

Identifying the heterogeneity of physical resilience in Chinese older adult stroke patients using latent profile analysis and network analysis

Maohua Li

Harbin Medical University

Qing Li

XXXXXXXXXXXX

Rong Tang

Harbin Medical University

Yuqin Liu

Harbin Medical University

Wei Xue

Harbin Medical University

Yongkui Han

hanyongkui2011@163.com

Harbin Medical University

Research Article

Keywords: physical resilience, stroke, older adults, latent profile analysis, network analysis

Posted Date: July 1st, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10006507/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at BMC Geriatrics on August 20th, 2026. See the published version at <https://doi.org/10.1186/s12877-026-08101-6>.

Abstract

Background

Physical resilience varies widely among older stroke survivors, yet its latent heterogeneity and underlying psychosocial mechanisms remain unclear.

Aim

To identify distinct subgroups of physical resilience in older adults with stroke and to examine differences in network structures across these subgroups.

Design:

A cross-sectional study.

Methods

A total of 346 older adults with stroke were recruited from a tertiary Grade-A hospital in Daqing, China, between May 2025 and January 2026 using a convenience sampling method. Data were collected using the Physical Resilience Instrument for Older Adults (PRIFOR), the Perceived Social Support Scale (PSSS), the Patient Health Questionnaire-9 (PHQ-9), the Self-Rating Anxiety Scale (SAS), the Health Behavior Scale for Stroke Patients (HBS-SP) and the Stroke Self-Efficacy Questionnaire (SSEQ). Latent profile analysis and network analysis were performed.

Results

Three latent profiles were identified: low physical resilience–externally dependent profile (31.5%), moderate physical resilience–balanced profile (35.0%) and high physical resilience–proactive optimistic profile (33.5%). Education, comorbidities, social support, anxiety, depression, health behaviors, and rehabilitation self-efficacy predicted profile membership. Network structures were globally similar but differed significantly between moderate and high resilience groups; coping and lifestyle adjustment was the core bridge node.

Conclusion

Physical resilience in older stroke patients exhibits heterogeneous characteristics and can be categorised into three profiles with distinct network configurations. Nursing managers can provide targeted intervention strategies based on these profiles.

Patient or Public Contribution:

No patient or public contribution.

1 | Introduction

Stroke is one of the leading causes of disability and mortality among older adults globally. Its high recurrence rate and persistent functional deficits severely compromise patients' quality of life (Wang et al. 2022). With rapid population ageing, the proportion of older adults affected by stroke continues to rise. Data from the Global Burden of Disease Study 2021 (GBD 2021) indicate that China had 26.34 million prevalent stroke cases in 2021, with incidence increasing markedly with age

(Naghavi et al. 2025). In the context of population ageing, older adults carry not only the highest stroke risk but also the greatest disease burden.

Stroke survivors commonly experience multisystem physiological impairments. In the motor system, patients present with reduced muscle function, impaired coordination, and weakened motor control(Burton et al. 2022; Palmer et al. 2019; Zhang et al. 2022). In the nervous system, autonomic dysfunction increases susceptibility to myocardial injury and gastrointestinal disorders(Basantsova et al. 2017; Mihalovic and Tousek. 2021; Mo et al. 2019). In the immune system, lowered immunity raises the risk of infection and chronic inflammation(Brea 2023). Meanwhile, physical limitations and diminished quality of life often trigger a range of psychological problems(Singh et al. 2016). Collectively, these multisystem disruptions reduce stress resistance and hinder physical recovery following adverse events (Zhang 2024).

Stroke rehabilitation represents the most effective strategy to alleviate stroke-related disability(Powers et al. 2019). However, older adults with stroke typically experience a poorer prognosis and longer recovery trajectories than younger patients, largely due to age-related multisystem decline(Harada et al. 2019). Notably, clinical observations reveal striking heterogeneity in functional recovery even among patients with comparable lesion severity: some regain ambulation and social participation rapidly, whereas others remain bedridden long-term. This variability cannot be fully explained by stroke characteristics alone; it also reflects differences in the body's inherent capacity to resist and recover from stress(Whitson et al. 2016), and this intrinsic capacity lies at the core of physical resilience.

Physical resilience (PR) is an emerging geriatric concept introduced by the National Institute on Aging (NIA), referring to the ability to withstand physical stressors (as opposed to psychological or social stressors) and rapidly restore homeostasis. PR encompasses health, psychological, emotional, personality-related, and physiological domains, reflecting the body's capacity to counteract functional decline and restore health under physical stress(Mei et al. 2024). Shaped by age, genetics, and psychosocial factors, PR exhibits substantial individual differences(Sun and Zhu. 2024). Individuals with higher PR mount more effective adaptive responses, recover faster, and face lower risks of disability, hospital readmission, and all-cause mortality(Rui et al. 2024). As a dynamic construct, PR naturally declines with age, undermining health and well-being among older adults(Li et al. 2023). Against this backdrop, stroke contributes to heavy disability burdens and multisystem complications, resulting in long-term physical dysfunction; accordingly, physical rehabilitation is critically important for elderly stroke survivors.

Research on physical resilience in China is still at a preliminary stage, and empirical evidence among older adults with stroke remains scarce. Existing studies have explored conceptual frameworks, measurement tools, and associated factors(Shang et al. 2023), yet subgroup heterogeneity and network mechanisms of PR remain unexamined. Traditional variable-centered approaches overlook population heterogeneity and fail to capture complex interrelationships among multidimensional factors. As a person-centered method, latent profile analysis (LPA) identifies unobserved subgroups and characterizes distinct patterns of PR(Shan et al. 2021). Complementarily, network analysis quantifies interconnectedness among variables, pinpoints core and bridge nodes, and clarifies underlying mechanisms across subgroups(Xue et al. 2024). Together, LPA and network analysis enable a comprehensive understanding of PR that conventional methods cannot provide.

Therefore, this study combines latent profile analysis and network analysis to address two research questions: (1) Do distinct latent subgroups of physical resilience exist among older adults with stroke? (2) Do network structures of key influencing factors and three dimensions of physical resilience differ across these subgroups? By clarifying subgroups and network mechanisms, this study aims to generate evidence to support precise, stratified, and personalized rehabilitation interventions for older adults with stroke.

2 | Methods

2.1 | Design

This study adopted a cross-sectional design and followed the STROBE guidelines .

2.2 | Participants

A total of 346 elderly stroke patients were recruited from a tertiary Grade-A hospital in Daqing, Heilongjiang Province, between May 2025 and January 2026, using a convenience sampling method.

Inclusion criteria were: (1) age ≥ 60 years; (2) a confirmed diagnosis of stroke based on computed tomography (CT) or magnetic resonance imaging (MRI) findings; (3) being conscious, hemodynamically stable, and able to communicate effectively; and (4) voluntary participation with written informed consent.

Exclusion criteria were: (1) presence of severe organ dysfunction or malignant tumours; (2) audio-visual impairment or mental disorders that would prevent completion of the survey.

2.3 | Sample Size

The sample size was determined based on methodological recommendations for latent profile analysis (LPA). Simulation studies have indicated that each latent class should include at least 50 individuals to ensure robust parameter estimation (Yang 2006). Based on previous literature and clinical observations, we expected to identify 3 to 4 latent classes; therefore, a sample size of approximately 200 was considered sufficient. Considering a potential 10–20% invalid response rate, the target sample size was set at 240. A total of 368 questionnaires were distributed, and 346 valid questionnaires were returned, with an effective response rate of 94.02%, which met the preset requirement.

2.4 | Instruments

2.4.1 | General Information Questionnaire

This questionnaire, developed by the research team, collected sociodemographic and disease-related data: (1) sociodemographic data included age, gender, body mass index (BMI), education level, marital status, smoking history, drinking history, living status, travel time to the nearest tertiary hospital, and monthly household income per capita; (2) disease-related data included stroke type, lesion location, first stroke event, disease duration, and number of chronic comorbidities. All data were obtained from medical records and participant self-reports.

2.4.2 | Physical Resilience Instrument for Older Adults (PRIFOR)

The Physical Resilience Instrument for Older Adults (PRIFOR), developed by Hu et al. (2022), was used to assess physical resilience in older adults under acute stressors. The Chinese version was revised by Li et al. (2024), and has shown good reliability among Chinese older adults (Yang et al. 2026). The scale comprises 16 items across three dimensions: “Positive Thinking”, “Cope and Adjust Lifestyle”, and “Belief and Hopeful Mindset”. Each item is rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), with total scores ranging from 16 to 80. Higher scores indicate better physical resilience. In this study, the Cronbach's α of the PRIFOR was 0.943.

2.4.3 | Perceived Social Support Scale (PSSS)

The Perceived Social Support Scale (PSSS), developed by Zimet et al. (1988), was used to assess perceived social support. The Chinese version was revised by Jiang et al. (2001). The scale comprises 12 items across three dimensions: Family Support, Friend Support, and Other Support. Each item is rated on a 7-point Likert scale. Total scores range from 12 to 84. Higher scores indicate greater perceived social support. In this study, the Cronbach's α of the PSSS was 0.957.

2.4.4 | Patient Health Questionnaire (PHQ-9)

The Patient Health Questionnaire-9 (PHQ-9), developed by Kroenke et al. (2001), was used to assess depressive symptoms. The Chinese version was revised by Xu (2007). The scale comprises 9 items. Each item is rated on a 4-point Likert scale. Total scores range from 0 to 27. Higher scores indicate more severe depressive symptoms. In this study, the Cronbach's α of the PHQ-9 was 0.873.

2.4.5 | Self-Rating Anxiety Scale (SAS)

The Self-Rating Anxiety Scale (SAS), developed by Zung(1971), was used to assess anxiety symptoms. The scale comprises 20 items, including five reverse-scored items. Each item is rated on a 4-point Likert scale. Total scores range from 25 to 100. Higher scores indicate more severe anxiety. In this study, the Cronbach's α of the SAS was 0.848.

2.4.6 | Health Behavior Scale for Stroke Patients (HBS.SP)

The Health Behavior Scale for Stroke Patients (HBS-SP), developed by Wan et al.(2017), was used to assess health behaviors in stroke patients. The scale comprises 25 items across six dimensions. Each item is rated on a 4-point Likert scale ranging from 1 (never) to 4 (routinely), with several items reverse-scored. Total scores range from 25 to 100. Higher scores indicate better health behaviors. In this study, the Cronbach's α of the HBS-SP was 0.882.

2.4.7 | Stroke Self-Efficacy Questionnaire (SSEQ)

The Stroke Self-Efficacy Questionnaire (SSEQ), developed by Jones et al. (2008), was used to assess rehabilitation self-efficacy. The Chinese version was revised by Li et al.(2015). The scale comprises 11 items across two dimensions. Each item is rated on an 11-point scale ranging from 0 (no confidence at all) to 10 (completely confident). Total scores range from 0 to 110. Higher scores indicate stronger rehabilitation self-efficacy. In this study, the Cronbach's α of the SSEQ was 0.944.

2.4.8 | Modified Barthel Index (MBI)

The Modified Barthel Index (MBI) was used to assess activities of daily living. The scale comprises 10 items covering basic self-care functions. Total scores range from 0 to 100. Lower scores indicate greater dependence. For analytical purposes, total scores were dichotomized into intact and impaired self-care ability. In this study, the Cronbach's α of the MBI was 0.858.

2.5 | Data Collection

This study used a cross-sectional survey design for data collection. Investigators received unified training and explained the purpose, significance, completion instructions, and data confidentiality principles to participants using standardized statements. After obtaining written informed consent, questionnaires were distributed on a one-to-one basis. Participants completed the questionnaires independently; investigators only provided necessary clarification without influencing responses. Questionnaires were collected immediately after completion. Two investigators independently checked the completeness and logical consistency of each questionnaire. Missing items or logical inconsistencies were verified and corrected on the spot, and invalid questionnaires were excluded. A total of 368 questionnaires were distributed, and 346 valid questionnaires were recovered, with an effective response rate of 94.02%.

2.6 | Ethical Consideration

This study was conducted in strict accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of Harbin Medical University (approval number: HMUDQ20250617131). Written informed consent was obtained from all participants.

2.7 | Statistical Analyses

The statistical analyses for this study were conducted using SPSS 27.0 for descriptive statistics and correlation analysis, Mplus 8.3 for latent profile analysis, and R 4.4.1 for network analysis. The R packages qgraph, bootnet, and Network Comparison Test were used for network visualization, stability evaluation, and between-profile comparisons, respectively. A two-tailed $p < 0.05$ was considered statistically significant.

Descriptive statistics were conducted for all sociodemographic, clinical, and study variables. Continuous variables were reported as mean $\pm$ standard deviation (SD) or median (interquartile range, IQR) based on normality test results, and categorical variables as frequencies and percentages. Group comparisons were performed using chi-square tests, one-way ANOVA, or Kruskal–Wallis H tests as appropriate.

Latent profile analysis was conducted using the 16 items of the Physical Resilience Instrument for Older Adults to identify distinct subgroups. Models with 1 to 4 profiles were fitted sequentially. The optimal number of profiles was determined by the

Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), adjusted BIC (aBIC), entropy, the Lo-Mendell-Rubin (LMR) test, and the Bootstrap Likelihood Ratio Test (BLRT)(Kim 2014). Lower AIC, BIC, and aBIC values, higher entropy, and significant LMR and BLRT tests ($p < 0.05$) indicated better model fit(Steinley and Brusco. 2011).

Upon identifying the optimal profile solution, univariate analyses were used to compare sociodemographic, clinical, and psychosocial variables across profiles. Multinomial logistic regression was performed to explore independent factors associated with profile membership.

Separate network analysis was conducted for each subgroup to examine interrelationships among three dimensions of physical resilience (Positive Thinking, Coping and Lifestyle Adjustment, and Belief and Hope), perceived social support (PSSS), anxiety (SAS), depression (PHQ-9), health behaviours (HBS), and rehabilitation self-efficacy (SSEQ). Gaussian graphical models (GGM) were applied to estimate partial correlation networks(Epskamp et al. 2018). Expected influence (EI) centrality was used to identify core variables, whereas bridge centrality was employed to detect bridge nodes that connect physical resilience with other psychosocial factors(Robinaugh et al. 2016).

Network stability was verified using nonparametric bootstrapping (1,000 iterations) and assessed by the correlation stability (CS) coefficient; a CS coefficient ≥ 0.25 indicated acceptable stability(Epskamp et al. 2018). The Network Comparison Test (NCT) with 1,000 permutations was used to compare global network strength and structure between subgroups(Van Borkulo et al. 2023).

3 | Results

3.1 | Participants Characteristics

Among the 346 older adults with stroke, the mean age was 71.36 ± 7.36 years. More than half of the participants were male ($n = 194, 56.1\%$). The majority of participants were married ($n = 271, 78.3\%$), lived with their spouses ($n = 214, 61.8\%$), had ischemic stroke ($n = 337, 97.4\%$), and presented with multiple bilateral lesions ($n = 241, 69.7\%$). Additionally, 45.7% of participants had a BMI of $\geq 24 \text{ kg/m}^2$ ($n = 158$). Regarding health-related habits, 36.4% had a smoking history ($n = 126$) and 29.8% had a drinking history ($n = 103$). Other general characteristics are presented in Table 1. Physical resilience scores ranged from 28 to 78, with a mean score of 57.47 ± 11.22 , as shown in Table 2.

Table 1
Univariate analysis of latent classes of physical resilience among older adults with stroke (n = 346)

Variables	Number(n/%)	Low physical resilience: externally dependent profile (n = 109)	Moderate physical resilience: balanced profile (n = 121)	High physical resilience: proactive optimistic profile (n = 116)	Statistical value	P
Educational level					$\chi^2 = 47.460$	<0.001
Junior high school or below	227(65.6)	90(82.6)	89(73.6)	48(41.4)		
Senior high school or above	119(34.4)	19(17.4)	32(26.4)	68(58.6)		
One-way travel time to nearest tertiary hospital (minutes),					$\chi^2 = 44.985$	<0.001
<30	243(70.2)	60(55.0)	75(62.0)	108(93.1)		
≥ 30	103(29.8)	49(45.0)	46(38.0)	8(6.9)		
Monthly family income (RMB)					$H = 83.421$	<0.001
<3000	75(21.7)	35(32.1)	34(28.1)	6(5.20)		
3000 ~ 5000	160(46.2)	61(56.0)	64(52.9)	35(30.2)		
>5000	111(32.1)	13(11.9)	23(19.0)	75(64.7)		
Lesion site					$\chi^2 = 14.211$	0.001
Unilateral	105(30.3)	21(19.3)	35(28.9)	49(42.2)		
Bilateral multiple lesions	241(69.7)	88(80.7)	86(71.1)	67(57.8)		
Patients' stroke frequency					$\chi^2 = 17.832$	<0.001
First time	139(40.2)	31(28.4)	44(36.4)	64(55.2)		
Twice or more	207(59.8)	78(71.6)	77(63.6)	52(44.8)		

Table 1
(continued)

Variables	Number(n/%)	Low physical resilience: externally dependent profile (n = 109)	Moderate physical resilience: balanced profile (n = 121)	High physical resilience: proactive optimistic profile (n = 116)	Statistical value	P
Disease duration					$\chi^2 = 12.605$	0.002
<6 months	148(42.8)	35(32.1)	49(40.5)	64(55.2)		
≥ 6 months	198(57.2)	74(67.9)	72(59.5)	52(44.8)		
Number of comorbid chronic diseases					$\chi^2 = 61.639$	<0.001
<3	261(75.4)	54(49.5)	99(81.8)	108(93.1)		
≥ 3	85(24.6)	55(50.5)	22(18.2)	8(6.9)		
Complete self-care ability					$\chi^2 = 57.769$	<0.001
Yes	188(54.3)	28(25.7)	73(60.3)	87(75.0)		
No	158(45.7)	81(74.3)	48(39.7)	29(25.0)		
PSSS score, M(P25,P75)	54.0(46, 64)	44(38, 50)	51(48, 58)	66.5(61, 70)	H = 199.397	<0.001
SAS score, M(P25,P75)	35(30, 52)	56(50, 64.5)	36(32, 44)	28(27, 30)	H = 241.060	<0.001
PHQ-9 score, M(P25,P75)	4(2,8)	10(7,13)	4(3,6)	1(0,2)	H = 237.553	<0.001
HBS.SP score, M(P25,P75)	71(65,80)	64(60,69)	70(65,75)	82(77,87)	H = 160.142	<0.001
SSEQ score, M(P25,P75)	98(90,104)	88(70.5,96)	98(91.5,102)	104(100,107)	H = 131.023	<0.001
PSSS score, M(P25,P75)	54.0(46,64)	44(38,50)	51(48,58)	66.5(61,70)	H = 199.397	<0.001
SAS score, M(P25,P75)	35(30,52)	56(50,64.5)	36(32,44)	28(27,30)	H = 241.060	<0.001

Table 2
Total scores and dimensional scores of physical resilience among older adults with stroke (n = 346)

Variables	Total score	Mean item score
Physical resilience	57.47 ± 11.22	3.59 ± 0.70
Positive thinking	14.64 ± 4.11	3.66 ± 1.03
Cope and adjust lifestyle	27.16 ± 4.61	3.88 ± 0.66
Belief and hopeful mindset	15.67 ± 3.41	3.13 ± 0.68

3.2 | Latent Profile Analysis of Physical Resilience Among Older Adults With Stroke

Using the scores of 16 items on the Physical Resilience Scale among 346 older adults with stroke as explicit indicators, latent profile analysis was performed. Models with 1 to 4 profiles were fitted sequentially (Table 3). The results revealed that the values of AIC, BIC and aBIC gradually decreased when the number of profiles increased from 1 to 3, and both LMR and BLRT tests reached statistical significance (all $P < 0.05$). When the profile number rose to 4, the entropy value decreased, and the LMR test was no longer significant ($P > 0.05$). By comprehensively comparing all model fitting indices, the three-profile model was identified as the optimal fitting model. In this model, the average membership probabilities of the three latent profiles were 0.966, 0.986 and 0.985 respectively, all exceeding 0.90, and the off-diagonal probability values were close to zero, indicating high classification accuracy and satisfactory discriminative validity of the model.

Table 3
Fit Indices of Latent Profile Analysis for Physical Resilience in Older Adults with Stroke

Class	P-value							
	LL	AIC	BIC	aBIC	Entropy	LMR	BLRT	Class probability(%)
1	-6878.632	13821.263	13944.349	13842.836	-	-	-	-
2	-5279.679	10657.359	10845.834	10690.392	0.974	<0.001	<0.001	0.410/0.590
3	-4806.014	9744.028	9997.893	9788.522	0.951	0.0286	<0.001	0.350/0.315/0.335
4	-4544.287	9254.575	9573.829	9310.529	0.950	0.2871	<0.001	0.133/0.254/0.335/0.277

Based on the explicit characteristics of scores across all dimensions and items, the three latent profiles were named accordingly (Fig. 1). A total of 109 cases (31.5%) were classified into Profile 2 (C2). Participants in this subgroup obtained the lowest scores on all items, but exhibited obvious peaks on Item 5 ("After illness or injury, I can adapt to changes in my life"), Item 6 ("I learn to flexibly adjust my lifestyle from illness or injury"), and Item 7 ("During illness or injury, I can receive help from family and friends"). These findings indicated that although these patients lack intrinsic positive beliefs, they tend to rely on external environmental adaptation and social support. Their physical resilience primarily derives from external support rather than internal motivation. Therefore, this subgroup was named Low physical resilience: externally dependent profile. Profile 1 accounted for 35% of all participants ($n = 121$). This subgroup had average scores on all items between those of C2 and C3, indicating an overall moderate level of physical resilience. Additionally, the score curve was relatively stable without drastic fluctuations. Thus, this subgroup was named Moderate physical resilience: balanced profile. Profile 3 contained 116 participants (33.5%), who scored higher on all items than the other two subgroups. Notably, they achieved the highest average scores on items under the dimensions of Positive thinking and Cope and adjust lifestyle, reflecting their strengths in viewing things positively and actively adjusting behaviors. Accordingly, this subgroup was named High physical resilience: proactive optimistic profile. Comparisons of physical resilience scores among different profiles of older adults with stroke are presented in Table 4.

Table 4
Comparison of physical resilience scores among older adults with stroke across different latent classes

Classes	Number	Total score	Positive thinking	Cope and adjust lifestyle	Belief and hopeful mindset
Low physical resilience: externally dependent profile	109	44.10 ± 5.37	9.83 ± 1.87	21.98 ± 2.98	12.28 ± 2.15
Moderate physical resilience: balanced profile	121	57.86 ± 3.74	14.74 ± 2.06	27.29 ± 1.87	15.83 ± 2.43
High physical resilience: proactive optimistic profile	116	69.64 ± 4.10	19.05 ± 1.15	31.90 ± 1.95	18.69 ± 2.07
<i>F</i>		934.683	786.20	521.53	232.99
<i>P</i>		< 0.001	< 0.001	< 0.001	< 0.001
Note: Tamhane's T2 test was applied in cases of unequal variances.					

3.3 | Univariate Analysis and Multivariate Logistic Regression Analysis of Physical Resilience Latent Profiles in Elderly Stroke Patients

Univariate analysis revealed statistically significant differences ($P < 0.05$) among the three physical resilience subgroups in educational level, one-way travel distance to the nearest tertiary hospital, per capita monthly household income, lesion site, number of strokes, disease course, number of combined chronic diseases, complete self-care status, perceived social support score, anxiety score, depression score, health behavior score, and rehabilitation self-efficacy score (Table 5).

Before constructing the multivariate regression model, variance inflation factor (VIF) and tolerance values were used to diagnose collinearity among all candidate independent variables. The results indicated a high correlation between disease course and first-ever stroke ($VIF > 5$, tolerance < 0.2). To avoid model estimation bias, disease course was excluded from the final regression model, and only first-ever stroke, which was considered more clinically significant, was retained.

A multinomial logistic regression model was constructed with the three latent profiles of physical resilience in elderly stroke patients as dependent variables (with the moderate physical resilience-balanced development group as the reference group), and statistically significant factors derived from univariate analysis as independent variables. The results indicated that educational level, number of combined chronic diseases, perceived social support score, anxiety score, depression score, health behavior score, and rehabilitation self-efficacy score were influencing factors of latent profiles of physical resilience in elderly stroke patients (Table 6).

Table 6

Multivariate logistic regression analysis of latent classes of physical resilience in older adults with stroke (n = 346)

Dependent variable	Independent variable	Reference group	β	SE	Wald χ^2	P	OR	95%CI
Low physical resilience: externally dependent profile	Constant		3.150	4.091	0.593	0.441		
	Educational level	Senior high school or above						
	Junior high school or below		1.645	0.789	4.246	0.039	5.180	1.084 ~ 24.761
	Number of comorbid chronic diseases	≥ 3						
	< 3		-2.649	0.724	13.390	0.000	0.071	0.017 ~ 0.292
	PSSS score		-0.107	0.041	6.698	0.010	0.899	0.829 ~ 0.974
	SAS score		0.161	0.041	15.386	0.000	1.175	1.084 ~ 1.273
	PHQ-9 score		0.337	0.125	7.229	0.007	1.401	1.096 ~ 1.791
	HBS.SP score		0.046	0.045	1.006	0.316	1.047	0.957 ~ 1.144
	SSEQ score		-0.120	0.034	12.131	0.000	0.887	0.829 ~ 0.949
High physical resilience: proactive optimistic profile	Constant		-24.840	7.459	11.088	0.001		
	Educational level	Senior high school or above						
	Junior high school or below		0.006	0.650	0.000	0.993	1.006	0.282 ~ 3.594

Table 6
(continued)

Dependent variable	Independent variable	Reference group	β	SE	Wald χ^2	P	OR	95%CI
	Number of comorbid chronic diseases	≥ 3						
	< 3		1.574	0.742	4.501	0.034	4.827	1.127 ~ 20.667
	PSSS score		0.248	0.059	17.828	0.000	1.282	1.142 ~ 1.438
	SAS score		-0.224	0.089	6.407	0.011	0.799	0.672 ~ 0.951
	PHQ-9 score		-0.414	0.212	3.802	0.051	0.661	0.436 ~ 1.002
	HBS.SP score		0.103	0.050	4.284	0.038	1.109	1.005 ~ 1.223
	SSEQ score		0.078	0.035	4.853	0.028	1.081	1.009 ~ 1.158

3.4 | Network Analysis of Different Physical Resilience Subgroups

Although the above regression analysis identified influencing factors, it failed to reveal the interactions between these factors and the dimensions of physical resilience within each subgroup. Therefore, network analysis was performed for the three subgroups. The correlation networks for each physical resilience subgroup are illustrated in Fig. 2. Nodes represent the three dimensions of physical resilience (Positive Thinking, Coping and Lifestyle Adjustment, and Belief and Hope), perceived social support (PSSS), anxiety (SAS), depression (PHQ-9), health behaviours (HBS.SP), and rehabilitation self-efficacy (SSEQ). Edges denote positive (blue) and negative (red) correlations, with edge thickness and colour saturation indicating correlation strength.

3.4.1 | Network Stability Testing and Between-Group Network Difference Testing

Edge weight bootstrap stability analyses (1,000 iterations) indicated reliable edge weight estimates across all three physical resilience subgroups, with narrow confidence intervals and consistent edge ordering (Supplementary Figures S1–S3). The CS coefficients for the low, moderate, and high resilience subgroups, corresponding to the externally dependent, balanced, and proactive optimistic profiles, were 0.596, 0.281, and 0.362 respectively. All values exceeded the recommended threshold of 0.25, indicating acceptable stability of the centrality indices (Epskamp et al. 2018).

The Network Comparison Test (NCT) revealed no significant differences in global network strength among the three subgroups (all $p > 0.05$). In terms of network structure invariance, no significant disparities were observed between low and moderate subgroups, as well as low and high subgroups (both $p > 0.05$). Nevertheless, there was a remarkable difference in network structure between moderate and high subgroups ($p = 0.035$). These results demonstrated that overall network connectivity was not affected by physical resilience levels, whereas obvious distinct connectivity patterns existed between balanced and proactive optimistic profiles.

3.4.2 | Local Network Characteristics of Each Subgroup

Figure 2(a) illustrates the network of the Low physical resilience: externally dependent profile, with a density of 0.321 and 9 non-zero edges. Structurally, Cope and adjust lifestyle (W2) occupied the central position, showing strong positive correlations with perceived social support (PSSS) and rehabilitation self-efficacy (SSEQ). Positive thinking (W1) was located

at the network periphery, forming a local cluster with anxiety (SAS) and depression (PHQ), while its connections with the other two physical resilience dimensions were weak. The centrality plot (Fig. 2b) indicated that Cope and adjust lifestyle (W2) had the highest positive expected influence ($EI = 1.481$), acting as the key node driving the network. Positive thinking (W1) exhibited negative expected influence ($EI = -0.750$), suggesting a protective buffering role. Bridge strength analysis (Fig. 2c) showed that Cope and adjust lifestyle (W2) had the highest bridge strength (1.379), serving as the primary node linking physical resilience dimensions to influencing factors.

Figure 2(d) presents the network of the moderate physical resilience: balanced profile, with a density of 0.286 and 8 non-zero edges. Compared with the low-resilience profile, the network density was slightly lower, but the node association patterns showed new characteristics. Cope and adjust lifestyle (W2) remained the core node, maintaining strong positive associations with perceived social support (PSSS) and rehabilitation self-efficacy (SSEQ). The centrality plot (Fig. 2e) indicated that Cope and adjust lifestyle (W2) had the highest positive expected influence ($EI = 1.172$), while Positive thinking (W1) showed enhanced negative expected influence ($EI = -1.002$). Bridge strength analysis (Fig. 2f) revealed that Cope and adjust lifestyle (W2) remained the main bridge node; although the bridge strength of Positive thinking (W1) increased compared with the previous group, it was still mainly limited to connections with negative emotional variables and had not yet formed cross-domain connections.

Figure 2(g) displays the network of the high physical resilience: proactive optimistic profile, with a density of 0.536 and 15 non-zero edges, representing the densest connectivity among the three subgroups. Cope and adjust lifestyle (W2) retained its core position, with significantly strengthened positive correlations with perceived social support (PSSS), rehabilitation self-efficacy (SSEQ), and health behaviours (HBS.SP). Belief and hopeful mindset (W3) showed elevated positive expected influence ($EI = 0.662$). Instead of connecting with only a single variable, it formed multi-directional connections with Positive thinking (W1), perceived social support (PSSS), and health behaviours (HBS.SP). The centrality plot (Fig. 2h) indicated that Cope and adjust lifestyle (W2) still had the highest positive expected influence ($EI = 1.749$), and health behaviours (HBS.SP) also showed markedly increased positive expected influence ($EI = 0.605$). Bridge strength analysis (Fig. 2i) showed that Cope and adjust lifestyle (W2) had the highest bridge strength (1.472), and health behaviours (HBS.SP) had significantly increased bridge strength (0.958), emerging as a secondary bridge node.

3.4.3 | Exploratory Edge Weight Differences

Additional exploratory analysis of edge weight differences revealed that the association between Cope and adjust lifestyle (W2) and Belief and hopeful mindset (W3) was the edge with the largest difference between the low and high physical resilience subgroups. Specifically, the edge weight of the W2–W3 connection was 0.41 in the low-resilience subgroup, whereas it was 0 in the high-resilience subgroup, yielding a difference of 0.41 (Supplementary Figures S4).

Further analysis of the connectivity pattern of W3 showed that in the low-resilience subgroup, W3 was relatively isolated, maintaining only a single connection with W2. In contrast, in the high-resilience subgroup, W3 demonstrated significantly enhanced connectivity, forming three valid connections with Positive thinking (W1), perceived social support (PSSS), and health behaviours (HBS.SP). These findings indicate that the coupling mechanism between behavioural coping and hopeful mindset, as well as the pivotal role of W3 in the network, differ fundamentally between the two resilience patterns.

4 | Discussion

This study, for the first time, adopted LPA combined with NA to explore the latent subgroup characteristics and psychosocial network mechanisms of physical resilience in elderly stroke patients. Three subgroups of physical resilience were identified: Low physical resilience: externally dependent profile, Moderate physical resilience: balanced profile, and High physical resilience: proactive optimistic profile. Further network analysis revealed that although the global network strength was comparable across the three groups, significant differences existed in network structure between the moderate and high physical resilience profiles. These findings indicate that variations in physical resilience among elderly stroke patients mainly stem from distinct psychobehavioral coupling patterns, rather than an individual variables alone (Van Schoor et al. 2022).

4.1 | Heterogeneity of Physical Resilience Among Elderly Stroke Patients

Latent profile analysis confirmed that physical resilience among elderly stroke patients is not a single continuum but exhibits significant group heterogeneity, which can be stably categorized into three subtypes.

The Low physical resilience: externally dependent profile accounted for 31.5%. Patients in this subtype demonstrated an overall low level of physical resilience, with the lowest scores particularly in the “Positive thinking” dimension. This reflects a lack of positive illness perception and intrinsic rehabilitation beliefs, leading to negative attitudes toward recovery. Nevertheless, they obtained relatively higher scores on certain items within the “Cope and adjust lifestyle” dimension. This suggests that despite insufficient internal motivation, these patients retain a degree of environmental adaptability, and their physical resilience relies more heavily on external support. These findings mirror the prevalent psychological vulnerability among older adults with advanced age and multimorbidity(Xu et al. 2025; Yang et al. 2026). Consequently, this group is highly susceptible to negative emotions and demonstrates low engagement in rehabilitation, marking them as a high-risk population requiring close clinical attention(Seok and Lee 2025; Yuan et al. 2024).

The Moderate physical resilience: balanced profile was the largest subgroup (35%), characterized by moderate and balanced scores across all dimensions. Patients in this subtype are in a transitional state from external dependence to internal drive. Given their high plasticity, this group represents the population with the greatest potential for intervention.

The High physical resilience: proactive optimistic profile comprised 33.5% of the sample. Scores across all dimensions were significantly higher than those in the other two subgroups, with particularly prominent performance in the “Positive thinking” and “Cope and adjust lifestyle” dimensions. This indicates that these patients possess strong intrinsic rehabilitation beliefs; they confront the disease with a positive mindset, proactively adjust their lifestyles, persist in rehabilitation exercises, and maintain a strong sense of conviction and hope.

Building on this, multivariate logistic regression further identified the independent factors distinguishing the three subtypes: education level, number of comorbid chronic diseases, perceived social support, anxiety, depression, health behaviors, and rehabilitation self-efficacy. Together, these constitute the core influence system for the heterogeneity of physical resilience. Specifically, a lower education level and multimorbidity significantly increased the risk of patients being classified into the Low physical resilience: externally dependent profile(Van Schoor et al. 2022; Qiao et al. 2025). In contrast, robust social support, healthy behaviors, and high self-efficacy served as protective factors for the Moderate physical resilience: balanced profile as well as the High physical resilience: proactive optimistic profile(Duan-Porter et al. 2016; Sotos-Prieto et al. 2021). Meanwhile, anxiety and depression levels showed a distinct gradient across the three subtypes, effectively differentiating them. This finding aligns with previous research indicating that psychological distress undermines physical resilience in older adults with chronic conditions(Zhao et al. 2024). These modifiable psychological and behavioral factors provide a crucial theoretical basis for precision rehabilitation interventions in elderly stroke patients.

4.2 | Network Mechanisms of Physical Resilience Heterogeneity

Network analysis results showed that the three physical resilience subtypes demonstrated high consistency in global network topology and overall connectivity strength: all groups had similar network density, with no statistically significant differences in global strength. This indicates that the underlying relational patterns between physical resilience and psychosocial factors among older adult stroke patients are stable across subtypes, and no fundamental structural reorganization occurs due to differences in resilience levels.

Despite this homogeneity in global network architecture, the edge weights of specific key pathways showed significant heterogeneity across subtypes, which constitutes the core mechanism of physical resilience heterogeneity. Taking the negative association between anxiety (SAS) and positive thinking (W1) as an example: in the low physical resilience subtype, this negative edge weight was the strongest, suggesting that the inhibitory effect of negative emotions on positive thinking

was significantly amplified in this group; in the high physical resilience subtype, this negative association was significantly weakened, indicating that protective regulatory mechanisms effectively buffered the inhibitory effect of anxiety.

Among all subtype-specific associations, the dynamic coupling pattern between Cope and adjust lifestyle (W2) and Belief and hopeful mindset (W3) demonstrated the greatest subtype discriminant validity. In the low physical resilience subtype, these two variables exhibited a high positive association, suggesting that resilience maintenance was highly dependent on the tight coupling between Cope and adjust lifestyle (W2) and hopeful mindset (W3). In the medium and high physical resilience subtypes, however, this direct association disappeared, indicating that as resilience levels increase, hopeful mindset (W3) is no longer solely dependent on Cope and adjust lifestyle (W2) but shifts toward collaborative integration with multiple resources such as social support and emotion regulation, forming a more intrinsically driven regulatory pattern. These differential reconfigurations of key local associations provide a profound explanation for why the three groups of patients still exhibit significant gradient differences in resilience function despite similar global networks.

Based on this network mechanism, clinical interventions should adopt stratified precision strategies: for patients with low physical resilience, the primary task is to block the excessive inhibition of positive thinking by anxiety; for patients with medium and high physical resilience, the focus should be on promoting the collaborative integration of hopeful mindset with multiple social resources to consolidate their endogenous protective networks. These findings provide clear network targets for precision rehabilitation in older adult stroke patients.

4.3 | Implications for Clinical Nursing Practice

This study identified three heterogeneous subtypes of physical resilience among older adult stroke patients, with educational level, comorbidity burden, negative emotions, social support, health behaviors, and rehabilitation self-efficacy confirmed as key influencing factors. These findings provide an important evidence base for shifting rehabilitation nursing for older adult stroke patients from experience-based care to precision, stratified interventions.

Given the substantial differences in psychobehavioral characteristics and influencing factors across subtypes, clinical nurses should integrate screening for physical resilience and its subtypes into the admission rehabilitation assessment. A validated physical resilience scale may be used, combined with core variables including educational level, number of comorbidities, anxiety and depression, social support, health behaviors, and rehabilitation self-efficacy, to early identify patients with Low physical resilience: externally dependent profile. This subgroup relies heavily on external support but lacks intrinsic motivation, with anxiety and depression markedly inhibiting positive thinking, rendering them vulnerable to functional decline. They should be prioritized for targeted assessment and intervention to guide subsequent precision nursing.

For patients with Low physical resilience: externally dependent profile, psychological interventions should be prioritized: cognitive behavioral therapy or mindfulness-based stress reduction may be applied to help patients identify and reframe negative illness perceptions, thereby blocking the excessive inhibition of positive thinking by negative emotions. Concurrently, the social support system should be strengthened by guiding family members to provide appropriate assistance rather than excessive substitutional care, and multi-dimensional support networks should be established through peer support groups and community resource linkages, gradually translating external support into intrinsic rehabilitation motivation.

For patients with Moderate physical resilience: balanced profile, this subgroup exhibits balanced scores across all dimensions with no obvious weaknesses nor distinct strengths, representing the subgroup with the greatest potential for intervention. Nursing care should focus on enhancing rehabilitation self-efficacy and consolidating health behaviors: set stepwise rehabilitation goals to build confidence through successful experiences; reinforce positive feedback and peer modeling to foster proactive engagement. Meanwhile, guidance on balanced diet, regular exercise, and medication adherence should be strengthened to help patients establish stable rehabilitation behavioral patterns and facilitate progression toward High physical resilience: proactive optimistic profile.

For patients with High physical resilience: proactive optimistic profile, this subgroup possesses strong intrinsic beliefs and behavioral initiative, serving as a positive resource in the rehabilitation process. Nursing priorities focus on maintaining

strengths and preventing regression: regular follow-ups and individualized rehabilitation plan adjustments help sustain positive states and mitigate functional decline due to plateaus or complications. Additionally, these patients may be invited to participate in peer education, sharing experiences and acting as role models to enhance rehabilitation engagement among peers and foster a positive rehabilitation climate.

Furthermore, targeted supportive measures should be implemented in clinical practice addressing key influencing factors: (1) For patients with lower educational levels, simplified, visual educational materials should be adopted to reduce cognitive barriers and improve accessibility to rehabilitation knowledge; (2) For patients with high comorbidity burden, integrated rehabilitation plans should be developed to manage comorbidities alongside stroke rehabilitation, avoiding depletion of physical and psychological resources; (3) A family-peer-community social support system should be established, guiding families to provide appropriate support; (4) Rehabilitation self-efficacy should be targeted through stepwise goal-setting and successful experiences to continuously enhance patient confidence.

5 | Conclusion

This study identified three distinct physical resilience subtypes among older adult stroke patients: Low physical resilience (externally dependent profile), Moderate physical resilience (balanced profile), and High physical resilience (proactive optimistic profile). It further elucidated the psychosocial network mechanisms of these subtypes. The findings confirm that physical resilience heterogeneity is not reflected in global network architecture but arises from subtype-specific reconfiguration of local key pathways, particularly the dynamic coupling between behavioral coping and hopeful mindset, as well as the inhibitory linkage between anxiety and positive thinking.

Multiple modifiable factors including educational level, comorbidity burden, negative emotions, social support, health behaviors, and rehabilitation self-efficacy were confirmed as key influencing factors of resilience profiles. These factors, together with the identified network patterns, provide an empirical basis for stratified, precision rehabilitation nursing. From a clinical perspective, integrating resilience subtype screening into routine admission assessment is recommended, with subtype-specific interventions: reducing negative emotional inhibition in the low-resilience group, enhancing motivational and behavioral integration in the moderate-resilience group, and sustaining proactive adaptation in the high-resilience group.

Overall, physical resilience in older adult stroke patients is a dynamic, networked system shaped by psychosocial interactions rather than a simple continuum. These findings provide actionable evidence to refine rehabilitation strategies and improve holistic care for this vulnerable population.

5.1 | Limitations and Future Directions

This study has several limitations. First, the cross-sectional design limits the ability to establish causal relationships between the identified psychosocial factors and physical resilience subtypes. Second, participants were recruited from a single tertiary hospital using convenience sampling, which may restrict the generalisability of the findings to community or primary care settings. Third, all data were based on self-report measures, which may introduce response bias, and objective clinical indicators were not incorporated.

Future research should address these limitations. Longitudinal studies are needed to track changes in resilience profiles over the rehabilitation trajectory and validate the causal pathways observed. Multi-centre studies with larger, more diverse samples are required to confirm the stability and generalisability of the three-profile structure. Integrating objective physiological data and clinical outcomes into the analysis would provide a more comprehensive understanding of resilience mechanisms. Furthermore, intervention studies targeting key influencing factors and profile-specific characteristics are warranted to test the effectiveness of stratified nursing strategies.

6. | Declarations

Ethics Statement

This study has been approved by the Ethics Committee of Harbin Medical University (approval number: HMUDQ20250617131), and it conformed to the ethical guidelines of the Declaration of Helsinki. All subjects agreed to participate in the study voluntarily. Before starting the survey, participants provided written informed consent. During the investigation, participants were free to terminate their participation and withdraw at any time. They were assured that their information would only be used for research.

Declarations

Ethics Statement

This study has been approved by the Ethics Committee of Harbin Medical University (approval number: HMUDQ20250617131), and it conformed to the ethical guidelines of the Declaration of Helsinki. All subjects agreed to participate in the study voluntarily. Before starting the survey, participants provided written informed consent. During the investigation, participants were free to terminate their participation and withdraw at any time. They were assured that their information would only be used for research.

Consent for publication

All 346 older adult stroke patients provided informed consent for their anonymized survey data to be used for research and publication. This manuscript contains no identifiable personal information.

Data Availability Statement

The datasets generated and analysed in this study are not publicly available due to the principle of confidentiality. They are available from the corresponding author upon reasonable request.

Declaration of competing interest

The authors declare no competing interests.

Funding

No funding was received for this study.

Author contributions

Maohua Li, Qing Li: Conceptualization, Methodology, Software, Investigation, Formal analysis, Writing - Original Draft, Writing - Review & Editing. Rong Tang, Yuqin Liu: Investigation, Data curation, Validation. Wei Xue: Visualization, Writing - Review & Editing. Yongkui Han: Supervision, Project administration, Methodology, Writing- Reviewing and Editing, Resources.

Acknowledgements

The authors sincerely appreciate the 346 older adult stroke patients who participated in the survey.

References

1. Basantsova, N. Yu., Tibekina, L. M., and Shishkin, A. N. (2017). A role of the autonomic nervous system in cerebro-cardiac disorders. *Zhurnal Nevrologii I Psikhiatrii Im. S.S. Korsakova*, 117(11), 153. <https://doi.org/10.17116/jnevro2017117111153-160>
2. Brea, D. (2023). Post-stroke immunosuppression: Exploring potential implications beyond infections. *European Journal of Neuroscience*, 58(11), 4269–4281. <https://doi.org/10.1111/ejn.16174>

3. Burton, J. K., Stewart, J., Blair, M., Oxley, S., Wass, A., Taylor-Rowan, M., and Quinn, T. J. (2022). Prevalence and implications of frailty in acute stroke: Systematic review & meta-analysis. *Age and Ageing*, 51(3), afac064. <https://doi.org/10.1093/ageing/afac064>
4. Dong, R., Zhao, L. B., and Liu, L. (2024). Status quo of research on physical resilience in the elderly. *Chinese Journal of Multiple Organ Diseases in the Elderly*, 23(9), 713–716.
5. Duan-Porter, W., Cohen, H. J., Demark-Wahnefried, W., Sloane, R., Pendergast, J. F., Snyder, D. C., and Morey, M. C. (2016). Physical resilience of older cancer survivors: An emerging concept. *Journal of Geriatric Oncology*, 7(6), 471–478. <https://doi.org/10.1016/j.jgo.2016.07.009>
6. Epskamp, S., Borsboom, D., and Fried, E. I. (2018). Estimating psychological networks and their accuracy: A tutorial paper. *Behavior Research Methods*, 50(1), 195–212. <https://doi.org/10.3758/s13428-017-0862-1>
7. Harada, S., Inatomi, Y., Nakajima, M., Yonehara, T., and Ando, Y. (2019). Clinical characteristics of oldest-old patients with ischemic stroke. *Rinsho Shinkeigaku*, 59(3), 125–132. <https://doi.org/10.5692/clinicalneuro.001262>
8. Hu, F. W., Lin, C. H., Yueh, F. R., Lo, Y. T., and Lin, C. Y. (2022). Development and psychometric evaluation of the physical resilience instrument for older adults (PRIFOR). *BMC Geriatrics*, 22(1), 229. <https://doi.org/10.1186/s12877-022-02918-7>
9. Jones, F., Partridge, C., and Reid, F. (2008). The stroke self-efficacy questionnaire: Measuring individual confidence in functional performance after stroke. *Journal of Clinical Nursing*, 17(7b), 244–252. <https://doi.org/10.1111/j.1365-2702.2008.02333.x>
10. Jiang, Q. J. 2001. Perceived Social Support Scale (PSSS). *Chinese Journal of Behavioral Medical Science* 10, no. 10: 41–43.
11. Kim, S.Y. (2014). Determining the number of latent classes in single- and multiphase growth mixture models. *Structural Equation Modeling: A Multidisciplinary Journal*, 21(2), 263–279. <https://doi.org/10.1080/10705511.2014.882690>
12. Kroenke, K., Spitzer, R. L., and Williams, J. B. W. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine*, 16(9), 606–613. <https://doi.org/10.1046/j.1525-1497.2001.016009606.x>
13. Li, J. X., Liu, Z. W., Wang, Y. Y., Shang, Y. M., Zhang, Y. J., Li, Y. G., and Liu, F. L. (2023). Research progress of physical resilience in older adults. *CHINESE NURSING RESEARCH*, 37(11), 1934–1939.
14. Li, J. X., Liu, J., Liu, Z. W., et al. Revision of Simplified Chinese Version of the Physical Resilience Instrument for older Adults and Its Reliability and Validity Test[J]. *Mil Nurs*, 2024, 41(10): 48-51. <https://doi.org/10.3969/j.issn.2097-1826.2024.10.012>
15. Li, H. Y., Fang, L., Bi, R. X., et al. The reliability and validity of the Chinese version of Stroke Self-Efficacy Questionnaire. *Chin J Nurs* 2015, 50(7): 790-794. <https://doi.org/10.3761/j.issn.0254-1769.2015.07.005>
16. Mei, A. Y., Xi Chen, X. and Han, B. R. (2024). Research progress of physical resilience assessment methods for the elderly in the context of healthy aging. *Chinese Journal of Modern Nursing*, 30(24), 3357–3360. <https://doi.org/10.3760/cma.j.cn115682-20231020-01606>
17. Mihalovic, M., and Tousek, P. (2021). Myocardial injury after stroke. *Journal of Clinical Medicine*, 11(1), 2. <https://doi.org/10.3390/jcm11010002>
18. Mo, J., Huang, L., Peng, J., Ocak, U., Zhang, J., and Zhang, J. H. (2019). Autonomic disturbances in acute cerebrovascular disease. *Neuroscience Bulletin*, 35(1), 133–144. <https://doi.org/10.1007/s12264-018-0299-2>
19. Naghavi, M., Kyu, H. H., A, B., Aalipour, M. A., Aalruz, H., Ababneh, H. S., Abafita, B. J., Abaraogu, U. O., Abbafati, C., Abbasi, M., Abbaspour, F., Abbastabar, H., Abd Al Magied, A. H. A., Abd ElHafeez, S., Abdalla, A. N., Abdalla, M. A., Abdallah, E. M., Abdeeq, B. A., Abdel Razeq, N. M. I., ... Murray, C. J. L. (2025). Global burden of 292 causes of death in 204 countries and territories and 660 subnational locations, 1990–2023: A systematic analysis for the global burden of disease study 2023. *Lancet*, 406(10513), 1811–1872. [https://doi.org/10.1016/S0140-6736\(25\)01917-8](https://doi.org/10.1016/S0140-6736(25)01917-8)
20. Palmer, K., Vetrano, D. L., Padua, L., Romano, V., Rivoiro, C., Scelfo, B., Marengoni, A., Bernabei, R., and Onder, G. (2019). Frailty syndromes in persons with cerebrovascular disease: A systematic review and meta-analysis. *Frontiers in Neurology*, 10, 1255. <https://doi.org/10.3389/fneur.2019.01255>

21. Powers, W. J., Rabinstein, A. A., Ackerson, T., Adeoye, O. M., Bambakidis, N. C., Becker, K., Biller, J., Brown, M., Demaerschalk, B. M., Hoh, B., Jauch, E. C., Kidwell, C. S., Leslie-Mazwi, T. M., Ovbiagele, B., Scott, P. A., Sheth, K. N., Southerland, A. M., Summers, D. V., Tirschwell, D. L., and on behalf of the American Heart Association Stroke Council. (2019). Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke*, 50(12).
<https://doi.org/10.1161/STR.0000000000000211>
22. Qian Sun and Wenjuan Zhu. (2024). Research progress of physical resilience in the elderly from the perspective of society ecosystems theory. *CHINESE NURSING RESEARCH*, 38(20), 3670–3674.
23. Qiao, L.M., Zhao, Y. N., Liu, Y., Zhang, P., and Zhao, D. Y., (2025). Study on influencing factors of social frailty in elderly patients with mild ischemic stroke. *Chin J Nurs* 60(10), 1251–1256. <https://doi.org/10.3761/j.issn.0254-1769.2025.10.015>
24. Robinaugh, D. J., Millner, A. J., and McNally, R. J. (2016). Identifying highly influential nodes in the complicated grief network. *Journal of Abnormal Psychology*, 125(6), 747–757. <https://doi.org/10.1037/abn0000181>
25. Shan, Y., Shang, J., Yan, Y., Lu, G., Hu, D., and Ye, X. (2021). Mental workload of frontline nurses aiding in the COVID-19 pandemic: A latent profile analysis. *Journal of Advanced Nursing*, 77(5), 2374–2385. <https://doi.org/10.1111/jan.14769>
26. Singh, V., Roth, S., Llovera, G., Sadler, R., Garzetti, D., Stecher, B., Dichgans, M., and Liesz, A. (2016). Microbiota dysbiosis controls the neuroinflammatory response after stroke. *Journal of Neuroscience*, 36(28), 7428–7440.
<https://doi.org/10.1523/JNEUROSCI.1114-16.2016>
27. Shang, S. Y., Liu, T. T., Chen, S. G., Qi, L. X., Li Song, Wang, S. J., Yi, J. Y., and Zhang, Q. H., (2023). Research progress on physical resilience in older adults. *Military Nursing*, 40(10), 88–91, 95.
28. Sotos-Prieto, M., Ortolá, R., López-García, E., Rodríguez-Artalejo, F., and García-Esquinas, E. (2021). Adherence to the Mediterranean diet and physical resilience in older adults: The seniors-ENRICA cohort. *The Journals of Gerontology: Series A*, 76(3), 505–512. <https://doi.org/10.1093/gerona/glaa277>
29. Steinley, D., and Brusco, M. J. (2011). Evaluating mixture modeling for clustering: Recommendations and cautions. *Psychological Methods*, 16(1), 63–79. <https://doi.org/10.1037/a0022673>
30. Seok, Y., & Lee, M. K. (2025). Health-related quality of life predictors for patients with stroke: A prospective longitudinal study of matched pairs of patients with stroke and family caregivers. *Journal of Clinical Nursing*, 34(4), 1277–1292.
<https://doi.org/10.1111/jocn.17173>
31. Van Borkulo, C. D., Van Bork, R., Boschloo, L., Kossakowski, J. J., Tio, P., Schoevers, R. A., Borsboom, D., and Waldorp, L. J. (2023). Comparing network structures on three aspects: A permutation test. *Psychological Methods*, 28(6), 1273–1285.
<https://doi.org/10.1037/met0000476>
32. Van Schoor, N. M., Timmermans, E. J., Huisman, M., Gutiérrez-Misis, A., Lems, W., Dennison, E. M., Castell, M. V., Denking, M. D., Pedersen, N. L., Maggi, S., and Deeg, D. J. H. (2022). Predictors of resilience in older adults with lower limb osteoarthritis and persistent severe pain. *BMC Geriatrics*, 22(1), 246. <https://doi.org/10.1186/s12877-022-02926-7>
33. Wang, L. D., Peng, B., Zhang, H. Q., Wang, Y. L., Liu, M., Shan, C. L., Cao, L., Wang, L. X., Xie, W., Wang, P. J., and Lin Ma. (2022). IBrief report on stroke prevention and treatment in China 2020. *Chinese Journal of Cerebrovascular Diseases*, 19(2), 136–144.
34. Whitson, H. E., Duan-Porter, W., Schmader, K. E., Morey, M. C., Cohen, H. J., and Colón-Emeric, C. S. (2016). Physical resilience in older adults: Systematic review and development of an emerging construct. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 71(4), 489–495. <https://doi.org/10.1093/gerona/glv202>
35. Wan, L. H., Xiong, X. N., Pan, J. H., et al. Development and reliability as well as validity test of Health Behavior Scale for Stroke Patients. *Journal of Nursing Science*, 2017, 32(1): 25-29. <https://doi.org/10.3870/j.issn.1001-4152.2017.01.025>
36. Xue, S., Lu, A., Chen, W., Li, J., Ke, X., and An, Y. (2024). A latent profile analysis and network analysis of anxiety and depression symptoms in chinese widowed elderly. *Journal of Affective Disorders*, 366, 172–180.
<https://doi.org/10.1016/j.jad.2024.08.181>

37. Xu, Y., Wu, H. S., Xu, Y. F., The reliability and validity of patient health questionnaire depression module (PHQ -9) in Chinese elderly. *Shanghai Archives of Psychiatry*, 2007(5): 257-259, 276.

38. Xu, T. T., Shen, X. H., Liu, Q. S., et al. Current status and influencing factors of physical resilience of the elderly in community. *China Medical Herald*, 2025, 22(14): 31-34, 40. <https://doi.org/10.20047/j.issn.1673-7210.2025.14.06>

39. Yang, C.C. (2006). Evaluating latent class analysis models in qualitative phenotype identification. *Computational Statistics and Data Analysis*, 50(4), 1091–1104. <https://doi.org/10.1016/j.csda.2004.11.004>

40. Yang, D., Cai, P., Zhao, X., et al. Analysis of the current status and influencing factors of physical resilience in elderly patients with ischemic stroke in Guizhou province. *Modern Medical Journal*, 2026, 54(2): 211-218. <https://doi.org/10.3969/j.issn.1671-7562.2026.02.003>

41. Yuan, L., Shen, J., Ye, S., & Zhou, N. (2024). Assessing care dependence status and associated influencing factors among middle-aged hemiplegic stroke patients during the post-acute rehabilitation phase: A correlational study. *Journal of Clinical Nursing*, 33(6), 2249–2258. <https://doi.org/10.1111/jocn.17124>

42. Zhang, L. H., (2024). *Analysis of Factors Affecting Frailty in Elderly Ischaemic Stroke Patients and Construction of a Risk Prediction Model* [Master's thesis, Qingdao University]. <https://doi.org/10.27262/d.cnki.gqdau.2024.001036>

43. Zhang, X.M., Jiao, J., Xu, T., and Wu, X.J. (2022). The association between frailty of older stroke patients during hospitalization and one-year all-cause mortality: A multicenter survey in China. *International Journal of Nursing Sciences*, 9(2), 162–168. <https://doi.org/10.1016/j.ijnss.2022.02.001>

44. Zimet, G. D., Dahlem, N. W., Zimet, S. G., and Farley, G. K. (1988). The Multidimensional Scale of Perceived Social Support. *Journal of Personality Assessment*, 52(1), 30–41. https://doi.org/10.1207/s15327752jpa5201_2

45. Zung, W. W. K. (1971). A Rating Instrument For Anxiety Disorders. *Psychosomatics*, 12(6), 371–379. [https://doi.org/10.1016/S0033-3182\(71\)71479-0](https://doi.org/10.1016/S0033-3182(71)71479-0)

46. Zhao, Q., Gao, J. P., Gao, K. X., et al. Status QUO of Physical Resilience of Elderly Patients with Urostomy for Bladder Cancer and Its Influencing Factors. *Mil Nurs*, 2024, 41(9): 21-24. <https://doi.org/10.3969/j.issn.2097-1826.2024.09.005>

Figures



Figure 1

Latent profile characteristics of physical resilience in older stroke patients

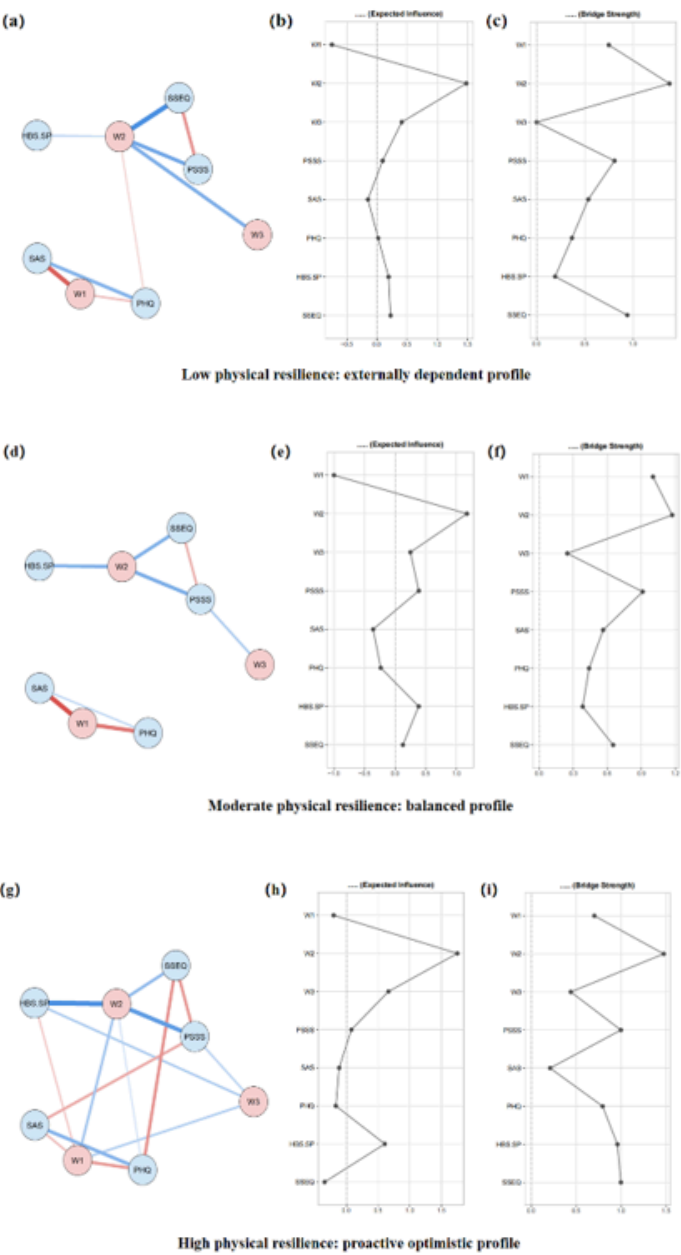


Figure 2

Correlation networks, expected influence (EI), and bridge strength indices for the three physical resilience subgroups. Nodes represent the three dimensions of physical resilience (W1=Positive Thinking, W2=Coping and Lifestyle Adjustment, and W3= Belief and Hope), perceived social support (PSSS), anxiety (SAS), depression (PHQ-9), health behaviours (HBS.sp), and rehabilitation self-efficacy (SSEQ). Edges denote positive (blue) and negative (red) correlations, with edge thickness and colour saturation indicating the strength of each association.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryFile.docx](#)