



## Original Article

Disparities in Ischemic Stroke Subtypes and Risk Factors between Taiwanese Aborigines and Han Chinese in Taitung, Taiwan<sup>☆</sup>Kuo-Hua Hung<sup>1</sup>, Kuang-Chung Liou<sup>2</sup>, Kuang-Nan Hsu<sup>1\*</sup>, Chihmin Hu<sup>1</sup><sup>1</sup> Department of Neurology, Mackay Memorial Hospital-Taitung Branch, Taitung, <sup>2</sup> Department of Neurology, Evergreen General Hospital, Taoyuan, Taiwan

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## SUMMARY

**Background:** There are two major ethnic categories in Taiwan, i.e., the Han Chinese (98%) and the Taiwanese Aborigines (2%). The interethnic disparities in ischemic stroke etiological subtypes, conventional and behavioral vascular risk factors were unknown.

**Methods:** From June 2007 to May 2009, a prospective stroke registry was conducted by a referral hospital in Taitung, Taiwan. Using the database, the interethnic disparities were examined by univariate analyses, followed by multivariate analysis of the ischemic stroke subtype [by TOAST (Trial of Org 10172 in Acute Stroke Treatment) classification] with significant difference between the two ethnicities.

**Results:** We included 433 acute ischemic stroke patients, comprising 302 Han Chinese (70%) and 131 Aborigines (30%). The Taiwanese Aborigines are more likely to be illiterate and living in rural areas (both  $p < 0.001$ ); they are also more likely to have atrial fibrillation ( $p = 0.018$ ), and to engage in alcohol drinking ( $p = 0.046$ ) and areca nut chewing ( $p < 0.001$ ), but less likely to have diabetes mellitus ( $p = 0.022$ ). Univariate analysis shows higher prevalence of cardioembolism among the Taiwanese Aborigines. However, ethnicity is not one of the independent variables of cardioembolism, which include atrial fibrillation [odds ratio (OR) = 28.04; 95% confidence interval (CI), 13.39–58.72], hyperlipidemia (OR = 0.46; 95% CI, 0.23–0.95), and areca nut chewing (OR = 2.85; 95% CI, 1.21–6.72).

**Conclusion:** Risk factors differ between the Han Chinese and the Taiwanese Aborigines, and areca nut chewing correlates with cardioembolic stroke. Future measures for stroke prevention should take these factors into consideration.

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## 1. Introduction

Ischemic stroke has diverse etiological subtypes with different risk factors that need tailored preventive strategies. Effective prevention for this devastating disorder involves modification of both conventional and behavioral risk factors. However, the risk factor profile and distribution of ischemic stroke subtypes differ among

ethnicities, and the data are lacking in Taitung, the homeland of several tribes of Taiwanese Aborigines in Taiwan.

The Taiwanese Aborigines makes up only 2% (500,000 as of 2010) of Taiwan's total population, with the Han Chinese as the remaining ethnic category (98%). The former comprises indigenous peoples of Taiwan who are linguistically and genetically grouped as Austronesian, who have probably been living in this island for several thousand years. Some linguistic and anthropologic studies suggest that the ancestors of the Taiwanese Aborigines could be the origins of Austronesian linguistic family<sup>1</sup>, whose area of distribution spreads from Madagascar to Easter Island, and from Taiwan to New Zealand. After the major immigration of the Han Chinese started in 17<sup>th</sup> century, the Taiwanese Aborigines gradually became the minority in Taiwan. The last area in this island to be colonized by the Han Chinese immigrants is Taitung, a county isolated by mountains at the southeast coast of Taiwan. Taitung is the homeland of seven tribes of Taiwanese Aborigines, namely, the Amis,

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Paiwan, Bunun, Rukai, Yami (Tao), Puyuma, and Kavalan, constituting 30% (80,000 as of 2010) of Taitung's population.

The Han Chinese is the largest ethnic group in the world, comprising 92% of China's population and 98% of Taiwan's population. In comparison to the Han Chinese in Taiwan, the Taiwanese Aborigines have shorter life expectancy<sup>2</sup>. As stroke is the third leading cause of death in Taiwan, recognition of the aborigines' stroke epidemiology could be helpful in closing the health gap. This study used database derived from a prospective stroke registry to compare the demographic details, as well as conventional and behavioral risk factors between the two ethnic categories. Furthermore, determinants of the ischemic stroke subtype with interethnic disparity were investigated.

## 2. Materials and methods

Mackay Memorial Hospital-Taitung Branch, a regional hospital in Taitung, is equipped with a stroke unit. From June 2007 to May 2009, a prospective stroke registry was conducted in this hospital. It had been approved by the Institutional Review Board of Mackay Memorial Hospital-Taipei, Taiwan (MMH-I-S-572), and an informed consent document was obtained from each enrolled patient. A proxy family member was used if the patient was aphasic, demented, or having consciousness disturbance.

This registry tried to recruit all the acute stroke patients, first-ever and recurrent, admitted to the stroke unit of this hospital within 7 days after stroke onset. Those younger than 18 years or who left the hospital within 24 hours after onset were excluded. For this analysis, we took three steps in sorting the patients. First, we omitted those with any uncertainty in ethnic identification. Second, patients with hemorrhagic stroke, transient ischemic attack, spinal cord infarction, or cerebral venous thrombosis were excluded. Finally, we included only patients whose paternal and maternal grandparents' ethnicities, i.e., three generations, were all in the same category of either the aboriginal or the Han Chinese. Those with intermarriage between different ethnic categories in their lineal relatives were also excluded.

Ethnic identification was self-reported<sup>3</sup>, and each participant was requested to choose the ethnicities of his/her parents, as well as paternal and maternal grandparents from a list. The list contains three ethnic categories: (1) the aborigines (including the tribes of Amis, Paiwan, Bunun, Rukai, Yami, Puyuma, Kavalan, Atayal, Tsou, Saisiyak, Thao, and "other tribes"); (2) the Han Chinese (including the Minnan, Hakka, and mainland Chinese); and (3) foreigners (including Indonesian, Filipino, Vietnamese, Thai, and "other countries"). Descendants of foreigners are excluded in this study.

### 2.1. Definitions

Body mass index (BMI), defined as the individual's body mass (in kilograms) divided by the square of height (in meters), was divided into four categories: underweight (BMI < 18.5), normal weight (18.5 ≤ BMI ≤ 24), overweight (24 ≤ BMI ≤ 27), and obese (BMI > 27)<sup>4</sup>. Abdominal obesity was defined as waist circumference of at least 80 cm and 90 cm, in females and males, respectively, using World Health Organization Asia Pacific guidelines. The risk-inducing behaviors recorded included areca nut chewing, in addition to smoking, drinking, and sedentary lifestyle. Smoking and areca nut chewing were defined as currently consuming the substances; drinking habit as taking alcohol for at least 3 days a week; sedentary lifestyle as never exercise or exercise for less than once a week. Participants were considered to have ischemic heart disease if they had a history of angina pectoris, myocardial infarction, coronary artery angioplasty, or bypass surgery. The diagnosis of atrial fibrillation (AF) was based on at least one electrocardiogram

obtained prior to or after admission. Hypertension was defined as blood pressure > 140/90 mmHg on at least two occasions in the nonacute phase, or the patient's prior history and treatment of such a disease. Diabetes mellitus (DM) was defined as recurrent hyperglycemia on different days (fasting glucose level > 125 mg/dL or nonfasting glucose level > 200 mg/dL), or the patient's antecedent diagnosis and treatment of DM. For those with newly diagnosed DM during acute stroke, their blood sugar levels were rechecked during the chronic stage to confirm the diagnosis. Hyperlipidemia was defined as high serum lipid level(s) (total cholesterol level ≥ 200 mg/dL, low-density lipoprotein cholesterol ≥ 130 mg/dL, or triglyceride ≥ 200 mg/dL), or prescription of statin or fibrate.

### 2.2. Statistical analysis

SAS version 9.3 for Windows (SAS Institute, Cary, NC, USA) was used for statistical analysis. We compared the sociodemographics, risk factor profiles, initial scores, short-term outcomes, and stroke subtypes by TOAST (Trial of Org 10172 in Acute Stroke Treatment) classification<sup>5</sup> between the two ethnic groups. For continuous variables, the *t* test was used to compare the means. For categorical variables, the Chi-square test was used to test the difference between groups. Multivariate analysis was also performed using logistic regression models, with cardioembolic stroke (yes/no) as the response variable and stroke predictors found significant by univariate analysis as covariates. Each covariate was tested independently and with the main interaction terms. Measures of association were odds ratios (ORs) with 95% confidence intervals (95% CIs). The continuous variables were expressed as the mean ± standard deviation. All calculated *p* values were two-tailed, and we considered *p* < 0.05 to be statistically significant.

## 3. Results

Within 2 years, we included 433 patients, identifying 302 patients in the Han Chinese group (70%) and 131 patients in the aboriginal group (30%). The ethnic ratio is in proportion to that of Taitung's population. As Taiwan's National Health Insurance program has enrolled 99% of the Taiwan's population, the discrepancy in healthcare between the two ethnic groups is reasonably small. It was reassured by comparison of the percentiles of individuals receiving medications prior to admission in each ethnic group. The *p* values (not shown) were all in excess of 0.05 and therefore statistically insignificant. In average, 28.9% of the patients took antiplatelets, 1.8% took warfarin, 38.1% took antihypertensives, 11.8% took fibrates or statins, 18.7% took insulin or oral hypoglycemic agents. After inclusion into this study, 100% of the patients had neuroimaging of brain (91.7% had computerized tomography and 60.7% had magnetic resonance imaging), 93.1% had neurosonography (carotid and transcranial color-coded duplex sonographies), and 84.3% had transthoracic cardiac echo.

Table 1 compares the patient demographics and vascular risk factors between the two ethnic groups. There was no demographic diversity in age, sex, marital status, social class, and BMI. However, the aborigines were more commonly rural living and had a higher percentage of illiteracy. Although not shown in the table, the time lags between symptom onset and the first medical encounter in these two ethnicities were compared. The durations were categorized into ≤ 2 hours, 2–3 hours, 3–6 hours, 6–24 hours, 1–3 days, and ≥ 3 days. In spite of a trend for Han Chinese to seek medical aid earlier, statistical significance was not reached (*p* = 0.084).

In both groups, one-third of the participants had previous ischemic stroke, and hypertension was the most common risk factor. The prevalence of hypertension, ischemic heart disease, hyperlipidemia, abdominal obesity, current smoking, and

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