

Favorable Functional Recovery in Overweight Ischemic Stroke Survivors: Findings from the China National Stroke Registry

Lu Zhao, MD,* Wanliang Du, MD,† Xingquan Zhao, MD,† Liping Liu, MD,†
Chunxue Wang, MD,† Yilong Wang, MD,† Anxin Wang, MD,† Gaifen Liu, PhD,†
Yongjun Wang, MD,† and Yuming Xu, MD*

Background: Obesity paradox has been reported because of the inverse relationship between the body mass index (BMI) and mortality in stroke patients. The relationship between BMI and functional recovery in stroke survivors is less well established. We explored the impact of BMI on functional recovery and mortality in stroke patients in the China National Stroke Registry (CNSR). *Methods:* Patients were consecutively recruited based on a standard protocol and prospectively followed up for outcomes at 3 months after disease onset. Patients were divided into 5 groups according to their BMI: underweight (<18.5 kg/m²), normal weight (18.5-22.9 kg/m²), overweight (23-27.4 kg/m²), obese (27.5-32.4 kg/m²), or severely obese (≥32.5 kg/m²). Multivariate logistic regression was performed to analyze the association between BMI and functional recovery or mortality. *Results:* CNSR enrolled 22,216 patients hospitalized for acute cerebrovascular events, and 10,905 eligible acute ischemic stroke patients were analyzed in our study. Favorable functional recovery (modified Rankin Scale score 0-1) was seen in 52.4% of underweight, 55.0% of normal weight, 61.0% of overweight, 59.2% of obese, and 60.3% of severely obese stroke survivors ($P < .001$). Overweight was independently associated with favorable 3-month functional recovery (odds ratio [OR] 1.24; 95% confidence interval [CI] 1.12-1.38). Mortality rate was 14.9% in underweight, 7.8% in normal weight, 7.1% in overweight, 7.2% in obese, and 11.5% in severely obese patients ($P < .001$). Severe obesity was independently associated with higher 3-month mortality (OR 2.01; 95% CI 1.10-3.69). *Conclusions:* The stroke obesity paradox can be extended to include functional recovery but should not be interpreted as the fatter the better. **Key Words:** Body mass index—ischemic stroke—functional recovery—mortality—obesity paradox.

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The prevalence of obesity in developed¹ and developing countries² has risen to epidemic proportions. Obesity is strongly associated with the increased risk of stroke^{3,4} and may predict early death among general population.⁵⁻⁸

However, recent literature has reported the phenomenon of “obesity paradox”, suggesting an inverse relationship between body mass index (BMI) and mortality in patients with established cardiovascular disease.⁹⁻¹⁴

From the *Department of Neurology, The First Affiliated Hospital of Zhengzhou University, Zhengzhou, Henan; and †Department of Neurology, Beijing Tiantan Hospital, Capital Medical University, Beijing, China.

Received September 20, 2013; accepted October 6, 2013.

L.Z. and W.D. contributed equally to this work.

Grant support: The study was funded by the Ministry of Science and Technology and the Ministry of Health of the People's Republic of China: National Science and Technology Major Project of China (2008ZX09312-008), the State Key Development Program of Basic Research of China (2009CB521905), the Research Special Fund for

Public Welfare Industry of Health (200902004), and the National Natural Science Foundation of China (81000505).

Disclosure: None.

Address correspondence to Yuming Xu, MD, Department of Neurology, The First Affiliated Hospital of Zhengzhou University, No. 1 Jianshe Road, Zhengzhou, Henan, China, 450052. E-mail: xuyuming@zzu.edu.cn.

1052-3057/\$ - see front matter

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<http://dx.doi.org/10.1016/j.jstrokecerebrovasdis.2013.10.002>

Obesity paradox was first described in hemodialysis patients¹⁵ and also seen in patients with myocardial infarction,¹⁶ heart failure,¹⁷ hypertension,¹⁸ diabetes,¹⁹ and peripheral artery disease.²⁰ Although data for stroke obesity paradox are limited and controversial, most of the reports support the inverse relationship between BMI and mortality after stroke.^{9-14,21} However, for stroke survivors, the association between BMI and functional recovery is less well established, and results of the limited studies are conflicting.²²⁻²⁵ In our study, we examined the impact of BMI on functional recovery and mortality rate in a large, nationwide, and prospective cohort of Chinese patients hospitalized for acute ischemic stroke (AIS).

Methods

Data Collection

This study was based on the China National Stroke Registry (CNSR), which was a nationwide and prospective cohort study. Details about CNSR have been published elsewhere.²⁶ Briefly, CNSR recruited consecutive patients with the diagnoses of acute cerebrovascular events from 132 hospitals in 27 provinces and 4 municipalities (including Hong Kong SAR) in China between September 2007 and August 2008. Acute cerebrovascular events included ischemic stroke, intracerebral hemorrhage, subarachnoid hemorrhage, and transient ischemic attack within 14 days after the symptom onset. AIS patients were included in the present study. The ethics committees at all participating hospitals approved the protocols, and patients or their designated relatives gave the informed consents.

Demographic data, vascular risk factors, and laboratory findings were recorded. Baseline vascular risk factors included history of stroke (defined as a medical chart-confirmed history of stroke), hypertension (history of hypertension or antihypertensive drug use), diabetes (history of diabetes or use of diabetes medication), dyslipidemia (history of dyslipidemia or lipid-lowering drug use), atrial fibrillation or flutter (history of atrial fibrillation or flutter confirmed by at least 1 electrocardiogram or the presence of the arrhythmia during hospitalization), coronary heart disease, and current or previous smoking history. Initial neurologic status was evaluated by using the National Institutes of Health Stroke Scale score within 24 hours after admission. The subtypes of AIS were classified according to the Trial of ORG 10172 in Acute Stroke Treatment criteria.²⁷ Patients' weight and height were measured by nurses on admission. BMI was defined as the weight in kilograms divided by the square of height in meters. As recommended for Asian population by the World Health Organization,²⁸ patients were categorized as underweight (BMI < 18.5 kg/m²), normal weight (BMI 18.5-22.9 kg/m²), overweight (BMI 23-27.4 kg/m²),

obese (BMI 27.5-32.4 kg/m²), or severely obese (BMI ≥ 32.5 kg/m²).

Outcomes and Follow-up

At 3 months after the onset of stroke, the outcomes of these AIS patients were prospectively followed up for mortality and functional recovery measured by modified Rankin Scale (mRS).²⁹ Functional recovery was analyzed among survivors at 3 months after AIS, and favorable functional recovery was defined as an mRS score of 0 or 1. Follow-up was performed centrally by trained and qualified telephone interviews that were not involved in the registry and blinded to the baseline data.

Statistical Analysis

Demographic and clinical characteristics were compared among BMI groups by the chi-square test for categorical variables and Kruskal-Wallis test as a nonparametric analysis for continuous variables. Multivariate logistic regression analyses were used to calculate the adjusted odds ratios (ORs) with 95% confidence intervals (CIs). The normal weight (BMI 18.5-22.9 kg/m²) was used as the reference group. Multivariate logistic analyses for ischemic stroke outcomes were adjusted for the following covariates: age, gender, National Institutes of Health Stroke Scale score at admission, prestroke mRS, AIS Trial of ORG 10172 in Acute Stroke Treatment subtype, and risk factors or comorbidities (including hypertension, diabetes, dyslipidemia, coronary heart disease, atrial fibrillation or flutter, heart failure, current or previous smoking, and history of stroke). Data were analyzed with SAS version 9.1.3 statistical software.

Results

CNSR consecutively enrolled 22,216 patients hospitalized for acute cerebrovascular events within 14 days of onset in 132 hospitals in China from 2007 to 2008. Of 22,216 patients, 12,415 were transferred directly to the registry hospital, diagnosed with AIS and agreed to be followed up. Of these 12,415 AIS patients, BMI was available in 11,112 (89.5%) of them. Among them, 3-month follow-up information were available in 10,905 (98.1%) patients who were eligible for the present study.

Of 10,905 AIS patients, 6769 were men and 4136 were women. According to the BMI, 449 (4.1%) patients were underweight, 3429 (31.4%) had normal weight, 5345 (49.0%) were overweight, 1534 (14.1%) were obese, and 148 (1.4%) were severely obese. Baseline characteristics of the 5 BMI groups were listed in Table 1. With statistical significance, obese group had more hypertension, diabetes, and dyslipidemia, whereas underweight group had more atrial fibrillation/flutter and heart failure. Underweight group were older and had more cardioembolic strokes.

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