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Prevalence of Diabetes Mellitus and Its Influencing Factors in Ischemic Stroke Patients in Liaoning Province: A Postprint Analysis

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Abstract

Background: Diabetes is an important risk factor for the onset, recurrence, disability, and mortality of ischemic stroke. Assessing the prevalence status of diabetes in ischemic stroke patients and implementing comprehensive prevention and control can effectively improve patient prognosis. Objective: To understand the current status of diabetes comorbidity in ischemic stroke patients in Liaoning Province and provide a theoretical basis for targeted interventions. Methods: From 2017 to 2018, a cross-sectional survey was conducted on ischemic stroke patients in 28 villages and communities across 6 counties and districts in Liaoning Province using cluster sampling. Multivariate logistic regression was used to analyze the influencing factors of diabetes prevalence, awareness, treatment, and control among ischemic stroke patients. Results: The prevalence, awareness, treatment, and control rates of diabetes among ischemic stroke patients in Liaoning Province were 29.5%, 63.3%, 56.4%, and 47.2%, respectively. Multivariate logistic regression results indicated that urban-rural residence [OR=1.818, 95% CI (1.317, 2.508), P<0.001], family history of diabetes [OR=2.790, 95% CI (1.922, 4.050), P<0.001], hypertension [OR=1.813, 95% CI (1.160, 2.834), P=0.009], hypertriglyceridemia [OR=2.312, 95% CI (1.631, 3.277), P<0.001], high low-density lipoprotein cholesterol [OR=2.241, 95% CI (1.300, 3.865), P=0.004], and overweight or obesity [OR=1.562, 95% CI (1.136, 2.146), P=0.006] were influencing factors for diabetes prevalence in ischemic stroke patients; urban-rural residence [OR=1.865, 95% CI (1.086, 3.203), P=0.024], family history of diabetes [OR=2.402, 95% CI (1.306, 4.416), P=0.005], and hypercholesterolemia [OR=0.389, 95% CI (0.215, 0.705), P=0.002] were influencing factors for diabetes awareness; age 60-69 years [OR=3.052, 95% CI (1.523, 6.115), P=0.002], urban-rural residence [OR=1.866, 95% CI (1.104, 3.155), P=0.020], family history of diabetes [OR=2.303, 95% CI (1.275, 4.161), P=0.006], and hypercholesterolemia [OR=0.387, 95% CI (0.210, 0.713), P=0.002] were influencing factors

for diabetes treatment; urban-rural residence [OR=1.916, 95% CI (1.021, 3.595), P=0.043] was an influencing factor for blood glucose control target achievement in ischemic stroke patients with diabetes. Conclusion: The prevalence of diabetes among ischemic stroke patients in Liaoning Province is relatively high, while the status of disease awareness, treatment, and control remains at a relatively low level, warranting urgent implementation of relevant comprehensive prevention and control measures.

Full Text

Analysis of Diabetes Prevalence and Influencing Factors Among Ischemic Stroke Patients in Liaoning Province

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Abstract

Background: Diabetes mellitus is an important risk factor for the onset, recurrence, disability, and mortality of ischemic stroke. Assessing the prevalence of diabetes among ischemic stroke patients and implementing comprehensive prevention and control measures can effectively improve patient prognosis. **Objective:** To understand the current status of diabetes among ischemic stroke patients in Liaoning Province and provide a theoretical basis for targeted interventions. **Methods:** From 2017 to 2018, a cross-sectional survey was conducted using cluster sampling among ischemic stroke patients in 28 villages/communities across 6 counties/districts in Liaoning Province. Multivariate logistic regression was used to analyze factors influencing diabetes prevalence, awareness, treatment, and control among ischemic stroke patients. **Results:** The prevalence, awareness, treatment, and control rates of diabetes among ischemic stroke patients in Liaoning Province were 29.5%, 63.3%, 56.4%, and 47.2%, respectively. Multivariate logistic regression indicated that region [OR=1.818, 95%CI(1.317,2.508), P<0.001], family history of diabetes [OR=2.790, 95%CI(1.922,4.050),

P<0.001], hypertension [OR=1.813, 95%CI(1.160,2.834), P=0.009], high triglycerides [OR=2.312, 95%CI(1.631,3.277), P<0.001], high LDL cholesterol [OR=2.241, 95%CI(1.300,3.865), P=0.004], and overweight/obesity [OR=1.562, 95%CI(1.136,2.146), P=0.006] were influencing factors for diabetes prevalence. Region [OR=1.865, 95%CI(1.086,3.203), P=0.024], family history of diabetes [OR=2.402, 95%CI(1.306,4.416), P=0.005], and high cholesterol [OR=0.389, 95%CI(0.215,0.705), P=0.002] influenced diabetes awareness. Age 60-69 years [OR=3.052, 95%CI(1.523,6.115), P=0.002], region [OR=1.866, 95%CI(1.104,3.155), P=0.020], family history of diabetes [OR=2.303, 95%CI(1.275,4.161), P=0.006], and high cholesterol [OR=0.387, 95%CI(0.210,0.713), P=0.002] influenced diabetes treatment. Region [OR=1.916, 95%CI(1.021,3.595), P=0.043] was the influencing factor for achieving blood glucose control targets. **Conclusion:** The prevalence of diabetes among ischemic stroke patients in Liaoning Province is relatively high, while awareness, treatment, and control rates remain low, necessitating urgent comprehensive prevention and control efforts.

Keywords: Ischemic stroke; Diabetes; Prevalence; Awareness; Treatment; Control; Influencing factors

Introduction

As China' s population aging deepens, the prevalence of stroke continues to rise annually [1]. The 2019 China Stroke Prevention and Treatment Report indicates that stroke in China is experiencing explosive growth with obvious gender and regional disparities, and incidence is rising rapidly among low-income groups and younger populations, creating enormous social and economic burdens. Ischemic stroke accounts for over 70% of all strokes [2], and actively controlling its occurrence and recurrence can effectively curb the rising stroke incidence in China. Numerous previous studies have demonstrated that diabetes is a crucial risk factor for ischemic stroke onset, recurrence, and post-stroke disability and mortality. Research from Beijing Tiantan Hospital showed that approximately 34.2% of acute ischemic stroke patients had or possibly had diabetes [3]. National stroke registry data revealed that diabetes is an independent risk factor for death or disability within six months of ischemic stroke onset, with diabetic patients having a 45% higher risk of stroke recurrence. Poor glycemic control in ischemic stroke patients leads to increased vascular sclerosis and blood hypercoagulability, triggering more severe changes in intracerebral neurotransmitters and worsening neurological deficits, making blood glucose management critically important for ischemic stroke patients.

Liaoning Province, located in Northeast China, has the deepest aging population according to the seventh national census and is a high-prevalence area for stroke. Timely evaluation of diabetes prevalence, awareness, treatment, and control rates among ischemic stroke patients in Liaoning, along with analysis of

related influencing factors, can provide scientific evidence for local comprehensive management decision-making and medical resource allocation.

Methods

1.1 Study Subjects From 2017 to 2018, considering geographical distribution and economic differences across regions in Liaoning Province, we selected 6 counties/districts using a combination of stratified, cluster, and random sampling: Donggang City and Zhen' an District of Dandong City in southeastern Liaoning, Liaoyang County and Gongchangling District of Liaoyang City in central Liaoning, and Chaoyang County and Lingyuan City of Chaoyang City in western Liaoning. From each county/district, 4-6 villages/communities were randomly selected for a cross-sectional survey. Eligible participants were aged $ $40 years and local permanent residents (living in the area for $ $6 months/year). After excluding those unable to communicate normally, 986 ischemic stroke patients were identified, of whom 980 completed the survey, yielding a response rate of 99.4%. Survey data were obtained from the national "Screening and Intervention for High-Risk Stroke Populations" project, which was approved by the Ethics Committee (Approval No.: 临研审 [2015]024). All participants provided informed consent.

1.2 Data Collection A survey team composed of trained and certified CDC professionals and medical staff from municipal tertiary hospitals conducted on-site, face-to-face questionnaires using standardized forms and collected clinical data. Height and weight were measured on-site, and fasting venous blood samples were collected for laboratory testing. Specific questionnaire information and laboratory indicators are detailed in the study by TIAN Yuanmeng et al. [4].

1.3 Diagnostic Criteria and Definitions

1. **Ischemic stroke:** All patients in this study had confirmed diagnoses from secondary or higher-level medical institutions with neurological deficit symptoms at onset, verified and confirmed on-site by specialists from tertiary hospitals [5,6].
2. **Diabetes:** Fasting blood glucose (Glu) $ $7.0 mmol/L and/or glycated hemoglobin (HbA1c) $ $6.5% and/or previously diagnosed by formal medical institutions and/or currently taking hypoglycemic medications.
3. **Diabetes awareness rate:** The proportion of individuals identified as diabetic in this survey who knew they had diabetes before blood glucose measurement.
4. **Diabetes treatment rate:** The proportion of individuals identified as diabetic who were taking hypoglycemic medications or insulin.
5. **Diabetes control rate:** The proportion of diabetic patients receiving treatment with current HbA1c <7.0%.
6. **Current smoking:** Self-reported smoking $ $1 cigarette/day.

7. **Current drinking:** Self-reported alcohol consumption $ $1 time/week.
8. **Physical inactivity:** Regular exercise defined as moderate-intensity exercise (equivalent to walking) $ $30 minutes/session and $ $3 sessions/week; those engaged in moderate or heavy physical labor were also considered regular exercisers, otherwise defined as lacking exercise.
9. **Family history of diabetes:** Parents and/or siblings and/or children of the participant having diabetes.
10. **Overweight/obesity:** Defined as body mass index $ $24kg/m\^{}\{2\}$.
11. **Hypertension:** Average systolic blood pressure $ $140 mmHg and/or average diastolic blood pressure $ $90 mmHg, or systolic blood pressure <140 mmHg and diastolic blood pressure <90 mmHg but taking antihypertensive medication within the past 2 weeks.
12. **High total cholesterol (TC):** TC $ $6.22 mmol/L.
13. **High triglycerides (TG):** TG $ $2.27 mmol/L.
14. **High low-density lipoprotein cholesterol (LDL):** LDL $ $4.14 mmol/L.
15. **Low high-density lipoprotein cholesterol (HDL):** HDL <1.04 mmol/L.
16. **Atrial fibrillation:** All atrial fibrillation patients in this study were verified by specialists from tertiary hospitals, including those with self-reported atrial fibrillation history and those identified through on-site electrocardiograms.
17. **Region:** Urban residents defined as permanent residents of municipal districts, rural residents defined as permanent residents of counties and county-level cities.

1.4 Statistical Analysis All data were entered into a database using Epidata software and analyzed using SPSS 23.0. Quantitative data were expressed as ($\bar{x}\pm s$) and qualitative data as percentages (%). Diabetes prevalence, awareness, treatment, and control rates among ischemic stroke patients were calculated stratified by age group, gender, and region. Between-group comparisons used two-sided trend chi-square tests. Standardized rates were calculated using the 2020 Liaoning Province population structure. Variables with significant results from univariate logistic regression analysis were entered into multivariate stepwise backward logistic regression models to analyze influencing factors of diabetes prevalence, awareness, treatment, and control among ischemic stroke patients. $P<0.05$ was considered statistically significant.

Results

2.1 Basic Characteristics of Study Population A total of 980 ischemic stroke patients completed the survey, with a mean age of (66.24$±$8.41) years. There were 493 males (50.3%) and 487 females (49.7%), with 258 urban residents (26.3%) and 722 rural residents (73.7%).

2.2 Diabetes Prevalence Among Ischemic Stroke Patients in Liaoning Province The diabetes prevalence among ischemic stroke patients in Liaoning Province was 29.5%, with a standardized rate of 28.6%. The prevalence was higher in female patients (33.3%) than in male patients (25.8%), ^{2}=6.635, P=0.010, and higher in urban patients (40.3%) than in rural patients (25.6%), ^{2}=19.718, P<0.001. Diabetes prevalence rates among ischemic stroke patients aged 40-59, 60-69, and $ 70 $years were 27.2^{2}$=5.231, P=0.073 .

2.3 Diabetes Awareness, Treatment, and Control Rates Among Ischemic Stroke Patients in Liaoning Province The diabetes awareness, treatment, and control rates among ischemic stroke patients in Liaoning Province were 63.3%, 56.4%, and 47.2%, respectively, with standardized rates of 61.0%, 51.0%, and 44.4%. Rates were 61.4%, 54.3%, and 46.4% in males and 64.8%, 58.0%, and 47.9% in females, with no statistically significant gender differences (P>0.05). Urban rates were 73.1%, 66.3%, and 56.5%, respectively, compared to 57.8%, 50.8%, and 40.4% in rural areas, with urban patients showing significantly higher rates (P<0.05). Diabetes treatment rates differed significantly across age groups, ^{2}=8.639, P=0.013 .

2.4 Univariate Logistic Regression Analysis of Factors Influencing Diabetes Prevalence, Awareness, Treatment, and Control Using presence of diabetes among ischemic stroke patients (assignment: 0=no, 1=yes), awareness among diabetic patients (0=no, 1=yes), treatment among diabetic patients (0=no, 1=yes), and control among treated diabetic patients (0=no, 1=yes) as dependent variables, and age (1=40-59 years, 2=60-69 years, 3=$ 70 $years), region(0 = rural, 1 = urban), gender(1 = male, 2 = female), educationlevel(1 = primaryschoolorbelow, 2 = middleschool, 3 = highschoolorabove), annualhouseholdincome(1 =< 5000 $yuan, 2 = 5000 - 9999 $yuan, 3 = 10000 - 19999 $yuan, 4 = $20000 yuan), marital status (0=married, 1=other), family history of diabetes (0=no, 1=yes), current smoking (0=no, 1=yes), current drinking (0=no, 1=yes), physical inactivity (0=no, 1=yes), hypertension (0=no, 1=yes), high TC (0=no, 1=yes), high TG (0=no, 1=yes), high LDL (0=no, 1=yes), low HDL (0=no, 1=yes), overweight/obesity (0=no, 1=yes), and atrial fibrillation (0=no, 1=yes) as independent variables, univariate logistic regression showed that region, gender, education level, annual household income, family history of diabetes, hypertension, current smoking, current drinking, high TC, high TG, high LDL, low HDL, and overweight/obesity were influencing factors for diabetes prevalence. Region, annual household income, family history of diabetes, and high TC influenced diabetes awareness. Age 60-69 years, region, family history of diabetes, and high TC influenced diabetes treatment. Region was the influencing factor for achieving blood glucose control targets among ischemic stroke patients with diabetes .

2.4 Multivariate Logistic Regression Analysis of Factors Influencing Diabetes Prevalence, Awareness, Treatment, and Control Multivariate logistic regression results showed that region, family history of diabetes, hypertension, high TG, high LDL, and overweight/obesity were influencing factors for diabetes prevalence among ischemic stroke patients. Region, family history of diabetes, and high TC influenced diabetes awareness among ischemic stroke patients with diabetes. Age 60-69 years, region, family history of diabetes, and high TC influenced diabetes treatment. Region was the influencing factor for achieving blood glucose control targets among treated ischemic stroke patients with diabetes .

Discussion

The China Kadoorie Biobank study found that diabetes significantly increases stroke risk and is an important influencing factor for ischemic stroke onset, recurrence, and prognosis [7,8,9]. Early diagnosis, treatment, and control of diabetes can greatly reduce stroke incidence and improve patient outcomes. This study found that the diabetes prevalence among ischemic stroke patients aged $ $40 years in Liaoning Province was 29.5%, with a standardized prevalence of 28.6%, higher than the 21.0% prevalence among ischemic stroke patients aged >40 years nationwide in 2014 and the 25.2% reported in Tianjin during the same period [10], but lower than the 32.6% prevalence among ischemic stroke patients in Jilin in 2019 [11]. The prevalence was significantly higher than the 16.2% prevalence among rural residents aged $ $40 years in Liaoning Province in 2018 [6], with ischemic stroke patients showing 1.8 times the diabetes prevalence of the general population. Overall, prevalence was higher in urban patients (40.3%) than rural patients (25.6%) and higher in female patients (33.3%) than male patients (25.8%).

The diabetes awareness, treatment, and control rates among ischemic stroke patients aged $ $40 years in Liaoning Province were 63.3%, 56.4%, and 47.2%, respectively, with standardized rates of 61.0%, 51.0%, and 44.4%. These rates were higher than those among the general population of the same age group in Liaoning Province (39.7%, 31.1%, and 43.9%), higher than the 34.8%, 30.1%, and 24.4% reported in Shandong Province in 2013 [12], and higher than the 56.3%, 47.1%, and 29.4% reported in Xiaoshan District, Hangzhou [13]. Compared with Shunyi District, Beijing, awareness was lower (77.2%) while treatment and control rates were higher (44.6% and 26.0%) [14]. These comparisons with the general population likely reflect greater health awareness and treatment compliance following stroke. However, although awareness, treatment, and control rates among ischemic stroke patients in Liaoning were higher than among non-stroke patients, the differences were not substantial, and awareness was even lower than among general residents in Shunyi District, Beijing, indicating considerable room for improvement.

Multivariate logistic regression showed that urban ischemic stroke patients in Liaoning had higher diabetes risk (OR=1.818, 95%CI(1.317,2.508), P<0.001) and better awareness (OR=1.865, 95%CI(1.086,3.203), P=0.024), treatment (OR=1.866, 95%CI(1.104,3.155), P=0.020), and control (OR=1.916, 95%CI(1.021,3.595), P=0.043), consistent with numerous previous studies [12-15]. This likely reflects higher living standards in urban areas, relative lack of health awareness among rural patients, and disparities in healthcare quality between urban and rural areas. Individuals with a family history of diabetes had higher diabetes risk (OR=2.790, 95%CI(1.922,4.050), P<0.001), awareness (OR=2.402, 95%CI(1.306,4.416), P=0.005), and treatment (OR=2.303, 95%CI(1.275,4.161), P=0.006), confirming the hereditary predisposition to diabetes [16] and indicating that individuals with family history pay more attention to blood glucose monitoring and early treatment. However, family history did not influence treatment status, suggesting that active treatment can effectively control blood glucose regardless of family history. The 60-69 age group showed better diabetes treatment (OR=3.052, 95%CI(1.523,6.115), P=0.002), indicating greater health consciousness in this age bracket. Hypertension was a risk factor for diabetes among ischemic stroke patients (OR=1.813, 95%CI(1.160,2.834), P=0.009). Previous studies [17] showed that hypertensive patients have higher probability of developing diabetes, closely related to increased aldosterone levels that enhance insulin resistance and impair insulin secretion, ultimately leading to glucose metabolism disorders. Ischemic stroke patients with high triglycerides (OR=2.312, 95%CI(1.631,3.277), P<0.001) and high LDL cholesterol (OR=2.241, 95%CI(1.300,3.865), P=0.004) had higher diabetes risk, consistent with findings by Peng J et al. [18-20]. Excessive triglyceride and LDL cholesterol levels promote insulin resistance, causing glucose metabolism disorders and diabetes development. Overweight/obesity was a diabetes risk factor (OR=1.562, 95%CI(1.136,2.146), P=0.006), as it is associated with multiple metabolic abnormalities [21] that ultimately lead to insulin resistance and abnormal glucose levels. Additionally, ischemic stroke patients with normal cholesterol levels showed better diabetes awareness (OR=0.389, 95%CI(0.215,0.705), P=0.002) and treatment (OR=0.387, 95%CI(0.210,0.713), P=0.002) than those with high cholesterol, suggesting that individuals with normal cholesterol are more aware of their blood glucose status and have higher treatment rates.

This study has limitations. As a cross-sectional survey, lifestyle changes after stroke onset (including smoking cessation, alcohol limitation, increased physical activity, and treatment of underlying chronic diseases) may have occurred, potentially leading to negative or protective results when analyzing related factors.

In summary, the diabetes prevalence among ischemic stroke patients in Liaoning Province is higher than in other provinces, and although awareness, treatment, and control rates exceed those of the general population, they remain relatively low overall. Urgent comprehensive interventions targeting key populations and major influencing factors are needed, including health education, reasonable diet, increased physical activity, regular medication, and periodic physical examina-

tion. Urban patients showed significantly higher diabetes prevalence, awareness, treatment, and control rates than rural patients, indicating widespread disparities in living standards, medical resource distribution, and healthcare provider expertise, as well as limited health knowledge among rural patients. Enhanced education on diabetes awareness and self-management among rural ischemic stroke patients and improved diabetes diagnosis and treatment capabilities of rural healthcare providers are urgently needed to comprehensively improve post-stroke glycemic management and survival status among ischemic stroke patients in Liaoning Province.

Author Contributions

LIU Fengdong: Conceptualization, drafting and writing of the manuscript
ZHANG Boqiang: Investigation, statistical analysis
YAN Han: Investigation, statistical analysis
JING Li: Investigation, statistical analysis
YU Xiaochen: Data collection, acquisition, and cleaning
WANG Li: Data collection, acquisition, and cleaning
LIU Yunfei: Data collection, acquisition, and cleaning
XING Liying: Conceptualization, study design
TIAN Yuanmeng: Revision of final version, responsibility for the manuscript

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