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Original Article

Compassion imbalance, resilience, and depressive symptoms among older stroke survivors: A moderated–moderated mediation analysis of neuroticism, compassion, and self-compassion

Aye M. Thaw[1], Jiranan Griffiths[1,2*], Tinakon Wongpakaran[1,3*], Nahathai Wongpakaran[1,3], Joshua Tsoh[1,4], Montana Buntragulpoontawee[5], Kitti Thiankhaw[6] and Nopdanai Sirimaharaj[6]

[1]Mental Health Program, Multidisciplinary and Interdisciplinary School (MIdS), Chiang Mai University, Chiang Mai, Thailand; [2]Department of Occupational Therapy, Faculty of Associated Medical Sciences, Chiang Mai University, Chiang Mai, Thailand; [3]Department of Psychiatry, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand; [4]Department of Psychiatry, Faculty of Medicine, The Chinese University of Hong Kong, Sha Tin, Hong Kong; [5]Department of Rehabilitation Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand; [6]Division of Neurology, Department of Internal Medicine, Faculty of Medicine, Chiang Mai University, Chiang Mai, Thailand

*Corresponding author: jiranan.gr@cmu.ac.th (JG) and tinakon.w@cmu.ac.th (TW)

Abstract

Post-stroke depression is a frequent and clinically important complication among stroke survivors, contributing to poorer functional recovery and reduced quality of life. The aim of this study was to examine the interrelationships among neuroticism, resilience, compassion, self-compassion, and depressive symptoms in older stroke survivors. Stroke survivors aged ≥50 years were recruited from outpatient clinics at Chiang Mai University Hospital, Thailand. Participants completed standardized questionnaires assessing neuroticism, resilience, compassion, self-compassion, and depressive symptoms. Pearson correlation, multiple regression, mediation, and moderated–moderated mediation analyses were conducted to examine direct, indirect, and conditional associations among these psychological constructs. A total of 142 patients were included in the final analysis. Neuroticism was positively correlated with depressive symptoms (r=0.412, p<0.01) and negatively correlated with resilience (r=−0.311, p<0.01), whereas resilience was negatively correlated with depressive symptoms (r=−0.400, p<0.01). Mediation analysis showed that resilience partially mediated the association between neuroticism and depressive symptoms (indirect effect of 0.098, 95%CI: 0.029–0.195). This indirect association was conditional on levels of compassion and self-compassion. Compassion significantly moderated the association between resilience and depressive symptoms (B=−0.018, p=0.003), and self-compassion moderated the association between compassion and depressive symptoms (B=−0.072, p=0.019). The moderated–moderated mediation model was significant, as indicated by the index of moderated–moderated mediation (index=−0.0096, 95%CI: −0.0230 to −0.0021). The indirect pathway through resilience was strongest among participants with higher compassion for others but lower self-compassion, suggesting a pattern of compassion imbalance. These findings indicate that resilience functions within a broader emotional context, in which the balance between compassion for others and compassion toward oneself may shape vulnerability to depressive symptoms after stroke. Incorporating self-compassion-based strategies into post-stroke rehabilitation may help strengthen psychological recovery and reduce depressive symptoms among older stroke survivors.

Keywords: Stroke, compassion, resilience, neuroticism, depression

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Introduction

Stroke is a leading cause of long-term disability and morbidity among older adults worldwide. In addition to physical impairments, many stroke survivors experience emotional and psychological difficulties that continue throughout the recovery period [1,2]. Depression is one of the most common mental health problems after a stroke. It affects about one-third of survivors, leads to a poorer quality of life, reduces participation in rehabilitation, and increases the risk of mortality [3-6]. Although there are improvements in acute stroke care and rehabilitation, psychological recovery still remains inadequately addressed, particularly among older stroke survivors.

Resilience has been widely recognized as a protective factor in post-stroke recovery. Resilience refers to a person's ability to cope with adversity and to regain emotional balance while continuing to function psychologically under stressful conditions [7,8]. Many studies have shown that higher resilience is associated with lower levels of post-stroke depression and anxiety, as well as better quality of life outcomes [9,10]. As a result, resilience has received increasing attention in stroke rehabilitation research and the development of psychological interventions. However, resilience may provide the same level of protection against depression for all individuals, indicating that its effects may vary depending on other psychological factors, such as compassion.

Compassion-related constructs have gained increasing attention as psychological resources that may influence emotional recovery after illness. In the Buddhist framework, loving-kindness (*mettā*) is described as the foundation from which compassion (*karuṇā*) develops. The Four Immeasurable Minds are cultivated sequentially, with loving-kindness preceding and supporting the emergence of compassion [11,12]. Therefore, compassion can be understood as an extension or deepening of loving-kindness in response to suffering. It also includes motivation to relieve that suffering. This process is accompanied by emotional openness and a non-judgmental attitude [13,14]. Previous studies have linked compassion to better emotional regulation. It has also been associated with stronger social connections and higher psychological well-being in both clinical and non-clinical populations [15,16]. In Buddhist-influenced societies such as Thailand, compassion is not seen only as a moral value, it is also deeply rooted in cultural and psychological practices. This makes compassion especially relevant for understanding mental health among Thai stroke survivors.

In contrast, self-compassion refers to having compassion toward oneself during times of personal suffering or failure. It involves responding to one's own distress with kindness. It also includes recognizing that suffering is part of human experience. In addition, self-compassion includes maintaining mindfulness without becoming overly identified with negative emotions [17,18]. Previous studies have shown that self-compassion is associated with lower levels of depression and anxiety and greater psychological well-being across different populations [19,20]. In healthcare settings, self-compassion may be particularly important for individuals with chronic illness and functional limitations. This is especially relevant after stroke, as survivors often experience long-term physical, emotional, and psychological challenges, and changes in personality traits are common during post-stroke recovery.

Personality traits also play an important role in vulnerability to depression after stroke. Among these traits, neuroticism has been consistently identified as a strong risk factor. Neuroticism is characterized by emotional instability and heightened sensitivity to stress. It is also associated with a tendency toward negative emotions [21-23]. Neuroticism is strongly associated with depression in older adults, with prior studies suggesting that 15–25% of elderly individuals display high neuroticism [24,25]. Neuroticism may influence mental health outcomes through resilience. Higher resilience may help buffer the negative emotional effects associated with neuroticism [9,10]. However, this buffering effect may not work in the same way for all individuals and may depend on other internal psychological resources.

Despite growing interest in compassion, self-compassion, and resilience, limited studies have examined how these factors work together to influence depression among stroke survivors [19]. Most existing research has considered these constructs separately [16,26]. Other studies have focused on general populations rather than clinical stroke samples [20,27,28]. Therefore, the understanding of their combined effects in stroke recovery remains limited. In addition, there

is limited understanding of how personality traits such as neuroticism contribute to depression through resilience. This is particularly unclear when levels of compassion and self-compassion are different.

To address these gaps, the present study examines an integrated theoretical model. In this model, the relationship between neuroticism and depression through resilience is studied. This indirect pathway is expected to vary depending on levels of compassion for others and self-compassion. This study focuses on older stroke survivors in a Thai clinical setting to identify psychological factors associated with a higher risk of post-stroke depression. Understanding when resilience is weaker among which types of patients may help develop more targeted, compassion-based interventions in stroke rehabilitation.

Methods

Study design and setting

A cross-sectional study was conducted among older Thai stroke survivors receiving outpatient care at Chiang Mai University Hospital, Thailand. Participants were recruited from the outpatient rehabilitation medicine, geriatric psychiatry, general medicine, and neurology clinics, which provide follow-up care for patients with stroke and related physical, neurological, and psychological conditions. The study was carried out from August 2025 to January 2026. The cross-sectional design was used to examine the relationships among neuroticism, resilience, compassion, self-compassion, and depressive symptoms at a single time point during the post-stroke recovery period. Data were collected through in-person assessments using standardized questionnaires administered during routine outpatient clinic visits.

Participants and criteria

Participants were eligible if they were aged 50 years or older, had a clinical diagnosis of stroke based on ICD-10 criteria, and were at least three months post-stroke to ensure medical stability. All participants were required to have stable vital signs and be able to communicate adequately in Thai. Participants were excluded if they showed signs of cognitive impairment, defined as a Mini-Cog score below three, or if they were unable to provide informed consent. Additional exclusion criteria included severe bilateral upper motor impairments that prevented cognitive screening, major comorbid medical conditions such as cancer or severe organ dysfunction, and significant sensory or communication impairments that interfered with participation.

Sample size and sampling method

The sample size was estimated using G*Power version 3.1.9.7 (Heinrich Heine University Düsseldorf, Germany) based on a multiple linear regression model with a fixed R^2 deviation-from-zero approach. Assuming a medium effect size (f^2=0.15), statistical power of 0.80, significance level of 0.05, and 15 predictors, the minimum required sample size was 139 participants. To account for incomplete responses, 160 participants were targeted for recruitment. Eligible participants attending the outpatient clinics during the study period were invited to participate until the target sample size was reached. A total of 142 participants were included in the final analysis. The sample consisted of 54.9% males and 45.1% females, with a mean age of 65.55 years (SD=8.33).

Data collection procedure

Data collection began with screening potentially eligible participants during routine outpatient clinic visits using the predefined inclusion and exclusion criteria. Cognitive screening was performed using the Mini-Cog test, and participants with a score <3 were excluded. Eligible participants received an explanation of the study objectives, procedures, potential risks and benefits, confidentiality measures, and voluntary nature of participation. Written informed consent was obtained before enrollment.

After consent was provided, trained healthcare-related research assistants conducted in-person assessments using standardized Thai-language questionnaires. Data were collected on sociodemographic and clinical characteristics, neuroticism, resilience, compassion, self-compassion, and depressive symptoms. The assessments were conducted in a quiet area of the

outpatient clinic to ensure privacy and minimize distraction. Research assistants clarified instructions when necessary but did not influence participants' responses. The full assessment took approximately 20–30 minutes to complete.

Study variables and measures

Sociodemographic information, including age, sex, marital status, education, employment, income, comorbidities, alcohol and smoking habits was collected. Neuroticism, depression, resilience, compassion and self-compassion were then assessed.

Neuroticism was assessed using the Neuroticism subscale of the ZKA-20 Personality Inventory [29]. This subscale consists of 4 items that assess emotional instability and proneness to negative emotions. Items were rated on a Likert-type scale, with higher scores indicating higher levels of neuroticism. A total neuroticism score was calculated by summing item responses. In the present study, the Neuroticism subscale demonstrated acceptable internal consistency (Cronbach's α=0.78).

Depressive symptoms were assessed using the Depression subscale of the Outcome Inventory-21 (OI-21) [30]. The depression subscale consists of 5 items, rated on a 5-point Likert scale ranging from 0 (not at all) to 4 (extremely), reflecting the severity of depressive symptoms. Subscale scores were obtained by summing item responses, with higher scores indicating greater depressive symptom severity. In the present study, the depression subscale demonstrated good internal consistency (Cronbach's α=0.82)

Resilience was assessed using the 9-item Resilience Inventory (RI-9), which measures individuals' capacity to adapt to and recover from adversity [31]. Items were rated on a Likert-type scale, with higher scores indicating greater resilience. A total resilience score was calculated by summing all responses. In the present study, RI-9 demonstrated good internal consistency (Cronbach's α=0.87).

Compassion was assessed using the 12-item Four Immeasurable Scale (FIS), which measures four core dimensions of compassion: loving-kindness, compassion, empathetic joy, and equanimity [32]. Items were rated on a Likert-type scale, with higher scores indicating greater levels of compassion. A total compassion score was calculated by summing all item responses. The FIS demonstrated excellent internal consistency (Cronbach's α=0.902).

Self-compassion was assessed using the 12-item Self-Compassion Scale–Short Form (SCS-SF), which measures individuals' attitudes toward themselves during times of difficulty [33]. Items were rated on a Likert-type scale, with higher scores indicating greater self-compassion. A total self-compassion score was calculated by averaging the responses across items. In the present study, the 12-item version demonstrated low internal consistency (Cronbach's α=0.52). Therefore, a 6-item version consisting of positively worded items was used in subsequent analyses, which demonstrated acceptable internal consistency (Cronbach's α=0.81).

Statistical analysis

Descriptive statistics were calculated for all study variables, with means and standard deviations reported for continuous variables and frequencies for demographic characteristics. Pearson correlation analysis was conducted to examine associations among neuroticism, resilience, compassion, self-compassion, and depression. Mediation and moderated mediation analyses were performed using the PROCESS macro (Model 18) in SPSS (IBM, New York, US). The mediation analysis examined whether resilience mediated the association between neuroticism and depressive symptoms. The moderated–moderated mediation analysis further examined whether the indirect effect through resilience differed according to levels of compassion and self-compassion. Compassion and self-compassion were included as moderators of the resilience–depression pathway, and interaction effects among these variables were examined. The conceptual moderated–moderated mediation model is presented in **Figure 1**. A p-value<0.05 was considered statistically significant. All analyses were conducted using IBM Statistical Package for Social Sciences (SPSS) version 27 (IBM, New York, US).

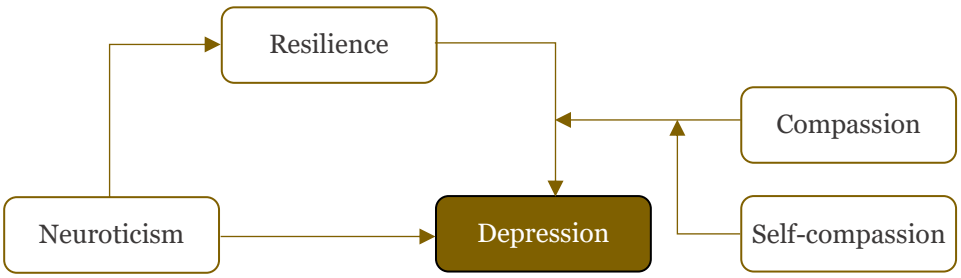

Figure 1. Conceptual moderated–moderated mediation model showing the indirect association between neuroticism and depression through resilience, conditional on compassion and self-compassion.

Results

Characteristics of participants

A total of 142 stroke survivors were included in this study and their characteristics are presented in **Table 1**. The majority of the participants had ischemic stroke (97.9%), with a mean age of 65.55±8.33 years, and 54.9% were male. Most participants were married or cohabiting (78.2%), with varied educational backgrounds and income levels. The majority were non-smokers (95.1%) and non-drinkers (88.7%), and nearly half were unemployed (46.5%). Common comorbidities included cardiovascular disease (88.7%), hypercholesterolemia (76.1%), and hypertension (61.3%) (**Table 1**).

Table 1. Sociodemographic and clinical characteristics of stroke survivors included in the study (n=142)

Variables	Frequency	Percentage
Stroke type		
Ischemic	139	97.9
Hemorrhagic	3	2.1
Age (years), mean±SD		65.55±8.33
Sex		
Male	78	54.9
Female	64	45.1
Marital status		
Single/widowed/divorced	31	21.8
Married/cohabiting	111	78.2
Education level		
Primary school	46	32.4
Lower secondary school	13	9.2
Upper secondary/vocational certificate	24	16.9
Diploma/higher vocational certificate	9	6.3
Bachelor's degree or higher	50	35.2
Monthly income		
No income	41	28.9
1–3,000 Baht	9	6.3
3,001–9,000 Baht	18	12.7
9,001–15,000 Baht	9	6.3
15,001–21,000 Baht	27	19.0
≥21,000 Baht	38	26.8
Smoking status		
Non-smoker	135	95.1
Smoker	7	4.9
Alcohol use		
Non-drinker	126	88.7
Drinker	16	11.3
Occupation		
Unemployed	66	46.5
Daily wage worker	10	7.0
Self-employed	14	9.9
Government officer	10	7.0
State enterprise employee	2	1.4
Farmer	2	1.4
Retired government officer	26	18.3

Variables	Frequency	Percentage
Other	12	8.5
Comorbidities		
Cardiovascular disease	126	88.7
Diabetes mellitus	46	32.4
Hypercholesterolemia	108	76.1
Hypertension	87	61.3
Heart disease	25	17.6

Levels of neuroticism, depression, resilience, compassion and self-compassion

Levels of neuroticism, depression, resilience, compassion and self-compassion are presented in **Table 2**. The mean neuroticism score was 7.85±2.98, while resilience was relatively high (40.65±5.09). Participants reported low levels of depression (2.08±3.28), alongside high compassion (50.77±8.64) and moderate to high self-compassion (3.96±1.01) (**Table 2**).

Table 2. Level of neuroticism, depression, resilience, compassion and self-compassion among stroke survivors included in the study (n=142)

Domain (instrument)	Possible score ranges	Mean±SD
Neuroticism (ZKA-20 Personality Inventory)	4–16	7.85±2.98
Resilience (Resilience Inventory 9)	9–45	40.65±5.09
Depression (Depression subscale, Outcome Inventory-21)	0–20	2.08±3.28
Compassion (Four Immeasurable Scale)	12–60	50.77±8.64
Self-compassion (6-items of Self-compassion Scale Short Form)	1–5	3.96±1.01

Correlations between neuroticism, resilience, compassion, self-compassion and depression

Correlations between neuroticism, resilience, compassion, self-compassion and depression are presented in **Table 3**. Neuroticism was positively correlated with depression (r=0.412, p<0.01) and negatively correlated with resilience (r=−0.311, p<0.01), compassion (r=−0.199, p<0.05), and self-compassion (r=−0.171, p<0.05). Resilience showed positive correlations with compassion (r=0.418, p<0.01) and self-compassion (r=0.274, p<0.01), and a negative correlation with depression (r=−0.400, p<0.01). Compassion and self-compassion were positively correlated (r=0.498, p<0.01), while depression was negatively correlated with self-compassion (r=−0.178, p<0.05) but not significantly associated with compassion (**Table 3**).

Table 3. Correlations between neuroticism, resilience, compassion, self-compassion and depression among stroke survivors

Items	Neuroticism	Resilience	Compassion	Self-compassion	Depression
Neuroticism	–				
Resilience	−0.311**	–			
Compassion	−0.199*	0.418**	–		
Self-compassion	−0.171*	0.274**	0.498**	–	
Depression	0.412**	−0.400**	−0.105	−0.178*	–

* Statistically significant at p<0.05
** Statistically significant at p<0.01

Mediation analysis: neuroticism, resilience, and depressive symptoms

The mediation analysis first examined whether resilience mediated the association between neuroticism and depressive symptoms. In the mediator model, neuroticism was negatively associated with resilience (B=−0.514, p<0.001), indicating that higher neuroticism was associated with lower resilience. Age, sex, income, and marital status were not significantly associated with resilience. The model explained 11.7% of the variance in resilience (R^2=0.117) (**Table 4**).

In the outcome model, neuroticism was positively associated with depressive symptoms (B=0.352, p<0.001), whereas resilience was negatively associated with depressive symptoms (B=−0.190, p<0.001). This indicates that higher neuroticism and lower resilience were associated with greater depressive symptoms. The model explained 26.2% of the variance in depressive symptoms (R^2=0.262) (**Table 5**).

The bootstrapped indirect effect of neuroticism on depressive symptoms through resilience was statistically significant (effect=0.098, 95%CI: 0.029–0.195), indicating that resilience partially mediated the association between neuroticism and depressive symptoms (**Table 6**).

Table 4. Regression model examining the association between neuroticism and resilience in the mediation analysis

Antecedent	Unstandardized regression coefficients (B)	Standard error (SE)	*p*-value
Neuroticism	−0.514	0.139	<0.001
Age	0.074	0.05	0.142
Sex	0.054	0.842	0.949
Income	0.082	0.204	0.688
Marital status	1.088	1.0087	0.2825
Constant	37.59	4.307	<0.001
R^2=0.117, F (5, 135) =3.61, *p*=0.004			

Table 5. Regression model examining the associations of neuroticism and resilience with depressive symptoms in the mediation analysis

Antecedent	Unstandardized regression coefficients (B)	Standard error (SE)	*p*-value
Neuroticism	0.352	0.086	<0.001
Resilience	−0.190	0.051	<0.001
Age	−0.005	0.03	0.869
Sex	−0.374	0.498	0.454
Income	−0.117	0.121	0.335
Marital status	-0.446	0.599	0.740
Constant	8.747	3.183	0.007
R^2=0.262, F (6, 135) =7.99, *p*<0.001			

Table 6. Bootstrapped indirect effect of neuroticism on depressive symptoms through resilience in the mediation analysis

Indirect pathway	Effect	Boot standard error	95% boot confidence interval
Neuroticism → Resilience → Depression	0.098	0.043	(0.029, 0.195)

Bootstrap confidence intervals are based on 5,000 resamples

Moderating effect of compassion on the resilience–depression pathway

The next analysis examined whether compassion moderated the association between resilience and depressive symptoms (**Figure 1**). In the interaction model, resilience (B=0.593, *p*=0.041) and compassion (B=0.776, *p*=0.002) were positively associated with depressive symptoms (**Table 7**). More importantly, the interaction between resilience and compassion was statistically significant (B=−0.018, *p*=0.003), indicating that the association between resilience and depressive symptoms differed across levels of compassion (**Table 7**).

The interaction term explained an additional 5.4% of the variance in depressive symptoms (ΔR^2=0.054), and the full model explained 22.7% of the variance (R^2=0.227) (**Table 7**). These findings suggest that the protective association between resilience and depressive symptoms depends on the level of compassion.

Table 7. Moderating effect of compassion on the association between resilience and depressive symptoms

Predictor	Unstandardized regression coefficients (B)	Standard error (SE)	*p*-value
Resilience	0.593	0.287	0.041
Compassion	0.776	0.246	0.002
Resilience × compassion	−0.018	0.006	0.003
Age	0.003	0.031	0.919
Sex (0=male, 1=female)	−0.382	0.512	0.456
Income	−0.122	0.124	0.325
Constant	−22.793	11.843	0.056
R^2=0.227, ΔR^2 (interaction)=0.054, F (1, 135) =9.47, *p*=0.003			

Moderating effect of self-compassion on the compassion–depression pathway

The second moderation analysis examined whether self-compassion moderated the association between compassion and depressive symptoms (**Figure 1**). Compassion was positively associated with depressive symptoms (B=0.244, p=0.030), while self-compassion showed a marginal association with depressive symptoms (B=3.074, p=0.051) (**Table 8**). The interaction between compassion and self-compassion was statistically significant (B=−0.072, p=0.019), indicating that the association between compassion and depressive symptoms varied according to the level of self-compassion (**Table 8**).

The interaction term explained an additional 3.8% of the variance in depressive symptoms (ΔR^2=0.038), and the full model explained 8.9% of the variance in depressive symptoms (R^2=0.089) (**Table 8**). These results suggest that self-compassion modifies the emotional effect of compassion on depressive symptoms.

Table 8. Moderation of compassion–depression by self-compassion

Predictor	Unstandardized regression coefficients (B)	Standard error (SE)	p-value
Compassion	0.244	0.111	0.03
Self-compassion	3.074	1.563	0.051
Compassion × self-compassion	−0.072	0.03	0.019
Age	−0.030	0.033	0.356
Sex	−0.314	0.553	0.571
Income	−0.230	0.135	0.089
Constant	−4.671	5.738	0.417
R^2=0.089, ΔR^2 (interaction)=0.038, F (1, 135) =5.69, p=0.019			

Moderated–moderated mediation analysis of neuroticism, resilience, compassion, and self-compassion on depression

The full moderated–moderated mediation model was then examined to determine whether the indirect association between neuroticism and depressive symptoms through resilience varied according to the joint levels of compassion and self-compassion, as proposed in **Figure 1**. In this model, neuroticism was positively associated with depressive symptoms (B=0.337, p<0.001). Resilience (B=3.141, p<0.001), compassion (B=3.476, p<0.001), and self-compassion (B=33.415, p=0.002) were also significantly associated with depressive symptoms (**Table 9**).

Table 9. Moderated–moderated mediation model predicting depression

Predictor	Unstandardized regression coefficient (B)	Standard error (SE)	p-value
Neuroticism	0.337	0.082	<0.001
Resilience	3.141	0.898	<0.001
Compassion	3.476	0.823	<0.001
Self-compassion	33.415	10.702	0.002
Resilience × compassion	−0.080	0.02	<0.001
Resilience × self-compassion	−0.770	0.26	0.004
Compassion × self-compassion	−0.812	0.233	<0.001
Resilience × compassion × self-compassion	0.019	0.006	0.001
Age	0.016	0.029	0.569
Sex	−0.328	0.482	0.498
Income	−0.069	0.116	0.551
R^2=0.380, ΔR^2=0.054, F (1, 135) =11.22, p=0.001			
Index of moderated–moderated mediation: Index = −0.0096, 95%CI: −0.0230 to −0.0021			

Bootstrap confidence intervals are based on 5,000 resamples

All two-way interaction terms were statistically significant, including resilience × compassion (B=−0.080, p<0.001), resilience × self-compassion (B=−0.770, p=0.004), and compassion × self-compassion (B=−0.812, p<0.001) (**Table 9**). The three-way interaction among resilience, compassion, and self-compassion was also significant (B=0.019, p=0.001), indicating that the moderating effect of compassion on the resilience–depression association depended on the level of self-compassion. The model explained 38.0% of the variance in

depressive symptoms (R^2=0.380), with the three-way interaction contributing an additional 5.4% of the variance (ΔR^2=0.054) (**Table 9**).

The index of moderated–moderated mediation was statistically significant (index=−0.0096, 95%CI: −0.0230 to −0.0021) (**Table 9**), confirming that the indirect effect of neuroticism on depressive symptoms through resilience was conditional on the combined levels of compassion and self-compassion. Specifically, the resilience pathway was stronger among participants with higher compassion for others but lower self-compassion, suggesting a pattern of compassion imbalance. This finding indicates that resilience does not operate independently, but within a broader emotional context shaped by both compassion for others and compassion toward oneself. The full moderated–moderated mediation model, including the direct, indirect, and interaction pathways with unstandardized regression coefficients, is illustrated in **Figure 2**.

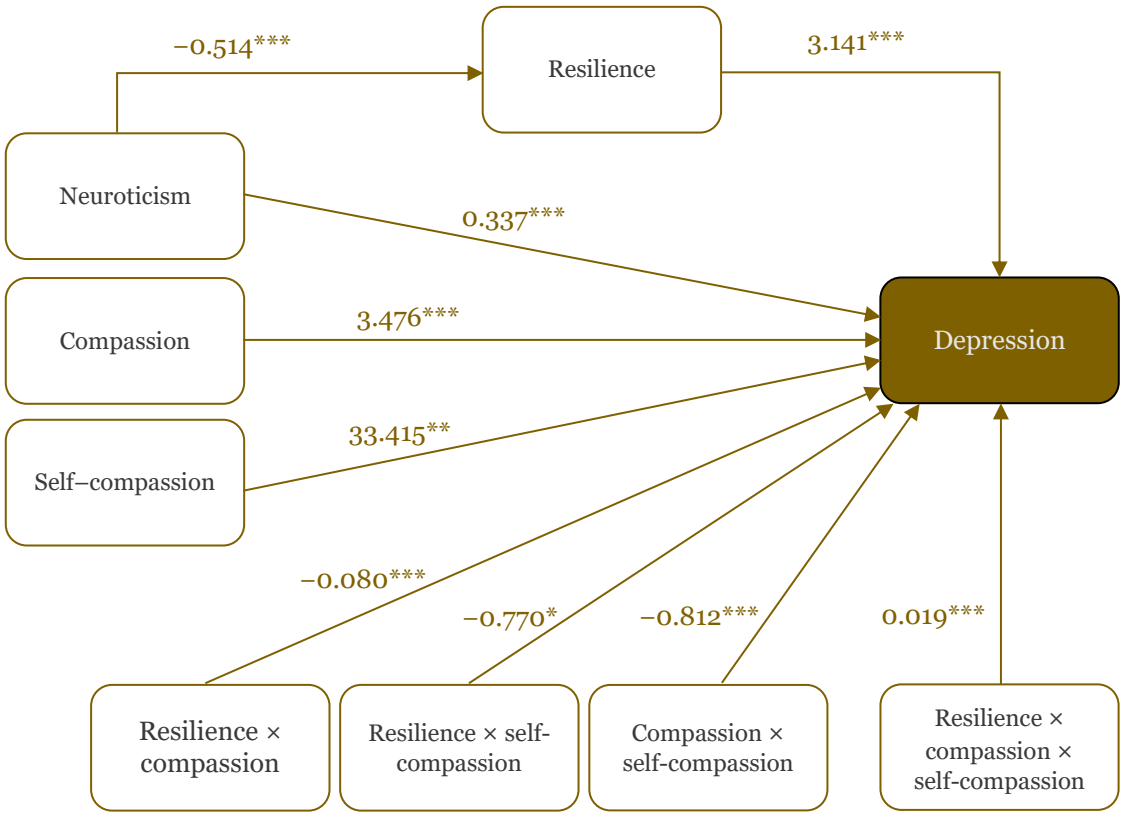

Figure 2. Moderated–moderated mediation model showing unstandardized regression coefficients (B), controlling for age, sex, and income. *Statistically significant at p<0.05, **statistically significant at p<0.01; and ***statistically significant at p<0.001.

Discussion

The present study examined how neuroticism, resilience, compassion for others, and self-compassion jointly influence depressive symptoms among older stroke survivors in a Thai clinical setting. Post-stroke depression is a prevalent and clinically significant condition that poorly affects recovery, quality of life, and mortality among stroke survivors [1,2,5,6,34]. The correlation, mediation, and conditional process analyses indicated that these psychological factors are interrelated and function in a conditional manner (**Tables 3–9**). By testing a moderated–moderated mediation model, this study extends previous research by showing that resilience transmits the effect of neuroticism on depression, but that indirect pathway varies depending on levels of compassion for others and self-compassion.

Neuroticism showed a moderate positive association with depressive symptoms (r=0.412, p<0.01) and a significant negative association with resilience (r=−0.311, p<0.01; **Table 3**). Regression analysis showed that neuroticism remained a significant predictor of depression (B=0.352, SE=0.086, p<0.001), even after controlling for resilience and sociodemographic covariates (**Table 5**). These findings are consistent with the Five-Factor Model of personality,

which conceptualizes neuroticism as emotional instability and heightened vulnerability to stress [21-23]. Previous research has shown that higher neuroticism is strongly associated with depressive and anxiety symptoms across clinical and chronic illness populations, including neurological conditions [35,36]. Among stroke survivors, elevated neuroticism may intensify emotional responses to functional loss, uncertainty, and reduced autonomy, increasing the risk of post-stroke depression.

Resilience was negatively associated with depressive symptoms (r=−0.400, p<0.01; **Table 3**) and significantly mediated the relationship between neuroticism and depression. Higher neuroticism was associated with lower resilience (B=−0.514, SE=0.139, p<0.001; **Table 4**), while lower resilience was related to higher depressive symptoms (B=−0.190, SE=0.051, p<0.001; **Table 5**). The bootstrapped indirect effect of neuroticism on depression via resilience was statistically significant (indirect effect=0.098, Boot SE=0.043, 95%CI: 0.029 to 0.195); **Table 6**), indicating partial mediation. These findings are consistent with previous studies suggesting that resilience plays an important role in linking vulnerability traits to mental health outcomes during stroke recovery [7,9,10].

However, the protective role of resilience was different for all individuals. Compassion for others significantly moderates the association between resilience and depression (**Table 7**). The interaction between resilience and compassion was significant (B=−0.018, SE=0.006, p=0.003) and explained an additional 5.4% of variance in depressive symptoms (ΔR^2 = .054). Compassion refers to emotional openness to suffering and motivation to alleviate it [13,14]. It is generally associated with improved psychological well-being [15,16]. However, the present findings suggest that the effect of resilience on depressive symptoms varies across levels of compassion for others, indicating that its role is not uniform across individuals. In Buddhist-influenced societies where altruism and self-sacrifice are highly valued, prolonged emotional engagement with others' suffering may increase emotional burden and limit a person's ability to cope.

Self-compassion further shaped these relationships. Self-compassion showed a weak but significant negative association with depressive symptoms (r=−0.178, p<0.05; **Table 3**). It significantly moderates the association between compassion for others and depression (**Table 8**). The interaction between compassion and self-compassion was significant (B=−0.072, SE=0.030, p=0.019), explaining an additional 3.8% of variance in depressive symptoms (ΔR^2=0.038). Self-compassion involves responding to personal suffering with kindness, recognizing common humanity, and maintaining mindful awareness [17,18]. It has been linked to lower depression and better psychological well-being across clinical populations [19,20].

The moderated–moderated mediation model provided the most comprehensive insight into these dynamics (**Table 9**). The three-way interaction among resilience, compassion, and self-compassion was statistically significant (B=0.019, SE=0.006, p=0.001), and the index of moderated–moderated mediation was also significant (Index=−0.0096, 95%CI: −0.0230 to −0.0021). This indicates that the indirect effect of neuroticism on depression via resilience varies depending on the joint levels of compassion and self-compassion. Specifically, the resilience pathway was strongest among individuals with high compassion for others and low self-compassion. The pathway became weaker or non-significant at higher levels of self-compassion. Therefore, this pathway reflects a pattern of 'compassion imbalance,' in which high level of compassion for others combined with low self-compassion, is associated with a stronger indirect pathway linking neuroticism to depression.

Clinically, these findings suggest that interventions focusing mainly on enhancing resilience or encouraging compassion for others may be insufficient for some stroke survivors. Individuals high in neuroticism who show strong compassion for others, but low self-compassion may remain vulnerable to depressive symptoms, even though the resilience pathway appears to be stronger under these conditions. Integrating self-compassion-based approaches into stroke rehabilitation may strengthen resilience and reduce emotional vulnerability, together with existing compassion-focused and resilience-enhancing interventions [16,27].

Some limitations should be acknowledged. The cross-sectional design limits causal inference; although the moderated–moderated mediation analysis provided insight into the relationships among neuroticism, resilience, compassion, self-compassion, and depressive symptoms, the temporal direction of these associations cannot be determined. Longitudinal

studies are needed to clarify whether these psychological factors predict changes in mental health outcomes across different stages of stroke recovery. All variables were assessed using self-report questionnaires, which may be affected by recall bias or social desirability. The Self-Compassion Scale–Short Form showed low internal consistency in this older clinical stroke sample, possibly due to age, clinical condition, or cultural influences, which may have weakened associations with self-compassion. Future studies should further evaluate the psychometric performance of self-compassion measures in older clinical populations and consider additional assessment methods. Participants were recruited from a single tertiary hospital, which may limit generalizability to stroke survivors in other healthcare or community settings. Individuals with significant cognitive impairment were excluded, and important clinical variables, including stroke severity, lesion characteristics, and rehabilitation intensity, were not assessed. Future longitudinal and intervention-based studies, including randomized controlled trials, are needed to determine whether strengthening self-compassion and promoting balanced compassion practices can reduce vulnerability associated with high neuroticism and low resilience in stroke rehabilitation.

Conclusion

This study examined the relationships between neuroticism, resilience, compassion, self-compassion, and depressive symptoms among stroke survivors. The results suggest that resilience plays an important role in the relationship between neuroticism and depression. Individuals with higher neuroticism tend to have lower resilience and greater depressive symptoms. The findings also indicate that compassion and self-compassion influence this relationship. In particular, the indirect effect was stronger when individuals showed higher compassion for others but lower self-compassion. This pattern may reflect a form of compassion imbalance, where individuals are kind and concerned toward others but less kind toward themselves. In such cases, compassion alone may not be sufficient to reduce emotional distress in the absence of self-compassion. These findings highlight the potential importance of self-compassion as a psychological resource for stroke survivors. Although caring for others is valuable, including self-compassion may help individuals better cope with emotional difficulties after a stroke. Therefore, integrating not only resilience-focused but also self-compassion–based strategies into stroke rehabilitation programs may help strengthen emotional coping and support psychological recovery. Compassion-focused and self-compassion interventions may provide additional benefits when combined with existing rehabilitation and mental health support services for stroke survivors.

Ethics approval

This study was conducted according to the guidelines of the Declaration of Helsinki and was approved by the Institutional Review Board of the Faculty of Medicine, Chiang Mai University (Study Code: PSY- 2568-0441, Research ID: 0441, date of approval: 15 August 2025).

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Competing interests

All the authors declare that there are no conflicts of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

Declaration of artificial intelligence use

We hereby confirm that no artificial intelligence (AI) tools or methodologies were utilized at any stage of this study, including during data collection, analysis, visualization, or manuscript preparation. All work presented in this study was conducted manually by the authors without the assistance of AI-based tools or systems.

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