

ORIGINAL ARTICLES

Epidemiology of cerebrovascular disease among Chinese-Canadians: A ten years retrospective case-mix study

Joseph Y CHU, *Jason K CHU, **Arthur G CHUNG

Toronto Western-Hospital-University Health Network and Trillium Health Centre, Toronto, CANADA

*Institute of Medical Sciences, University of Toronto, CANADA

**Faculty of Medicine, University of Western Ontario, CANADA

Abstract

Background: Asians are commonly known to have more intracranial vascular stenosis and a lower incidence of carotid stenosis than Caucasians. A pilot retrospective study between 1990-1992 had demonstrated that Chinese-Canadians have a higher frequency of subcortical infarctions and lower frequency of carotid stenosis when compared to Caucasians. **Methods:** This report is a retrospective, case-mix study over 10 years (1990-1999) on the epidemiological characteristics of cerebrovascular disease among a cohort of Chinese-Canadians seen in an out-patient consultative neurological practice in Toronto. **Results:** There were 110 Chinese-Canadians with diagnosis of strokes and these were compared to 92 Caucasians with similar diagnosis. Their mean age of onset was 64 years and their average duration of symptom was 1.8 years. Their stroke severity based on the Modified Rankin Scale was severe in 14, moderate in 71 and mild in 25 with 4 deaths. Stroke types based on CT scan showed a statistically significant difference with Caucasians having more cortical infarcts than Chinese-Canadians (50% vs. 25.5%, $p < 0.05$). Only 6.4% of the Chinese-Canadians compared to 32.6% of the Caucasians had carotid stenosis ($p < 0.05$). The other significant difference is in stroke risk factors with higher frequency of smoking ($p < 0.025$) and hyperlipidemia ($p < 0.05$) among the Chinese-Canadian patients.

In **conclusions:** This retrospective epidemiological study has identified some significant difference in the stroke characteristics and risk factors among Chinese-Canadian patients.

INTRODUCTION

Racial differences in the pattern of cerebrovascular disease has long been a subject of interest.¹⁻⁶ Angiographic studies had shown that Asians tend to have a higher incidence of intracranial vascular stenosis and less carotid disease.⁷ Further pathological findings confirm that the extent of intracranial atherosclerosis is much more severe in Hong Kong Chinese, whereas atherosclerotic narrowing of the extracranial carotid artery is less severe in Hong Kong Chinese than in Caucasians.⁶ A pilot retrospective case-mix study in Toronto between 1990 and 1992 had demonstrated that Chinese-Canadians have a higher frequency of subcortical infarctions and lower frequency of carotid stenosis when compared to Caucasians.⁸ This report is a case-mix, retrospective study over ten years (1990 to 1999) on the

epidemiological characteristics of cerebrovascular disease among a cohort of Chinese-Canadian patients seen in an office-based consultative neurological practice in Toronto. This study is an extension of the previous preliminary study on the pattern of cerebrovascular diseases and clinical risk factors for stroke which may be unique in this population. In 1991, ethnic Chinese are among the largest ethnic groups in Canada numbering 558,600.⁹ Statistics Canada in 2003 found that immigrants from China ranked number one and accounted for 17.18% of all immigrants going to Toronto.

METHODS

Between 1990 and 1999, patients with a history of stroke referred to the lead author (JYC) in his office formed the basis of this retrospective study.

Address correspondence to: Dr Joseph Chu, Queensway Professional Centre, 312-190 Sherway Drive, Toronto, Ontario, CANADA M9C 5N2 Phone: 416-626-0740, Fax: 416-626-0635, Email: jychu@rogers.com

Since 1984, the lead author (JYC) is the first Chinese-speaking adult neurologist trained in Canada who had started his clinical practice in Toronto. Referrals from general practitioners and internists are mainly from within Toronto and the Greater Toronto Area. This was a unique opportunity to collect epidemiological data on stroke patterns among this large Chinese-Canadian population. The diagnosis of stroke was classified based on the *International Classification of Diseases (ICD) 9th revision*.¹⁰ Stroke types included in this study are: ischemic cerebral infarction (ICD code 436), lacunar infarction (ICD code 434.9), embolic cerebral infarction (ICD code 434.1) and intracerebral hemorrhage (ICD code 431). The reasons for referral were suspected stroke or a recent history of stroke. Patients with transient ischemic attacks were excluded. All patients were examined by the lead author (JYC) and had undergone CT scanning which confirmed the clinical diagnosis. Patients found to have other lesions such as brain tumor or abscess on CT scans were excluded. Patients of Chinese ethnicity were identified based on their surname and country of birth.¹¹ A group of Caucasian patients seen during this same period of time and with similar diagnosis were chosen for comparison. Two hundred and two patients who fulfill these criteria were identified, with 110 Chinese-Canadians and 92 Caucasians. Their charts were systematically reviewed and analyzed for stroke types, primary stroke risk factors and results of investigations. All patients had CT scan, extracranial Doppler ultrasound and if indicated cerebral angiogram. Significant extracranial carotid artery stenosis was defined by either Doppler ultrasound demonstrating hemodynamically significant stenosis or carotid angiogram showing >70% diameter stenosis according to the NASCET criteria. Stroke types were based on CT findings indicating whether there was intracerebral hemorrhage, cortical infarctions, subcortical infarcts, lacunars infarcts or brainstem/cerebellar infarctions. Information on stroke risk factors includes hypertension, diabetes mellitus, hypercholesterolemia, smoking, coronary heart disease. A diagnosis of hypertension was established if a patient's mean systolic blood pressure was 160 mmHg or higher or if their diastolic blood pressure was 90 mm Hg or higher, in accordance with the World Health Organization criteria.¹² Patients were considered to have hypercholesterolemia if their total cholesterol levels were 6.0 mmol/L or more.¹³ Smoking was considered if the patient is a current

smoker or a recent ex-smoker (stopping within 3 months). Chi square analysis and unpaired student "t" tests were carried out between these two groups to determine statistical significance.

RESULTS

The demographics of this cohort are illustrated in Table 1. Aside from a significantly younger mean age of onset for the Chinese-Canadians, there was no significant difference in their age range and duration of disease. The mean number of years in Canada for the Chinese-Canadians was 3.3 years indicating they were recent immigrants. The side of involvement was Chinese Canadians: right (55%), left (44%), bilateral (6%); Caucasians: right (42%), left (42%) and bilateral (15%). Table 2 shows the stroke severity according to the Modified Rankin Scale. The majority of Chinese-Canadians (65%) who had suffered a stroke were in the moderate category while the frequency of severe strokes and mortality were significantly lower. Figure 1 shows the stroke types base on the CT brain scans. There were significantly more cortical infarctions among the Caucasians and more subcortical infarcts among the Chinese-Canadians. Figure 2 shows the stroke risk factors among both groups of patients. The Chinese-Canadians had a higher frequency of hyperlipidemia and being smokers. There was also a trend towards higher frequency of hypertension and diabetes. The frequency of carotid stenosis was significantly lower compared to the Caucasians (6.4% vs. 32.6%).

DISCUSSION

In this case-mix, retrospective study of a cohort of Chinese-Canadians with stroke, it primarily represents first generation Chinese immigrants with an average time in Canada being 3.3 years. Their age of stroke onset was slightly younger than Caucasians although it did not reach statistical significance. This finding is similar to the stroke study of Chinese-Americans from the New York Downtown Hospital.¹⁴ The majority of Chinese-Canadians (64.5%) were in the moderate category while the frequency of severe strokes and mortality were significantly lower. This may be attributable to many of these patients had subcortical lacunar infarctions rather than cortical infarctions. The frequency of intracerebral hemorrhage was not significantly higher in the Chinese-Canadians than Caucasians. This is different from a number of previous reports^{4,15-17} with incidence of intracerebral hemorrhage as high as 44% in a

Table 1: Demographic characteristics of the stroke patients by ethnicity

Demographics	Chinese-Canadians	Caucasians
Number (%Male)	110 (50%)	92 (49%)
Mean age \pm SD in years	64 \pm 11	71 \pm 9
Age range in years	27-89	45-88
Disease duration in years	1.8	1.0
Years in Canada	3.3	N/A

N/A: not available

Table 2: Stroke severity according to Modified Rankin Scale and mortality rate

Stroke severity	Chinese-Canadians	Caucasians
Mild	25 (23%)	13 (14%)
Moderate	71 (65%)	40 (44%)
Severe *	14 (12.7%)	39 (42.4%)
Deaths *	4 (3.6%)	14 (15.2%)

Mild: Modified Rankin Scale = 0 to 1

Moderate: Modified Rankin Scale = 2 to 3

Severe: Modified Rankin Scale = 4 to 5

* $p < 0.05$

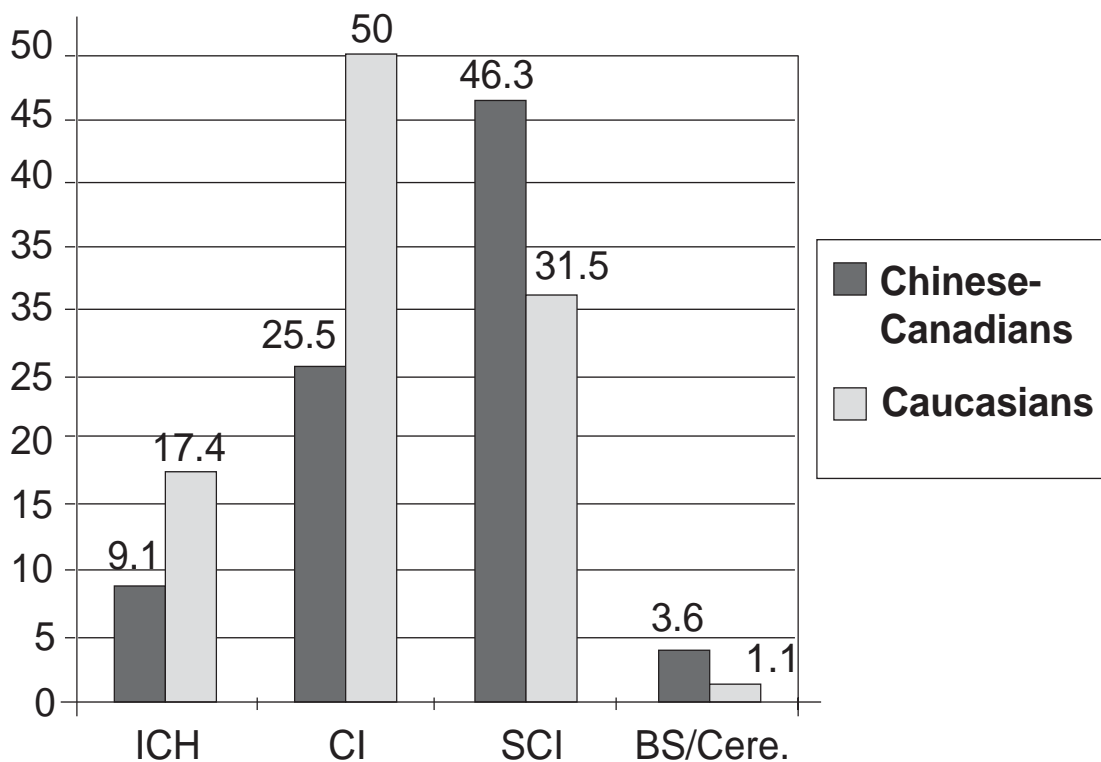


Figure 1: Stroke types based on CT scans showing significantly more subcortical infarcts (SCI) among the Chinese-Canadians ($p < 0.005$), and more cortical infarcts among the Caucasians ($p < 0.005$). There is no significant in Intracerebral Hemorrhage (ICH) and brainstem/cerebellar infarcts (BS/Cere) between the two groups.

Percent

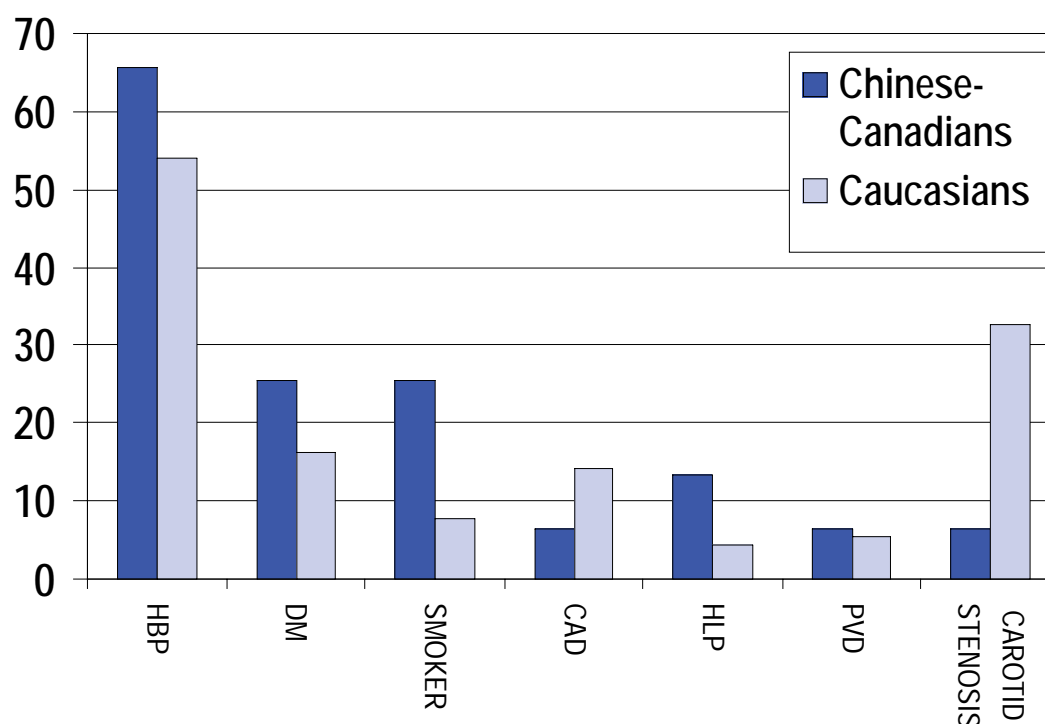


Figure 2: Illustrates the frequency of stroke risk factors among Chinese-Canadians and Caucasians. Chinese-Canadians have a higher frequency of hyperlipidemia and being smokers. There is also a trend towards higher frequency of hypertension and diabetes but significantly lower frequency of carotid stenosis compared to the Caucasians. HBP: Hypertension, DM: Diabetes mellitus, CAD: Coronary artery disease, HLP: Hyperlipidemia, PVD: Peripheral vascular disease.

report from the People's Republic of China.⁴ This could be due to lack of statistical power resulting from a small number of patients in this study. In addition, this study is office-based instead of hospitalized patients and may have inherent bias of "survivorship". The high incidence of intracerebral hemorrhage reported in People's Republic of China could be due to poor blood pressure control in particular within the rural population.

Based on CT scan findings, cortical infarctions were more common in Caucasians than among the Chinese-Canadians while subcortical infarcts of the lacuna types were more frequent in Chinese-Canadians. This may indicate Caucasians have a higher frequency of carotid disease causing more cortical infarctions while Chinese-Canadians have more intracranial vascular stenosis causing more intracranial occlusive and small vessel disease. This observation is further supported by the significantly higher frequency of carotid stenosis among Caucasians (32.6%) than Chinese-

Canadians (6.4%). This finding is comparable to the observation made by the Asian Acute Stroke Registry Panel and studies from Hong Kong.^{15,18} Recent studies using transcranial Doppler ultrasound and diffusion weighted MRI for acute stroke patients of Chinese descent confirms the mechanism for stroke in this population is frequently due to the occlusion of a single penetrating artery producing a small subcortical lacuna-like infarct.¹⁹ Similar findings have been observed among other ethnic groups such as the African Americans, who were found to have more intracranial atherosclerosis compared to Caucasians.²⁰ Certain primary stroke risk factors and socioeconomic factors were thought to be major determinants of the specific stroke pattern among different ethnic groups such as in African Americans and Hispanic Americans.¹⁷⁻²³ A comparative study of stroke subtype between Malaysians and Australians also showed more ischemic infarct among the Caucasians, versus more lacunar infarct among Malaysians. It was

suggested that the older age and higher frequency of atrial fibrillation among Caucasians in that study may contribute to this difference in stroke subtype.²⁴

Among the stroke risk factors analyzed in this study, the frequency of hypertension and diabetes were slightly more frequent among the Chinese-Canadians although they did not achieve statistical significance. The frequency of coronary artery disease was lower among the Chinese-Canadians (6%) but again it did not reach statistical significance. Similar observation of lower frequency of coronary artery disease in Chinese-Canadians was recently published based on a case-mix study from an urban tertiary care cardiology clinic in Toronto.²⁵ These observations need to be further studied in a large-scale prospective case-matched study. Smoking, hyperlipidemia and lower frequency of carotid stenosis were factors found to be statistically significant between the Chinese-Canadians and the Caucasians. In the New York Downtown Hospital study from 2000, it was also noted that Chinese Americans smoked more than Blacks, Hispanics and Whites.²⁶ These observations may be important in contributing to different stroke pattern among Chinese-Canadians. Strategies aimed at raising the awareness of these stroke risk factors among this population would be vital in reducing their stroke incidence and mortality.²⁷⁻³² Future studies into the interactions of genetic factors such as apolipoprotein gene²⁶⁻²⁷, lifestyle and dietary pattern of this population would be important. In particular, high salt content of the Chinese diet has been known to be strongly correlated with the high incidence of hypertension among Chinese in Asia.¹⁶ Reduced meat intake had been suggested to be associated with lower incidence of extracranial carotid artery stenosis.¹⁶ It has also been postulated that hypertension and diabetes mellitus are more often noted in patients with intracranial internal carotid artery and middle cerebral artery disease.⁶ Although there are some intrinsic limitations in this pilot retrospective study such as small numbers and referral bias, the information collected could form basis for future large scale prospective population-based study.

In conclusion, this preliminary case-mix retrospective study shows that smoking and hyperlipidemia were more frequent among Chinese-Canadians. Extracranial carotid stenosis was six times less frequent in Chinese-Canadians than Caucasians. Large scale population-based prospective studies like the Framingham study would be necessary to assess the full extent of

cerebrovascular disease and its risk factors within the Chinese-Canadian community. Studies of stroke pattern of successive generations of Chinese-Canadians, similar to the Honolulu Heart Study², would be essential in the understanding of how genetic and environmental factors influence the development of stroke among this specific ethnic group.

ACKNOWLEDGEMENTS

This study was supported by a Research Summer Scholarship in 1999 by the Chinese Canadian Council, Heart & Stroke Foundation of Ontario. The authors also wish to thank Dr. Robert Chen, Dr. Gordon Moe, Dr. Jack Tu and Dr. Ka Sing Lawrence Wong for their review and insightful comments in preparing this manuscript. This paper was presented at the 36th Canadian Congress of Neurological Sciences, Halifax, CANADA June 12th to 16th, 2001.

REFERENCES

1. Kato H, Tillotson J, Nichaman MZ Epidemiologic studies of coronary heart disease and stroke in Japanese men living in Japan, Hawaii and California. Serum lipids and diet. *Am J Epidemiol* 1973; 97: 372-85.
2. Kagan A, Popper JS, Rhoads GG Factors related to stroke incidence in Hawaii Japanese men: The Honolulu Heart Study. *Stroke* 1980; 11: 14-21.
3. Abu-Zeid HAH, Choi NW, Nelson NA Epidemiologic features of cerebrovascular disease in Manitoba: Incidence by age, sex and residence, with etiologic implication. *Can Med Assoc J* 1975; 113: 379-84.
4. Li SC, Schoenberg BS, Wang CC, Cheng XM, Bolis CL *et al.* Cerebrovascular disease in the People's Republic of China: Epidemiologic and clinical features. *Neurology* 1985; 35: 1708-13.
5. Wong KS, Huang YN, Gao S, Lam WWM, Chan YL *et al.* Intracranial stenosis in Chinese patients with acute stroke. *Neurology* 1998; 50: 812-3.
6. Leung SY, Ng THK, Yuen ST, Lauder IJ, Ho FCS. Pattern of cerebral atherosclerosis in Hong Kong Chinese: Severity in intracranial and extracranial vessels. *Stroke* 1993; 24: 779-86.
7. Brust RW Jr. Patterns of cerebrovascular disease in Japanese and other population groups in Hawaii: an angiographical study. *Stroke* 1975; 6(5): 539-42.
8. Chu JY. Epidemiology of cerebrovascular disease among Chinese-Canadians-A retrospective study. *Can J Neurol Sci* 1993; 20(5): S-70.
9. 1991 census: ethnic origin, Ottawa: Statistics Canada, 1992. Cat.no 913-315-XPB.
10. International Classification of Diseases, ninth revision. Geneva: World Health Organization, 1978.
11. Sheth T, Nargundkar M, Chagani K, Anand S, Nair C *et al.* Classifying ethnicity utilizing the Canadian Mortality Data Base. *Ethn Health* 1997; 2(4): 287-95.

12. WHO MONICA Project. WHO MONICA project: risk factors. *Int. J Epidemiol* 1989; 18: S46-55.
13. De Lorenzo F, Mukherjee M, Kadziola Z, Sherwood R, Kakkar VV. Central cooling effects in patients with hypercholesterolemia. *Clin Sci (Colch)* 1998; 95: 213-7.
14. Foo SH, Fang J, Jeng JS, Yip PK, Alderman MH. Clinical characteristics of stroke among Chinese patients. Tenth Conference on Health Problems Related to the Chinese in North America Proceedings 2000: 21.
15. Wong KS. Asian Acute Stroke Advisory Panel. Risk factors for early death in acute ischemic stroke and intracerebral hemorrhage: A prospective hospital-based study in Asia. *Stroke* 1999; 30: 2326-30.
16. Lynch GF, Gorelick PB. Stroke in African Americans. In: Morgenstern LB, ed: *Neurologic Clinics*. Philadelphia: W.B. Saunders Co., 2000: 273-90.
17. Yatsu FM. Strokes in Asians and Pacific-Islanders, Hispanics and Native Americans. *Circulation* 1991; 83(4): 1471-2.
18. Caplan LR, Gorelick PB, Hier DB. Race, sex and occlusive cerebrovascular disease: A review. *Stroke* 1986; 17: 648-54.
19. Wong KS, Gao S, Chan YL, Hansberg T, Lam WWM, et al. Mechanisms of Acute Cerebral infarctions in patients with middle cerebral artery stenosis: A diffusion-weighted imaging and microemboli monitoring study. *Ann Neurol* 2002; 52: 74-81.
20. Staub L, Morgenstern LB. Stroke in Hispanic Americans. In: Morgenstern LB, ed: *Neurologic Clinics*. Philadelphia, W.B. Saunders Co., 2000: 291-308.
21. Hajat C, Dundas R, Stewart JA, Lawrence E, Rudd AG, et al. Cerebrovascular risk factors and stroke subtypes: Differences between ethnic groups. *Stroke* 2001; 32:37-42.
22. Wong KS, Li H, Chan YL, Ahuja A, Lam WWM, Wong A, et al. Use of transcranial Doppler ultrasound to predict outcome in patients with intracranial large-artery occlusive disease. *Stroke* 2000; 31: 2641-7.
23. Sacco RL, Kargman DE, Gu Q, Zamanillo MC. Race-ethnicity and determinants of intracranial atherosclerotic cerebral infarction: The North Manhattan Stroke Study. *Stroke* 1995; 26: 14-20.
24. Ng WK, Goh KJ, George J, Tan CT, Biard A, Donnan GA. A comparative study of stroke subtypes between Asian and Caucasians in two hospital-based stroke registries. *Neurol J Southeast Asia* 1998; 3: 19-26.
25. Tso DK, Moe G. Cardiovascular disease in Chinese Canadians: A case-mix study from an urban tertiary care cardiology clinic. *Can J Cardiol* 2002; 18: 861-9.
26. Fang J, Madhavan S, Alderman MH. Cardiovascular mortality of Chinese in New York City. *J Urban Health* 1999; 76(1): 51-61.
27. Sheth T, Nair C, Nargundkar M, Anand S, Yusuf S. Cardiovascular and cancer mortality among Canadians of European, south Asian and Chinese origin from 1979 to 1993: an analysis of 1.2 million deaths. *CMAJ* 1999; 161(2): 132-8. Hegele RA, Breslow JL. Apolipoprotein genetic variation in the assessment of atherosclerosis susceptibility. *Gen Epidemiol* 1987; 4: 163-84.
28. Sheth T, Nair C, Nargundkar M, Anand S, Yusuf S. Cardiovascular and cancer mortality among Canadians of European, south Asian and Chinese origin from 1979 to 1993: an analysis of 1.2 million deaths. *CMAJ* 1999; 161(2): 132-8.
29. Zenker G, Koltringer P, Bone G, Niederkorn, Pfeiffer K, et al. Lipoprotein(a) as a strong indicator for cerebrovascular disease. *Stroke* 1986; 17: 942-5.
30. Kurtzke JF. Epidemiology of Cerebrovascular Disease. In: McDowell FH, Caplan LR. *Cerebrovascular Survey Report 1985 for the National Institute of Neurological and Communicative Disorders and Stroke*. 1985:1-34.
31. Wild SH, Laws A, Fortmann SP, Varady AN, Byrne CD. Mortality from coronary heart disease and stroke for six ethnic groups in California, 1985 to 1990. *Ann Epidemiol* 1995; 5(6): 432-9.
32. Jeng JS, Lee TK, Chang YC, Huang ZS, Ng SK, et al. Subtypes and case-fatality rates of stroke: a hospital-based stroke registry in Taiwan (SCAN-IV). *J Neurol Sci* 1998; 156(20): 220-6.