Attitudes and Behaviors toward Long-term Medication Adherence and Related Factors among Stroke Patients in Rural China: A Postprint Based on Follow-up Data from a County in Hebei

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Abstract

Background Good medication adherence can significantly reduce the risk of recurrence in stroke patients and is key to secondary prevention for stroke patients. However, existing research has mostly focused on short-term medication use and adherence behaviors among rural stroke patients, while studies on long-term medication adherence behaviors in similar patients are relatively limited.

Objective This study aims to analyze the long-term medication behaviors, adherence attitudes and behaviors of stroke survivors in rural China, and identify factors associated with medication behaviors.

Methods Based on the rural stroke patient management study conducted in 2017 in 5 townships and 60 villages in Nanhe County, Hebei Province—the System-Integrated Technology-Enabled Care Model for Stroke Management in Rural China (SINEMA), the study subjects were all stroke survivors who had participated in the 2017 SINEMA study and agreed to participate in the follow-up survey from May to July 2024 and completed it. The survey investigated the subjects' use of antihypertensive drugs, statins, antiplatelet drugs, and hypoglycemic drugs, and used the Maastricht Utrecht Adherence in Hypertension-16 (MUAH-16) scale to assess their medication adherence attitudes (positive medical and medication attitude dimension). The Morisky Green Levine scale was used to measure medication adherence behaviors among patients taking the four types of drugs (a score of 0 was defined as high adherence). Descriptive analysis was used to present patients' basic characteristics, medication adherence status, and factors identified through multivariate Logistic regression analysis.

Results This study included a total of 912 subjects with an average age of (72.0$±$7.9) years, of which 46.1% (420/912) were female; in terms of medication use, 772 cases (84.6%) self-reported taking antihypertensive drugs, 547 cases (59.9%) taking antiplatelet drugs, 427 cases (46.8%) taking statins, and 203 cases (22.3%) taking hypoglycemic drugs. Among those currently taking the four types of drugs, adherence to hypoglycemic drugs was 77.3% (157/203), adherence to antihypertensive drugs was 71.5% (552/772), adherence to antiplatelet drugs was 71.2% (392/547), and adherence to statins was 71.2% (304/427). The survey results showed that 49.2% (449/912) of patients had positive medical and medication attitudes. Multivariate Logistic regression analysis results showed that among patients taking antihypertensive drugs, those with higher education levels (middle school and above: OR=1.87, 95%CI=1.13~3.09) and positive medical and medication attitudes (OR=1.53, 95%CI: 1.08-2.17) had high medication adherence, while those who could work independently (OR=0.56, 95%CI=0.32~0.99) and visited village clinics $ $1 time/month (OR=0.68, 95%CI=0.53~0.88) had lower medication adherence (P<0.05). Among patients taking antiplatelet drugs, those with higher education levels (middle school and above: OR=1.79, 95%CI=1.09~2.96) had higher medication adherence, while patients with hemorrhagic stroke (OR=0.55, 95%CI=0.31~0.98) had lower medication adherence (P<0.05). Among patients taking statins, those who visited village clinics $ $1 time/month (OR=0.67, 95%CI=0.46~0.98) had lower medication adherence (P<0.05). Among patients taking hypoglycemic drugs, males (OR=0.21, 95%CI=0.06~0.73), those registered for chronic disease critical illness insurance (OR=0.34, 95%CI=0.15~0.79), and those who visited village clinics $ $1 time/month (OR=0.34, 95%CI=0.13~0.89) had lower medication adherence (P<0.05).

Conclusion The results of this study show that stroke survivors with longer disease histories in rural areas have relatively high medication adherence, but nearly 30% of patients still fail to regularly follow treatment recommendations, and factors influencing adherence behaviors differ across medication types. Personalized medication adherence interventions should be implemented to increase patients' medication adherence and secondary prevention behaviors.

Full Text

Long-term Medication Adherence Attitudes and Behaviors of Stroke Patients in Rural Areas of China and Related Factors: Based on Follow-up Data from a County in Hebei Province

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Abstract

Background: Good medication adherence can significantly reduce the risk of recurrence in stroke patients and is crucial for secondary prevention. However, existing research has primarily focused on short-term medication use and adherence behaviors among rural stroke patients, while studies on long-term medication adherence behaviors in this population remain limited.

Objective: This study aims to analyze the long-term medication behaviors, adherence attitudes, and related factors among stroke survivors in rural China.

Methods: Based on the Stroke Management in Rural China—System-integrated Technology-enabled Model of Care (SINEMA) study conducted in 60 villages across 5 towns in Nanhe County, Hebei Province in 2017, this study included all stroke survivors who had previously participated in the 2017 SINEMA study, consented to participate in the follow-up survey conducted from May to July 2024, and completed the survey. The study investigated participants' use of antihypertensive drugs, statins, antiplatelet drugs, and hypoglycemic drugs, and assessed their medication adherence attitudes using the Maastricht Utrecht Adherence in Hypertension-16 (MUAH-16) scale, focusing on the dimension of positive medical and medication attitudes. The Morisky Green Levine scale was used to measure medication adherence behaviors among patients taking the four categories of drugs, with a score of 0 defined as high adherence. Descriptive analysis was used to present patient characteristics, medication adherence status, and factors identified through multivariate logistic regression analysis.

Results: A total of 912 participants were included, with a mean age of (72.0$\pm$7.9) years; 46.1% (420/912) were female. Regarding medication use, 772 cases (84.6%) reported taking antihypertensive drugs, 547 cases (59.9%) took antiplatelet drugs, 427 cases (46.8%) used statins, and 203 cases (22.3%) took hypoglycemic drugs. Among patients currently taking these four drug types, adherence rates were 77.3% (157/203) for hypoglycemic drugs, 71.5% (552/772) for antihypertensive drugs, 71.2% (392/547) for antiplatelet drugs,

and 71.2% (304/427) for statins. The survey showed that 49.2% (449/912) of patients had positive medical and medication attitudes. Multivariate logistic regression analysis revealed that among patients taking antihypertensive drugs, those with higher education (secondary school or above: OR=1.87, 95%CI=1.13~3.09) and positive attitudes toward medical care and medication (OR=1.53, 95%CI: 1.08-2.17) had higher medication adherence, while those who could independently complete work tasks (OR=0.56, 95%CI=0.32~0.99) and visited village clinics $ $1 time per month (OR=0.68, 95%CI=0.53~0.88) had lower adherence (P<0.05). Among patients taking antiplatelet drugs, higher education (secondary school or above: OR=1.79, 95%CI=1.09~2.96) was associated with higher adherence, while patients with hemorrhagic stroke (OR=0.55, 95%CI=0.31~0.98) had lower adherence (P<0.05). Among patients taking statins, those visiting village clinics $ $1 time per month (OR=0.67, 95%CI=0.46~0.98) had lower adherence (P<0.05). Among patients taking hypoglycemic drugs, males (OR=0.21, 95%CI=0.06~0.73), those enrolled in chronic disease major illness insurance (OR=0.34, 95%CI=0.15~0.79), and those visiting village clinics $ $1 time per month (OR=0.34, 95%CI=0.13~0.89) had lower adherence (P<0.05).

Conclusion: This study demonstrates that stroke survivors in rural areas with longer disease histories exhibit relatively high medication adherence, yet nearly one-third of patients still fail to regularly follow treatment recommendations. The factors influencing adherence behaviors vary across different medication types, indicating the need for personalized adherence interventions to improve medication compliance and secondary prevention behaviors.

Keywords: Stroke; Multiple medications; Medication adherence; Rural

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1. Introduction

Stroke is one of the major global burdens of non-communicable diseases and the leading cause of disability and mortality in China. The prevalence and incidence of stroke in China continue to rise. Research based on Chinese populations indicates an annual prevalence of 1,329.5 per 100,000 and an annual incidence of 442.1 per 100,000. Although stroke mortality has declined with improvements in healthcare, it remains as high as 35.8% (95%CI=26.1%~46.1%), demonstrating that the characteristic of high incidence has not been alleviated. Secondary prevention medications are critical for improving stroke prognosis and reducing stroke recurrence and related complications. Existing research and domestic and international stroke secondary prevention guidelines emphasize the effectiveness of rational use of antihypertensive drugs, antiplatelet drugs, statins, and hypoglycemic drugs in reducing stroke recurrence. However, current studies have also found that poor medication adherence is a widespread problem and an important barrier affecting long-term stroke management.

Rural areas face more prominent issues with rational drug use and adherence

behaviors among stroke patients due to scarce medical resources and limited continuous health management support. Previous studies have primarily focused on short-term medication behaviors in stroke patients, with limited research on long-term medication adherence, which is particularly important for controlling stroke recurrence. Stroke patients often have multiple chronic conditions, which not only increase the complexity of medication management but may also weaken adherence to long-term medications. Additionally, patients' attitudes and beliefs toward treatment significantly influence their long-term medication behaviors, with negative attitudes (such as concerns about adverse drug reactions or doubts about treatment efficacy) potentially leading to reduced adherence. Therefore, understanding long-term medication behaviors in stroke patients requires comprehensive consideration of the complexity of multimorbidity and the influence of psychological and social support factors.

This study builds on a long-term follow-up survey of stroke patient management to understand the current status of long-term medication use among stroke patients in rural Hebei, China, analyze adherence to antihypertensive drugs, antiplatelet drugs, statins, and hypoglycemic drugs, explore related factors, and provide evidence for optimizing stroke medication management in rural areas.

1.1 Study Population This study was conducted in Nanhe County, Hebei Province, located in a "stroke high-incidence area" in China with a stroke burden twice the national average. Before national poverty alleviation, Nanhe County was designated as a "provincial-level poverty county," with residents' per capita annual disposable income of 11,030 yuan, only half of the national average. Based on the System-integrated Technology-enabled Model of Care for Stroke Management in Rural China (SINEMA) study—a cluster randomized controlled trial conducted in 60 villages across 5 towns in 2017 that developed and evaluated a system-integrated mobile health intervention model to improve secondary prevention for stroke patients in rural China—this study' s intervention period was 1 year, with follow-ups conducted in 2018, 2022, and 2023. The study population comprised all stroke survivors who had participated in the 2017 SINEMA study and consented to participate in the follow-up survey conducted from May to July 2024, completing the investigation. This study was approved by the Ethics Review Committee of the Chinese Academy of Medical Sciences (approval number: CAMS & PUMC-IEC-2024-047), and all participants signed informed consent forms.

1.2 Data Collection Data were collected through face-to-face questionnaires and physical examinations. The questionnaire covered sociodemographic characteristics (including age, sex, education level, marital status, annual household income, work intensity), enrollment in chronic disease major illness insurance (the chronic disease insurance package only applies to individuals enrolled in the health insurance system with serious chronic diseases, allowing reimbursement for outpatient services at county hospitals), lifestyle factors (such as smoking status), self-reported number of comorbid chronic diseases, stroke type and re-

currence history, disability level (assessed using the modified Rankin Scale), and medication use.

The validated Maastricht Utrecht Adherence in Hypertension-16 (MUAH-16) scale was used to assess medication adherence attitudes. This scale includes four dimensions: positive medical and medication attitudes, lack of self-discipline, medication resistance, and active health management. This study focused on the "positive medical and medication attitudes" dimension, with scores dichotomized based on previous research and population distribution (16 points defined as positive attitude, <16 points as non-positive attitude).

Participants self-reported their current use of stroke secondary prevention medications (including antihypertensive drugs, antiplatelet drugs, statins, and hypoglycemic drugs). For each medication category, the Morisky Green Levine scale was used to assess medication adherence behaviors. This 4-item scale has been validated for assessing patient medication adherence, demonstrating strong validity and predictive validity, with a score of 0 defined as high adherence. The study also evaluated medication utilization rates, adherence proportions, stroke recurrence rates, and disability indicators [modified Rankin Scale (mRS) score $ $3]. All surveys were conducted by uniformly trained investigators from neighboring counties. All data for this study were collected during a single survey using digital face-to-face interview systems and on-site supervision to ensure standardized and high-quality data collection.

1.3 Statistical Analysis This study primarily employed descriptive statistics and multivariate logistic regression models to assess factors associated with high adherence behaviors among users of various medication types. In the regression models, all analyses followed the methods in the original SINEMA study statistical analysis plan (SAP), using intention-to-treat principles and controlling for cluster structure (village-level). Descriptive analysis was first conducted for all survey participants. Continuous variables were expressed as (mean ± SD) if normally distributed, with group comparisons using independent t-tests; non-normally distributed variables were expressed as median (P25, P75), with group comparisons using rank-sum tests. Categorical variables were expressed as frequencies and percentages, with group comparisons using ^{2} tests. For populations taking each medication type, descriptive analysis compared the distribution of variables across different adherence behaviors and analyzed differences in medication attitudes across adherence statuses. Multivariate logistic regression analysis was used to explore the impact of medication adherence attitudes on adherence behaviors. All analyses were performed using STATA 18.0 software, with statistical significance set at $P<0.05$.

2. Results

2.1 Main Demographic and Health Characteristics of the Survey Population This study included 912 participants with a mean age of (72.0$±$7.9) years; 46.1% (420/912) were female. Educational attainment was primary school

or below for 71.8% (655/912) of participants, and most (74.9%, 683/912) were married. Annual household income was below 5,000 yuan for 37.7% (344/912) of participants. Stroke type was predominantly ischemic (86.2%, 784/912), with a median time since first stroke onset of 13 (10, 18) years. Stroke recurrence within the past 2 years occurred in 16.2% (148/912) of participants, and 38.0% (347/912) had moderate to severe disability. Most patients had comorbid chronic conditions, primarily hypertension (90.0%), dyslipidemia (53.7%), diabetes (24.1%), and heart disease (22.9%). Detailed information is provided in Table 1 .

Regarding medication use, 772 cases (84.6%) reported taking antihypertensive drugs, 547 cases (59.9%) took antiplatelet drugs, 427 cases (46.8%) used statins, and 203 cases (22.3%) took hypoglycemic drugs. The demographic and health characteristics of patients taking these four medication types are shown in Table 1.

2.2 Patient Medication Adherence Behaviors, Attitudes, and Related Factors Among patients taking antihypertensive drugs, 71.5% (552/772) had high adherence. No statistically significant differences were found in sex, marital status, annual household income, work intensity, enrollment in chronic disease major illness insurance, smoking status, or proportions of self-reported comorbid hypertension, dyslipidemia, diabetes, or heart disease, stroke type, stroke recurrence within the past 2 years, or time since first recurrence between patients with different antihypertensive adherence levels ($P>0.05$). However, statistically significant differences were observed in education level, frequency of village clinic visits in the past year, and disability level ($P<0.05$). The proportion of patients with positive medical and medication attitudes was higher among those with high antihypertensive adherence compared to those with low adherence, with a statistically significant difference ($P<0.05$). See Table 2 .

Among patients taking antiplatelet drugs, 71.2% (392/547) had high adherence. No statistically significant differences were found in sex, marital status, education level, annual household income, work intensity, enrollment in chronic disease major illness insurance, frequency of village clinic visits in the past year, smoking status, proportions of self-reported comorbid conditions, stroke type, stroke recurrence within the past 2 years, time since first recurrence, disability level, or positive medical and medication attitudes between patients with different antiplatelet adherence levels ($P>0.05$). See Table 2 .

Among patients taking statins, 71.2% (304/427) had high adherence. No statistically significant differences were found in any of the examined variables between patients with different statin adherence levels ($P>0.05$). See Table 2 .

Among patients taking hypoglycemic drugs, 77.3% (157/203) had high adherence. No statistically significant differences were found in sex, education level, annual household income, work intensity, enrollment in chronic disease major illness insurance, smoking status, or proportions of self-reported comorbid con-

ditions, stroke type, stroke recurrence within the past 2 years, time since first recurrence, disability level, or positive medical and medication attitudes between patients with different hypoglycemic adherence levels (P>0.05). However, statistically significant differences were observed in marital status and frequency of village clinic visits in the past year (P<0.05). See Table 2 .

Multivariate Logistic Regression Analysis

Using high adherence behavior for the four medication types as the dependent variable (with low adherence as reference), and including potential related factors and indicators with statistical significance in univariate analysis as independent variables (P<0.05), multivariate logistic regression analysis was performed. Results showed that among patients taking antihypertensive drugs, those with higher education (secondary school or above: OR=1.87, 95%CI=1.13~3.09) and positive medical and medication attitudes (OR=1.53, 95%CI: 1.08-2.17) had higher medication adherence, while those who could independently complete work tasks (OR=0.56, 95%CI=0.32~0.99) and visited village clinics $ $1 time per month (OR=0.68, 95%CI=0.53~0.88) had lower adherence (P<0.05).

Among patients taking antiplatelet drugs, higher education (secondary school or above: OR=1.79, 95%CI=1.09~2.96) was associated with higher adherence, while patients with hemorrhagic stroke (OR=0.55, 95%CI=0.31~0.98) had lower adherence (P<0.05).

Among patients taking statins, those visiting village clinics $ $1 time per month (OR=0.67, 95%CI=0.46~0.98) had lower adherence (P<0.05).

Among patients taking hypoglycemic drugs, males (OR=0.21, 95%CI=0.06~0.73), those enrolled in chronic disease major illness insurance (OR=0.34, 95%CI=0.15~0.79), and those visiting village clinics $ $1 time per month (OR=0.34, 95%CI=0.13~0.89) had significantly lower adherence (P<0.05). See Table 3 .

3. Discussion

Based on long-term follow-up data from Nanhe County in Hebei Province, this study found that stroke patients had relatively high overall adherence to secondary prevention medications, but significant differences existed across medication types, with influencing factors showing clear heterogeneity. Compared with previous studies focusing on short-term stroke patients, this study included mostly patients with longer disease courses, who demonstrated higher medication adherence levels, possibly reflecting the positive impact of long-term follow-up and medical care on patients' self-management behaviors. In terms of medication categories, the utilization rates of antihypertensive and antiplatelet drugs were significantly higher than those of statins and hypoglycemic drugs. Although overall medication adherence was relatively high, males among hypoglycemic drug users showed low adherence, suggesting potential gender differences in long-term self-management. The study further confirmed that patients'

education level, disease control status, and attitudes toward medication were associated with adherence behaviors, particularly indicating that medication behaviors among stroke patients with low education levels in rural areas need improvement.

Compared with previous research, this study focused on patients who had suffered from stroke for a relatively long time, a population that may have established long-term medication behaviors and represents a key group of interest, differing substantially from studies focusing on newly diagnosed patients. Previous research has primarily examined medication behaviors in newly diagnosed or short-term stroke patients, mainly within 1-2 years of onset. For example, a study of elderly stroke survivors in Hunan (mean disease course 49.37 months) found that 61.4% had poor medication adherence, while a study in Harbin of ischemic stroke patients (mean disease course 3.77 years) reported a non-adherence rate of 65.48%. In contrast, this study focused on patients requiring long-term management after stroke (mean disease course up to 13 years). Long-term stroke patients may face more challenges in medication adherence, particularly regarding medication beliefs, disease perception, and health literacy, which may significantly impact adherence over the prolonged disease management process. The lower non-adherence rate found in this study compared to previous research may be related to the characteristics of this population, including an average 13-year stroke history, 14.8% with previous stroke recurrence, and 38% in a disabled state. These long-term stroke patients may have developed better medication adherence behaviors, resulting in higher adherence rates compared to short-term newly diagnosed patients in previous studies.

Secondary prevention medications are widely used among long-term stroke patients in rural Hebei, with relatively high overall adherence, though nearly one-third of patients remain non-adherent, and differences exist in utilization rates and adherence across medication types. Education level, clinic visit frequency, and patient attitudes toward medication are key influencing factors that show heterogeneity across different medications. We recommend that future rural stroke management implement targeted interventions for key populations such as those with low education levels, combined with personalized education and coordination with primary care resources to improve long-term adherence and reduce stroke recurrence, thereby improving patient outcomes.

Compared with previous studies, this study further demonstrates that medication adherence issues are more pronounced among populations with lower education levels and warrant greater attention. Education level is typically associated with health literacy, disease awareness, and appreciation for long-term regular medication use. Consistent with previous research, this study also found that patients' medication attitudes, particularly their perception of medication necessity and concerns about adverse reactions, were significantly associated with adherence behaviors for antihypertensive drugs. Previous studies have emphasized the negative impact of medication concerns on adherence, while perception of medication necessity is associated with higher adherence.

Village clinic visit frequency was identified as a positive factor across multiple medication categories, suggesting that primary care services play an active role in long-term self-management for stroke patients. This study also found potential differences in utilization rates and adherence behaviors across medication types. Previous research has found that among high-risk stroke populations in China, medication persistence varies across drug types. Specifically, 4.7-year persistence for hypoglycemic drugs (39.9%) was lower than for antithrombotic drugs (59.8%) and lipid-lowering drugs (43.9%). This study also found that over 70% of participants had two or more comorbidities, and 22.3% of patients simultaneously took hypoglycemic drugs. These complex comorbidity issues increase the burden of disease management for stroke patients and may raise concerns about drug efficacy and cross-medication adverse reactions, potentially leading to low adherence. Future research should pay greater attention to multiple risk factor control and polypharmacy behaviors in stroke patients.

This study' s focus on medication behaviors among stroke patients with long disease courses in rural areas has certain unique value. The study covered four commonly used secondary prevention drug types for rural stroke patients, providing valuable supplementary evidence for exploring medication adherence in this population. The study employed standardized assessment tools and statistical methods, ensuring result reliability. However, this study has several main limitations: First, measurement of medication use and adherence relied on patient self-reporting, which may introduce recall bias and social desirability bias, potentially overestimating actual adherence levels. Second, as a cross-sectional study, it can only establish associations between factors of interest and adherence; although some confounding factors were controlled, interference from unobserved variables cannot be excluded. Third, survey participants were drawn from a previously enrolled stroke patient population, so caution is needed when generalizing results, and external validity requires further verification. Finally, influencing factors from healthcare providers' perspectives were not included, which could be addressed in future research focusing on multi-level influences.

In conclusion, this study further demonstrates that strengthening secondary prevention medication management remains necessary to improve outcomes among long-term stroke patients in rural areas. The findings have guiding significance for developing targeted interventions. Future intervention strategies should focus more on improving patients' understanding of different drug treatments and combine health education to improve medication attitudes and behavioral motivations.

Author Contributions: Yutong Long, Lijing Yan, Enying Gong, and Ruitai Shao were responsible for conceptualization and overall framework design. Yutong Long, Shiyu Lu, Jie Tan, Bolu Yang, and Tongde Yang were responsible for data collection, collation, and entry. All authors approved the manuscript for submission. Yutong Long, Enying Gong, and Ruitai Shao are responsible for the overall article and its supervision.

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Note: Figure translations are in progress. See original paper for figures.