6-2.2)	-3.6	
45-59	48	35	(32.2-38.6)	-2.0	
60-74	135	171	(161.9-180.1)	0.0	
75+	146	556	(527.6-584.5)	-0.7	
Total	341	50	(48.7-52.1)	-0.7	
Females					
0-44	11	1.8	(1.5-2.2)	-2.6	
45-59	31	24	(21.5-26.8)	0.7	
60-74	94	109	(101.6-115.5)	-1.5	
75+	192	431	(411.2-450)	2.9	✠
Total	328	36	(34.9-37.4)	1.3	✠

Notes:
1. Rate = age-standardised rates per 100,000 persons.
2. Figures in parentheses are 95% confidence intervals of the rate.
3. The symbols ▲ and ▼ indicate statistically significant increases or decreases in rates respectively.

Age-adjusted rates
The rate of first-ever hospitalisation for TIA increased with age. The annual average rate among males younger than 45 years was 1.9 per 100,000 person-years and increased to 556 among males older than 74 years. Among females younger than 44 years the rate was 1.8 and increased to 431 among females older than 74 years (Table 7).

While there was no change in the rate of first-ever hospitalisation for TIA among males of all age groups from 1989 to 1998, there was a significant increase by an annual average of 2.9% in the rate among females older than 74 years (Table 7). The rate among females older than 74 years increased from 328 per 100,000 person-years to 453, accounting for the increase in the overall female rates over the ten-year period.

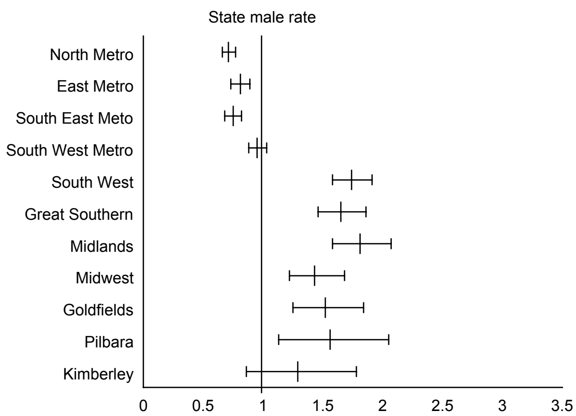
Apart from the youngest age group, the rates among males of the older age groups were higher than among females of the same age (Table 7) and this was consistent over the ten-year period.

3.3.2 GEOGRAPHIC VARIATION

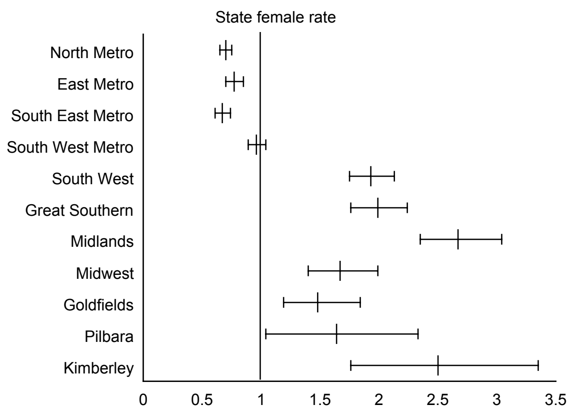
The rate of first-ever hospitalisation for TIA varied across the State for the ten-year period, 1989 to 1998. Among males, rates were significantly higher than the State male rate for residents of all Non-metropolitan Health Zones, other than the Kimberley Health Zone, while male residents of the North Metropolitan, East Metropolitan and South East Metropolitan Health Zone had significantly lower rates than the State male rate. Female residents of all Health Zones outside the Metropolitan area had a significantly higher rate than State females, whereas female residents of all Metropolitan Health Zones, except the South West Metropolitan had rates significantly lower than State females (Figure 4).

Figure 4: Standardised rate ratios for first-ever hospitalisation for TIA by Health Zone and gender, Western Australia, 1989 to 1998

Males



Females



Numbers and age-standardised rates

In the Metropolitan area during 1989 to 1998 there were a total of 2,154 first-ever hospitalisations for TIA among males, and 2,079 among females. This represents an annual average of 215 among males and 208 among females.

In the Non-metropolitan area during 1989 to 1998 there were a total of 1,260 first-ever hospitalisations for TIA among males, and 1,196 among females. This represents an annual average of 126 among males and 120 among females.

Among Metropolitan residents, there was a statistically significant increase in the rate of first-ever hospitalisation for TIA among females by an annual average of 2.4% from 24 per 100,000 person-years in 1989 to 30 in 1998, whereas there was no change in the male rate. Despite a constant rate of first-ever hospitalisation for TIA, males had a higher average rate than females (Table 8) and this was consistent over the ten-year period.

Although the rate of first-ever hospitalisation for TIA peaked in 1993 among both males and females there were no statistically significant changes in rates from 1989 to 1998 among either males or females in the Non-metropolitan area (Table 8). Males had a higher rate of first-ever hospitalisations for TIA than females (Table 8) and this was consistent over the ten-year period.

Table 8: Annual average number, age-adjusted rates and percent annual change for first-ever hospitalisation for TIA by gender and area, 1989 to 1998

	Males				Females				
	Number	Rate[1,2]		% Annual Change[3]	Number	Rate[1,2]		% Annual Change[3]	
Metro									
0-44	8	1.7	(1.3-2.1)	-4.1	7	1.4	(1.1-1.8)	-1.3	
45-59	29	28	(24.4-30.8)	0.3	17	17	(14.0-19.0)	0.7	
60-74	87	141	(131.7-150.4)	0.4	60	86	(78.6-92.3)	-0.3	
75+	92	442	(413.8-471.1)	-0.4	125	338	(318.6-356.4)	4.2	✠
Total	215	41	(38.9-42.4)	-0.1	208	28	(26.8-29.2)	2.4	✠
Non-Metro									
0-44	4	2.5	(1.7-3.3)	-2.7	4	3.2	(2.3-4.2)	-4.0	
45-59	19	60	(52.0-68.9)	-4.7	14	52	(43.9-60.9)	1.3	
60-74	48	278	(253.3-302.9)	-0.6	34	206	(183.8-227.5)	-3.7	✡
75+	55	969	(887.9-1049.1)	-1.4	67	885	(817.8-952.0)	0.1	
Total	126	85	(80.0-89.5)	-1.6	120	72	(68.2-76.4)	-1.0	

Notes:
1. Rate = age-adjusted rates per 100,000 person-years.
2. Figures in parentheses are 95% confidence intervals of rate.
3. The symbols ▲ and ▼ indicate statistically significant increases or decreases in rates respectively.

Age-adjusted rates

The rate of first-ever hospitalisation for TIA among Metropolitan area residents increased with age. The annual average rate among males younger than 45 years was 1.7 per 100,000 person-years and increased to 442 among males older than 74 years. Among females younger than 45 years the rate was 1.4 and increased to 338 among females older than 74 years (Table 8).

There was no change in rate among Metropolitan males of all ages from 1989 to 1998. The increase in the overall Metropolitan female rate is accounted for by a statistically significant increase among females older than 74 years, with the rate increasing by an annual average of 4.2% from 260 in 1989 to 388 in 1998 (Table 8).

The rates of first-ever hospitalisations for TIA among Non-metropolitan residents also increased with age. The annual average rate among males younger than 45 years was 2.5 per 100,000 person-years and increased to 969 among males older than 74 years. Among females younger than 45 years the rate was 3.2 and increased to 885 among females older than 74 years (Table 8).

There was no change in the rate among Non-metropolitan males of all age groups from 1989 to 1998. Among Non-metropolitan females aged between 60 and 74 years the rate decreased significantly by an annual average of 3.7% from 223 per 100,000 person-years in 1989 to 146 in 1998. The rate among females older than 74 years increased from 676 in 1989 to a maximum of 1,107 in 1993 and then declined to a rate of 747 by 1998.

The age-adjusted rates among Non-metropolitan residents were higher than among their Metropolitan counterparts for both sexes and all age groups, except the youngest male age group (Table 8).

Comparison of Metropolitan area and Non-metropolitan areas
Over the period 1989 to 1998 the Non-metropolitan rate of first-time hospitalisation for TIA was higher than Metropolitan rates. The difference in rates of first-ever hospitalisation for TIA between both male and female residents of the Metropolitan and Non-metropolitan areas was consistent from 1989 to 1998. On average the ratio of Non-metropolitan rates to Metropolitan rates was of a greater magnitude among females than among males (Table 9).

Table 9: Standardised rate ratio of first-ever hospitalisation for TIA for Non-metropolitan residents compared to Metropolitan residents, Western Australia, 1989 to 1998

	Males			Females		
Year	Obs[1]	Exp[2]	SRR[3,4]	Obs[1]	Exp[2]	SRR[3,4]
1989	98	56	1.75 (1.43-2.14)	94	33	2.85 (2.32-3.50)
1990	132	59	2.24 (1.88-2.66)	87	35	2.52 (2.03-3.12)
1991	109	49	2.22 (1.84-2.69)	108	42	2.56 (2.11-3.10)
1992	135	57	2.37 (2.00-2.82)	131	42	3.08 (2.58-3.67)
1993	119	64	1.86 (1.55-2.24)	141	48	2.93 (2.48-3.47)
1994	157	64	2.44 (2.08-2.86)	143	50	2.88 (2.44-3.40)
1995	117	54	2.14 (1.78-2.58)	133	44	3.03 (2.55-3.60)
1996	140	67	2.09 (1.76-2.47)	132	52	2.55 (2.14-3.04)
1997	136	68	1.99 (1.68-2.36)	125	54	2.29 (1.91-2.73)
1998	116	73	1.58 (1.31-1.91)	101	63	1.61 (1.32-1.97)
1989-1998	1,259	613	2.06 (1.94-2.17)	1,195	462	2.59 (2.44-2.74)

Notes:
1. Obs = frequency observed in Non-metropolitan area.
2. Exp = frequencies expected in the Non-metropolitan area if metropolitan rates applied.
3. SRR = standardised rate ratio.
4. Figures in parentheses are 95% confidence intervals of SRR.

3.4 INTRACEREBRAL HAEMORRHAGE

3.4.1 STATE OVERVIEW

Numbers and age-standardised rates

In Western Australia during 1989 to 1998 there were a total of 1,103 first-ever hospitalisations for ICH among males, and 1,100 among females. This represents an annual average of 110 among both males and females.

There was a statistically significant increase in the rates of first-ever hospitalisation for ICH from 1989 to 1998 among both males and females (Table 10). The rate among males increased by an annual average of 3.5% from 13 per 100,000 person-years in 1989 to 16 in 1998. Among females the rate increased by an annual average of 2.6% from 11 per 100,000 to 14 over the same period. Males had a higher rate of first-ever hospitalisation (Table 10), and this was consistent over the ten-year period.

Table 10: Annual average numbers, age-adjusted rates and percent annual change by gender for first-ever hospitalisations for ICH, Western Australia, 1989 to 1998

	Number	Rate[1,2]		% Annual Change[3]	
Males					
0-44	12	2.0	(1.7-2.4)	-1.3	
45-59	20	14	(12.3-16.2)	4.8	✠
60-74	43	54	(48.9-59.1)	3.1	
75+	35	131	(117.0-144.5)	4.9	✠
Total	110	15	(14.4-16.3)	3.5	✠
Females					
0-44	9	1.6	(1.2-1.9)	-1.2	
45-59	12	10	(7.8-11.2)	1.8	
60-74	34	40	(36.0-44.4)	0.3	
75+	55	124	(113.7-134.7)	5.0	✠
Total	110	13	(11.8-13.2)	2.6	✠

Notes: 1. Rate = age-adjusted rates per 100,000 person-years.
2. Figures in parentheses are 95% confidence intervals of the ASR.
3. The symbols ▲ and ▼ indicate statistically significant increases or decreases in rates respectively.

Age-adjusted rates

The rate of first-ever hospitalisations for ICH increased with age. The annual average rate among males younger than 45 years was 2.0 per 100,000 person-years and increased to 131 among males older than 74 years (Table 10). Among females younger than 45 years the rate was 1.6 and increased to 124 among females older than 74 years (Table 10).

Males experienced statistically significant increases in rates of first-ever hospitalisation for ICH among those aged from 45 to 59 years and those older than 74 years, while females experienced increases in the rate among those older than 74 years (Table 10). The rate increased by an annual average of 4.8% among males aged from 45 to 59 years from 11 per 100,000 person-years in 1989 to 17 in 1998, while it increased by an annual average of 4.9% from 106 per 100,000 to 161 among males older than 74 years. Among females older than 74 years, the rate increased by an annual average of 5.0% from 91 in 1989 to 151 in 1998.

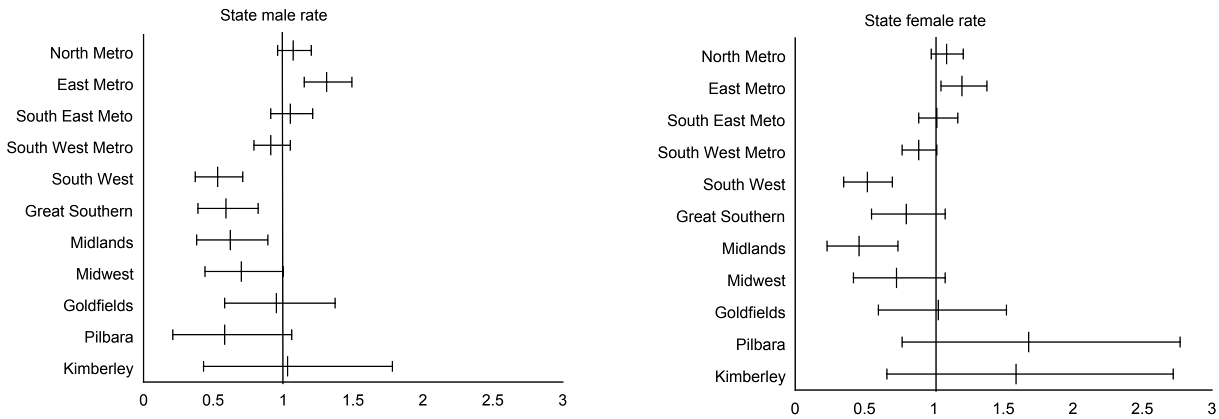
Although the overall rate among males was higher than the overall female rate, only the age-adjusted rates among males aged from 45 to 74 were higher than the rates among females of the same age (Table 10).

3.4.2 GEOGRAPHIC VARIATION

The rate of first-ever hospitalisation for ICH varied across the State for the ten-year period, 1989 to 1998. Among males, rates were significantly higher than the State male rate for residents of the East Metropolitan Health Zone, while male residents of the South West, Great Southern and Midlands Health Zones had a significantly lower rate than the State male rate. Female residents of the East Metropolitan Health Zone also had significantly higher rates than State females, and females resident in the South West and Midlands Health Zones also had rates significantly lower than State females (Figure 5).

Figure 5: Standardised rate ratios for first-ever hospitalisation for ICH by Health Zone and gender, Western Australia, 1989 to 1998

Males **Females**



The low numbers of first-ever hospitalisations for some types of stroke across health zones restricted further analysis of variation at the health zone level. The following section outlines geographic variation for ICH events in Western Australia by reporting results for the Metropolitan and the Non-metropolitan areas.

Numbers and age-standardised rates
In the Metropolitan area during 1989 to 1998 there were a total of 939 first-ever hospitalisations for ICH among males, and 950 among females. This represents an annual average of 94 among males and 95 among females.

In the Non-metropolitan area during 1989 to 1998 there were a total of 164 first-ever hospitalisations for ICH among males, and 150 among females. The annual number of first-ever hospitalisations was low with an average of 16 among males and 15 among females.

Among Metropolitan residents, there was a statistically significant increase in rates among males, which increased by an annual average of 2.8% from 15 per 100,000 person-years in 1989 to 17 in 1998. Among females there was no significant change. Males had a higher average rate of first-ever hospitalisations for ICH than females (Table 11) and this was consistent over the ten-year period.

The number of first-ever hospitalisations for ICH annually in the Non-metropolitan area was low, reducing the precision of the rate estimations. There were statistically significant rate increases in first-ever hospitalisations for ICH over the ten-year period among both males and females in the Non-metropolitan area. Among males, rates increased from 6.3 in 1989 to 13 in 1998, while among females, rates increased from 5.5 to 12 over the same period (Table 11). Males and females had similar rates of first-ever hospitalisations for ICH from 1989 to 1998 (Table 11).

Table 11: Annual average number, age-adjusted rates and percent annual change for first-ever hospitalisation for ICH by gender and area, 1989 to 1998

	Males					Females				
	Number	Rate[1,2]		% Annual Change[3]		Number	Rate[1,2]		% Annual Change[3]	
Metro										
0-44	9	2.1	(1.7-2.5)	-1.6		6	1.3	(1.0-1.7)	-6.9	
45-59	16	15	(12.3-16.9)	6.0	✠	10	10	(7.7-11.5)	3.3	
60-74	37	59	(53.3-65.4)	1.4		30	44	(38.8-48.7)	-0.2	
75+	32	153	(135.9-169.4)	4.4	✠	49	135	(122.9-147.0)	4.5	✠
Total	94	17	(15.9-18.1)	2.8	✠	95	13	(12.4-14.1)	2.1	
Non-Metro										
0-44	3	1.9	(1.2-2.5)	-0.2		3	2.2	(1.4-3.0)	11.2	
45-59	4	13	(9.3-17.2)	0.8		2	9	(5.5-12.6)	-4.0	
60-74	6	35	(26.1-43.6)	14.3	✠	4	26	(17.9-33.3)	3.7	
75+	3	51	(32.2-68.9)	12.2		5	71	(51.9-90.9)	10.9	✠
Total	16	9	(7.9-10.9)	7.3	✠	15	9	(7.5-10.3)	6.2	✠

Notes:
1. Rate = age-adjusted rates per 100,000 person-years.
2. Figures in parentheses are 95% confidence intervals of the ASR.
3. The symbols ▲ and ▼ indicate statistically significant increases or decreases in rates respectively.

By aggregating the data into two five-year periods the precision of the rate estimates among the Non-metropolitan population can be increased. There was an increase in the rate of first-ever hospitalisations for ICH among males and females from the five-year period 1989–1993 to the five-year period 1994–1998. The rate increased by 55% among males and 45% among females from the 1989–1993 period (Table 12).

Table 12: Standardised rate ratios of first-ever hospitalisations for ICH among Non-metropolitan residents for the periods 1989 to 1993 and 1994 to 1998

	Obs[1] 94-98	Exp[2] 94-98	SRR[3,4]	
Males	105	68	1.55	(1.12-2.13)
Females	92	64	1.45	(1.04-2.01)

Notes: 1. Obs = frequency observed during 94–98.
2. Exp = frequencies expected in 94–98 if 89–93 rates applied.
3. SRR = standardised rate ratio.
4. Figures in parentheses are 95% confidence intervals of SRR.

Age-adjusted rates
The incidence of hospitalisations for ICH among Metropolitan residents increased with age. The annual average rate among males younger than 45 years was 2.1 (per 100,000 person years) and increased to 153 among males older than 74 years. Among females younger than 45 years the rate was 1.3 and increased to 135 among females older than 74 years (Table 11).

Among Metropolitan males aged 45 to 59 years, the rate increased significantly by an annual average of 6.0% from 11 in 1989 to 18 in 1998, while among those older than 74 years it increased by an annual average of 4.4% from 127 to 180. Among Metropolitan females older than 74 years the rate increased significantly by an annual average of 4.5% from 101 to 162 over the same time.

The rate of first-ever hospitalisations for ICH among Non-metropolitan residents also increased with age. The annual average rate among males younger than 45 years was 1.9 per 100,000 person-years and increased to 51 among males older than 74 years. Among females younger than 45 years the rate was 2.2 and increased to 71 among females older than 74 years (Table 11).

Males experienced significant increases in rates among those aged between 60 and 74 years from 1989 to 1998, while the rates among females older than 74 years increased significantly from 1989 to 1998 (Table 11). The age-adjusted rates fluctuated annually because of the low number of first-ever hospitalisations. The rate increased among males, aged between 60 and 74, by an annual average of 14.3% from 15 in 1989 to 51 in 1998, while it increased among females older than 74 years by an annual average of 10.9% from 40 to 103 over the same period.

Comparison of Metropolitan area and Non-metropolitan area
Over the period 1989 to 1998, the Non-metropolitan rates of first-ever hospitalisations for ICH were lower than Metropolitan rates among both males and females (Table 13). Non-metropolitan rates were not consistently lower than Metropolitan rates annually and the SRR among males and females indicated that later in the ten-year period the rates in the two areas were similar (Table 13).

Table 13: Standardised rate ratio of first-ever hospitalisation for ICH for Non-metropolitan

residents compared to Metropolitan residents, Western Australia, 1989 to 1998

Year	Males				Females			
	Obs[1]	Exp[2]	SRR[3,4]		Obs[1]	Exp[2]	SRR[3,4]	
1989	9	23	0.38	(0.15-0.69)	6	16	0.38	(0.10-0.75)
1990	13	20	0.65	(0.31-1.06)	12	19	0.61	(0.28-1.01)
1991	9	16	0.56	(0.22-0.99)	13	19	0.69	(0.33-1.12)
1992	13	28	0.47	(0.22-0.76)	19	23	0.81	(0.46-1.22)
1993	16	29	0.55	(0.29-0.85)	9	19	0.46	(0.18-0.81)
1994	26	28	0.92	(0.57-1.31)	15	23	0.66	(0.34-1.04)
1995	15	36	0.41	(0.21-0.65)	19	19	1.00	(0.56-1.50)
1996	16	33	0.49	(0.26-0.75)	12	25	0.47	(0.22-0.78)
1997	21	28	0.75	(0.43-1.10)	21	29	0.73	(0.43-1.08)
1998	27	31	0.86	(0.54-1.21)	25	26	0.97	(0.60-1.39)
1989-1998	165	272	0.61	(0.52-0.71)	151	217	0.70	(0.59-0.82)

Notes:
1. Obs = frequency observed in Non-metropolitan area.
2. Exp = frequencies expected in the Non-metropolitan area if Metroplitan rates applied.
3. SRR = standardised rate ratio.
4. Figures in parentheses are 95% confidence intervals of SRR.

3.5 SUBARACHNOID HAEMORRHAGE

3.5.1 STATE OVERVIEW

Numbers and age-standardised rates

In Western Australia during 1989 to 1998 there were a total of 404 first-ever hospitalisations for SAH among males, and 552 among females. This represents an annual average of 40 among males and 55 among females.

There were significant decreases in the rates of first-ever hospitalisations for SAH from 1989 to 1998 among both males and females (Table 14). The rate among males declined by an annual average of 3.6% from 6.7 per 100,000 person-years in 1989 to 5.0 in 1998, while the female rate decreased by an annual average of 3.9% from 8.7 to 5.7 over the same period. Females had a higher rate of first-ever hospitalisation (Table 14), and this was consistent over time.

Table 14: Annual average numbers, age-adjusted rates and percent annual change by gender for first-ever hospitalisations for SAH, Western Australia, 1989 to 1998

	Number	Rate[1,2]		% Annual Change[3]	
Males					
0-44	15	2.5	(2.1-2.8)	-5.7	✡
45-59	13	9.4	(7.8-11.1)	-5.9	✡
60-74	9	11	(9.1-13.8)	-2.0	
75+	3	11	(6.9-14.9)	15.1	✠
Total	40	4.9	(4.4-5.4)	-3.6	✡
Females					
0-44	14	2.4	(2.0-2.8)	-2.4	
45-59	16	12	(10.3-14.1)	-7.6	✡
60-74	14	17	(14.3-19.8)	-5.3	
75+	11	26	(20.8-30.4)	2.0	
Total	55	6.5	(6.0-7.1)	-3.9	✡

Notes: 1. Rate = age-adjusted rates per 100,000 person-years.
2. Figures in parentheses are 95% confidence intervals of the AAR.
3. The symbols ▲ and ▼ indicate statistically significant increases or decreases in rates respectively.

Age-adjusted rates

The rate of first-ever hospitalisation for SAH increased with age among females, but the age-adjusted rates among males stabilised after 45 years of age. The annual average rate among males younger than 45 years was 2.5 per 100,000 person-years and increased to 11 among males older than 59 years. Among females younger than 45 years the rate was 2.4 and increased to 26 among females older than 74 years (Table 14).

The age-adjusted rates significantly decreased from 1989 to 1998 for the youngest age groups among males. Rates decreased by an annual average of 5.7% from 3.6 per 100,000 person-years in 1989 to 2.2 in 1998 among males younger than 45 years, and by 5.9% from 15 to 10 over the same period among men aged between 45 to 59 years. In contrast, the rate among males older than 74 years significantly increased from 1989 to 1998. The rate among males older than 74 years increased by an annual average of 15.1% from 6.3 in 1989 to 20 in 1998, although the average annual number was low (Table 14).

Among females, the rate decreased among women aged between 45 and 59 years (Table 14). From 1989 to 1999, the rate among females aged 45 to 59 years decreased by an annual average of 7.6% from 21 per 100,000 to 9.0.

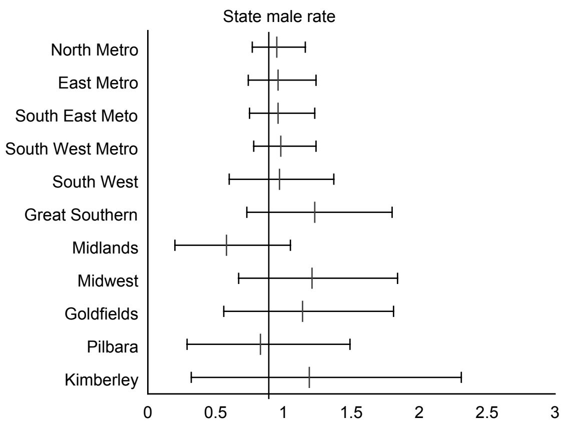
Over the ten-year period the rate among females older than 60 years remained higher than the rate among males of the same age (Table 14).

3.5.2 GEOGRAPHIC VARIATION

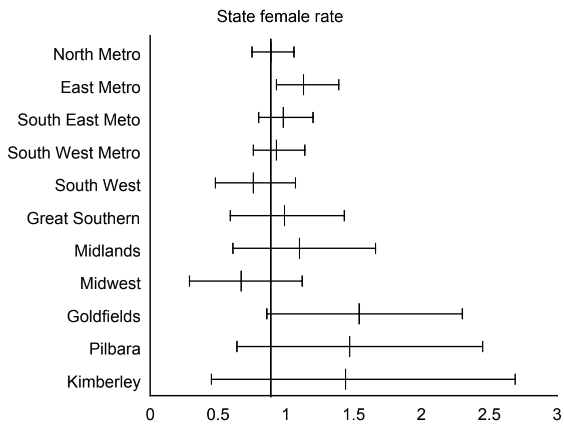
The number of first-ever hospitalisations for SAH in the ten-year period from 1989 to 1998 was low for those health zones located in rural and remote areas of the State. Estimates of the SRR were less precise for health zones with fewer first-ever hospitalisations, as indicated by the confidence intervals for the standardised rate ratios. Consequently, little variation was detected in the rate of first-ever hospitalisation across the State for the ten-year period (Figure 6).

Figure 6: Standardised rate ratios for first-ever hospitalisation for SAH by Health Zone and gender, Western Australia, 1989 to 1998

Males



Females



The low numbers of first-ever hospitalisations for some types of stroke across health zones restricted further analysis of variation at the health zone level. The following section outlines geographic variation for SAH first-ever hospitalisations in Western Australia by reporting results for the Metropolitan and Non-metropolitan areas.

Numbers and age-standardised rates

In the Metropolitan area from 1989 to 1998 there were a total of 303 first-ever hospitalisations for SAH among males, and 436 among females. This represents an annual average of 30 among males and 44 among females.

In the Non-metropolitan area the number of first-ever hospitalisations for SAH was much lower than the Metropolitan area. During 1989 to 1998 there were a total of 102 first-ever hospitalisations for SAH among males, and 116 among females. This represents an annual average of 10 among males and 12 among females.

Among Metropolitan residents there was a statistically significant decrease in the rate among females by an annual average of 5.3%, declining from 9.7 per 100,000 person years in 1989 to 5.5 in 1998. Among males there was no significant change. Females had a higher average rate of first-ever hospitalisations for SAH than males (Table 15) and this was consistent over time, although by 1998 the differential had reduced.

The low number of first-ever hospitalisations for SAH in the Non-metropolitan area reduced the precision of the annual rate estimates. From 1989 to 1998 there were no statistically significant changes in the rate for first-ever hospitalisation for SAH among either males or females in the Non-metropolitan area (Table 15).

Table 15: Annual average number, age-adjusted rates and percent annual change by gender and area for first-ever hospitalisation for SAH, 1989 to 1998

	Males			Females			
	Number	Rate[1,2]	% Annual Change[3]	Number	Rate[1,2]	% Annual Change[3]	
Metro							
0-44	10	2.1 (1.7-2.6)	-4.1	9	2.0 (1.6-2.4)	-7.4	
45-59	10	9.7 (7.8-11.5)	-5.7	13	13 (10.6-14.9)	-9.2	✡
60-74	7	12 (9.2-14.7)	-3.6	12	18 (14.4-20.6)	-5.8	
75+	3	13 (7.9-17.6)	12.9	10	28 (22.1-33.2)	2.8	
Total	30	4.8 (4.3-5.4)	-3.2	44	6.5 (5.8-7.1)	-5.3	✡
Non-Metro							
0-44	5	3.3 (2.4-4.2)	-8.1	5	3.7 (2.7-4.7)	6.9	
45-59	3	8.7 (5.5-11.9)	-7.0	3	10 (6.4-14.0)	0.5	
60-74	2	9.8 (5.2-14.5)	0.1	2	15 (9.2-21.1)	-3.0	
75+	0	3.9 (0.0-9.0)	63.6	1	16 (6.5-24.7)	-4.2	
Total	10	4.9 (3.9-5.8)	-4.7	12	6.5 (5.3-7.7)	2.0	

Notes:
1. Rate = age-adjusted rates per 100,000 person-years.
2. Figures in parentheses are 95% confidence intervals of the AAR.
3. The symbols ▲ and ▼ indicate statistically significant increases or decreases in rates respectively.

Furthermore, aggregating data into two five-year periods to compensate for the low annual numbers indicated that there was no statistically significant difference in rates among males or females in the Non-metropolitan area between the five-year period 1994 to 1998 and the previous five-year period (Table 16).

Table 16: Standardised rate ratios of first-ever hospitalisations for SAH among Non-metropolitan residents for the periods 1989 to 1993 and 1994 to 1998

	Obs[1] 94-98	Exp[2] 94-98	SRR[3,4]
Males	45	60	0.76 (0.51-1.12)
Females	63	59	1.07 (0.74-1.54)

Notes: 1. Obs = frequency observed during 94–98.
2. Exp = frequencies expected in 94–98 if 89–93 rates applied.
3. SRR = standardised rate ratio.
4. Figures in parentheses are 95% confidence intervals of the SRR.

Age-adjusted rates

In the Metropolitan area, rates of first-ever hospitalisation for SAH increased with age among females, while the age-adjusted rates among males stabilised after 45 years of age. The annual average rate among males younger than 45 years was 2.1 per 100,000 person-years and this increased to 13 among males older than 74 years. Among females younger than 45 years the rate was 2.0 and this increased to 28 among females older than 74 years (Table 15).

The annual age-adjusted rates fluctuated due to the small number of first-ever hospitalisations for some age groups in the Metropolitan area. There was no significant change among males of any age group from 1989 to 1998 (Table 15). Females aged from 45 to 59 years experienced a statistically significant rate decrease by an annual average of 9.2 % from 25 in 1989 to 8.9 in 1998 (Table 15).

The rate of first-ever hospitalisations for SAH increased to age 74 among males, while increasing with age among females in the Non-metropolitan area. The annual average rate among males younger than 45 years was 3.3 per 100,000 person years and this increased to 9.8 among males aged between 60 and 74 years. Among females younger than 45 years the rate was 3.7 and this increased to 15 among females aged between 60 and 74 years (Table 15).

The annual number of first-ever hospitalisations for SAH among both males and females in all age groups was low and the annual age-adjusted rates fluctuated from year to year resulting in large annual changes. Consequently, the low number of first-ever hospitalisations reduced the precision of the trend analysis and there was no detectable change in the rate of first-ever hospitalisation found among either males or females of any age (Table 15).

Comparison of Metropolitan area and Non-metropolitan area

On average, over the period 1989 to 1998, the Non-metropolitan rates of first-ever hospitalisations for SAH among both males and females were not significantly different from those in the Metropolitan area. The similarity in rates for the two areas was consistent from 1989 to 1998 (Table 17).

Table 17: Standardised rate ratio of first-ever hospitalisation for SAH for Non-metropolitan residents compared to Metropolitan residents, Western Australia, 1989 to 1998

	Males			Females		
Year	Obs[1]	Exp[2]	SRR[3,4]	Obs[1]	Exp[2]	SRR[3,4]
1989	21	14	1.46 (0.86-2.16)	5	15	0.32 (0.07-0.67)
1990	10	9	1.11 (0.46-1.90)	11	15	0.72 (0.31-1.20)
1991	9	10	0.94 (0.36-1.66)	11	9	1.16 (0.51-1.94)
1992	6	9	0.67 (0.18-1.30)	13	10	1.30 (0.62-2.09)
1993	11	8	1.40 (0.61-2.34)	13	10	1.33 (0.63-2.14)
1994	9	8	1.07 (0.41-1.87)	12	12	0.99 (0.45-1.63)
1995	4	10	0.42 (0.07-0.92)	10	7	1.33 (0.55-2.28)
1996	9	8	1.12 (0.43-1.95)	17	11	1.55 (0.83-2.37)
1997	13	10	1.30 (0.62-2.10)	11	13	0.86 (0.38-1.44)
1998	10	10	0.98 (0.40-1.67)	13	9	1.50 (0.72-2.42)
1989-1998	102	95	1.07 (0.88-1.30)	116	111	1.04 (0.86-1.25)

Notes:
1. Obs = frequency observed in Non-metropolitan area.
2 Exp = frequencies expected in the Non-metropolitan area if metropolitan rates applied.
3. SRR = standardised rate ratio.
4. Figures in parentheses are 95% confidence intervals of SRR.

4 DISCUSSION

First-ever hospitalisations for stroke accounted for a large proportion of all hospitalisations for stroke in WA. In 1998 the age-standardised rate among males was 226 per 100,000 and 137 per 100,000 among females, compared to the age-standardised rate for all stroke hospitalisations of 264 per 100,000 among males and 161 per 100,000 among females in the same year (HDWA, 2001).

The rate of first-ever hospitalisation for stroke in WA decreased by an annual average of 1.6% among males but remained unchanged among females during the ten-year study period. Similar trends in sex-specific age-standardised rates were reported for Metropolitan residents by both the current study and using data from the PCSS (Jamrozik et al., 1999). The actual level of decline in the incidence of stroke using the 'first-ever hospitalised' approach may be masked slightly by the observation that the proportion of people being admitted to hospital after suffering a stroke increased during the last ten years. However, the similarity of rates reported by the PCSS and the current study for Metropolitan residents suggests that the impact of this change in admission practice is minimal.

Males had a higher incidence of hospitalisation for stroke than for females throughout WA, a finding that is consistent with that described in the PCSS for stroke incidence (Jamrozik et al., 1999). Our findings indicated a higher incidence of stroke for the whole of WA than reported for the PCSS area. The rate reported for the Metropolitan area in our study was similar to the rate found for the PCSS area. Our study found a higher incidence in the Non-metropolitan area than in the Metropolitan area, so it would appear applying the PCSS estimates to the Non-metropolitan area may underestimate the size of the problem in this area.

Despite decreasing rates among Metropolitan and Non-metropolitan residents the differential in the incidence of stroke hospitalisation between the two areas remained over the ten-year period. Higher incidence of stroke might be expected in rural and remote areas, because of the high prevalence of risk factors for stroke in these areas. Generally residents of Non-metropolitan areas reported a higher prevalence for hypertension, tobacco smoking, diabetes, physical inactivity and harmful levels of alcohol consumption (Milligan R, 1998). Furthermore, the Aboriginal population component is much higher in the Non-metropolitan area and this population is known to have a higher death rate due to stroke (Commonwealth Department of Health and Aged Care, 1999). Mortality data indicated that the death rate attributable to stroke was also higher in Non-metropolitan areas than Metropolitan areas during the ten-year period (HDWA, 2000).

In addition to a higher incidence rate, people are more likely to be hospitalised for stroke in rural and remote areas than in metropolitan areas because of the distance the patient may have to travel to the hospital from home. Furthermore, the lack of community health services such as nursing homes and community-based care may influence the decision to admit a stroke patient to hospital in rural and remote areas. As GPs have admitting rights in many regional hospitals a difference in case management by rural and remote GPs may contribute to a higher first-ever hospitalisation rate in Non-metropolitan areas. For this reason hospitalisation data from Non-metropolitan areas may provide a closer estimate of the true incidence of stroke than from the Metropolitan area.

In contrast to a higher incidence of stroke in Non-metropolitan areas, the proportion of the population diagnosed with stroke indicate that the prevalence was lower among people resident in the Non-metropolitan area than their Metropolitan counterparts in 2001. Among Metropolitan residents 1.7% reported having ever been told by a doctor that they had a stroke, compared with 1.5% among Non-metropolitan residents (HDWA, 2001). Lack of stroke rehabilitation units and continuing care services in Non-metropolitan areas may result in stroke patients moving to the city for these services. Non-metropolitan residents have reported their willingness to relocate to urban centres if appropriate services were available (National Stroke Foundation, 2001). Additionally, the survival rate of stroke patients may differ between the Metropolitan and Non-metropolitan areas, with a lower survival rate in Non-metropolitan areas. A study of patients hospitalised for ischaemic stroke in Western Australia found that the survival rate of patients residing in rural and remote areas of the State was significantly lower than that of their Metropolitan counterparts (Lee et al., 2002).

The incidence of stroke hospitalisation increased with age among both sexes. In an ageing population this has major implications for future hospital resource requirements as research indicates that older stroke patients have longer hospital stays (Hakim et al., 1998). Despite, the rate of first-ever stroke hospitalisation decreasing among older age groups in both the Metropolitan and Non-metropolitan areas, age-specific rates of the elderly remain well above those of the younger age groups.

Limitations exist in estimating the true incidence of stroke and its subtypes using linked hospital separation data. Patients only mildly affected or experiencing strokes which are rapidly fatal may not be admitted to hospital resulting in an underestimate of true stroke incidence. Estimates of first-ever hospitalisations for stroke are affected by the difficulties in determining a correct diagnosis. For example, the definition used to determine ICD includes ill-defined cerebrovascular disease and this grouping includes a mixture of thrombotic stroke and ICH which can be difficult to distinguish clinically. Similar problems exist in the diagnosis of TIA. Furthermore, the management of TIA patients by GPs or outpatient clinics without admission to hospital will also affect estimates of stroke incidence (Stewart-Wynne et al., 1992). Including TIA in the definition for stroke results in an overestimate of true stroke, but as TIA has a similar aetiology to ischaemic stroke and is a major risk factor for stroke, information on TIA incidence is important to the management of stroke in the State.

The smaller proportion of first-ever hospitalisations due to haemorrhagic strokes may not reflect the true incidence of this subtype of stroke as people are more likely to die before reaching medical care from the effects of haemorrhagic stroke than ischaemic stroke (Anderson et al., 1994). For example, a population-based study estimated the proportion of patients who die from SAH before reaching medical attention at 10 to 15% (Schievink et al., 1995). In addition, better ascertainment and diagnosis of stroke using computer tomography in the latter part of the ten-year period may also explain the change in haemorrhagic stroke hospitalisation incidence over this period. Fewer people were hospitalised for SAH at the end rather than the start of the ten-year period, resulting in a decrease in the rate among both sexes. This apparent decline in the incidence of SAH has been explained by a greater proportion of patients investigated with computer tomography (Linn et al., 1996).

The increase in hospitalisation incidence for ICH may be also due to computer tomography detecting small ICHs which were previously diagnosed as cerebral infarction (Rowe et al., 1988). In fact the proportion of all stroke hospitalisations that were coded as acute ill-defined cerebrovascular disease decreased among both the Metropolitan and Non-Metropolitan populations over the study period. Presumably the increase in hospitalisations for ICH is the result of a coding shift from acute ill-defined cerebrovascular disease based on a more precise diagnosis. In addition, the admission of more patients to hospital before death, through improvements in emergency care could potentially increase hospitalisation incidence.

Of all first-ever hospitalisations for stroke, ICD accounted for 63% of all male and 61% of all female occurrences. TIA accounted for 26% of all male and all female first-ever stroke hospitalisations over the ten-year period. Of the haemorrhagic subtypes of stroke, ICH accounted for 8% of all male and 9% of all female first-ever hospitalisations for stroke, while SAH accounted for 3% of all male and 4% of all female first-ever hospitalisations for stroke.

There was considerable variation in the gender effects on the subtypes of stroke. Except for SAH, males had a higher hospitalisation incidence than females over the ten-year period for the different stroke subtypes. Other studies have found that the female incidence rate was significantly higher than the male incidence rate for SAH (ACROSS, 2000; Linn et al., 1996). Whilst the hospitalisation incidence for SAH and ICD was declining for both sexes in WA it was increasing among females for TIA and among both sexes for ICH.

For ICD, it appears that the differential between the sexes remained unchanged as the decline in rates among both sexes was similar. The differential between the sexes for TIA hospitalisation incidence decreased over the ten-year period with an increase in female rates. The large proportion of total stroke cases represented by TIA and the increasing female rate is of concern because of the high risk of recurrent stroke and ischaemic heart disease among people suffering TIA (Hankey and Warlow, 1994).

The increase in hospitalisation incidence among both sexes for ICH throughout WA was explained by an increase among the elderly, while the decline in the rates of first-ever hospitalisation for SAH among the youngest age groups accounted for the decrease in the overall rate. For SAH there was an increase in the rate among elderly males over the ten-year period, but the rates were the highest among elderly females. The increase of first-ever hospitalisation rates with age for SAH among females was similar to that found in another study. The stabilisation of the male rates with increasing age, as found in our study, has been attributed to small numbers and difficulties with diagnosis in other studies (ACROSS, 2000).

A major advantage of using linked hospitalisation separation data to estimate stroke incidence is the ability to study regional variations in incidence, which is not possible in local population-based studies.

For ischaemic stroke the hospitalisation incidence was higher among Non-metropolitan residents than their Metropolitan counterparts, with residents of remote areas having the highest rates. Despite this difference, overall rates for ICD among residents in both areas decreased at similar rates. However, there was an increase among younger Non-metropolitan female residents. It is unclear whether these variations are explained by regional differences in either ischaemic stroke management or in the incidence of ischaemic cerebrovascular disease, which are not reflected in local population-based stroke studies. The poorer risk factor profile for ischaemic stroke and the greater Aboriginal component of the population in the Non-metropolitan area suggest that incidence may be higher in this area compared to the Metropolitan area.

Similarly, the regional variation for TIA hospitalisation incidence might be due to variation in hospital admission practices and the management of TIA cases between Metropolitan and Non-metropolitan hospitals, a difference in incidence of TIA or a combined effect. The hospitalisation incidence for TIA in the Non-metropolitan area was much higher than that among Metropolitan residents which was similar to estimates of incidence for TIA from the PCSS (Stewart-Wynne et al., 1992). Therefore a higher first-ever hospitalisation for TIA in the Non-metropolitan area may result from a higher incidence of TIA in the Non-metropolitan area. At the same time, the increase and subsequent decline in the rate among Non-metropolitan females older than 74 years from 1989 to 1998 indicates that the influence of factors other than incidence affect the rate of first-ever hospitalisation for TIA in Non-metropolitan areas. As the risk of recurrent stroke is greatest in the weeks following TIA, patients may be admitted to Non-metropolitan hospitals in cases where the patient has a long distance to travel from home to the hospital.

Higher rates of first-ever hospitalisation for ischaemic stroke in the Non-metropolitan area suggest the need for primary prevention to improve the risk profile of residents. Early and accurate diagnosis improves the outcome of stroke patients by ensuring appropriate early secondary prevention and rehabilitation (Hankey, 2000). Secondary prevention measures such as drug therapy, carotid endarterectomy and risk factor profile changes through dietary change and drug therapy will be necessary to prevent recurrent stroke and ischaemic heart disease among people with ischaemic stroke conditions. An enhanced level of secondary prevention may reduce the increasing demand for stroke rehabilitation services in the future. Outcomes of these acute stroke services are best when delivered through co-ordinated stroke services in a stroke unit within hospital (Hankey, 2000).

In contrast to ischaemic stroke, over the ten-year period hospitalisation incidence for ICH was lower among Non-metropolitan residents than among their Metropolitan counterparts, but increased substantially among Non-metropolitan residents over this period resulting in similar rates in the latter years for the two regions. The substantial increase among Non-metropolitan residents was also accounted for by an increase in the rate among the elderly of both sexes.

There may be a number of explanations accounting for the trends in ICH rates relating to the limitations of hospital separation data and the small number of ICH events annually. A lower rate of first-ever hospitalisation in Non-metropolitan areas than Metropolitan areas initially may in part relate to the availability of diagnostic procedures. Computer tomography has allowed better ascertainment of ICH and studies have found ICH incidence increases with its use (Rowe et al., 1988). In Western Australia, access to computer tomography facilities varies between hospitals, with reduced access in rural and remote areas of the State (National Stroke Foundation, 2001). The increase in the Non-metropolitan area may be explained by better diagnosis through the expansion of diagnostic facilities in the region over the period of the study. Better ascertainment of ICH cases would see a shift of cases previously coded as ICD (ill-defined cerebrovascular disease) to ICH, but not an increase in the true incidence of ICH. In addition, the impact of improved emergency care would be expected to be greater in the Non-metropolitan area than in the Metropolitan area, thereby increasing the proportion of ICH cases hospitalised. However, hypertension is considered a major risk factor for ICH (Dorsch, 1997) and the increase in prevalence of self-reported high blood pressure in Non-metropolitan areas from 1995 to 2000 (HDWA, 2001) may have also had an impact on the incidence of ICH in Non-metropolitan areas.

The low number of first-ever hospitalisations for SAH among Non-metropolitan residents annually restricts the analysis of the variation of the rate throughout the State over the ten-year period. Among female metropolitan residents the rate decreased to a rate similar to that among Metropolitan males. The decrease is also thought to be due to the availability of more reliable diagnostic procedures resulting in better stroke ascertainment. If the observed decrease was due to better diagnosis then the number of new cases of SAH might be expected to stabilise once the true baseline has been established.

Although SAH and ICH are clinically and pathologically quite distinct, diagnostic procedures such as computer tomography and magnetic resonance are essential to accurately diagnose haemorrhagic stroke early and consequently provide appropriate therapy. However, management of SAH, and in some cases large haematomas of intracerebral strokes, is most likely to require surgery to prevent neurological disability and re-bleeding (Dorsch, 1997). Access to these diagnostic and surgical services is vital to the outcome of stroke patients, especially in Non-metropolitan areas.

Despite limitations in estimating the true incidence of stroke, analysis of linked hospitalisation separation data provides a means of obtaining estimates of stroke incidence of a large and dispersed population. Linked hospital separation data also provide a large sample size from which to calculate estimations. At the same time, the utilisation of acute care services for management of stroke in hospital within regions of the State can be quantified. Population-based prospective studies designed to overcome the problems encountered in analysis of hospital separation data are capable of identifying and classifying individual stroke events more precisely, but have time and cost constraints when extended to larger and geographically dispersed populations. The geographical variation described in this report suggests the need for further study that extends the population-based approach to rural and remote areas to clarify and reduce the limitations involved when using linked hospitalisation data for this purpose.

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