ABSTRACT

Background: Studying stroke rates in a whole community is a rational way to assess the quality of patient care and primary prevention. However, there are few studies of trends in stroke rates worldwide and none in Brazil.

Objective: Established study methods were used to define the rates for first ever stroke in a defined population in Brazil compared with similar data obtained and published in 1995.

Methods: All stroke cases occurring in the city of Joinville during 2005–2006 were prospectively ascertained. Crude incidence and mortality rates were determined, and age-adjusted rates and 30 day case fatality were calculated and compared with the 1995 data.

Results: Of the 1323 stroke cases registered, 759 were first ever strokes. The incidence rate per 100 000 was 105.4 (95% CI 98.0 to 113.2), mortality rate was 23.9 (95% CI 20.4 to 27.8) and the 30 day case fatality was 19.1%. Compared with the 1995 data, we found that the incidence had decreased by 27%, mortality decreased by 37% and the 30 day case fatality decreased by 28%.

Conclusions: Using defined criteria we showed that in an industrial southern Brazilian city, stroke rates are similar to those from developed countries. A significant decrease in stroke rates over the past decade was also found, suggesting an improvement in primary prevention and inpatient care of stroke patients in Joinville.

Methods and period of data collection

We obtained information on all cases of first ever stroke occurring in residents of Joinville between 1 January 2005 and 31 December 2006. We used the methodology proposed by Sudlow and Warlow8 as well as the Stroke Steps modular programme proposed by the WHO.9 In the first step (hospitalised cases), the study nurses registered, on a daily basis, all stroke cases that were confirmed by a neurologist. A neuroradiologist, unaware of the previous comorbidity listed on the death certificate, as were those for which the only diagnosis listed in the 10th revision of the International Classification of Diseases (ICD-10) were reviewed and each medical chart was later discussed with a neurologist (NLC). In the second step (fatal cases),7 we analysed, month by month, all death certificates issued by the Municipal Department of Health. We initially selected all death certificates containing any references to the ICD-10 codes related to stroke (I61 through I69) or any descriptions of cerebrovascular diseases, as well as those listing death as being from an unknown cause (R99). The deaths of patients not identified in the first module were investigated through evaluation of hospital medical charts and, when available, imaging examinations. Sudden deaths occurring within the first 24 h (either at home or in the hospital) not confirmed by brain CT or by a compatible medical history were excluded. This is because these deaths did not always have their underlying causes confirmed by a physician, as were those for which the only previous comorbidity listed on the death certificate was stroke. Finally, some death certificate analyses remained inconclusive even after investigation of the medical charts, or a diagnosis was listed as “undetermined” on the charts. In those cases, the deaths were investigated by contacting the surviving family.
In the third step (non-hospitalised alive cases), we aimed at minimising losses among the patients presenting as mild cases and therefore not admitted to hospital. In the two 24 h emergency care clinics, an automated email notification system was created in order to report all cases in which the patient died within the first 24 h with no reliable medical record and without a brain CT, patients residing outside the Joinville city limits and patients with subdural, epidural or intracerebral haemorrhage secondary to arteriovenous malformation or tumours.

### Diagnostic criteria

We defined stroke as the presence of signs of sudden focal or global cerebral dysfunction that lasts longer than 24 h without any apparent non-vascular cause. TIA was defined as a sudden acute loss of cerebral or ocular function, with symptoms lasting less than 24 h, which could be indicative of an embolic or atherothrombotic disease after appropriate investigation. Infarctions were defined when the CT revealed hypodense brain areas in a topography consistent with the clinical syndrome. Intracerebral haemorrhage was defined when the CT revealed hyperdense brain areas in a topography consistent with the clinical syndrome, and intracerebral haemorrhage was defined when the CT revealed hypodense brain areas in a topography consistent with the clinical syndrome. SAH was defined as a sudden, severe headache, occasionally accompanied by loss of consciousness, convulsions or focal neurological signs unrelated to trauma, with the CT revealing hyperdense brain areas in the cisternal or subarachnoid spaces, confirmed either by cerebral digital subtraction angiography or by a non-traumatic lumbar puncture showing an erythrocyte count higher than 2×10^5/l or a xanthochromic supernatant on CSF analysis. Cases without brain imaging were classified as undetermined and coded as ischaemic for the rate analyses.

### Routine investigation

After obtaining written informed consent, we obtained demographics and risk factor information, and performed biochemical,

### Table 1  Incidence rates of first ever stroke, by sex, per 100 000 population, Joinville, 1995 and 2005–2006

| Age group (years) | Crude incidence (95% CI) | Men | Women | Total population |
|-------------------|--------------------------|-----|-------|-----------------|
| Joinville 1995    |                          |     |       |                 |
| ≤ 34              | 100.8 (65.8–148.2)       | –   | 70.8 (42.0–111.9) | 85.8 (62.4–115.0) |
| 35–44             | 211.6 (141.8–304.7)     | 177.5 (113.8–264.5) | 194.7 (145.8–255.1) |
| 45–54             | 683.6 (514.5–888.3)     | 312.0 (207.5–452.4) | 497.6 (388.6–604.6) |
| 55–64             | 1079.0 (784.4–1455.9)   | 698.4 (482.6–963.8) | 866.5 (687.1–1074.5) |
| 65–74             | 2011.2 (1192.6–3177.7)  | 1031.7 (577.8–1733.3) | 1421.0 (792.0–2003.6) |
| 75–79             | 1943.2 (1033.8–3232.9)  | 1310.0 (733.6–2161.5) | 1543.6 (1026.5–2238.2) |
| ≥80               | 96.4 (82.3–111.6)       | 70.6 (59.4–83.8) | 83.5 (74.6–93.1) |
| Adjusted Brazil*  |                          |     |       | 113.6 (101.5–126.8) |
| Adjusted world†   |                          |     |       | 143.7 (128.4–160.3) |
| JOINVASC 2005–6   |                          |     |       |                 |
| ≤ 24              | 8.1 (3.2–16.7)          | 10.3 (4.7–19.6) | 9.2 (5.3–15.0) |
| 25–34             | 34.3 (22.4–50.3)        | 19.4 (10.9–32.0) | 26.8 (19.2–36.4) |
| 35–44             | 120.4 (91.7–155.3)      | 125.7 (96.6–160.8) | 123.0 (102.1–146.9) |
| 45–54             | 426.7 (347.9–518.0)     | 202.3 (151.1–265.3) | 310.4 (263.3–363.5) |
| 55–64             | 734.3 (589.7–903.6)     | 400.8 (319.2–496.9) | 523.9 (445.8–608.3) |
| 65–74             | 865.6 (584.5–1259.4)    | 707.8 (484.1–999.2) | 784.1 (596.9–1011.4) |
| 75–79             | 3580.8 (2847.9–4444.7)  | 2491.2 (2053.1–2995.1) | 2856.7 (2469.9–3287.0) |
| ≥80               | 80.2 (72.5–88.5)        | 73.5 (66.2–81.4) | 76.9 (71.6–82.6) |
| Adjusted Brazil*  |                          |     |       | 86.6 (80.5–93.0) |
| Adjusted world†   |                          |     |       | 105.4 (98.0–113.2) |

*Adjusted to the Brazilian population according to the 2000 census.
†Segi’s world population.
electrocardiographic and radiological tests. The attending neurologist then informed the study nurse of the Bamford classification.11 The pathophysiological diagnosis of stroke was based on the criteria described in the Trial of ORG 10127 in Acute Stroke Treatment (TOAST) study.12 Routine stroke investigation followed the guidelines issued by the Brazilian Society of Cerebrovascular Diseases.13

Outpatient follow-up
All patients were contacted by telephone 30 days after discharge. We registered patient losses resulting from incomplete address, address change or refusal to provide information. Patients who refused to give written informed consent were identified but not followed.

Table 2  Stroke mortality rates by sex per 100 000 population, Joinville, 1995 and 2005–2006

| Age group (years) | Crude incidence (95% CI) |        |        |
|-------------------|--------------------------|--------|--------|
|                   | Men                      | Women  | Total  |
| Joinville 1995    |                          |        |        |
| <24               | 27.1 (10.9–55.8)         | 20.4 (6.6–47.5) | 23.4 (12.1–41.0) |
| 35–44             | 21.9 (4.5–63.9)          | 55.7 (18.0–129.8) | 135.1 (85.7–202.7) |
| 55–64             | 223.6 (132.6–353.3)      | 65.1 (22.7–129.8) | 127.0 (75.0–204.0) |
| 65–74             | 267.8 (206.0–360.9)      | 174.6 (80.0–331.8) | 259.9 (166.6–387.3) |
| 75–79             | 102.6 (71.5–180.9)       | 365.8 (119.4–858.6) | 391.8 (188.1–720.9) |
| 75–84             | 127.4 (72.1–212.4)       | 211.1 (45.6–465.6) | 243.5 (173.1–324.5) |
| All               | 27.6 (20.7–36.2)         | 16.2 (10.9–23.0)  | 21.9 (17.5–27.2)  |

Adjusted Brazil†  29.6 (23.8–36.6)  
Adjusted world†  37.5 (29.9–46.5)  

JOINVASC 2005–6

| Age group (years) | Crude incidence (95% CI) |        |        |
|-------------------|--------------------------|--------|--------|
|                   | Men                      | Women  | Total  |
| <24               | –                        | 1.1 (0.02–6.1)  | 0.6 (0.01–3.3) |
| 25–34             | 6.6 (2.1–15.4)           | 9.1 (2.5–23.3)  | 5.9 (2.7–11.2) |
| 35–44             | 6.7 (2.5–14.6)           | 27.9 (15.2–46.9) | 20.2 (12.3–31.1) |
| 55–64             | 71.1 (41.4–113.8)        | 35.0 (16.0–66.5) | 52.4 (34.2–77.0) |
| 65–74             | 99.0 (51.2–173.3)        | 96.6 (59.0–148.8) | 97.5 (66.7–137.5) |
| 75–79             | 332.9 (159.8–612.5)      | 154.8 (62.1–318.9) | 225.9 (131.5–361.4) |
| 75–84             | 1048.0 (671.8–1561.5)    | 903.9 (648.7–1126.2) | 952.2 (734.9–1213.7) |
| All               | 15.1 (11.9–19.0)         | 19.2 (15.6–23.4)  | 17.2 (14.7–20.0) |

Adjusted Brazil†  20.5 (17.5–23.8)  
Adjusted world†  23.9 (20.4–27.8)  

*Adjusted to Brazilian population according to the 2000 census.  †Segi’s “world” population.

Statistical analysis
We calculated the 95% confidence interval (CI) assuming a Poisson distribution for the number of events.14 Incidence and mortality rates were calculated using intercensal data from 1995 and from the 2005–2006 period as the denominators.15 We calculated crude incidence rates and crude mortality rates for the years 2005 and 2006, using the sum of the intercensal population from those years as the denominators and the sum of the cases (deaths) from the same years as the nominators. First ever stroke incidence and mortality rates were age adjusted by the direct method, taking as standards both the 2000 census population of Brazil15 and Segi’s “world” population.16 We used the χ² test to compare proportions. All tests were two tailed. We created a database using Microsoft Access for the compilation and correlation of data. Statistical analysis was carried out using the Statistical Package for Social Sciences, V.12.0 (SPSS Inc, Chicago, Illinois, USA).
Chicago, Illinois, USA). The study was approved by the ethics in research committees of the hospitals and universities involved.

RESULTS

In the 2005–2006 period, we diagnosed 1376 patients with stroke. Of those, eight patients refused to participate in the study and 45 were excluded because of changes in their initial diagnosis of stroke to other diagnoses (29 patients had a definitive diagnosis of seizures, eight patients had a primary or metastatic cerebral tumour and eight had a metabolic encephalopathy). Therefore, the final sample consisted of 1325 patients. Of these, 90 were TIA and 759 were diagnosed with first ever stroke: 610 (80.4%) with ischaemic stroke, 94 (12.4%) with haemorrhagic stroke and 55 (7.3%) with SAH. Of the 759 patients with first ever stroke, 639 (84.2%) were diagnosed in an outpatient clinic. Of the 52 cases identified based on their death certificates, 49 (46%) were confirmed only after contacting the surviving family members. Three patients who died in the first 24 h without a medical history or brain CT were excluded.

Undetermined cases without a brain CT were classified as metastatic cerebral tumour and eight had a metabolic encephalopathy. Therefore, the final sample consisted of 1325 patients. Of these, 90 were TIA and 759 were diagnosed with first ever stroke: 610 (80.4%) with ischaemic stroke, 94 (12.4%) with haemorrhagic stroke and 55 (7.3%) with SAH. Of the 759 patients with first ever stroke, 639 (84.2%) were diagnosed in an outpatient clinic. Of the 52 cases identified based on their death certificates, 49 (46%) were confirmed only after contacting the surviving family members. Three patients who died in the first 24 h without a medical history or brain CT were excluded. Undetermined cases without a brain CT were classified as ischaemic stroke (n = 28).

Of the patients identified with first ever stroke, 385 (51%) were male. Mean age was 64.9 (SD 13.9) years and 707 (93.1%) patients underwent brain CT within 30 days after the event. For patients who did not awake with symptoms (759), the mean time from symptom onset to CT was 2.4 (SD 1.2) days. During the study period, 31 (2.3%) patients with stroke underwent intravenous thrombolysis.

The incidence of first ever stroke adjusted to the Brazilian population was 20.5 per 100 000 (95% CI 17.5 to 23.8) and 23.9 per 100 000 (95% CI 20.4 to 27.8) when adjusted to the world population. This is lower than in 1995.1 Table 2 shows the mortality rates by sex in 1995 and in the 2005–2006 period. Figure 1 shows the evolution of age specific incidence rates between 1995 and the 2005–6 period, demonstrating a fall in rates for all age groups, except the very oldest, at the later period studied. The same pattern is seen on fig 2 for mortality rates.

Table 3 shows the differences between the two periods in terms of the incidence and mortality rates of first ever stroke, by sex and age group. Incidence adjusted for age fell by 26% (p = 0.02) in males and by 20% (p = 0.21) in females although only among individuals younger than 75 years of age (41%; p = 0.003).

There was also a decrease in the mortality adjusted for age, although it was much more pronounced in males (48%) than in females (3%).

The case fatality was 19.1% (145/759) in the 2005–2006 period, which is also lower than that found in 1995 (26% (84/320)). Therefore, over a span of approximately 10 years, the incidence fell by 27% and mortality fell by 57%. The 30 day case fatality decreased by 28.2% during the period (from 26.6% to 7.5%).

DISCUSSION

We have shown that, over an interval of nearly 10 years, there was a significant decrease in the incidence, mortality and 30 day case fatality of first ever stroke in Joinville, Brazil. Mortality adjusted for age decreased by 57%. A recent study on mortality corroborates these findings. Andrè et al, using official Brazilian Ministry of Health data, reported that the adjusted mortality rates decreased by 40% (68.2 vs 40.9 per 100 000 population) from 1980 to 2000, while in the Southern region of Brazil, where Joinville is located, mortality decreased by 44% (79.9/44.0).5

What could have caused the 57% reduction in stroke mortality in Joinville over those 10 years? Classically, mortality is considered to be directly influenced by incidence and case fatality rates.15 The Monitoring Trends and Determinants in Cardiovascular Disease (MONICA) project, which included no Latin American countries, showed that in the populations

---

**Table 3** Standardised mortality and incidence rates of first ever stroke, by sex and age, per 100 000 population and 30 day case fatality rate in Joinville, 1995 and 2005–2006

|           | 1995* | 2005–6† | Relative incidence | p Value‡ |
|-----------|-------|---------|--------------------|----------|
| **Incidence** |       |         |                    |          |
| Men       | 145.1 (124.9–167.6) | 108.6 (98.1–119.9) | 0.74 (0.59–0.96) | 0.02     |
| Women     | 88.3 (74.0–104.5)  | 71.5 (64.4–79.2)  | 0.80 (0.60–1.12) | 0.21     |
| Age <75 years |        |         |                    |          |
| Age ≥75 years |        |         |                    |          |
| All       | 113.6 (101.5–126.8) | 86.8 (80.5–93.0)  | 0.76 (0.58–1.01) | 0.06     |
|**30 day case fatality** |       |         |                    |          |
| Men       | 43.0 (32.2–56.2)   | 22.5 (17.7–28.2)  | 0.52 (0.32–0.89) | 0.01     |
| Women     | 19.8 (13.5–28.1)   | 19.4 (15.7–23.4)  | 0.97 (0.51–1.78) | 0.87     |
| Age <75 years |        |         |                    |          |
| Age ≥75 years |        |         |                    |          |
| All       | 29.6 (23.6–36.6)‡  | 20.5 (17.5–23.8)§ | 0.69 (0.40–1.22) | 0.21     |
|**Case fatality** |       |         |                    | 0.009    |
| Men       | 26.6 (16.0–40.7)   | 20.5 (17.5–23.8)¥ | 0.63 (0.38–1.05) | <0.01    |
| Women     | 19.1 (145/759)     | 19.1 (145/759)     | 28                |          |

*Brazilian population according to the intercensal projection for 1995.
†Intercensal projection for the 2005–2006 period.
‡Adjusted to Brazilian population census 2000.
§Adjusted to world Segi’s population.
presenting declining mortality rates, one-third of the decrease could be attributed to incidence and two-thirds to case fatality. In Joinville, stroke incidence and case fatality significantly decreased over the past 10 years. However, what led case fatality to decrease by 28.2% and the incidence adjusted for age for the world population to decrease by 27%?

Currently, Joinville ranks 13th among Brazilian cities in terms of its human development index, which increased from 0.779 in 1991 to 0.857 in 2000. The increase in socioeconomic conditions in the city might have influenced primary prevention and, subsequently, the decrease in incidence. In our study, however, incidence rates increased among individuals over 75 years of age. We believe this was caused by the increase in life expectancy, with a subsequent increase in the absolute number of older people. Over the past 20 years, the elderly population of Joinville has increased by 151%, from 11 265 in 1980 to 28 236 in 2000. In 1991, life expectancy was 70.6 years compared with 76.6 years in 2000.

Another reason for the decrease in mortality was the 28% decrease in 30 day case fatality. In one review article on the effectiveness of stroke treatment, it was reported that the public health care measures that had a higher impact on stroke prevention were the presence of stroke units, followed by the routine use of aspirin and thrombolysis. The largest hospital in Joinville has had a stroke unit since 1997. Since 2002, intravenous thrombolysis has been used with increasing frequency in most hospitals in the city although this is unlikely to alter case fatality. In the JOINVASC study, 31 of 23% of the patients received thrombolytic treatment. In one study on hospitalisations due to cerebral infarction occurring in the USA between 1999 and 2004, it was reported that only 1.12% of the patients received thrombolytic treatment.

Another aspect that influences case fatality is the severity of the events. Considering 15 of the 15 population based studies on stroke selected by Feigin et al, mean case fatality was 22.9%. Case fatality for first ever stroke, regardless of subtype, was 19.1% in the JOINVASC study and 25% in the Proyecto Investigación de Stroke en Chile: Iguique Stroke (PISCIS) study. Moreover, comparing the case fatality rates by subtypes from both studies we can see that the Joinville’s rates were always lower, although CIs overlapped. Therefore, we assume that the decrease in case fatality in the present study was not caused by variations in the severity of the events in our population but rather by the quality of inpatient care.

Can the results obtained in the two periods be compared methodologically? Studies on incidence trends over time can be impaired by changes in the techniques of investigation and diagnosis. In order to guarantee comparability, we used the same methodology in 1995 and in the 2005–2006 period. In 1995, 98% of the study sample underwent brain CT, as did 93.1% (707/759) of the sample in the 2005–2006 period. The decrease in brain CT ascertainment on this last period could be explained by the inclusion of a public institutional care facility, where brain CT was not available, and also by the active search of patients performed by the social worker. The medical staff were essentially the same. In a recent review of population based studies carried out in Latin America and the Caribbean, the Joinville study in 1995 was reported to be semi-population based as survivors not hospitalised (third WHO module) were not included in the sample. In this 2005–2006 study, we made an effort to improve the recruitment of all stroke cases. The public outpatient clinic system in Joinville is not totally computerised and electronic medical charts are still unavailable, which makes data recovery difficult. However, in order to improve recruitment of patients who had not been hospitalised (hot pursuit), we used three additional resources: stickers stuck to the computer monitors in the medical offices of non-neurologist physicians; an email notification system in the 24 h emergency care clinics; and reports communicating the progress of the study to the physicians in the city every 6 months. The use of the first two resources, as case recruitment sources, resulted in a 2.5% increase in the total sample. The hot pursuit provided a 5.5% increase in the sample older than 60 years of age in the OXVASC. This is the main weakness of our study. Therefore, if we consider the lower recruitment of non-fatal cases in 1995, we believe that the 27% decrease in the adjusted incidence in the past 10 years might be underestimated. In the same way as the denominator will rise in the 2005–6 period, the decrease in case fatality rates found could be overestimated.

The percentage variations in the incidence, mortality rates and case fatality of first ever stroke over time in Joinville were similar to those found in the cities of Espoo-Kuaniainen (Finland), Oyabe (Japan), Perth (Australia), Novosibirski (Russia), Auckland (New Zealand) and Oxfordshire (UK).

In conclusion, there was a consistent decrease in morbidity, mortality rates and case fatality of first ever stroke in the city of Joinville, Brazil, from 1995 to 2006. The findings regarding incidence might have been influenced by the socioeconomic characteristics of the city of Joinville. Extrapolation of these results to other populations should be considered with caution, especially in a country as heterogeneous as Brazil. Although we cannot prove that the decrease in the incidence resulted directly from the control of risk factors for atherosclerosis, the size of the changes suggests advances in the quality of primary prevention.

Acknowledgements: We would like to thank our colleagues and the staff of the Joinville Neurologic Clinic. We are especially grateful to our colleagues and friends Edwin Schossland, Pablo Lavados, Peter Langhorne and Renato AC Castro.

Funding: This study received financial support from the Fundação de Amparo à Pesquisa do Estado de Santa Catarina, the Universidade Regional de Joinville and the Joinville Municipal Health Department and grant support from Fundação de Apoio à Pesquisa Científica do Estado de Santa Catarina-FAPESC. The sponsor had no role in the study design, data collection, data analysis, data interpretation or writing of the report. The corresponding author had full access to all of the data in the study and had the final responsibility for the decision to submit for publication.

Competing interests: None.

Ethics approval: The study was approved by the ethics in research committees of the hospitals and universities involved.

REFERENCES

1. Lavados PM, Hennis AJ, Fernandes JG, et al. Stroke epidemiology, prevention and management strategies at a regional level: Latin America and the Caribbean. Lancet Neurol 2007;6:362–72.
2. Lessa I, Bastos CA. Epidemiology of cerebrovascular accidents of Salvador, Bahia, Brazil. Bull Pan Am Health Organ 1983;17:292–303.
3. Cabral NL, Longo AL, Moro CHC, et al. Epidemiologia dos acidentes cerebrovasculares em Joinville, Brasil. Arq Neuropsiquiatr 1997;55:357–63.
4. Minelli C, Fen LF, Minelli DPC. Stroke incidence, prognosis, 30-day, and 1-year case fatality rates in Matao, Brazil. Stroke 2007;38:2908–11.
5. André C, Coroni CC, da Gunta GB, et al. Progressive decline in stroke mortality in Brazil From 1980 to 1992, 1990 to 1992, and 2000 to 2002. Stroke 2006;37:2784–9.
6. Instituto Brasileiro de Geografia e Estatística. IBGE. Available at http://www.ibge.gov.br/home/estatistica/populacao/censo2000/defaultdb_munic.shtml (accessed 18 March 2007).
7. Sudlow CL, Warlow CP. Comparing stroke incidence worldwide: what makes studies comparable? Stroke 1996;27:550–58.
8. The WHO STEPwise approach to Stroke Surveillance. Overview and Manual (V.2.0). Noncommunicable Diseases and Mental Health. World Health Organization. Disponible en www.who.int/entity/ncd_surveillance/steps/en (accessed 18 February 2008).
9. Ahu K, Harmoie P, Hatane S, et al. Cerebrovascular diseases in the community: results of a WHO collaborative study. Bull World Health Organ 1980;58:113–30.
10. Hankey GJ, Warlow CP. Transient ischaemic attack of the brain and eye. London: WB Saunders, 1994.
11. Bamford P, Sandercock M, Dennis J, et al. Classification and natural history of clinically identifiable subtypes of cerebral infarction. Lancet 1991;337:1521–6.

12. Adams HP Jr, Bendixen BH, Kappelle LJ, et al and the TOAST Investigators. Classification of subtype of acute ischemic stroke. Definitions for use in a multicenter clinical trial. Stroke 1993;24:35–4.

13. Sociedade Brasileira de Doenças Cerebrovasculares. Brazilian guideline for the management of acute stroke. Arq Neuropsiquiatr 2001;59:972–80.

14. Keyfitz N. Sampling variance of standardized mortality rates. Hum Biol 1966;38:309–17.

15. Ministério da Saúde. População residente por sexo segundo faixa etária - Município: Joinville. Available at: http://www.tabnet.datasus.gov.br/cgi/deftohtm.exe?ibe/cnv/popscc.def (accessed 18 March 2009).

16. Ahmad OB, Boschi-Pinto C, Murray CJL, et al. Age standardisation of rates: a new WHO world standard. http://www.who.int/healthinfo/paper31.pdf (accessed 18 February 2009).

17. Asplund K. What MONICA told us about stroke? Lancet Neurol 2005;4:64–8.

18. Programa das Nações Unidas para o Desenvolvimento. Atlas do Desenvolvimento Humano. Ranking do IDH-M dos municípios do Brasil. Disponível em: http://www.pnud.org.br/atlas/tabelas/index.php (accessed 18 February 2009).

19. Mastroeni MF, Enzinger GS, Mastroeni SSBS, et al. Demographic profile of the elderly in the city of Joinville, Santa Catarina: a household survey. Rev Bras Epidemiol 2007;10:190–201.

20. Hankey GJ, Wardlaw CP. Treatment and secondary prevention of stroke: evidence, costs and effects on individuals and populations. Lancet 1999;354:1457–63.

21. Cabral NL, Moro C, Silva GR, et al. Study comparing the stroke unit outcome and conventional ward treatment. Arq Neuropsiquiatr 2003;61:188–93.

22. Massaro AR. Stroke in Brazil: a South America perspective. Int J Stroke 2006;1:113–15.

23. Pandian JD, Padma V, Vijaya P, et al. Stroke and thrombolysis in developing countries. Int J Stroke 2007;2:17–26.

24. Wardlaw JM, Zoppo G, Yamaguchi T, et al. Thrombolysis for acute ischaemic stroke. Cochrane Database Syst Rev 2003;3:CD000213.

25. Schumacher HC, Bateman BT, Boden-Alba B, et al. Use of thrombolysis in acute ischaemic stroke: analysis of the National Inpatient Sample 1999 to 2004. Ann Emerg Med 2007;50:99–107.

26. Feigin VL, Lawes CM, Bennett DA, et al. Stroke epidemiology: a review of population-based studies of incidence, prevalence, and case fatality in the late 20th century. Lancet Neurol 2003;2:43–53.

27. Lavados PM, Sacks C, Frina L, et al. Incidence, 30 day case-fatality rate and prognosis of stroke in Iquique, Chile: a 2 year community-based prospective study (PISCIS project). Lancet 2005;365:2206–15.

28. Haan R, Limburg M, Bossuyt PM, et al. The Clinical Meaning of Rankin Handicap' Grades After Stroke. Stroke 1995;26:2027–30.

29. Rothwell PM, Coull AJ, Gilles MF, et al. Change in stroke incidence, mortality, case-fatality and risk factors in Oxfordshire, UK from 1981 to 2004 (Oxford Vascular Study). Lancet 2004;363:1925–33.

30. Rothman KJ. Epidemiology an introduction. Oxford: Oxford University Press, 2002.