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METHODS • ORIGINAL ARTICLE

Post-stroke depression in Vietnamese patients is associated with decreased sleep quality and increased fatigue: a one-institution cross-sectional analysis

Thao Thi Phuong Nguyen[1] · Thanh Xuan Nguyen[2,3] · Tat Cuong Nguyen[4,5] · Huong Thi Thu Nguyen[2,3] · Tam Ngoc Nguyen[2,3] · Thu Thi Hoai Nguyen[2,3] · Huong Thi Thanh Nguyen[6,7] · Hai Bui Hoang[8,9] · Huyen Thi Thanh Vu[2,3]

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Abstract

Purpose This study aimed to determine the prevalence of post-stroke depression (PSD) during the first year and its associated factors, especially focusing on sleep quality and fatigue severity.

Methods A cross-sectional study was conducted among stroke patients in Vietnam's National Geriatric Hospital. Data were collected by using standardized questionnaires for interviewing and evaluating patients at the research site. Several covariables were presented including demographics, stroke-related characteristics, activities of daily living, post-stroke fatigue, and sleep quality (Pittsburgh Sleep Quality Index [PSQI] scale). PSD was assessed as an outcome variable through the Patient Health Questionnaire-9 scale. To summarize sociodemographic and clinical variables, descriptive statistics were performed. A logistic regression model was used to explore the factors related to PSD.

Results Of 157 patients with stroke, mean age 73.1 (± 9.6), PSD was present in 60 patients (38%). The global score and all PSQI components of participants with PSD showed worse levels than those without depression. Furthermore, the prevalence of PSD was higher in patients with low IADL scores and functional disability at high levels. In the multivariate logistic regression analysis, the patients with PSD showed higher Fatigue Severity Scale (FSS) scores (OR = 4.11; 95% CI = 1.39; 12.19) and higher scores in two domains of the PSQI scale including subjective sleep quality (OR = 3.03; 95% CI = 1.21; 7.58) and sleep disturbance (OR = 5.22; 95% CI = 1.33; 20.47).

Conclusion There is a significant prevalence of depression following stroke. Furthermore, post-stroke fatigue and two PSQI scale components (subjective sleep quality and sleep disturbance) were shown to be associated with PSD. This finding may guide early screening and intervention strategies to address depression following stroke.

Keywords Stroke · Depression · Sleep quality · Fatigue

✉ Huyen Thi Thanh Vu
vuthanhhuyen11@hmu.edu.vn

[1] Institute for Preventive Medicine and Public Health, Hanoi Medical University, Hanoi, Vietnam

[2] Department of Geriatrics, Hanoi Medical University, Hanoi, Vietnam

[3] Scientific Research Department, National Geriatric Hospital, Hanoi, Vietnam

[4] Institute for Global Health Innovations, Duy Tan University, Da Nang, Vietnam

[5] Faculty of Medicine, Duy Tan University, Da Nang, Vietnam

[6] Dinh Tien Hoang Institute of Medicine, Hanoi, Vietnam

[7] Physiology Department, Hanoi Medical University, Hanoi, Vietnam

[8] Department of Emergency and Critical Care Medicine, Hanoi Medical University, Hanoi, Vietnam

[9] Emergency and Critical Care Department, Hanoi Medical University Hospital, Hanoi Medical University, Hanoi, Vietnam

Introduction

Post-stroke depression (PSD) is the most common neuropsychological disorder and may lead to burdensome consequences among stroke survivors. This adversely affects recovery, cognitive function, and survival among patients with [29]. According to the Diagnostic and Statistical Manual of Mental Disorders V (DSM-V), PSD is a mood disorder caused by general health problems (such as stroke), with specific features including depressive symptoms, severe depression-like episodes, manic symptoms, or mixed characteristics [1]. In 1955, Martin Roth et al. performed the first experimental studies on PSD and revealed the association between stroke and depression [25]. Furthermore, PSD was shown to be a phenomenon that may become a chronic condition. This neuropsychiatric condition may lead to reduced independence in daily activities, prolonging rehabilitation time and even causing suicidal thoughts and mortality [23].

A systematic review of 61 observational studies indicated that the frequency of PSD is 33%, ranging from 29 to 36% [12]. The significant fluctuation of incidence rates is mostly attributed to methodological differences, various depression rating scales, and different diagnostic criteria for patient recruitment. In recent decades, overwhelming evidence has identified a set of related factors of post-stroke depression, such as gender, demography, level of handicap, global medical history, mental disorder history, and stroke characteristics [26, 29]. In particular, post-stroke fatigue was determined as an important impact factor in PSD [24]. Post-stroke fatigue is often relieved when depression is appropriately treated [9].

One phenomenon that has attracted the attention of recent scholars is the association between PSD and sleep changes [22, 27] due to its nature as a modifiable factor. In fact, 20–40% of stroke survivors have reported sleep disorders [22], which significantly influenced post-stroke outcomes and recovery. Furthermore, several sleep disturbances such as the sleep–wake cycle, including long and short sleep duration, circadian rhythm disorders, and insomnia were considered the most strongly associated factors with depression [18]. Thus, numerous depression screening tools accepted sleep problems as a component of the scale. Although previous analyses using the global Pittsburgh Sleep Quality Index (PSQI) score explored the presence of a correlation between PSD and sleep disorders [6, 13], it remains unclear whether or not each PSQI component has an impact on depression among patients with stroke. Consequently, further studies are essential to explore the association between sleep quality components and post-stroke depression status.

Despite the extensive work published about the prevalence of post-stroke depression and related factors around the world, little information is available about this figure in low or middle-income countries such as Vietnam. Furthermore, it is unknown if risk factors such as fatigue or PSQI scale components have effects on PSD. Therefore, this study aimed to determine the prevalence of post-stroke depression (PSD) during the first year and its associated factors, especially focusing on sleep quality and fatigue severity.

Materials and methods

Design, setting, and sampling

A cross-sectional study was conducted among stroke survivors at the National Geriatric Hospital (Hanoi, Vietnam) from July to December 2021. The criteria for inclusion in this study were as follows: (1) aged ≥ 45 and (2) having had a confirmed stroke diagnosis one year prior. People who experienced (1) neurological diseases, (2) preexisting mood disorders, (3) preexisting cognitive dysfunction before the stroke, (4) using antidepressants, anxiolytics, or antipsychotics, (5) having transient ischemic attacks, (6) unstable medical conditions, (7) who were unable to give their informed consent, and (8) cases of consciousness disorders such as coma and poor cognition were excluded. We used a formula for estimating a population proportion with relative precision to calculate the sample size as follows: $n = Z^2_{1-\alpha/2} * [p*(1-p)/\varepsilon^2]$, with detailed indicators, including the required sample size (n), $Z1-\alpha/2 = 1.96$ (with $\alpha = 0.05\%$ and 95% confidence interval), the prevalence of depression in post-stroke patients (p), and relative precision assumed as 0.11 (ε). A recent study on stroke survivors in Vietnam showed that 69.6% of patients have depression [17], thus we chose $p = 0.696$ for the formula. The sample size was determined to have at least 139 participants. The sample size was increased by 10% to avoid incomplete responses or dropouts. Therefore, we recruited a total of 157 stroke patients, which provided sufficient data for the analysis. Patients with stroke were directly interviewed and evaluated using standardized questionnaires. Data collection was implemented by five trained nurses to ensure the reliability of assessment results. The nurses were trained on how to use the questionnaires and screen patients eligible to participate in the study. A pilot study was performed with 10 patients with stroke to determine the suitability of sentences and grammar utilized. Data from the pilot sample was not included in the current study.

Measure and instruments

Outcome variables

Post-stroke depressive symptoms The Patient Health Questionnaire-9 (PHQ-9) belongs to the PRIME-MD diagnostic

instrument for common mental illnesses, a self-administered questionnaire. It has been shown by previous studies that the PHQ-9 scale is a valid and reliable instrument to assess depression in the Vietnamese population [20, 33]. This instrument scores each item according to criteria as "0" (not at all) to "3" (nearly every day). It can be used to make a preliminary diagnosis of depression for people who are at high risk for depression, such as those who had a stroke [15]. In the total score of 0–27, the cut-off point used was 10 [15]. Cronbach's alpha for items related to answers in our study was good at 0.87.

Covariables

Demographic variables The questions answered by the interviewees include age, gender (male/female), education (secondary school and lower/high school and upper), occupation (not working/working), and marital status (living with spouse/single, widow, or widower).

Stroke-related characteristics Stroke characteristics were collected based on aspects including (i) stroke classification (ischemia/hemorrhage/unknown), which was based on medical records, (ii) time from stroke onset to study participation (< 1 month/1 month to < 3 months/3 months to < 6 months/6 months to 1 year), (iii) hemispheric lesion locations (left-sided lesions/right-sided lesions/unknown), which were categorized by the affected vascular territory through magnetic resonance imaging (MRI) or computed tomography (CT) scan, (iv) receiving beta-blocker therapy (yes/no), and (v) disability of stroke survivors according to Modified Rankin Scale (MRS) with six levels (no symptoms (0 points)/no significant disability (1 point)/slight disability (2 points)/moderate disability (3 points)/moderate-severe disability (4 points)/severe disability (5 points)).

Post-stroke fatigue Post-stroke fatigue severity was evaluated by the Fatigue Severity Scale (FSS), which has high validity for stroke patients [10]. The FSS is a short self-reported questionnaire that contains 10 statements about the severity of fatigue symptoms. The scoring method is based on a seven-point Likert scale, with a value of 1 indicating "strongly disagree" and a value of 7 indicating "strongly agree." The cut-off point for determining whether or not a person is non-fatigued or fatigued after stroke was 4 in the overall score of 0–70 [10]. In our study, Cronbach's alpha for items regarding answers was good at 0.89.

Instrumental activities of daily living The respondents were interviewed based on eight domains of function as determined by the Instrumental Activities of Daily Living (IADL). This instrument is most helpful for determining the functional activity levels of stroke patients at present as well as evaluating improvement or deterioration over time. Men are not assessed in the domains of food preparation, housekeeping, or laundry, while women are scored in all eight areas of function. The participants are scored at their highest level of performance in each domain [11]. A summary score ranged from 0 (poor function, dependent) to 8 (excellent function, independent).

Sleep quality The 19-item Pittsburgh Sleep Quality Index (PSQI) was used to measure the subjective experience of sleep quality in the previous month. This instrument comprises seven components (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction) that are combined from 19 separate items. Each item is scored on a 0–3 interval scale, giving a total score ranging from 0 to 21 points. A lower score indicates better sleep quality. Previous research has shown that a global PSQI score of over 5 may be used to discriminate between good and bad sleepers with high sensitivity and specificity [3]. A previous study indicated that the Vietnamese version of PSQI is a valid and reliable tool that can be used for assessing sleep disorders in Vietnamese patients or for community screening [30].

Data analysis

STATA version 16 (StataCorp. LP, College Station, Texas, USA) was utilized to address the study's main objectives. Variables such as sociodemographic and clinical characteristics were analyzed by descriptive statistics. The mean and standard deviation (SD) were used to represent continuous variables, while frequencies and percentages were utilized to describe categorical variables. To determine depression categorization, the PHQ-9 scores of each participant were used. Whitney Wilcoxon test was employed for continuous variables and the $\chi 2$ test was used for categorical variables. These aid in detecting a statistically significant difference between the groups with and without depressive symptoms.

Univariate regressions were used before using the multivariable regression model according to the spirit of the "purposeful selection of variables in regression methods" suggested by Hosmer and Lemeshow [14]. This could be to aid in selecting the predictors to include in the basic multivariable regression model. Thus, using univariate logistic regression models, the unadjusted association between PSD (with PHQ-9 score > 10) and predicted variables was determined. Besides, those without depression (PHQ-9 score ≤ 10) served as the reference group [19]. The multivariate logistic regression model comprised all variables that were significant in the unadjusted models, and logistic regression was performed to determine predictors associated with PSD (yes = 1/no = 0). Stepwise forward methods help

reduce and filter these models with a p-value > 0.2 as the threshold for excluding variables. Statistical significance was defined as a p-value ≤ 0.05.

Results

Table 1 shows the sociodemographic characteristics of the participants according to classification with or without depressive symptoms. The mean age of the 157 stroke patients was 73.1 (SD = ± 9.6) years, with 48% of them being female, 67% of the participants had no career at the time of the stroke, and the participants responded that their education level of high school and higher accounted for 56%. Most of the participants lived within spousal relationships (84%). A statistically significant difference between with and without post-stroke depressive symptoms was found in the variable of education levels (secondary school and lower/high school and upper) with p-value ≤ 0.05.

Table 2 demonstrates the clinical features of the participants according to classification with or without depressive symptoms. The percentage of PSD accounted for 38% of the participants. The respondents reported stroke status due to ischemia (64%), hemorrhage (115%), and unknown cause (22%). The majority of the participants were categorized into slight to moderate-severe disability groups (54%). The prevalence of post-stroke depression was highest in the first 3-month period following stroke onset (60%). The group with defined depressive symptoms had an average time from stroke onset to study participation of about 96 days (3 months). The majority of the participants had lesions in the left hemispheric location (n = 68, 43%). Among those with post-stroke depressive symptoms, left-sided lesions were prominent, with a percentage of 47%. Furthermore, 33 (21%) patients received beta-blocker therapy. Most of the post-stroke patients had fatigue (62%) and dependent activities of daily living (57%). The differences in post-stroke fatigue (including FSS scores), activities of daily living (including IADL scores, and disability of stroke survivors between the two groups of "no depressive symptoms" and "depressive symptoms" were statistically significant (p ≤ 0.05).

Table 3 shows the patient sleep scores and components of the PSQI scale according to depression status. The global score and PSQI components of the participants with PSD showed higher levels than those without depressive symptoms. Except for use of sleep medication, all the remaining PSQI components and global scores were related to depression classification (p-value ≤ 0.05).

In the logistic multivariable model adjusted for other associated symptoms (Table 4), the factors associated with the PSD groups were higher FSS scores (OR = 5.51; 95% CI: 1.74; 17.40) and higher scores in two domains of the PSQI scale, including subjective sleep quality (OR = 3.03; 95% CI: 1.21; 7.58) and sleep disturbance (OR = 5.22; 95% CI: 1.33; 20.47) with p-value ≤ 0.05.

Table 1 Patient sociodemographic characteristics according to classification with or without post-stroke depressive symptoms

Demographic variables	Post-stroke depressive symptoms *(PHQ-9 with cut-off point = 10)*						*p*-value
	Depressive symptoms (n = 60)		No depressive symptoms (n = 97)		Total (n = 157)		
	n	%	*n*	%	*n*	%	
Total	60	38	97	62	157	100	
Gender							
Male	27	45	55	57	82	52	0.154
Female	33	55	42	43	75	48	
Occupation							
Not working	36	60	69	71	105	67	0.150
Working	24	40	28	29	52	33	
Education							
Secondary school and lower	42	70	46	47	88	56	0.006
High school and upper	18	30	51	53	69	44	
Marital status							
Living with spouse	48	80	84	87	132	84	0.272
Single, widow/widower	12	20	13	13	25	16	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	***p*-value**
Age	73.9	11.1	72.7	8.5	73.1	9.6	0.444

Table 2 Patient clinical characteristics according to classification with or without post-stroke depressive symptoms

Clinical characteristics	Post-stroke depressive symptoms *(PHQ-9 with cut-off point = 10)*						*p*-value
	Depressive symptoms ($n=60$)		No depressive symptoms ($n=97$)		Total ($n=157$)		
	n	%	*n*	%	*n*	%	
Stroke characteristics							
Stroke classification							
Ischemia	40	67	60	62	100	64	0.830
Hemorrhage	8	13	15	16	23	15	
Unknown	12	20	22	23	34	22	
Disability of stroke survivors–MRS (points)							
No symptoms (0)	2	3	12	12	14	9	< 0.001
No significant disability (1)	9	15	35	36	44	28	
Slight disability (2)	13	22	18	19	31	20	
Moderate disability (3)	4	7	18	12	16	10	
Moderate-severe disability (4)	21	35	18	18	38	24	
Severe disability (5)	11	18	18	3	14	9	
Time from stroke onset to study participation							
< 1 month	26	43	28	29	54	34	0.224
1 month to < 3 months	10	17	15	16	25	16	
3 months to < 6 months	10	17	26	27	36	23	
6 months to 1 year	14	23	28	29	42	27	
Hemispheric lesion locations							
Left-sided lesions	28	47	40	41	68	43	0.035
Right-sided lesions	24	40	27	28	51	33	
Unknown	8	13	30	31	38	24	
Receiving beta-blocker therapy							
Yes	8	13	25	26	33	21	0.063
No	52	87	72	74	124	79	
Post-stroke factors							
Post-stroke fatigue							
No fatigue	7	12	53	55	60	38	< 0.001
Fatigue	53	88	44	45	97	62	
Classifying the independent or dependent in daily living activities (based on IADL)							
Independent	15	25	52	54	67	43	< 0.001
Dependent	45	75	45	46	90	57	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	***p*-value**
Mean time from stroke onset to study participation (day)	96.0	110.0	118.1	109.2	109.6	109.7	0.138
Fatigue Severity Scale (score)	41.2	4.6	34.3	8.1	36.9	7.7	< 0.001
Instrumental activities of daily living scale (score)	2.2	2.8	4.5	2.9	3.6	3.1	< 0.001

Discussion

This study assessed the association between PSD and related factors in Vietnam, especially focusing on the patients' sleep quality during the first year after stroke. The results indicated that the prevalence of PSD accounted for 38% of the respondents. This figure focused on groups that have high functional disability levels, daily living activity impairment, and post-stroke fatigue, with a statistically significant difference (p-value ≤ 0.05). In particular, most of the participants who had experienced a stroke for the first 3 months reported a high rate of depressive symptoms (60%). All the PSQI

Table 3 Patient sleep scores and components of the PSQI scale according to classification with or without post-stroke depressive symptoms

PSQI scores	Post-stroke depressive symptoms *(PHQ-9 with cut-off point = 10)*						*p*-value
	Depressive symptoms ($n=60$)		No depressive symptoms ($n=97$)		Total ($n=157$)		
	Mean	SD	Mean	SD	Mean	SD	
Global score (range 0–21)	11.4	4.2	7.4	3.7	8.9	4.4	< 0.001
Component scores (range 0–3)							
Subjective sleep quality	1.9	0.7	1.2	0.8	1.5	0.8	< 0.001
Sleep latency	2.2	1.0	1.5	1.0	1.8	1.0	< 0.001
Sleep duration	1.9	1.1	1.5	1.0	1.7	1.1	0.017
Habitual sleep efficiency	1.8	1.3	1.0	1.2	1.3	1.3	< 0.001
Sleep disturbance	1.3	0.5	1.0	0.3	1.1	0.4	< 0.001
Use of sleep medication	0.4	1.0	0.2	0.6	0.2	0.8	0.360
Daytime dysfunction	2.1	1.1	1.0	0.9	1.4	1.1	< 0.001
	n	**%**	***n***	**%**	***n***	**%**	***p*-value**
Global score > 5	52	87	61	63	113	72	0.001

Table 4 Associated factors with post-stroke depressive symptoms through the logistic regression analysis

Symptoms	Univariate analysis			Multivariate analysis		
	OR	95% CI	*p*-value	OR	95% CI	p-value
Stroke characteristics and post-stroke factors						
Disability of stroke survivors; MRS (per score)	1.68	(1.33; 2.13)	< 0.001	1.49	(0.98; 2.27)	0.059
Fatigue Severity Scale (per score)	9.12	(3.76; 22.07)	< 0.001	4.11	(1.39; 12.19)	0.011
Instrumental activities of daily living scale (per score)	3.46	(1.71; 7.03)	< 0.001	0.91	(0.25; 3.36)	0.89
Sleep symptoms (PSQI)						
Subjective sleep quality	3.05	(1.86; 4.98)	< 0.001	3.03	(1.21; 7.58)	0.018
Sleep latency	1.84	(1.30; 2.60)	< 0.001	1.00	(0.55; 1.82)	0.999
Sleep duration	1.43	(1.04; 1.96)	0.023	0.53	(0.26; 1.09)	0.083
Habitual sleep efficiency	1.61	(1.23; 2.10)	< 0.001	1.46	(0.83; 2.57)	0.190
Sleep disturbance	7.29	(2.64; 20.14)	< 0.001	5.22	(1.33; 20.47)	0.018
Use of sleep medication	1.36	(0.90; 2.06)	0.137	0.77	(0.44; 1.34)	0.359
Daytime dysfunction	2.85	(1.96; 4.13)	< 0.001	1.54	(0.96; 2.47)	0.071

scale components and global scores showed poorer sleep quality among the PSD group. The multivariate logistic regression analysis explored post-stroke fatigue and two significant components of the PSQI scale (including subjective sleep quality and sleep disturbance) associated significantly with depressive symptoms after stroke.

This study discovered a significant prevalence of post-stroke depression, which is consistent with prior studies that revealed a cumulative figure of depression for 1 year after stroke ranging from 36 to 41% [4, 16, 32]. However, compared to a systematic review and meta-analysis in 2014, the percentage of PSD was synthesized from 61 studies, which was lower than the current finding of 33% (ranging from 29 to 36%) in the first year after stroke [12]. In Vietnam, there is only one study that mentioned this figure [17]. We found that the prevalence of depression (based on a PHQ-9 score ≥ 10) [15], accounted for 43% in the first month following stroke onset and 17% in the 1- to 3-month period. Our findings are higher than the pooled prevalence of 61 observational studies according to a meta-analysis in 2014, with 28% in the 0- to 1-month period after an occurring stroke, and 36% in the period from 2–5 months [12]. Furthermore, the previous study found that post-stroke depression ranged from 14 to 63% at 3 months [28]. However, it is complicated to analyze these pooled estimates due to the heterogeneity between studies. Furthermore, our study revealed that the prevalence of PSD was higher in patients with low IADL scores and functional disability at high levels. This result was consistent

with previous studies that identified a meaningful association between PSD and functional disability [21, 31]. The association between daily living activity impairment and depression reached the highest level at 6 months and then decreased; however, it significantly remained at 1 year after stroke [21]. The common appearance of PSD in patients with severe disability and low IADL scores might reflect its impact on retarding recovery. Therefore, routine depression screening is the best way to prevent and decrease the negative impact on further recovery and quality of life for stroke survivors.

The significant association between depressive symptoms and post-stroke fatigue in the participants was explored through a logistic regression analysis. In the literature, researchers suggested fatigue as the most common concomitant symptom related to depression in stroke patients [9, 24]. Both symptoms often coexist and show similar experiences, making them difficult to distinguish as independent events [5]. From biomedical aspects, previous researchers explained PSD as a multifactorial psychological phenomenon [2]. Furthermore, the strong connection between post-stroke depression, sleep disturbance, and fatigue could be considered as evidence to support the multifactorial perspective of PSD [7, 27]. As a result, post-stroke fatigue conditions should be attended to by healthcare professionals and caregivers in both acute and chronic phases. Early fatigue screening will positively affect recovery and reduce worse outcomes when they are present.

The present findings revealed that those with post-stroke depressive symptoms had higher PSQI global scores than the remaining group, which is consistent with a previous study by Davis et al. [6]. Sleep disorders have been identified as a significant risk factor for depression in both the acute and chronic stages of stroke [8, 34]. In the acute stage, neuroendocrine changes and biological triggers (e.g., inflammatory biomarkers) may have a more significant influence than sleep quality in patients with stroke [34]. However, sleep quality may continue to affect depression in chronic stroke survivors over time. Changes in a person's brain activity, as well as the macrostructure and microstructure of their sleep, may contribute to depression in patients with chronic stroke [8]. Previous study indicated that sleep circadian rhythm and an individual's sleep–wake cycle may be changed by lesions caused by a stroke. These alterations may result in a variety of sleep disorders, which can contribute to depression [8]. In fact, sleep aids physical energy restoration and has good effects on mental functions such as memory consolidation. Stroke survivors can in turn disturb their sleep-rest patterns if levels of depression increase [6]. When the seven PSQI subcomponents were examined independently, we discovered that the "subjective sleep quality" and "sleep disturbance" (difficulty maintaining sleep) domains were associated with PSD among the participants. Previous research also showed that poor subjective sleep quality among stroke survivors was significantly associated with depressive symptoms [6]. Likewise, sleep disturbances delay stroke recuperation and might even be related to the development of depressive symptoms after stroke [8]. Therefore, focusing on these two modifiable sleep characteristics will be a promising intervention strategy for reducing depressive symptoms in those who are suffering from chronic stroke. Simultaneously, early diagnosis and treatment of sleep disturbances and poor sleep quality are essential to ensure the quality of life and reduce the risk of psychiatric problems after stroke.

The strengths of our study are that it was the first work in Vietnam to explore the association of all PSQI scale components and related factors with post-stroke depression. The PSQI scale has been shown to be a reliable tool with high sensitivity and specificity, and may be utilized for evaluating sleep problems in Vietnamese patients with stroke or for community screening [30]. Nevertheless, several study limitations should be considered in light of the current findings. First, sleep disorders and fatigue are considered to be risk factors for depression [5], which may occur before or after stroke. Since a cross-sectional study design was implemented in this survey, it did not allow us to establish cause-and-effect relationships according to temporal interaction between sleep quality/post-stroke fatigue and PSD. Thus, in the future, longitudinal studies should be implemented to examine whether or not screening and treating high-risk post-stroke survivors with depression, fatigue, and sleep disturbance is effective. Second, this is a single hospital-based cross-sectional study with a small sample size, so it may not be possible to extrapolate the results to the entire Vietnamese stroke population. Third, PHQ-9 has been shown to be a depression-measuring instrument with good sensitivity and specificity for stroke survivors. However, diagnosis of PSD should be based on the clinical standards of mental health professionals instead of PHQ-9. This may exclude false-positive cases due to the complex symptoms of stroke. Fourth, data collection was implemented from July to December 2021, which is in the COVID-19 pandemic era. Consequently, it could not be excluded that depressive symptoms occurred in the changing context of the COVID-19 pandemic. Fifth, although the FSS is the most frequently used scale in stroke, validation studies on the Vietnamese version are lacking. However, this scale showed an excellent internal consistency for participant response items in the current investigation, with a Cronbach's alpha of 0.89. Hence, this scale may be useful for post-stroke fatigue screening.

Conclusion

This investigation displayed the high prevalence of PSD and revealed that PSD was more common in patients with impairment of daily living activity and high levels of functional disability. Thus, routine depression screening may be

useful to assess in order to intervene to decrease the negative effect on further recovery and quality of life for stroke survivors. Fatigue and two components of the PSQI scale (subjective sleep quality and sleep disturbance) were found to have an association with post-stroke depression.

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Author contribution Conceptualization: Thao Thi Phuong Nguyen, HuyenThi Thanh Vu, Thanh Xuan Nguyen, Huong Thi Thu Nguyen, Tam Ngoc Nguyen, and Hai Bui Hoang. Methodology: Thao Thi Phuong Nguyen, HuyenThi Thanh Vu, and Hai Bui Hoang. Formal analysis and investigation: Thao Thi Phuong Nguyen, Thanh Xuan Nguyen, Tat Cuong Nguyen, Huong Thi Thu Nguyen, Tam Ngoc Nguyen, Thu ThiHoai Nguyen, Huong Thi Thanh Nguyen, and HuyenThi Thanh Vu. Writing (original draft preparation): Thao Thi Phuong Nguyen, Huyen Thi Thanh Vu, and Hai Bui Hoang. All the authors critically reviewed the draft of the manuscript and approved the final version of the manuscript.

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Data availability The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate The study protocol was approved by The Institutional Review Board for Ethics in Biomedical Research-Hanoi Medical University (Code: No 494/GCN-HDDDNC-SYHN-DHYHN dated 05/12/2021). Before participating in this study, all the participants or their relatives/guardians were requested to provide written informed consent following the Declaration of Helsinki.

Conflict of interest The authors declare no competing interest.

References

1. American Psychiatric Association (APA) (2013) Diagnostic And Statistical Manual Of Mental Disorders, 5th edn, Washington: American Psychiatric Publishing, Inc. https://doi.org/10.1176/appi.books.9780890425596
2. Aben I, Verhey F (2006) Depression after a cerebrovascular accident. The importance of the integration of neurobiological and psychosocial pathogenic models. Panminerva Med 48:49–57
3. Backhaus J, Junghanns K, Broocks A et al (2002) Test–retest reliability and validity of the Pittsburgh Sleep Quality Index in primary insomnia. J Psychosom Res 53:737–740
4. Bour A, Rasquin S, Aben I et al (2010) A one-year follow-up study into the course of depression after stroke. J Nutr Health Aging 14:488–493
5. Coster LD, Leentjens AF, Lodder J et al (2005) The sensitivity of somatic symptoms in post-stroke depression: a discriminant analytic approach. Int J Geriatr Psychiatry: j psychiatry late life allied sci 20:358–362
6. Davis JC, Falck RS, Best JR et al (2019) Examining the interrelations of depression, physical function, and cognition with subjective sleep parameters among stroke survivors: a cross-sectional analysis. J Stroke Cerebrovasc Dis 28:2115–2123
7. Douven E, Köhler S, Schievink SH et al (2017) Temporal associations between fatigue, depression, and apathy after stroke: results of the cognition and affect after stroke, a prospective evaluation of risks study. Cerebrovasc Dis 44:330–337
8. Ferre A, Ribó M, Rodriguez-Luna D et al (2013) Strokes and their relationship with sleep and sleep disorders. Neurol (English Edition) 28:103–118
9. Glader E-L, Stegmayr B, Asplund K (2002) Poststroke fatigue: a 2-year follow-up study of stroke patients in Sweden. Stroke 33:1327–1333
10. Graber M, Garnier L, Duloquin G et al (2019) Association between fatigue and cognitive impairment at 6 months in patients with ischemic stroke treated with acute revascularization therapy. Front Neurol 10:931
11. Graf C (2008) The Lawton instrumental activities of daily living scale. AJN Am J Nurs 108:52–62
12. Hackett ML, Pickles K (2014) Part I: frequency of depression after stroke: an updated systematic review and meta-analysis of observational studies. Int J Stroke 9:1017–1025
13. Hayashino Y, Yamazaki S, Takegami M et al (2010) Association between number of comorbid conditions, depression, and sleep quality using the Pittsburgh Sleep Quality Index: results from a population-based survey. Sleep Med 11:366–371
14. Hosmer DW Jr, Lemeshow S, Sturdivant RX (2013) Applied logistic regression. John Wiley & Sons
15. Janneke M, Gooskens F, Schepers VP et al (2012) Screening for poststroke depression using the patient health questionnaire. Nurs Res 61:333–341
16. Jia H, Damush TM, Qin H et al (2006) The impact of poststroke depression on healthcare use by veterans with acute stroke. Stroke 37:2796–2801
17. Jullamate P, Rosenberg E (2017) Factors related to post-stroke depression among older adults in Da Nang, Viet Nam. J Nurs Health Sci 11:148–157
18. Khot SP, Morgenstern LB (2019) Sleep and stroke. Stroke 50:1612–1617
19. Kroenke K, Spitzer RL, Williams JBW (2003) The patient health questionnaire-2. Med Care 41(11):1284–1292. https://doi.org/10.1097/01.MLR.0000093487.78664.3C
20. Le Hoang Ngoc T, Le MAT, Nguyen HT, Vo HV, Le NQ, Tang LNP, Tran TT, Le TV (2021) Patient Health Questionnaire (PHQ-9): A depression screening tool for people with epilepsy in Vietnam. Epilepsy Behav 125:108446. https://doi.org/10.1016/j.yebeh.2021.108446
21. Parikh RM, Lipsey JR, Robinson RG et al (1987) Two-year longitudinal study of post-stroke mood disorders: dynamic changes in correlates of depression at one and two years. Stroke 18:579–584
22. Pasic Z, Smajlovic D, Dostovic Z et al (2011) Incidence and types of sleep disorders in patients with stroke. Med Arch 65:225
23. Pompili M, Venturini P, Campi S, Seretti ME, Montebovi F, Lamis DA, Serafini G, Amore M, Girardi P (2012) Do stroke patients have an increased risk of developing suicidal ideation or dying by suicide? An overview of the current literature. CNS Neurosci Ther 18(9):711–721. https://doi.org/10.1111/j.1755-5949.2012.00364.x
24. Ponchel A, Bombois S, Bordet R et al (2015) Factors associated with poststroke fatigue: a systematic review. Stroke res treat 2015
25. Roth M (1955) The natural history of mental disorder in old age. J Meteorol Soc Jpn 101:281–301

26. Shi Y, Yang D, Zeng Y et al (2017) Risk factors for post-stroke depression: a meta-analysis. Front aging neurosci 9:218
27. Silva LC, Silva A, Rangel MFDA et al (2021) Depressive symptoms and functional status are associated with sleep quality after stroke. Top Stroke Rehabil 28:573–580
28. Strong B, Fritz MC, Dong L et al (2021) Changes in PHQ-9 depression scores in acute stroke patients shortly after returning home. PLoS One 16:e0259806
29. Taylor-Rowan M, Momoh O, Ayerbe L et al (2019) Prevalence of pre-stroke depression and its association with post-stroke depression: a systematic review and meta-analysis. Psychol Med 49:685–696
30. To N, Nguyen N (2015) Validity of the Vietnamese version of the Pittsburgh sleep quality index. Sleep Med 16:S52. https://doi.org/10.1016/j.sleep.2015.02.128
31. Towfighi A, Ovbiagele B, El Husseini N et al (2017) Poststroke depression: a scientific statement for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 48:e30–e43
32. Verdelho A, Henon H, Lebert F et al (2004) Depressive symptoms after stroke and relationship with dementia: a three-year follow-up study. Neurology 62:905–911
33. Vu LG, Le LK, Dam AVT, Nguyen SH, Vu TTM, Trinh TTH, Do AL, Do NM, Le TH, Latkin C, Ho RCM, Ho CSH (2022) Factor structures of patient health questionnaire-9 instruments in exploring depressive symptoms of suburban population. Frontiers in Psychiatry 13:838747. https://doi.org/10.3389/fpsyt.2022.838747
34. Wu S, Mead G, Macleod M et al (2015) Model of understanding fatigue after stroke. Stroke 46:893–898