

The Association between Health Literacy and Patient Activation among Patients with Stroke: The Mediating Role of Self-Regulatory Fatigue

Binbin Yang^{1,a}, Rui Yuan^{1,b}, Yawen Wu^{1,c}, Xinyue Zhang^{1,d}, Houming Si^{1,e}, Xixi Niu^{1,f}, Pan Zhang^{1,g,*}

¹*College of Nursing and Rehabilitation, North China University of Science and Technology, Tangshan, China*

^ayangbinbin_2001@163.com, ^byuanr0109@163.com, ^c2366376989@qq.com,
^d16603195843@163.com, ^em18263257212@163.com, ^fniuqianqian82@163.com,
^gzhangpan0901@163.com

**Corresponding author*

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Abstract: Patient activation supports long-term self-management after stroke; however, the mechanisms underlying the association between health literacy and patient activation remain unclear, and self-regulatory fatigue may play a role. This study aimed to examine the association between health literacy and patient activation among patients with stroke and to determine whether self-regulatory fatigue mediates this association. This cross-sectional study included 360 patients with stroke recruited in China between September and December 2025. Validated questionnaires were used to assess health literacy, self-regulatory fatigue, and patient activation. Pearson correlation analysis and an adjusted mediation model with 5,000 bootstrap resamples were used to estimate the indirect association. The mean scores for health literacy, self-regulatory fatigue, and patient activation were 67.01 ± 9.96 , 51.83 ± 6.21 , and 50.35 ± 13.65 , respectively. Health literacy was negatively correlated with self-regulatory fatigue ($r = -0.500$, $p < 0.001$) and positively correlated with patient activation ($r = 0.596$, $p < 0.001$), whereas self-regulatory fatigue was negatively correlated with patient activation ($r = -0.612$, $p < 0.001$). After adjustment for sociodemographic and clinical factors, higher health literacy was associated with lower self-regulatory fatigue ($B = -0.125$, 95% CI: -0.184 to -0.066 ; $\beta = -0.200$, $p < 0.001$). Higher self-regulatory fatigue was associated with lower patient activation ($B = -0.771$, 95% CI: -0.991 to -0.550 ; $\beta = -0.350$, $p < 0.001$), while health literacy remained positively associated with patient activation ($B = 0.413$, 95% CI: 0.286 to 0.539 ; $\beta = 0.301$, $p < 0.001$). The indirect effect was 0.096 (95% bootstrap CI: 0.045 to 0.155). Higher health literacy was associated with greater patient activation, partly through lower self-regulatory fatigue. These factors may help identify patients who require additional support; however, the cross-sectional design precludes conclusions regarding temporality or causality.

1. Introduction

Stroke remains a major cause of death and long term disability worldwide [1]. Long term secondary prevention and rehabilitation require patients to manage medications, risk factors, rehabilitation, and lifestyle changes, making active involvement in health management particularly important after stroke [3].

Patient activation refers to the knowledge, skills, confidence, and willingness that individuals have to manage their health and healthcare [5,6]. Higher patient activation has been associated with better medication adherence and self-management among people with stroke [8]. Identifying factors associated with patient activation may therefore provide useful targets for nursing support after stroke.

Health literacy may be closely related to patient activation because patients need to understand and use health information before they can make informed decisions about their care [9]. For people with stroke, health literacy includes understanding stroke symptoms, recurrence risks, treatment recommendations, rehabilitation requirements, and healthy lifestyle behaviors [2,4]. Recent studies in stroke populations have shown that higher health literacy is associated with better self-management. Similar associations between health literacy and patient activation have also been reported in other chronic disease populations [7]. However, understanding what should be done does not necessarily mean that patients can sustain the effort required for long term health management.

Self-regulatory fatigue refers to difficulty sustaining cognitive, emotional, and behavioral regulation under prolonged demands [10]. Chronic disease management requires repeated health decisions and sustained behavioral regulation, which may increase self-regulatory fatigue [12]. Patients with limited health literacy may need to invest greater effort in understanding information and managing health problems, and higher health literacy has previously been associated with lower self-regulatory fatigue [11]. In turn, greater self-regulatory fatigue may make it more difficult to maintain an active role in health management [5]. A recent study found that self-regulatory fatigue was negatively associated with patient activation and mediated the association between health empowerment and patient activation [12].

Although recent studies have examined psychological pathways linking health literacy with self-management outcomes [9], little is known about the role of self-regulatory fatigue in the association between health literacy and patient activation among patients with stroke. Therefore, this study examined the associations among health literacy, self-regulatory fatigue, and patient activation and tested whether self-regulatory fatigue mediated the association between health literacy and patient activation. We hypothesized that higher health literacy would be associated with higher patient activation and lower self-regulatory fatigue, that higher self-regulatory fatigue would be associated with lower patient activation, and that self-regulatory fatigue would mediate the association between health literacy and patient activation.

2. Methods

2.1. Study Design and Setting

A cross sectional study was conducted in the Department of Neurology of the Affiliated Hospital of North China University of Science and Technology, Tangshan, Hebei Province, China, from September to December 2025.

2.2. Participants

Patients hospitalized with stroke during the study period were screened for eligibility.

The inclusion criteria were: (1) age 18 years or older; (2) a diagnosis of ischemic or hemorrhagic stroke confirmed by a neurologist based on clinical assessment and neuroimaging; (3) a clinically stable condition at the time of the survey; (4) sufficient cognitive and communication ability to understand and complete the questionnaires; and (5) voluntary participation with informed consent.

Patients were excluded if they: (1) had severe aphasia, impaired consciousness, or substantial cognitive impairment that prevented reliable questionnaire completion; (2) had a severe psychiatric disorder or another condition that substantially interfered with communication or assessment; (3) were critically ill or medically unstable; or (4) were unable to complete the main study measures.

A total of 360 patients were included in the final analysis.

2.3. Measures

2.3.1. Sociodemographic and Clinical Characteristics

Sociodemographic and clinical information was collected using a structured questionnaire. The main variables included age, sex, education level, previous stroke, multimorbidity, disease duration, and Barthel Index.

2.3.2. Health Literacy

Health literacy was measured using the Health Literacy Scale for Stroke Patients (HLSSP) developed by Liu et al. for Chinese patients with stroke [13]. The scale contains 20 items covering three areas: basic knowledge and concepts, healthy lifestyle and behavior, and basic skills. Each item is scored on a 5 point scale. Total scores range from 20 to 100, with higher scores indicating better health literacy. The original scale showed good reliability and validity, with a Cronbach's α of 0.929 and a test retest reliability coefficient of 0.932.

2.3.3. Self-Regulatory Fatigue

Self-regulatory fatigue was measured using the Chinese version of the Self-Regulatory Fatigue Scale (SRF-S) [10,14]. The Chinese version contains 16 items covering cognitive, emotional, and behavioral regulation. Each item is rated from 1, strongly disagree, to 5, strongly agree. Higher total scores indicate greater self-regulatory fatigue. The scale has shown acceptable reliability in Chinese populations and has been used in recent clinical studies [12].

2.3.4. Patient Activation

Patient activation was assessed using the Chinese version of the 13 item Patient Activation Measure (PAM-13) [15]. The PAM-13 assesses patients' knowledge, confidence, and ability to take and maintain an active role in managing their health [5,6]. Responses are scored from 1, strongly disagree, to 4, strongly agree. Raw responses were converted to standardized PAM scores using the official scoring conversion procedure. Higher scores indicate greater patient activation. The Chinese version has shown good reliability and validity.

2.4. Data Collection

Eligible patients were approached during hospitalization. After written informed consent was obtained, participants completed the study questionnaires. Completed questionnaires were checked

for completeness before data entry.

2.5. Ethical Considerations

The study was approved by the Ethics Committee of North China University of Science and Technology (No. 2025101). All participants provided informed consent.

2.6. Statistical Analysis

Continuous variables were summarized using means and standard deviations. Categorical variables were described using frequencies and percentages. Pearson correlation coefficients were calculated to examine the associations among health literacy, self-regulatory fatigue, and patient activation.

A simple mediation analysis was conducted with health literacy as the independent variable, self-regulatory fatigue as the mediator, and patient activation as the dependent variable. The indirect effect was estimated using 5,000 bootstrap resamples. An indirect effect was considered statistically significant when the 95% bootstrap confidence interval did not include zero [16].

The primary model was adjusted for age, sex, education level, previous stroke, multimorbidity, disease duration, and Barthel dependency level. Multicollinearity was assessed using variance inflation factors, and HC3 robust standard errors were examined because heteroskedasticity was detected in models with patient activation as the outcome. The conclusions for the main regression paths did not change. All tests were two sided, and $P < 0.05$ was considered statistically significant.

3. Results

3.1. Participant Characteristics

A total of 360 patients with stroke were included. The mean age was 70.27 ± 10.08 years, and 223 (61.9%) were men. Detailed sociodemographic and clinical characteristics are presented in **Table 1**.

Table 1: Characteristics of the study participants (N = 360).

Characteristic	Category	Statistic
Age, years	Mean $\pm$ SD	70.27 ± 10.08
Sex	Male	223 (61.9%)
	Female	137 (38.1%)
Education	Primary school or below	130 (36.1%)
	Junior high school	134 (37.2%)
	Senior high school/technical secondary school	60 (16.7%)
	College or above	36 (10.0%)
Previous stroke	No	255 (70.8%)
	Yes	105 (29.2%)

Characteristic	Category	Statistic
Chronic disease comorbidity	<2 conditions	55 (15.3%)
	≥ 2 conditions	305 (84.7%)
Disease duration	≤ 3 months	118 (32.8%)
	3–12 months	96 (26.7%)
	>1 year	146 (40.6%)
Barthel dependency	Independent	30 (8.3%)
	Mild dependency	215 (59.7%)
	Moderate dependency	91 (25.3%)
	Severe dependency	24 (6.7%)

Note. Continuous variables are presented as mean $\pm$ SD and categorical variables as n (%). Barthel dependency was retained as a categorical covariate in the adjusted mediation model.

3.2. Descriptive Statistics and Correlations

The mean scores for health literacy, self-regulatory fatigue, and patient activation were 67.01 ± 9.96 , 51.83 ± 6.21 , and 50.35 ± 13.65 , respectively.

Health literacy was negatively correlated with self-regulatory fatigue ($r = -0.500$, $P < 0.001$) and positively correlated with patient activation ($r = 0.596$, $P < 0.001$). Self-regulatory fatigue was negatively correlated with patient activation ($r = -0.612$, $P < 0.001$). The results are shown in **Table 2**.

Table 2: Descriptive statistics and Pearson correlations among the study variables.

Variable	Mean	SD	Range	1	2	3
1. Health literacy	67.01	9.96	32.0–91.0	1.000		
2. Self-regulatory fatigue	51.83	6.21	37.0–68.0	-0.500* **	1.000	
3. Patient activation	50.35	13.65	20.8–100.0	0.596* **	-0.612* **	1.000

Note. N = 360. Pearson correlation coefficients are shown below the diagonal. *** $P < 0.001$.

3.3. Mediation Analysis

After adjustment for age, sex, education level, previous stroke, multimorbidity, disease duration, and Barthel dependency level, health literacy was negatively associated with self-regulatory fatigue ($B = -0.125$, 95% CI -0.184 to -0.066 , $\beta = -0.200$, $P < 0.001$).

Health literacy was positively associated with patient activation before self-regulatory fatigue

was entered into the model ($B = 0.509$, 95% CI 0.378 to 0.640, $\beta = 0.371$, $P < 0.001$).

When health literacy and self-regulatory fatigue were included simultaneously, higher self-regulatory fatigue was associated with lower patient activation ($B = -0.771$, 95% CI -0.991 to -0.550 , $\beta = -0.350$, $P < 0.001$). Health literacy remained positively associated with patient activation ($B = 0.413$, 95% CI 0.286 to 0.539, $\beta = 0.301$, $P < 0.001$).

The indirect effect of health literacy on patient activation through self-regulatory fatigue was 0.096 (bootstrap SE = 0.028, 95% bootstrap CI 0.045 to 0.155). As the confidence interval did not include zero, the indirect effect was statistically significant (**Table 3**).

Table 3: Mediation analysis.

Path	B	β	95% CI	P
Health literacy → Self-regulatory fatigue (a)	-0.125	-0.2	-0.184 to -0.066	<0.001
Health literacy → Patient activation (c)	0.509	0.371	0.378 to 0.640	<0.001
Self-regulatory fatigue → Patient activation (b)	-0.771	-0.35	-0.991 to -0.550	<0.001
Health literacy → Patient activation (c')	0.413	0.301	0.286 to 0.539	<0.001
Indirect effect (ab)	0.096		0.045 to 0.155	

4. Discussion

Higher health literacy was associated with greater patient activation in this study, which is consistent with previous findings in chronic disease and stroke populations [7]. Patients with stroke need to understand and apply information related to medication, rehabilitation, risk factor control, diet, physical activity, and recurrence prevention [2,4]. Better health literacy may therefore help patients feel more prepared to participate actively in their care. Health literacy and patient activation are related but distinct concepts. Health literacy concerns the ability to access, understand, and use health information, whereas patient activation also reflects confidence and readiness to take action [5]. This may explain why health literacy remained associated with patient activation after self-regulatory fatigue was included in the model.

Health literacy was also negatively associated with self-regulatory fatigue. Ji and Yu reported a similar relationship among older patients with coronary heart disease [11]. Patients with limited health literacy may need greater cognitive effort to understand health information, evaluate recommendations, and make health decisions. These demands may be particularly relevant after stroke because patients often need to manage several long term health tasks at the same time. Better health literacy may reduce some of this burden by making disease related information easier to understand and apply. However, the cross-sectional design does not allow us to determine the direction of this relationship.

Self-regulatory fatigue was negatively associated with patient activation. Patient activation requires patients to maintain confidence and continue health related behaviors despite difficulties [5,6]. Greater self-regulatory fatigue may make it harder to sustain this level of involvement. Zhou et al. similarly found that self-regulatory fatigue was associated with lower patient activation and played a mediating role among patients receiving chemotherapy [12]. Although the study population differed from ours, the finding supports the possible relevance of self-regulatory fatigue to active health management.

In the present study, self-regulatory fatigue accounted for part of the association between health

literacy and patient activation. This suggests that health literacy may be related to patient activation partly through differences in patients' ability to sustain cognitive, emotional, and behavioral regulation. Other factors are also likely to contribute, including self-efficacy, illness perception, social support, and communication with healthcare professionals [3,9]. The mediation result should therefore be interpreted as one possible pathway rather than a complete explanation of the relationship.

The findings have practical implications for nursing care. Health education should focus on whether patients can understand and use the information provided, rather than simply increasing the amount of information delivered. Clear explanations, simple written materials, repeated reinforcement, and teach back may be useful for patients with lower health literacy. For patients who understand treatment recommendations but struggle to maintain long term self-management, nurses may also need to consider self-regulatory fatigue. Simplifying care plans, setting realistic goals, breaking complex recommendations into manageable steps, and providing follow up support may help reduce the burden of disease management.

Several limitations should be considered. The cross-sectional design does not establish temporal or causal relationships among health literacy, self-regulatory fatigue, and patient activation. Participants were recruited from a single hospital in northern China, which may limit generalizability. The main variables were assessed using self-report measures, and common method bias cannot be excluded. Residual confounding from factors such as depression, cognitive function, stroke severity, social support, and self-efficacy may also remain. Future longitudinal and intervention studies are needed to clarify the temporal relationships among these variables and to determine whether reducing self-regulatory fatigue can improve patient activation.

5. Conclusion

Among patients with stroke, higher health literacy was associated with greater patient activation and lower self-regulatory fatigue. Self-regulatory fatigue accounted for part of the association between health literacy and patient activation, suggesting that both health literacy and regulatory burden are relevant to patients' engagement in long term self-management. These findings support considering both factors in nursing assessment and support, while longitudinal studies are needed to clarify the direction of these relationships.

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