

# Lifestyle Factors and Gender-Specific Risk of Stroke in Adults with Diabetes Mellitus: A Case-Control Study

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*Background:* The lifestyle interventions are effective preventive measures for stroke in general population, and the stroke risk with lifestyle factors may be modified by gender, health conditions, etc. Therefore, we conducted a case-control study to investigate the gender-specific association between stroke risk and lifestyle factors in adults with diabetes based on the China National Stroke Screening Survey. *Methods:* Structured questionnaires were used to collect demographic data and information regarding lifestyle factors, history of chronic medical conditions, and family history of stroke and the status of treatment. The case group comprised individuals diagnosed with first-ever stroke in 2013-2014 screening period. Their corresponding controls (frequency-matched for age group and urban/rural ratio) were randomly selected from individuals with diabetes without stroke. *Results:* There were 170 total stroke cases (500 controls) and 152 ischemic stroke cases (456 controls) among men with diabetes, and 183 total stroke cases (549 controls) and 168 ischemic stroke cases (504 controls) among women with diabetes. We found that physical inactivity was significantly associated with increased risk of total stroke (odds ratio [OR] = 1.50, 95% confidence interval [CI] 1.02-2.21) and of ischemic stroke (OR = 1.57, 95% CI 1.04-2.36) in women with diabetes. We found no significant association of smoking, overweight/obesity, or physical inactivity with risk of total or ischemic stroke in men with diabetes. *Conclusion:* Among the lifestyle factors of smoking, overweight/obesity, and physical inactivity, physical inactivity might increase the risk of total and ischemic stroke in women with diabetes.

**Key Words:** Gender—diabetes mellitus—lifestyle—stroke—ischemic stroke.  
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## Introduction

With economic development and urbanization, diabetes mellitus has become one of the most common chronic diseases.<sup>1,2</sup> Concurrently, significant lifestyle changes have occurred, especially in developing countries.<sup>3</sup> Diabetes mellitus and some lifestyle factors, including smoking, physical inactivity, and a high-fat diet, have been reported as independent risk factors of stroke.<sup>3,4</sup> In addition, an individual's lifestyle factors may change after a diagnosis of diabetes mellitus.<sup>5</sup> Therefore, the association of lifestyle factors with stroke risk might differ between individuals with diabetes and the general population. However, the association between lifestyle and stroke risk in individuals with diabetes is seldom studied.

A small number of studies have evaluated the relationships between specific lifestyle factors and stroke risk in individuals with diabetes. Li et al reported that an increased body mass index (BMI), which was used to categorize weight (e.g., overweight, obese), was significantly associated with a decreased incidence of stroke in individuals with diabetes based on a large hospital-based cohort.<sup>6</sup> Nilsson et al. suggested that smoking was an independent risk factor of stroke in people with diabetes.<sup>7</sup> Sone et al. showed that physical activity was significantly associated with lower risk of stroke in Japanese patients with diabetes in a nationwide multicenter randomized controlled trial.<sup>8</sup> To further investigate and verify the association between lifestyle factors and stroke risk in individuals with diabetes, additional large-scale investigations involving a wider range of lifestyle factors are needed.

Previous studies have reported that the association between stroke risk and lifestyle factors may be modified by many intrinsic factors, such as life stage, race/ethnicity, socioeconomic status, and health conditions.<sup>9-11</sup> The gender is also an important intrinsic factor, but limited studies have reported the gender-specific association between stroke risk and lifestyle factors. It has been proved that estrogen can counteract some of the unfavorable effects of lifestyle factor on stroke, such as reductions in insulin sensitivity, altered lipid metabolism, and increased inflammation, by improving vascular endothelial function.<sup>12,13</sup> Therefore, we hypothesized that the association of stroke risk with lifestyle factors could be different between men and women. Here, we conducted a case-control study to investigate the gender-specific association between lifestyle factors and risk of stroke in adults with diabetes based on a large population-based survey, the China National Stroke Screening Survey (CNSSS).

## Methods

### *Study Population*

This case-control study utilized data from the CNSSS database for the 2013-2014 screening period, which spanned

from September 2013 to September 2014. After excluding 150 participants with 2 types of stroke (i.e., ischemic stroke and hemorrhagic stroke) and 1481 duplicate participants, a total of 632,228 valid individual records were used in our study. Full details on the organization and implementation of the CNSSS and previous findings are reported elsewhere.<sup>14,15</sup> Briefly, the CNSSS is an ongoing surveillance system aimed assessing the risk of stroke and its risk factors in Chinese residents aged 40 years and older. This survey was designed as a community-based national survey and initiated coverage of all 31 provinces in mainland China (not including Hong Kong, Macau, and Taiwan) in 2013-2014 screening period.

The protocol of CNSSS was reviewed and approved by the ethics committee for medical research of Xuanwu Hospital Capital Medical University (2015024), and informed written consent was obtained from all the participants before they participated in this survey.

### *Definition of Stroke Cases*

Stroke is defined as an episode of focal dysfunction of the brain either lasting longer than 24 hours, or of any duration with imaging (computed tomography [CT] or magnetic resonance imaging [MRI]) showing focal infarction or hemorrhage relevant to the symptoms.<sup>16</sup> In the CNSSS, stroke history was established by a combination of self-reported previous medical diagnosis of stroke and the judgment of a neurologist or physician using neuroimaging (including CT or MRI) according to the criteria of the World Health Organization. The type of stroke was defined according to ICD-10 codes (I60-I69) as ischemic stroke, hemorrhagic stroke (intracerebral hemorrhage and subarachnoid hemorrhage combined), or nonspecific stroke. Nonspecific codes included I64, I67.9, I68.8, and I69.4-I69.9.<sup>16,17</sup> Transient ischemic attack (TIA) was defined as G45.<sup>16,17</sup> Participants with TIA were recorded, but not included in the stroke cases in this survey.

### *Criteria for Influence Factors*

The criteria for influence factors were consistent with the CNSSS. Structured questionnaires administered by neurologists or physicians from community hospitals were used to collect demographic data (age, gender, residential address, marital status, and ethnic group), information regarding lifestyle factors before the survey period (smoking, overweight/obesity, and physical inactivity), history of chronic medical conditions (hypertension, diabetes, atrial fibrillation, and abnormal blood lipids), and family history of stroke and the information of medication (antihypertensive agents, glucose-lowering agents, and cholesterol-lowering agents) during face-to-face interviews. All the information from interviews was checked against resident health records to ensure reliability and validity.

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