Theoretical and Review Articles // Artículos teóricos y de revisión

Research Articles // Artículos de investigación

Notes and Editorial Information // Avisos e información editorial

ISSN 1577-7057

Volume 25, number 1 March 2025
Volumen 25, número 1 Marzo 2025

ISSN: 1577-7057

IJP&PT

International Journal of Psychology & Psychological Therapy

IJP&PT 25 YEARS ANNIVERSARY 2001-2025

https://www.ijpsy.com

IJP&PT is included in the following indexing and documentation Centers:

University Grants Commission
Bahadur Shah Zafar Marg, New Delhi-110002
Website: www.ugc.ac.in

International Journal of Psychology & Psychological Therapy, 2025, 25, 1, 57-70

Predictors of Depression and Anxiety among Post-Stroke Patients: A Cross-Sectional Study

Ngoc Huy Nguyen*

Phutho Department of Health, and VNU University of Medicine and Pharmacy, Vietnam

Son Dinh Thanh Le, Ha Thi Thu Bui, Viet Quoc Hoang, Cuong Cao Do

General Hospital of Phutho, Vietnam

Abstract

Stroke is the second-leading cause of death worldwide and the third-leading cause when considering both death and disability. Beyond the financial burden it imposes, stroke also has a profound negative impact on mental health. Research indicates that post-stroke disability significantly contributes to the development of depression and anxiety. A cross-sectional study was conducted in Viettri City, Vietnam, from November 2023 to February 2024. Participants included adults diagnosed with post-stroke. Data were collected using a structured self-report questionnaire covering demographics, clinical characteristics, functional independence (Barthel Index), anxiety (GAD-7), and depression (PHQ-9) levels. Multivariable logistic regression was employed to identify factors associated with high anxiety and/or depression (HAD). A total of 348 participants, with a mean age of 67.49 years, and females comprising 54.0%, while 26.7% exhibited HAD. Factors significantly associated with these conditions included marital status (*OR*= 28.88; 95%*CI*= 2.72-717.24; *p*= .011), developed fastidiousness (*OR*= 7.34; 95%*CI*= 3.67-15.21; *p* <.001), exercise habits (*OR*= 2.90; 95%Cl= 1.42-6.07; *p*= .004), speech ability (*OR*= 13.10; 95%*CI*= 1.66-290.24; p= .035), personality types (*OR*= 0.35; 95%*CI*= 0.13-0.93; *p*= .033), and Barthel Index score (*OR*= 0.90; 95%*CI*= 0.85-0.95; *p* <.001) are significant predictors. The predictive model, which achieved an AUC of 89.6%, facilitated the development of a nomogram for straightforward assessment of HAD status. Marital status, developed fastidiousness, exercise habits, speech habits, personality traits and Barthel Index emerged as significant predictors of anxiety and depression among stroke patients. Addressing these factors through targeted interventions could potentially mitigate mental health challenges and improve overall outcomes for stroke survivors.
Key words: post-stroke; anxiety; depression; cross-sectional study.

How to cite this paper: Nguyen NH, Le SDT, Bui HTT, Hoang VQ, & Do CC (2025). Predictors of Depression and Anxiety Among Post-Stroke Patients: A Cross-Sectional Study. *International Journal of Psychology & Psychological Therapy, 25,* 1, 57-70.

Novelty and Significance

What is already known about the topic?

- Stroke is a leading cause of death and disability worldwide, with high rates of incidence and mortality.
- Post-stroke patients face an elevated risk of mental health issues, particularly depression and anxiety.
- Non-pharmacological interventions show promise in improving psychological outcomes post-stroke, though communication challenges may complicate their implementation.

What this paper adds?

- This study identifies six key predictors of post-stroke depression and anxiety.
- Functional independence and communication abilities are highlighted as significant factors influencing the mental health outcomes of stroke survivors.
- A prediction nomogram is developed as a practical tool to estimate the likelihood of post-stroke depression and anxiety.

In 2019 stroke caused 12.2 million incident cases, 101 million prevalent cases, 143 million Disability-Adjusted Life Years (DALYs), and 6.55 million deaths globally, maintaining its position as the second-leading cause of death (11.6% of total deaths) and the third-leading cause of death and disability combined (5.7% of total DALYs) (GBD 2019 Stroke Collaborators, 2021). Stroke not only causes physical disability but

* *Correspondence*: Ngoc Huy Nguyen, Phutho Department of Health and VNU University of Medicine and Pharmacy, Vietnam. ORCID: 0009-0002-5694-2198 Email: ngochuynguyen8888@gmail.com. *Data availability statement*: The data is not publicly available due to ethical board requirements and commitments made to the study participants. However, it could be provided upon reasonable request by contacting the corresponding author.

also significantly impacts psychological well-being, often leading to conditions such as depression and anxiety (Devereux & Berns, 2023).

There are numerous risk factors contributing to increased depression and anxiety among post-stroke patients, such as underlying conditions, education, income, marital status, personality traits, and so forth. Among these, studies indicate that marital status significantly influences the mental health outcomes of stroke survivors, with widowed or divorced individuals reporting higher levels of depression and suicidal ideations (Dong, Brown, Case, Morgenstern, & Lisabeth, 2020; Gloria *et alii*, 2024). Post-stroke, individuals may experience personality changes characterized by increased negative traits such as frustration and reduced patience, which exacerbate these psychological challenges (Lo Buono, Noto, Bonanno, Formica, & Corallo, 2022; Stone, 2004).

Studies consistently highlight that introversion, a component of neuroticism, increases vulnerability to depression and anxiety post-stroke, in contrast with the protective effect observed in extroversion (Aben *et alii*, 2002; Morris, & Robinson, 1995). Higher levels of functional impairment, as assessed by the Barthel Index, are closely associated with increased severity of depression, highlighting a significant interplay between physical limitations and mental health (Loong, Kenneth, & Paulin, 1995; Musa & Keegan, 2018).

Non-pharmacological interventions such as structured exercise programs, including Tai Chi, have shown promise in alleviating depressive symptoms immediately post-stroke (Eng & Reime, 2014; Li *et alii*, 2022). However, stroke survivors with aphasia face additional hurdles due to communication barriers, contributing to heightened rates of depression and poorer quality of life (Bueno-Guerra *et alii*, 2024; Lin, Sung, Muo, & Chen, 2023).

The study investigates prominent predictive factors linked to depression and anxiety (high anxiety and/or depression -HAD-) among post-stroke patients. Comprehensive understanding of these dynamics is pivotal for formulating targeted strategies aimed at enhancing psychological well-being and overall quality of life for stroke survivors.

METHOD

Participants

The study used the sample size formula for a proportion with two primary outcomes: Anxiety and Depression. The formula (Sahai, & Khurshid, 1996) was:

$$n = \frac{Z^2 \times p \times (1-p)}{E^2}$$

Where n= required sample size, Z= z-score for the confidence level (1.96 for 95%), p= estimated proportion, and E= margin of error (.05),

The sample size calculation for post-stroke Anxiety and post-stroke Depression used proportions 0.204 for Anxiety and 0.311 for Depression (Schöttke & Giabbiconi, 2015). The required sample size was 335, while 348 survey responses were collected.

All study procedures were approved by the ethics committee of Phutho Provincial General Hospital (#02/TB-HDDD). Patients provided informed consent after receiving explanations regarding the study's benefits and risks, prior to participating in direct interviews. Then, Participants who verbally agree to the research received a Google Form survey introduction outlining the project's benefits and risks once again. Participants were required to agree to take part in the study to access the questionnaire.

The study is a descriptive cross-sectional study conducted from November 2023, to February 2024, in Viettri City, Phutho Province, Vietnam. The inclusion criteria for the study were individuals over the age of 18 who had been diagnosed with a cerebral stroke, including thrombotic stroke, embolic stroke, or intracerebral hemorrhage. Additionally, participants were required to have experienced the stroke at least one month but no more than 12 months prior to joining the survey. We excluded participants who are unable to read and/or understand the content of the questionnaire.

Design

The study used the sample size formula for a proportion with two primary outcomes: Anxiety and Depression. Based on recommended screening and intervention guidelines for anxiety and depression, the study categorizes patients into two groups: *High Anxiety and/or Depression* (HAD) if they scord 10 or higher on the GAD-7, and/or 10 or higher on the PHQ-9 scales (Kroenke, Spitzer, & Williams, 2001); and *Low Anxiety and Depression* (LAD) if they scored below these thresholds.

Procedure

Participants were recruited from a registry of cerebral stroke patients maintained by the Phu Tho Department of Health. Eligible individuals were contacted via telephone and invited to participate. Upon providing informed consent, participants completed a 50-item online survey hosted on Google Forms. The survey covered six sections: demographics, lifestyle, clinical characteristics, functional independence (Barthel Index), anxiety (GAD-7), and depression (PHQ-9).

Data collection was conducted over three months, with participants instructed to complete the survey in one session to minimize contextual variability. Clear instructions were provided at the beginning of each section to ensure uniform understanding.

Survey responses were screened for completeness and consistency. Missing or implausible data were excluded based on pre-specified criteria. Anonymized data were securely stored on a password-protected server.

Instruments and Measures

Data were collected using a structured *Self-report Questionnaire* (SRQ) that covering demographics, clinical characteristics, functional independence (Barthel Index), anxiety (GAD-7), and depression (PHQ-9) levels.

The SRQ applied included 59 questions organized into several sections (the SRQ could be provided upon request by contacting the corresponding author):

- 24 questions designed to collect information on demographics data, lifestyle habits.
- 9 questions about clinical characteristics, encompassing underlying health conditions as well as specifics related to stroke events.
- 10 questions from the *Barthel Index Activities of Daily Living* (ADL; Collin, Wade, Davies, & Horne, 1998), to evaluate activities of daily living and functional independence, covering tasks like feeding, grooming, mobility, and more. McDowell & Newell (1996) in an early review reported that there was considerable psychometric data available for the Barthel Index. Most recently, Hsueh, Lee, & Hsieh (2001) have found a moderate to excellent agreement between raters for individual items (kappa value range: 0.53-0.94) and an excellent internal consistency (alpha value range: 0.89-0.92). Likewise, Marvin & Zeltzer (2015) have offered a more recent extensive review of the psychometric properties of the Index.

- 7 questions from the *Generalized Anxiety Disorder 7* (GAD-7; Mossman *et alii*, 2017) to assess levels of anxiety over the past two weeks, with scores ranging from 0 to 21 indicating varying degrees of anxiety severity. The GAD-7 has demonstrated good diagnostic validity (Spitzer *et alii*, 2006). Examples of items include "feeling restless so that it is hard to sit still"; "getting tired very easily"; and "muscle tension, aches, or soreness".
- 9 questions from the *Patient Health Questionnaire 9* (PHQ-9; Kroenke, Spitzer, & Williams, 2001): assessing the severity of depression symptoms over the same timeframe, with scores ranging from 0 to 27 to evaluate depression severity. The PHQ-9 has showed good diagnostic validity (Spitzer *et alii*, 1999). Examples of the PHQ-9 items are "little interest or pleasure in doing things,"; "feeling down, depressed, or hopeless," and "trouble falling or staying asleep, or sleeping too much."

Data Analysis

Descriptive statistics were applied to continuous variables using t-tests. For categorical variables, the Chi-Square test was used if expected cell counts were greater than 5, and the Fisher exact test if expected cell counts were less than 5, to compare between HAD and LAD groups. The main analysis aimed to optimize logistic regression related to HAD status. Variables encompassing demographics, lifestyle habits, underlying health conditions, and stroke events were selected to construct the optimal model. Model selection employed the Stepwise Akaike Information Criterion (AIC) method in the MASS package, utilizing both forward and backward stepwise methods based on minimizing AIC and maximizing Area Under the Curve (AUC) criteria (Zhang, 2016). while excluding missing values from the dataset. A predicting model for HAD status was then created based on the optimal logistic regression. The model was evaluated using a nomogram from the rms package in R, visually representing the relationship between predictors and HAD probability. Each variable's contribution was indicated by a point scale for easy translation of regression coefficients into predictive probabilities. All hypotheses were tested as two-tailed, with statistical significance defined as $p < .05$. Statistical analyses were performed using R language version 3.6.2 (R Core Team, 2022).

RESULTS

A total of 348 patients participated in the study, yielding a response rate of 31.7%. The mean age of the participants was 67.49 years ($SD = 13.02$), with females representing 54% of the cohort. The prevalence of HAD among the participants was 26.7%. Table 1 provides a comprehensive overview of stroke patient characteristics categorized by HAD and LAD status, shedding light on various facets of post-stroke recovery.

Among the patients, comorbidity prevalence differed notably between the HAD and LAD groups ($p = .001$), suggesting a potential interplay between mental health and other medical conditions.

Hypertension showed a significant association with anxiety and depression status ($p = .004$), indicating a possible link between cardiovascular health and mental well-being post-stroke.

Marital status exhibited a significant difference ($p = .016$) between HAD and LAD groups, implying a potential influence of social support structures on psychological outcomes post-stroke.

Income levels varied significantly ($p = .033$) between the two groups, highlighting the potential role of socioeconomic factors in shaping anxiety and depression levels post-stroke.

Exercise habits differed significantly ($p < .001$) between HAD and LAD groups,

Table 1. Characteristics of stroke patients by anxiety and depression status.

Characteristics		HAD (*n=93*)	LAD *n=255*	Total *N=348*	*p*
Age (years)		69.06 (13.12)	66.91 (12.96)	67.49 (13.02)	.176
Gender	Male	52 (55.91%)	136 (53.33%)	188 (54.02%)	.760
	Female	41 (44.09%)	119 (46.67%)	160 (45.98%)	
BMI (kg/m²)		21.66 (2.66)	21.71 (2.47)	21.70 (2.52)	.870
BMI classification	Underweight	8 (8.60%)	13 (5.10%)	21 (6.03%)	.728
	Normal	62 (66.67%)	172 (67.45%)	234 (67.24%)	
	At-risk of Obesity	16 (17.20%)	51 (20.00%)	67 (19.25%)	
	Obese I	7 (7.53%)	18 (7.06%)	25 (7.18%)	
	Obese II	0	1 (0.39%)	1 (0.29%)	
Comorbidity	No	20 (21.51%)	105 (41.18%)	125 (35.92%)	.001
	Yes	73 (78.49%)	150 (58.82%)	223 (64.08%)	
Hypertension	No	40 (43.01%)	156 (61.18%)	196 (56.32%)	.004
	Yes	53 (56.99%)	99 (38.82%)	152 (43.68%)	
Diabetes	No	58 (62.37%)	184 (72.16%)	242 (69.54%)	.104
	Yes	35 (37.63%)	71 (27.84%)	106 (30.46%)	
Religion	No religion	79 (84.95%)	190 (74.51%)	269 (77.30%)	.172
	Buddhism	10 (10.75%)	47 (18.43%)	57 (16.38%)	
	Christianity	4 (4.30%)	13 (5.10%)	17 (4.89%)	
	Other	0	5 (1.96%)	5 (1.44%)	
Education	University Postgraduate Degree	2 (2.15%)	8 (3.14%)	10 (2.87%)	.485
	Associate degree	11 (11.83%)	47 (18.43%)	58 (16.67%)	
	General Education Degree	78 (83.87%)	194 (76.08%)	272 (78.16%)	
	Others	2 (2.15%)	6 (2.35%)	8 (2.30%)	
Marital status	Married	88 (94.62%)	253 (99.22%)	341 (97.99%)	.016
	Divorced/ Separated/ Widowed	5 (5.38%)	2 (0.78%)	7(2.01%)	
Accommodation	Living alone	2 (2.15%)	9 (3.53%)	11(3.16%)	.734
	Living with family	91 (97.85%)	246 (96.47%)	337(96.84%)	
Profession	Farmer	24 (25.81%)	61 (23.92%)	85(24.43%)	.069
	Freelancer	30 (32.26%)	79 (30.98%)	109(31.32%)	
	Manual Laborer	0	15 (5.88%)	15(4.31%)	
	Office Worker	0	5 (1.96%)	5(1.44%)	
	Retired	39 (41.94%)	95 (37.25%)	134(38.51%)	
Income (USD)		156.83 (108.95)	193.50 (147.13)	183.73 (138.73)	.037
Alcohol drinking habits	Infrequent drinker	57 (61.29%)	177 (69.41%)	234(67.24%)	.332
	Former regular drinker	31 (33.33%)	68 (26.67%)	99(28.45%)	
	Regular drinker	5 (5.38%)	10 (3.92%)	15(4.31%)	
Smoking habits	Infrequent smoker	60 (64.52%)	168 (65.88%)	228(65.52%)	.887
	Former regular smoker	28 (30.11%)	76 (29.80%)	104(29.89%)	
	Regular smoker	5 (5.38%)	11 (4.31%)	16(4.60%)	
Exercise habits	No	71 (76.34%)	116 (45.49%)	187(53.74%)	<.001
	Yes	22 (23.66%)	139 (54.51%)	161(46.26%)	
Most severe stroke condition	Complete hemiplegia	41 (44.09%)	23 (9.02%)	64(18.39%)	<.001
	Hemiparesis cannot sit independently	5 (5.38%)	37 (14.51%)	42(12.07%)	
	Hemiparesis can sit independently	10 (10.75%)	34 (13.33%)	44(12.64%)	
	Hemiparesis, can still walk	37 (39.78%)	161 (63.14%)	198(56.90%)	
Time of stroke (months)		6.72 (3.17)	6.45 (3.01)	6.53 (3.05)	.479
Developed fastidious	No	29 (31.18%)	209 (81.96%)	238(68.39%)	<.001
	Yes	64 (68.82%)	46 (18.04%)	110(31.61%)	
Current hemiplegia status	No	24 (25.81%)	172 (67.45%)	196(56.32%)	<.001
	Yes	69 (74.19%)	83 (32.55%)	152(43.68%)	
Speech ability	Normal	33 (35.48%)	195 (77.38%)	228(66.09%)	<.001
	Speech difficult	50 (53.76%)	56 (22.22%)	106(30.72%)	
	Unable to communicate	10 (10.75%)	1 (0.40%)	11(3.19%)	
Memory capacity	Normal	28 (30.11%)	159 (62.35%)	187(53.74%)	<.001
	Slightly decrease	35 (37.63%)	32 (12.55%)	67(19.25%)	
	Significant decrease	30 (32.26%)	64 (25.10%)	94(27.01%)	
Receiving psychological counseling	No	78 (83.87%)	238 (93.33%)	316(90.80%)	.013
	Yes	15 (16.13%)	17 (6.67%)	32(9.20%)	
Personality Types	Introverted	33 (35.48%)	165 (64.71%)	198(56.90%)	<.001
	Extroverted	43 (46.24%)	60 (23.53%)	103(29.60%)	
	Neutral	17 (18.28%)	30 (11.76%)	47(13.51%)	
Barthel index (scores)		18.73 (6.95)	26.98 (5.47)	24.77 (6.93)	<.001
Barthel classification	Severe dependency	32 (34.41%)	218 (85.49%)	250(71.84%)	<.001
	Total dependency	61 (65.59%)	37 (14.51%)	98(28.16%)	
PHQ-9 Index (scores)		15.77 (4.61)	3.59 (3.61)	6.84 (6.66)	<.001
GAD-7 Index (scores)		11.99 (4.13)	2.71 (3.04)	5.19 (5.31)	<.001

suggesting the potential benefits of regular exercise in mitigating anxiety and depression post-stroke.

Factors such as speech ability (p <.001) and memory capacity (p <.001) demonstrated significant associations with anxiety and depression status, highlighting the impact of communication and cognitive functions on mental health post-stroke.

The proportion of patients receiving psychological counseling varied significantly (p= .013) between HAD and LAD groups, emphasizing the importance of tailored mental health interventions in stroke rehabilitation.

Figure 1 shows a strong positive correlation between GAD-7 and PHQ-9 scores, indicating that higher levels of anxiety are closely associated with higher levels of depression. Figures 1A and 1C reveal that the conditions of anxiety and/or depression are quite similar when assessed using the individual scales. Figure 1B shows that most participants with GAD-7 scores greater than 10 also have PHQ-9 scores greater than 9. Conversely, for participants with GAD-7 scores less than 10, there is a higher proportion of those with PHQ-9 scores above 9. However, overall, this proportion is significantly lower compared to the group with both GAD-7 scores less than 10 and PHQ-9 scores less than 11.

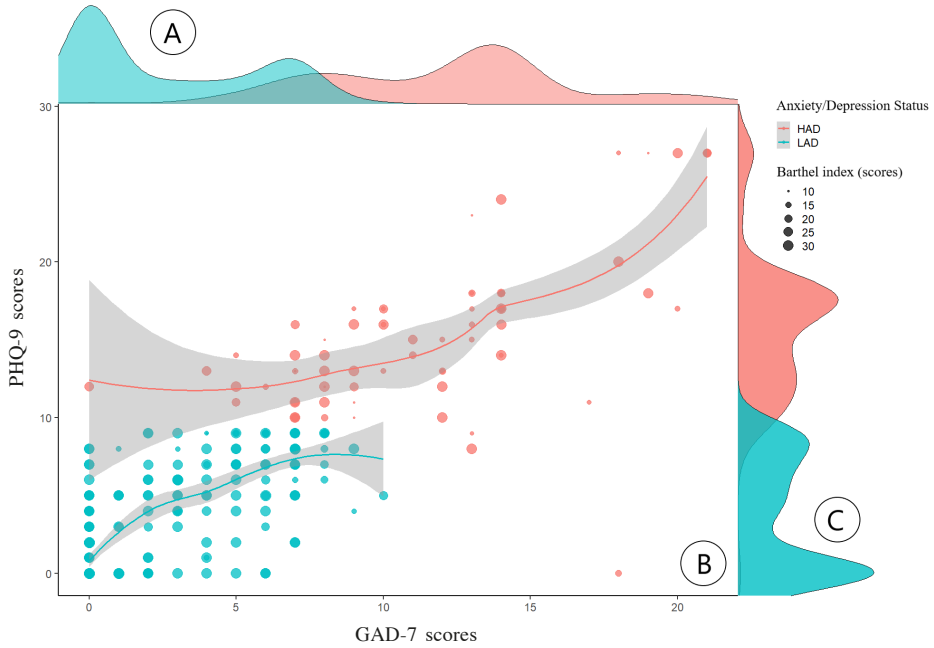

Figure 1. Correlation between GAD-7, PHQ-9 scores, and Barthel Index. Figures 1A and 1C present density plots illustrating the distribution of GAD-7 and PHQ-9 scores, respectively. Figure 1B displays a scatter plot depicting the relationship between GAD-7 and PHQ-9 scores, where the size of each data point corresponds to the Barthel Index score, and the color represents the Anxiety and/or Depression status.

Figure 2 shows the relationship between functional independence, measured by the Barthel Index, and psychological outcomes, including depression, as indicated by PHQ-9 scores, and anxiety, as indicated by GAD-7 scores. Figures 2A and 2B illustrate an inverse correlation between Barthel Index scores and both PHQ-9 and GAD-7 scores.

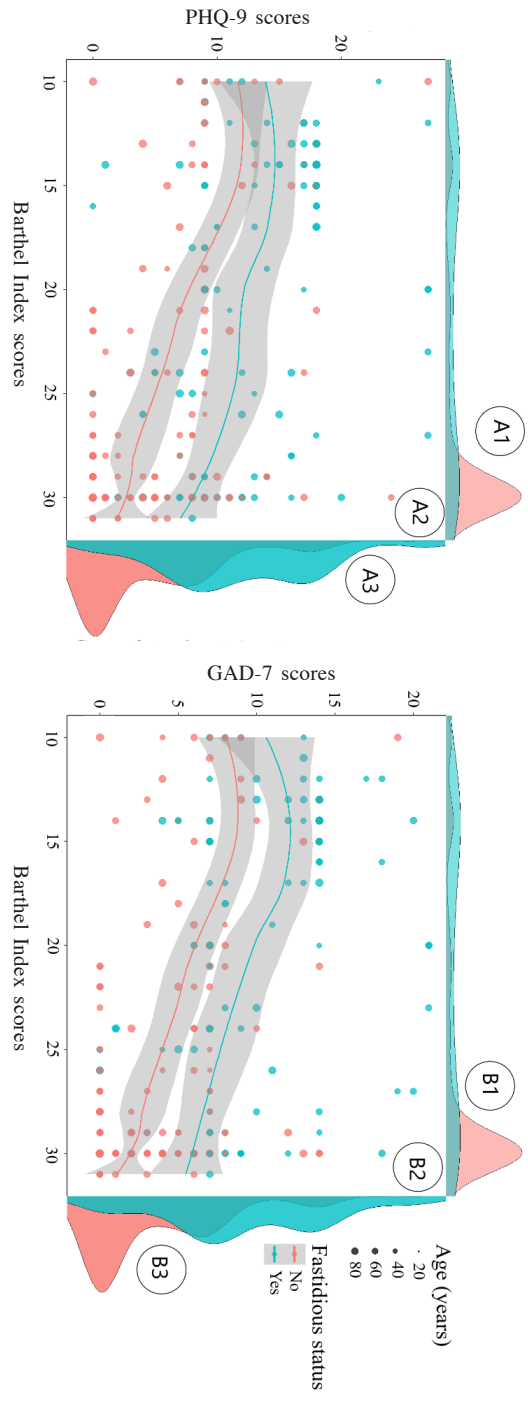

Figure 2. Figure 2. The relationship between Barthel Index scores and GAD-7 and PHQ-9 scores. Figures A1 and B1 represent density plots of Barthel Index scores, while Figures A3 and B3 depict density plots of PHQ-9 and GAD-7 scores. Figures A2 and B2 illustrate the relationship between Barthel Index scores and PHQ-9, and GAD-7 respectively.

This indicates that higher functional independence, as measured by the Barthel Index, is associated with lower levels of depression and anxiety. Additionally, participants exhibiting an increase level of fastidiousness compared to their pre-stroke condition tend to have significantly higher PHQ-9 and GAD-7 scores across all Barthel Index levels, compared to those without increased fastidiousness.

Table 2 presents a multivariable regression model identifying significant predictors associated with HAD status among post-stroke patients. This analysis highlights the complex interplay of various factors influencing mental health outcomes post-stroke.

Table 2. Multivariable regression model regarding HAD status.

Predictors		Univariable			Multivariable		
		OR	95%*CI*	*p*	*OR*	95%*CI*	*p*
Intercept		-	-	-	1.40	0.20-9.65	.732
Marital status	Married		Reference			Reference	
	Divorced/Separated/Widowed	13.94	2.21-269.14	.017	28.88	2.72-717.24	.011
Developed fastidious	No		Reference			Reference	<.001
	Yes	9.50	5.53-16.71	<.001	7.34	3.67-15.21	
Exercise habits	Yes		Reference			Reference	
	No	3.92	2.30-6.87	<.001	2.90	1.4-6.07	.004
Speech ability	Normal		Reference			Reference	
	Speech difficult	5.21	3.06-9.02	<.001	1.63	0.74-3.55	.223
	Unable to communicate	52.55	9.40-986.24	<.001	13.10	1.66-290.24	.035
Personality Types	Neutral		Reference			Reference	
	Introverted	0.37	0.18-0.79	.009	0.35	0.13-0.93	.033
	Extroverted	1.36	0.65-2.91	.421	0.44	0.16-1.21	.112
Barthel index (scores)		0.84	0.81-0.87	<.001	0.90	0.85-0.95	<.001
AUC			-			0.8958	
Observations			328			328	

In the multivariable model, six factors emerged as significant predictors of anxiety and depression (HAD) status. Comparing the univariable and multivariable models in Table 2 reveals notable differences in the strength and significance of these predictors.

In the univariable model, marital status demonstrates a strong association, with divorced, separated, or widowed individuals having an *OR* of 13.94 (95% *CI*= 2.21-269.14; *p*= .017). This effect becomes even stronger in the multivariable model (*OR*= 28.88; 95% *CI*= 2.72-717.24; *p*= .011).

For developed fastidiousness, the univariable model shows a ninefold increase in risk (*OR*= 9.50; 95% *CI*: 5.53-16.71; *p* <.001), which slightly decreases but remains significant in the multivariable model (*OR*= 7.34; 95% *CI*= 3.67-15.21; *p* <.001). Similarly, the effect of lack of exercise is attenuated from an *OR* of 3.92 (95% *CI*= 2.30-6.87; *p* <.001) in the univariable model to 2.90 (95% *CI*= 1.40-6.07; *p*= .004) in the multivariable model.

For speech ability, the univariable model indicates significant associations for individuals with speech difficulties (*OR*= 5.21; 95% *CI*= 3.06-9.02; *p* <.001) and those unable to communicate (*OR*= 52.55; 95% *CI*= 9.40-986.24; *p* <.001). However, in the multivariable model, the significance of speech difficulties diminishes (*p*= .223), while the risk associated with the inability to communicate remains substantial but decreases in magnitude (*OR*= 13.10; 95% *CI*= 1.66-290.24; *p*= .035).

Personality type follows a similar trend. Introversion significantly reduces the risk of HAD in both models, with the *OR* shifting from 0.37 (95% *CI*= 0.18-0.79; *p*= .009) in the univariable model to 0.35 (95% *CI*: 0.13-0.93, *p*= .033). Extroversion, however, remains non-significant in both models.

Lastly, the Barthel Index, which measures independence in daily activities, consistently demonstrates a protective effect. The univariable model suggests a stronger

association (*OR*= 0.84; 95% *CI*= 0.81-0.87, p <.001), consistent with the multivariable model (*OR*= 0.90; 95% *CI*= 0.85-0.95; p <.001).

The consistent trends between the univariable and multivariable models, with most predictors retaining their direction and significance, along with the multivariable model achieving an AUC of 89.6%, suggest that the model is well-specified and effectively accounts for confounding factors. Minimal changes in effect sizes for key predictors, such as developed fastidiousness and the Barthel Index, indicate robust, independent impacts, further supporting the model's quality and reliability in identifying predictors of HAD status.

Figure 3 illustrates a prediction nomogram derived from optimal model parameters, encompassing six variables detailed in Table 2: Marital status, developed fastidiousness, Exercise habits, Speech ability, Personality Types, and Barthel Index (scores). Each variable corresponds to a specific point value, and the total points are then associated with "the probability of the occurrence of HAD" to determine the likelihood of experiencing HAD. For example, a post-stroke patient who is married (0 points), lacks exercise habits (32 points), exhibits developed fastidiousness (59 points), experiences speech difficulty (14 points), is extroverted (7 points), and has a Barthel Index score of 18 (42 points). With a total score of 154 points, this patient has a greater than 80% risk of developing HAD. Notably, our study developed a prediction nomogram to easily forecast the risk of HAD among post-stroke patients.

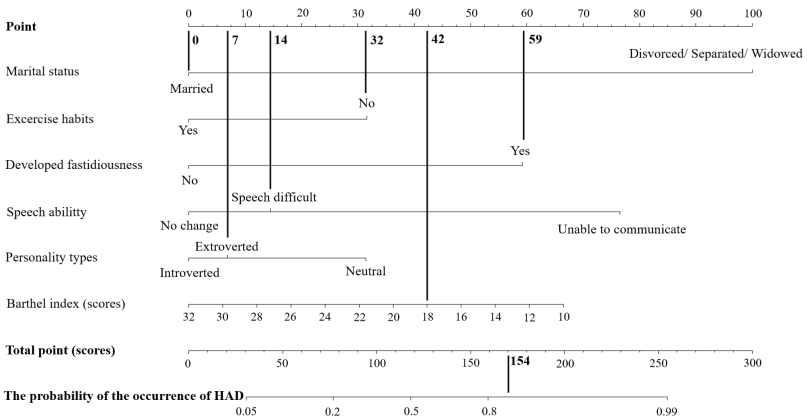

Figure 3. Prediction nomogram to evaluate the risk of HAD in post-stroke patients.

Discussion

Mood disorders are prevalent and can arise at any time after a stroke in all age groups, with depression and anxiety affecting 1 in 3 post-stroke survivors in their first year. Our study is a cross-sectional study conducted on 348 patients over the age of 18, diagnosed with cerebral stroke within one year prior to participating in the study. The main analysis used Stepwise AIC to determine the optimal logistic regression model to predict HAD status based on AIC and AUC. The optimal model includes six variables: marital status, developed fastidiousness, exercise habits, speech ability, personality types, and Barthel Index. This model was found to be highly suitable with the collected data, as evidenced by an AUC of 89.6%.

Marital status significantly influences depression and anxiety in post-stroke patients. Widowed or divorced individuals reported the highest levels of depression and suicidal thoughts, indicating that the loss of a life partner exacerbates these issues (Dong *et alii*, 2020; Gloria *et alii*, 2024). Research from the BASIC project further showed that unmarried stroke survivors had worse cognitive function, quality of life, and more depressive symptoms compared to married individuals (Dong *et alii*, 2020). Additionally, a study on middle-aged stroke survivors highlighted the increased severity of depressive symptoms post-stroke, emphasizing the need for targeted mental health interventions for unmarried survivors (Tan, Liao, Zhao, Sun, & Yi, 2023). A Saudi Arabian study reported a high prevalence of post-stroke depression, with marital status being a significant predictor (Abuadas *et alii*, 2023). Our study similarly found that stroke patients who were divorced, widowed, or separated faced a significantly higher risk of HAD, with an odds ratio of 29 compared to married patients.

Changes in personality, particularly the development of negative traits, significantly increase the risk of anxiety or depression in post-stroke patients (Lo Buono *et alii*, 2022; Stone, 2004). These alterations often manifest as increased frustration, reduced patience, decreased confidence, and a generally less easy-going nature, which are commonly observed in post-stroke patients (Lo Buono *et alii*, 2022; Stone, 2004). Such changes not only affect the emotional well-being of patients but also contribute to higher levels of psychological distress (Aben *et alii*, 2002; Dulay, Criswell, & Hodics, 2023). This heightened vulnerability to anxiety and depression is further exacerbated by the interplay of neurobiological changes and the psychological burden of coping with new post-stroke limitations and disabilities (Kim, 2016; Robinson & Jorge, 2016). Therefore, recognizing and addressing these personality changes is crucial for preventing and managing anxiety and depression in stroke survivors (Chun, Ford, Kutlubaev, Almeida, & Mead, 2022; Dulay, Criswell, & Hodics, 2023). Our findings support previous research indicating that post-stroke patients experiencing negative personality changes such as developed fastidiousness are at higher risk for HAD and are identified as a strong predictor.

Exercise is increasingly recognized for its potential to reduce depressive symptoms in post-stroke patients. Systematic reviews and meta-analyses have shown that structured exercise programs can significantly alleviate depression immediately post-intervention (Eng & Reime, 2014; Li *et alii*, 2022). Home-based mind-body exercises, particularly Tai Chi, have been identified as particularly effective (Chen, Guo, Kuang, & Zhang, 2024). Additionally, non-pharmacological interventions, including various forms of exercise, are supported by literature for their benefits in managing post-stroke depression (Villa, Ferrari, & Moretti, 2018; Wijeratne, Sales, & Wijeratne, 2022). Exercise has also been shown to reduce anxiety, which is common in the first-year post-stroke, affecting around 29.3% of patients (Chun, Ford, Kutlubaev, Almeida, & Mead, 2022; Pisegna, Knebel, Juckett, 2024; Rafsten, Danielsson, & Sunnerhagen, 2018). This aligns with our research, which found that a lack of exercise is associated with a three-fold increase in the occurrence of HAD, consistent with the studies mentioned above.

Post-stroke aphasia not only diminishes quality of life but also heightens susceptibility to depression, as evidenced by studies highlighting lower perceptions of health and quality of life among aphasic individuals compared to their non-aphasic counterparts (Bueno-Guerra *et alii*, 2024). Moreover, long-term follow-ups consistently reveal higher incidence rates of depression in aphasic patients, emphasizing the robust association between speech impairment and subsequent mental health challenges (Lin *et alii*, 2023). Efforts to enhance screening and implement targeted interventions are

crucial in addressing these issues and enhancing the overall well-being of stroke survivors struggling with speech difficulties (Schlesinger, Shiggins, Kneebone, Broomfield, & Ford, 2024). Our findings support this narrative, revealing that patients with speech difficulties are twice as likely to experience depression, with those unable to communicate facing a staggering thirteen-fold increase in HAD.

Introversion, as part of the broader neuroticism trait, consistently emerges as a significant risk factor for anxiety and depression in post-stroke patients. Studies consistently demonstrate that higher introversion scores correlate with increased depressive symptoms in stroke survivors (Aben *et alii*, 2002). This tendency to internalize negative emotions heightens vulnerability to depression. In contrast, extroversion, characterized by sociability and positive affect, does not show significant associations with depression severity post-stroke (Morris & Robinson, 1995), suggesting it lacks a protective effect against anxiety and depression. Our study further revealed that stroke patients with higher introversion were associated with a lower incidence of HAD compared to others. The results are influenced by cultural differences and the prioritization of community values in Eastern cultures, where the emphasis is often on the influence of others rather than individual traits like introversion, which is a part of neuroticism. Conversely, introversion typically correlates with increased vulnerability to anxiety and depression in Western contexts. However, in Vietnam, where community perceptions hold greater importance, introversion may be perceived as a protective factor. This reduces the likelihood that patients will be exposed to gossip or criticism from others, thereby lowering their risk of HAD. Therefore, our study's findings, which reveal a distinct relationship between introversion and HAD in Vietnam, underscore the impact of cultural factors on psychological outcomes following stroke.

Research shows that functional impairment, as measured by the Barthel Index, is strongly associated with depression (Amaricai & Poenaru, 2016; Loong *et alii*, 1995). Improved physical function correlates with better mood (Loong et alii, 1995). A study found that lower Barthel Index scores at discharge predicted higher depression levels, emphasizing the impact of physical disability on mental health (Ahn, Lee, Jeong, Kim, & Park, 2015). Additionally, longitudinal tracking of Barthel Index scores from discharge to three months post-discharge indicated that improvements in the Barthel Index were associated with better overall functional outcomes, indirectly suggesting improved mental health (Musa & Keegan, 2018). Moreover, the Post-Stroke Depression Risk Scale identified the Barthel Index as a significant predictor of depression six months post-stroke, highlighting its role in early identification of at-risk patients (Ladwig, Ziegler, Südmeyer, & Werheid, 2022). These findings coincide with our research, which indicates that for every 1-point increase in the Barthel Index, the HAD decreases by 10%. This further supports the crucial role of the Barthel Index in predicting and managing depression in post-stroke patients.

This study was conducted within a specific locality in Viettri, Phutho Province, Vietnam. Given that the research was confined to this particular geographic area, the generalizability of the findings to stroke patients in other regions or countries may be limited. The distinctive characteristics of the study site, such as local healthcare practices, demographic factors, and environmental conditions, could have influenced the results. Consequently, when extrapolating these findings to other populations or geographical contexts, it is essential to consider these limitations and exercise caution. The results may not fully capture the experiences or conditions of stroke patients beyond the study area.

Stroke remains a significant global health issue, impacting physical and psychological well-being and often leading to depression and anxiety among survivors. Our study highlights several critical factors influencing these mental health outcomes post-stroke.

Marital status emerged as a significant predictor, with divorced, widowed, or separated individuals showing a heightened risk of HAD. Personality changes post-stroke, characterized by increased negative traits like frustration and reduced patience, further exacerbate these psychological challenges. Additionally, lack of regular exercise, communication barriers due to speech impairments, and introverted personality traits contribute significantly to elevated HAD.

Effective interventions targeting these multifaceted factors are crucial for improving mental health outcomes and enhancing the overall quality of life for stroke survivors. By addressing these challenges through tailored strategies such as psychological counseling, structured exercise programs, and support for improving communication abilities, healthcare providers can significantly mitigate mental health issues and foster better recovery among stroke survivors.

REFERENCES

Aben I, Denollet J, Lousberg R, Verhey F, Wojciechowski F, & Honig A (2002). Personality and Vulnerability to Depression in Stroke Patients: A 1-Year Prospective Follow-Up Study. *Stroke, 33*, 2391-2395. Doi: 10.1161/01.STR.0000029826.41672.2E

Abuadas FH, Ayasrah SM, Ahmad MM, Abu-Snieneh HM, Obiedallah HF, & Basheti IA (2023). Prevalence of depression and its associated factors among stroke survivors in Saudi Arabia. *Nursing Open, 10*, 1629-1638. Doi: 10.1002/nop2.1417

Ahn DH, Lee YJ, Jeong JH, Kim YR, & Park JB (2015). The Effect of Post-Stroke Depression on Rehabilitation Outcome and the Impact of Caregiver Type as a Factor of Post-Stroke Depression. *Annals of Rehabilitation Medicine, 39*, 74-80. Doi: 10.5535/arm.2015.39.1.74

Amaricai E & Poenaru DV (2016). The post-stroke depression and its impact on functioning in young and adult stroke patients of a rehabilitation unit. *Journal of Mental Health, 25*, 137-141. Doi: 10.3109/09638237.2015.1022251

Bueno-Guerra N, Provencio M, Tarifa-Rodríguez A, Navarro A, Sempere-Iborra C, Jordi P, De Celis-Ruiz E, Alonso de Leciñana M, Martín-Alonso M, Rigual R, Ruiz-Ares G, Rodríguez-Pardo J, Virués-Ortega J, & Fuentes B (2024). Impact of post-stroke aphasia on functional communication, quality of life, perception of health and depression: A case–control study. *European Journal of Neurology, 31*, e16184. Doi: 10.1111/ene.16184

Chen R, Guo Y, Kuang Y, & Zhang Q (2024). Effects of home-based exercise interventions on post-stroke depression: A systematic review and network meta-analysis. *International Journal of Nursing Studies, 152,* 104698. Doi: 10.1016/j.ijnurstu.2024.104698

Chun HYY, Ford A, Kutlubaev MA, Almeida OP, & Mead GE (2022). Depression, Anxiety, and Suicide After Stroke: A Narrative Review of the Best Available Evidence. *Stroke, 53*, 1402-1410. Doi: 10.1161/STROKEAHA.121.035499

Collin C, Wade DT, Davies S, & Horne V (1988). The Barthel ADL Index: A reliability study. *International Disability Studies, 10*, 61-63. Doi: 10.3109/09638288809164103

Devereux N & Berns AM (2023). Evaluation & Treatment of Psychological Effects of Stroke. *Delaware Journal of Public Health, 9*, 62-69. Doi: 10.32481/djph.2023.08.011

Dong L, Brown D, Case E, Morgenstern L, & Lisabeth L (2020). Abstract WMP90: Marital Status and Post-Stroke Outcomes. *Stroke, 51* (Suppl-1). Doi: 10.1161/str.51.suppl_1.WMP90

Dulay MF, Criswell A, & Hodics TM (2023). Biological, Psychiatric, Psychosocial, and Cognitive Factors of Poststroke Depression. *International Journal of Environmental Research and Public Health, 20*, 5328. Doi: 10.3390/ijerph20075328

Eng JJ & Reime B (2014). Exercise for depressive symptoms in stroke patients: A systematic review and meta-analysis. *Clinical Rehabilitation, 28*, 731-739. Doi: 10.1177/0269215514523631

GBD 2019 Stroke Collaborators (2021). Global, regional, and national burden of stroke and its risk factors, 1990-2019:

A systematic analysis for the Global Burden of Disease Study 2019. *The Lancet Neurology, 20*, 795-820. Doi: 10.1016/S1474-4422(21)00252-0

Gloria MU, Jonah OE, Olusanjo AC, Chiebuka OE, Nene JJ, Nwakego AU, & Chinyere AC (2024). Post-Stroke Depression and Suicidal Ideations: Relationship with Gender and Marital Status: A Cross-Sectional Study. *Journal of Primary Care & Community Health, 15*. Doi: 10.1177/21501319241233172

Hsueh IP, Lee M, & Hsieh C (2001). Psychometric characteristics of the Barthel activities of daily living index in stroke patients. *Journal of the Formosan Medical Association, 100*, 526-532.

Kim JS (2016). Post-stroke Mood and Emotional Disturbances: Pharmacological Therapy Based on Mechanisms. *Journal of Stroke, 18*, 244-255. Doi: 10.5853/jos.2016.01144

Kroenke K, Spitzer RL, & Williams JBW (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine, 16*, 606-613. Doi: 10.1046/j.1525-1497.2001.016009606.x

Ladwig S, Ziegler M, Südmeyer M, & Werheid K (2022). The Post-Stroke Depression Risk Scale (PoStDeRiS): Development of an Acute-Phase Prediction Model for Depression 6 Months After Stroke. *Journal of the Academy of Consultation-Liaison Psychiatry, 63*, 144-152. Doi: 10.1016/j.jaclp.2021.08.003

Li C, Zhao M, Sun T, Guo J, Wu M, Li Y, Luo H, Wang X, & Li J (2022). Treatment effect of exercise training on post-stroke depression in middle-aged and older adults: A meta-analysis. *International Journal of Geriatric Psychiatry, 37*, gps.5798. Doi: 10.1002/gps.5798

Lin HL, Sung FC, Muo CH, & Chen PC (2023). Depression Risk in Post-Stroke Aphasia Patients: A Nationwide Population-Based Cohort Study. *Neuroepidemiology, 57*, 162-169. Doi: 10.1159/000530070

Lo Buono V, Noto F, Bonanno L, Formica C, & Corallo F (2022). Investigations of Personality Trait in Subacute Post-Stroke Patients: Some Preliminary Observations. *Medicina, 58*, 683. Doi: 10.3390/medicina58050683

Loong CK, Kenneth NKC, & Paulin ST (1995). Post-Stroke Depression: Outcome following Rehabilitation. *Australian & New Zealand Journal of Psychiatry, 29*, 609-614. Doi: 10.3109/00048679509064975

Marvin K & Zeltzer L (2015). *Barthel Index (BI). Evidence Reviewed as of before: 07-10-2015*. Retrieved from: https://strokengine.ca/en/assessments/barthel-index-bi/

McDowell I & Newell C (1996). *Measuring health: A guide to rating scales and questionnaires* (pp. 63-67, 2nd Ed.), New York: Oxford University Press.

Morris PLP, & Robinson, RG (1995). Personality Neuroticism and Depression after Stroke. *International Journal of Psychiatry in Medicine, 25*, 93-102. Doi: 10.2190/E25J-BCQB-BMEM-GY9F

Mossman SA, Luft MJ, Schroeder HK, Varney ST, Fleck DE, Barzman DH, Gilman R, DelBello MP, & Strawn JR (2017). The Generalized Anxiety Disorder 7-item scale in adolescents with generalized anxiety disorder: Signal detection and validation. *Annals of Clinical Psychiatry, 29*, 227-234A.

Musa KI & Keegan TJ (2018). The change of Barthel Index scores from the time of discharge until 3-month post-discharge among acute stroke patients in Malaysia: A random intercept model. *Plos One, 13*, e0208594. Doi: 10.1371/journal.pone.0208594

Pisegna J, Knebel R, Juckett L, Darragh A, Nichols-Larsen DS, & Krok-Schoen JL (2024). Occupational Therapy for Poststroke Anxiety and Depressive Symptoms in Inpatient Rehabilitation. *OTJR: Occupational Therapy Journal of Research, 44*, 78-87. Doi: 10.1177/15394492231151886

R Core Team (2022). *R: A language and environment for statistical computing*. Vienna: R Foundation for Statistical Computing.

Rafsten L, Danielsson A, & Sunnerhagen K (2018). Anxiety after stroke: A systematic review and meta-analysis. *Journal of Rehabilitation Medicine, 50*, 769-778. Doi: 10.2340/16501977-2384

Robinson RG & Jorge RE (2016). Post-Stroke Depression: A Review. *American Journal of Psychiatry, 173*, 221-231. Doi: 10.1176/appi.ajp.2015.15030363

Sahai H & Khurshid A (1996). Formulae and tables for the determination of sample sizes and power in clinical trials for testing differences in proportions for the two-sample design: A review. *Statistics in Medicine*, *15,* 1-21. Doi: 10.1002/(SICI)1097-0258(19960115)15:1<1::AID-SIM134>3.0.CO;2-E

Schlesinger H, Shiggins C, Kneebone II, Broomfield NM, & Ford C (2024). Screening Depression and Suicidality in Post Stroke Aphasia: A Theory of Planned Behaviour Study. *Aphasiology, 38*, 440–461. Doi: 10.1080/02687038.2023.2203801

Schöttke H & Giabbicon CM (2015). Post-stroke depression and post-stroke anxiety: Prevalence and predictors. *International Psychogeriatrics, 27*, 1805-1812. Doi: 10.1017/S1041610215000988

Spitzer RL, Kroenke K, & Williams JB (1999). Validation and utility of a self-report version of PRIME-MD: The

PHQ Primary Care Study. *Journal of the American Medical Association*, *282*, 1737-1744. Doi: 10.1001/jama.282.18.1737

Spitzer RL, Kroenke K, Williams JB, & Löwe B (2006). A brief measure for assessing generalized anxiety disorder: The GAD-7. *Archives of Internal Medicine*, *166*, 1092-1097. Doi: 10.1001/archinte.166.10.1092

Stone J (2004). Personality changes after stroke: Some preliminary observations. *Journal of Neurology, Neurosurgery & Psychiatry, 75*, 1708-1713. Doi: 10.1136/jnnp.2004.037887

Tan XM, Liao ZX, Zhao YY, Sun XC, & Yi FL (2023). Changes in depressive symptoms before and after the first stroke: A longitudinal study from China Family Panel Study (CFPS). *Journal of Affective Disorders, 340*, 567-574. Doi: 10.1016/j.jad.2023.08.058

Villa RF, Ferrari F, & Moretti A (2018). Post-stroke depression: Mechanisms and pharmacological treatment. *Pharmacology & Therapeutics, 184*, 131-144. Doi: 10.1016/j.pharmthera.2017.11.005

Wijeratne T, Sales C, & Wijeratne C (2022). A Narrative Review on the Non-Pharmacologic Interventions in Post-Stroke Depression. *Psychology Research and Behavior Management*, *15*, 1689-1706. Doi: 10.2147/PRBM.S310207

Zhang Z (2016). Variable selection with stepwise and best subset approaches. *Annals of Translational Medicine, 4*, 136-136. Doi: 10.21037/atm.2016.03.35

Received, November 19, 2024
Final Acceptance, January 22, 2025