White Rice-Based Food Consumption and Ischemic Stroke Risk: A Case-Control Study in Southern China

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White rice-based foods, which are high in refined carbohydrates, are widely consumed in China. A case-control study was conducted to investigate the association between white rice-based food consumption and the risk of ischemic stroke in the southern Chinese population. Information on diet and lifestyle was obtained from 374 incident ischemic stroke patients and 464 hospital-based controls. Logistic regression analyses were performed to assess the effects of rice-based foods on stroke risk. The mean weekly intake of rice foods appeared to be significantly higher in cases than in controls. Increased consumptions of cooked rice, congee, and rice noodle were associated with a higher risk for ischemic stroke after controlling for confounding factors. The corresponding adjusted odds ratios (with 95% confidence intervals) for the highest versus lowest intake level were 2.73 (1.31-5.69), 2.93 (1.68-5.13), and 2.03 (1.40-2.94), with significant dose-response relationships observed. The results provide evidence of a positive association between habitual rice food consumption and the risk of ischemic stroke in Chinese adults. **Key Words:** Case control study—China—ischemic stroke—refined carbohydrates—rice based foods.

Stroke is a leading cause of mortality and morbidity in China.[1-3] Ischemic stroke accounts for >70% of stroke cases in Western countries and about 60% of stroke cases in China.[4] A growing body of literature has suggested that high dietary intake of refined carbohydrates may increase the risk of hyperlipidemia[5,6] and diabetes mellitus.[7-9] Moreover, a high-carbohydrate diet may lead to endothelial and inflammatory responses, which increase the risk of hypertension and atherosclerosis.[9] Although hyperlipidemia, diabetes, hypertension, and atherosclerosis are known to be risk factors for stroke, the effect of refined carbohydrate intake on stroke and its subtypes remains unclear.[10,11]

China is the world's largest consumer of rice.[12] Refined carbohydrates, consumed mainly from white (polished) rice-based products, provide a major source of energy for the Chinese population.[13] Cooked rice, congee (rice porridge), and rice noodle are the 3 most common white rice-based foods. Similar to cooking rice, congee is prepared by adding extra water, boiling, and then simmering until it turns into a soupy form. Rice noodle, a processed white rice product, is usually cooked in boiling water and then served with soup or stir-fried. Our review of the literature found no report on the relationship between the risk of ischemic stroke and consumption of refined carbohydrates by the Chinese population. Thus, the purpose of this study was to investigate the possible association by conducting a hospital-based case-control study in southern China.

Methods

Subjects

Subjects were recruited between July 2007 and July 2008 from 3 teaching hospitals within Foshan city in the Guangdong Province of southern China: First People's Hospital of Shunde, First People's Hospital of Nanhai, and Second People's Hospital of Foshan. Cases were

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incident ischemic stroke patients referred from the inpatient wards of the hospital neurology departments. Controls were recruited during the same period from outpatient clinics of the Departments of Gastroenterology, Dermatology, Chinese Medicine, Urology, and Otolaryngology. To be eligible, subjects must have resided in Foshan for at least the past 5 years and been available for interview. Inclusion criteria for cases were sudden onset of a focal neurologic event, with symptoms lasting >24 hours and subsequent confirmation of brain infarct by computed tomography or magnetic resonance imaging, and no previous history of stroke. Therefore, only incident patients with a first ischemic stroke (thrombotic or embolic) were considered. Fatal cases due to stroke were excluded because of ethical constraints.

An eligible control had neither a history nor clinical evidence of a previous stroke, and whose treatment at the outpatient department was not related to cardiovascular disease, malignancy, or diabetes. Subjects diagnosed with Alzheimer's disease or with a long-term dietary modification for medical reasons were excluded. Controls were frequency-matched to cases within 5 years of age.

Interview

The hospital neurologists notified the first author within 2 days of each stroke patient's admission. A face-to-face interview was then arranged before the patient was discharged from the hospital. Eligible controls were recruited and interviewed by the first author when available. All participants were ensured of confidentiality and their right to withdraw from the project at any time without prejudice, before providing formal consent. Each interview took about 45 minutes. When a patient could not be interviewed due to the morbidity caused by stroke, the answers were obtained from his or her next-of-kin instead. The validity and reliability of using such proxy information has been established in previous studies.[14-17] The project protocol was approved by the Human Research Ethics Committee of the researchers' institution, and access to medical records was granted by the participating hospitals.

Instrument and Exposure Measurement

A structured questionnaire was administered to obtain demographic and lifestyle characteristics, including age, gender, weight (kg), height (m), education level (primary school or secondary school or above), smoking status (nonosmoker or current/former smoker) and pack-years, and alcohol drinking status (nondrinker or drinker). Information also was solicited on lifelong physical activity exposure, defined as "doing active sports or vigorous exercise long enough to get sweaty, at least twice a week," over the life course. Response options were "never been much involved," "previously active but not any more," "active just recently," "intermittently active," and "always been involved."[18] Self-reported height and weight measurements and comorbidities (ie, hypertension, hyperlipidemia, or diabetes) were confirmed by medical records whenever available. These comorbidities were considered positive if the condition was either self-reported or noted on the medical record.

Information on habitual food consumption, including rice-based food intake, was collected using a semiquantitative food frequency questionnaire developed and tested for the southern Chinese population.[19,20] This validated instrument includes 125 items covering commonly consumed foods in South China and records both the frequency (per day/week/month) and amount of intake. The reference recall period for dietary variables was set at 1 year before the interview. For rice food products, the quantity of cooked rice and congee was measured by the weight of white rice used in preparation, whereas the quantity of rice noodle was measured by its dry weight.

Energy intake for each food item was calculated by multiplying the consumption frequency, the number of standard size serving at each occasion, weight (in 100 g) of standard size serving, and the energy data per 100 g of food from the 2002 Chinese Food Composition Table.[21] Total energy intake (kcal/week) was then estimated by summing the energy intake across individual food items.

Statistical Analysis

Univariate statistics were used to describe the participant characteristics and to compare the dietary pattern between the case and control groups. Unconditional logistic regression analyses were then performed to investigate the effects of white rice-based foods on the risk of ischemic stroke. For cooked rice and congee, the 25th, 50th, and 75th percentiles of intake by controls were chosen as cutpoints, resulting in 4 increasing levels of exposure, with the lowest level considered the reference category. Rice noodle consumption was categorized into 2 groups based on the 50th percentile because of its small variation among the participants. Besides crude and adjusted odds ratios (ORs) and associated 95% confidence intervals (CI), tests for linear trend of continuous rice food variables were conducted to assess their dose-response relationship with the stroke risk. Other independent variables considered in the logistic regression models were age, gender, education level, body mass index (BMI; < 24 or ≥ 24 kg/m^2), lifelong physical activity exposure, smoking status, smoking pack-years, alcohol drinking status, and presence of hypertension, hyperlipidemia, and diabetes, as well as weekly total energy intake and weekly consumption of red meat, fish, poultry, fruit, and vegetables. These variables were either plausible risk factors obtained from the literature or considered potential confounders according to the univariate