

Rate of Post-Stroke Depression and Associated Factors in Saudi Single Tertiary Medical Center

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Purpose: Stroke is a significant global health concern, with post-stroke depression (PSD) affecting approximately 30% of patients and contributing to reduced quality of life and increased mortality. In Saudi Arabia, data on PSD frequency and associated factors remain limited in relation to the rehabilitation of stroke patients, highlighting the need for further investigation. The study's aims to investigate the rate of PSD and the factors that influence PSD.

Methods: This feasibility study was conducted at the Neurorehabilitation Unit of King Abdulaziz Medical City in Riyadh, Saudi Arabia (October 2023–October 2024), and included stroke patients aged 18–80 years. Data on stroke severity (NIHSS), functional independence (FIM), Hospital Anxiety and Depression Scale (HADS), and Short-Form Health Survey (SF-36) were collected using validated Arabic tools. All the analyses were performed with the significance level set at $p < 0.05$.

Results: Out of the 37 participants, the frequency of anxiety and depression was 59.5% at admission, and it decreased to 40.5% at discharge from rehabilitation services. Functional independence improved significantly, with a 9.5-point increase in FIM scores. The mean differences (-1.54 ± 4.3 , $p=0.03$) and categorical differences between the initial and discharge HADS scores were significant ($p=0.02$).

Conclusion: We found a high rate of depression and anxiety among stroke patients at admission. Rehabilitation services can lead to the improvement of depression and anxiety in stroke patients, from initial admission to discharge, with emotional health as a factor for better outcomes.

Keywords: anxiety, depression, rehabilitation, stroke, functional independent measure, emotional health

Introduction

Stroke is a significant global health concern, affecting approximately 12.2 million individuals globally resulting in 6.6 million deaths in 2019.¹ Recent data indicate that stroke prevalence has increased among both males and females with advancing age, with around 9.4 million Americans self-reporting a history of stroke between 2017 and 2020.²

In Saudi Arabia, the prevalence of stroke shows considerable variation across studies, ranging from 29 to 57.6 per 100,000 populations.^{3,4} This disparity may reflect differences in study methodologies or population demographics. With an aging population, the incidence of stroke in Saudi Arabia is expected to rise further, increasing the burden on healthcare systems.⁵ Stroke can lead to significant physical, sensory, and cognitive impairments, often resulting in diminished quality of life.

One of the most frequent and debilitating complications after stroke is post-stroke depression (PSD). PSD is associated with reduced functional ability, poorer quality of life, and increased mortality.⁶ Globally, PSD affects approximately 30% of stroke patients, persisting for up to five years' post stroke.^{7,8} A recent systematic review estimated the prevalence of PSD to be

around 27%.⁹ However, this prevalence has varied across regions; for example, it was 47% in Iran but 31% in Sub-Saharan Africa.^{10,11} Furthermore, post stroke anxiety (PSA) affects around 20 to 25% of stroke patients and can negatively impact the rehabilitation process and quality of life for patients.^{12,13} Depression and anxiety post stroke are highly related condition and can coexist in many stroke patients.¹⁴ In Saudi Arabia, data on PSD remain limited. Only two studies have reported PSD rates of 70.6% and 76.5%, but these studies had small sample sizes, did not follow up with participants, and were completed at one point only.^{15,16} Another study was conducted during the COVID-19 pandemic, and it reported a lower PSD prevalence of 36%, though the pandemic's impact on mental health might have influenced these findings.¹⁷

Mechanism that associated stroke with PSD are investigated with hypotheses related the cause to; stroke lesion site, amino acid neurotransmitters, and neuroinflammation.¹⁸ As for the stroke lesion location and its relation to PSD evidence suggested that specific brain regions such as the prefrontal cortex, limbic area, and basal ganglia can disturb the pathway which may lead to PSD.¹⁹ The monoamine neurotransmitters is considered the main biological factor that link PSD to stroke. If distributed occur at the hypothalamic-pituitary-adrenal axial, glutamate and gut-brain circuits this can lead to PSD.^{20,21} Lastly, studies proposed that elevated levels of inflammatory mediators are associated with PSD.^{22,23}

PSD contributes to increased physical disability, cognitive impairment, higher mortality risk, and a greater likelihood of falls.^{6,24,25} It also impedes rehabilitation progress, resulting in poorer quality of life and challenges in returning to work.^{17,25–27} Common risk factors for PSD include stroke severity, cognitive impairment, physical disability, and functional dependency.^{17,28,29} Patients with aphasia are at particularly high risk, with more severe aphasia correlating with more pronounced PSD symptoms.^{30,31} Additionally, a history of depression, psychiatric illness, and living alone further increase the likelihood of developing PSD.³²

This study aims to shed light on the current practice of stroke rehabilitation in Saudi Arabia and identify barriers that may hinder recovery—particularly post-stroke depression. Our objective is to track patients throughout their rehabilitation admission and at discharge to better understand how PSD evolves and impacts recovery.

Although some studies in Saudi Arabia have reported on PSD, there is still a lack of data regarding its frequency and associated factors within rehabilitation settings. A deeper understanding of PSD and its predictors is crucial for designing individualized and effective interventions in neurorehabilitation. Furthermore, no prior study in the region has included a follow-up to examine changes in depression levels throughout the rehabilitation process. Therefore, this study investigated the prevalence of PSD and explored clinical factors linked to its occurrence. To our knowledge, this is the first study in Saudi Arabia—and the broader Middle East—to examine PSD and its associated factors within a neurorehabilitation context.

Materials and Methods

Study Design

This predictive correlational feasibility study was conducted at the Neurorehabilitation Unit (NRU) of King Abdulaziz Medical City (KAMC) in Riyadh, Saudi Arabia, between October 1, 2023, and October 31, 2024, focusing on stroke patients admitted to the NRU with pre and post assessments of rehabilitation outcomes.

A non-probability convenience sampling method was used to recruit adult stroke survivors aged 18 to 80 years who met the inclusion criteria [Figure 1](#)

Eligibility Criteria

Patients were excluded if they had severe cognitive impairment (defined as a Montreal Cognitive Assessment [MoCA] score of ≤ 10), recurrent stroke or dementia diagnosed before the stroke, surgically treatable lesions on CT scans (eg, brain tumors), other central nervous system (CNS) conditions causing depression (eg, Parkinson's disease), severe aphasia, severe comorbidities (eg, end-stage renal disease), or a prior history of psychiatric disturbances. Clinical data were extracted from electronic health records using the BestCare health record system to ensure accuracy and reliability.

Ethical considerations were prioritized, with data collection initiated after obtaining Institutional Review Board (IRB) approval from the King Abdullah International Medical Research Center (KAIMRC) (Reference Number: SP34R/055/05). Informed consent was secured from patients and their families, ensuring confidentiality, privacy, and adherence to ethical research standards.

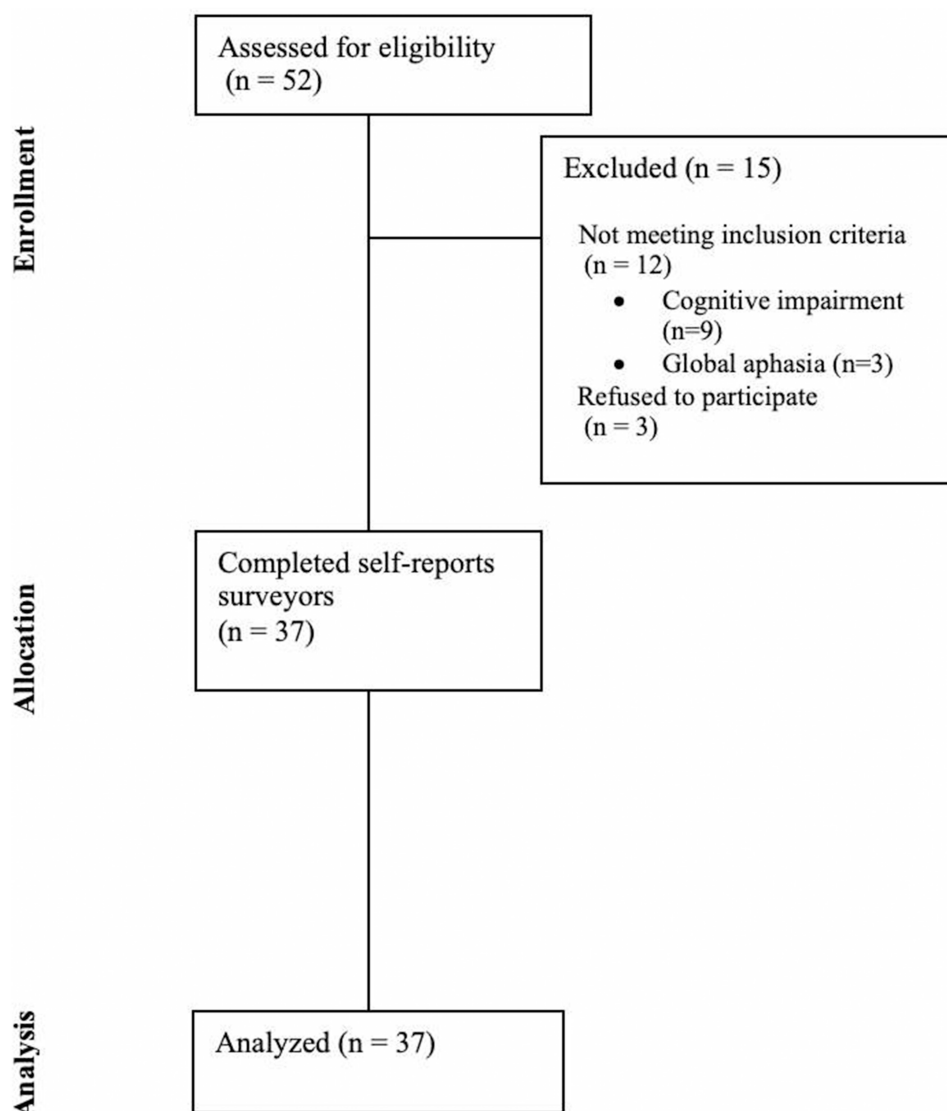


Figure 1 Flowchart of the recruitment process in the Neurorehabilitation Unit.

Outcome Measurement

All participants were assessed for the following: 1) stroke severity at the time of admission using the National Institute of Health Stroke Scale (NIHSS),^{33,34} 2) functional independence at admission and discharge using the Functional Independence Measure (FIM), focusing on items such as eating, grooming, bathing, toileting, and upper and lower body dressing,³⁵ 3) self-reported depression and anxiety using the Hospital Anxiety and Depression Scale (HADS) at both admission and discharge,³⁶ and 4) emotional and physical well-being at discharge using the 36-item Short Form Health Survey (SF-36).³⁷ Questions related to the physical well-being asked about activities such as claiming stairs, walking. While mental well-being asked questions regarding the person's such as if they feel clam, cheerful.

Both the Hospital Anxiety and Depression Scale (HADS) and the 36-item Short Form Health Survey (SF-36) were administered using their validated Arabic versions. The Arabic-translated form of the HADS has been utilized in this study due to its validation across various medical settings.^{38,39} The HADS consists of an anxiety subscale (7 items, assessed on a 4-point Likert scale) and a depression subscale (7 items, assessed similarly). The Arabic version demonstrates strong internal consistency, with Cronbach's alpha values ranging from 0.70 to 0.835. Scores for each subscale were calculated by summing the relevant items, with a maximum score of 21 for each subscale. A score of 0–7

is categorized as normal, 8–10 as mild, 11–14 as moderate, and 15–21 as severe for each subscale for depression and anxiety.⁴⁰ Both the HADS and SF-36 initial assessment were administered in day 5 or 6 after admission, while the discharge assessments were completed after 20 days on average.

Statistical Analysis

Descriptive analyses were performed, presenting categorical variables as frequencies and percentages. A one-way ANOVA test was used to assess the association between depression levels, as measured using the HADS, and variables including age, length of stay, NIHSS, FIM, SF-36 physical health, and emotional health. Spearman’s rank correlation test was used to assess the correlation between emotional well-being and physical functioning with depression. The McNemar test was used to assess changes in HADS classifications between admission and discharge (pre–post assessment). Lastly, multivariable logistic regression was conducted to examine the association between HADS scores at discharge, adjusting for relevant covariates including age and NIHSS scores, with adjusted odd ratio (AORs) and 95% confidence intervals (CI). A p-value <0.05 was considered statistically significant. All the statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS V.25.0, SPSS Inc., Chicago, IL).

Results

Participants Demographics

A total of 37 participants were included in the current study. The most common exclusion criteria were low cognitive ability and aphasia. The majority of participants were male (62.2%), and 83.8% had ischemic stroke. Most participants had comorbidities, including hypertension (75.7%) and diabetes (73.0%). The average age of participants was 59 years, with an average length of stay of 22 days in the NRU. Participant characteristics are presented in Table 1.

Initial and Discharge Hospital Anxiety and Depression Scale & Short Form Health Survey Correlation with Hospital Anxiety and Depression Scale

There was a statistically significant difference between the initial and discharge scores of the HADS (-1.54 ± 4.3 $p=0.03$). The mean difference in total scores decreased by 1.54 at discharge (Table 2). In Addition, a Spearman correlation was conducted between the HADS scores at discharge and emotional and physical Short Form Health Survey SF-36. There was a moderate significant correlation between the SF-36 emotion and HADS at discharge, with

Table 1 Participants Characteristics

Category	Subcategory	N (%)
Gender	Male	23 (62.2%)
	Female	14 (37.8%)
Type of stroke	Ischemic	31 (83.8%)
	Hemorrhagic	6 (16.2%)
Hypertension	Yes	28 (75.7%)
	No	9 (24.3%)
Diabetes Mellitus	Yes	27 (73.0%)
	No	10 (27.0%)
Dyslipidemia	Yes	16 (43.3%)
	No	21 (56.7%)
Tissue Plasminogen Activator (tPA)	Yes	3 (8.1%)
	No	34 (91.9%)
Age years	59.1 (12.5) ^a	
Length of stay days	22.1 (15.2) ^a	

Note: ^a values are in means and (SD).

Table 2 Initial and Discharge Hospital Anxiety and Depression Scale

HADS	Mean (SD)	Mean Difference	P-Value
HADS initial	8.30 (3.7)	– 1.54 (4.3)	0.03*
HADS discharge	6.76 (3.9)		

Note: Statistical significant at * $P < 0.05$.

the increase of emotional well-being correlated to decrease of HADS scores ($p = 0.03$, CI: -0.76 , -0.17). Moreover, a weak negative non-significant correlation was found between SF-36 physical and HADS scores at discharge (Table 3).

Rate and Severity Level of Hospital Anxiety and Depression Scale

The rate of depression or anxiety was 59.5% at admission among all participants, which decreased to 40.5% at discharge, with seven participants reporting no issues by the end of the rehabilitation sessions. In addition, the severity of depression and anxiety varies initially and at discharge with lower rate of severity at discharge (53.5% mild and 33.3% moderate in compared to 45.5% mild and 45.5% moderate cases) (Supplementary Table 1). To test the significant change in the proportion of patients with each category initially and at discharge we used a paired chi-square test (Table 4). There was a significant difference between the HADS initial, and discharge based on the present of depression and anxiety and the severity levels.

Functional Independent Measure Scores

Scores of the FIM initial assessment to discharge was statistically significant ($p = 0.001$), with an increase of 9.5 points between the initial and discharge scores (mean initial = 17.76, mean discharge = 27.32).

Factors Associated with Initial and Discharge Hospital Anxiety and Depression Scale Scores

The HADS scores at both initial assessment and discharge were grouped into categories: normal (no depression or anxiety), mild, moderate, and severe depression or anxiety. There was no association between the initial HADS scores and other variables (age, FIM, and initial NIHSS) (Table 5). However, the SF-36 emotional health score was significantly associated with HADS scores at discharge ($p = 0.01$) (Table 6).

Table 3 Spearman Correlation Between SF-36 and Discharge Hospital Anxiety and Depression Scale Scores

SF-36 and HADS	Spearman's Rho	95% CI	P-Value
SF-36 emotional and HADS discharge	–0.472	– 0.76, –0.17	0.03*
SF-36 physical and HADS discharge	–0.283	– 0.60, 0.03	0.09

Note: Statistical significant at * $P < 0.05$.

Table 4 Initial and Discharge Hospital Anxiety and Depression Scale Based on the Severity Level

HADS Initial	HADS Discharge				P-Value
	Normal	Mild	Moderate	Severe	
Normal	2 (15.4%)	3 (17.6%)	1 (20.0%)	0 (0.0%)	0.02*
Mild	7 (53.8%)	5 (29.4%)	1 (20.0%)	0 (0.0%)	
Moderate	4 (30.8%)	9 (52.9%)	3 (60%)	1 (50.0%)	
Severe	0 (0.0%)	0 (0.05%)	0 (0.0%)	1 (50.0%)	

Note: Statistical significant at * $P < 0.05$.

Table 5 Association Between Initial Hospital Anxiety and Depression Scale Scores and Variables

HADS Initial Means (SD)	Normal	Mild	Moderate	Severe	P- Value
Age	59.4 (13.3)	58.1 (11.0)	65.2 (13.1)	52.0 (10.3)	0.52
FIM initial	18.7 (7.0)	17.3 (8.6)	16.0 (7.1)	25.0 (7.2)	0.63
NIHSS initial	7.8 (4.7)	6.5 (3.9)	8.1 (3.3)	3 (1.6)	0.58

Table 6 Association Between Discharge Hospital Anxiety and Depression Scale Scores and Variable

HADS Discharge Means (SD)	Normal	Mild	Moderate	Severe	P- Value
Age	60.0 (14.2)	56.7 (8.6)	69.6 (8.6)	57.0 (7.0)	0.32
Length of stay	27.8 (16.8)	29.8 (11.3)	21.4 (15.0)	16.0 (7.0)	0.57
FIM discharge	28.2 (7.2)	27.6 (5.2)	23.0 (7.7)	26.5 (10.6)	0.51
NIHSS initial	7.4 (4.4)	7.5 (3.5)	6.6 (3.2)	8.5 (7.7)	0.95
SF-36 physical	30.6 (26.1)	11.8 (17.3)	24.0 (26.3)	2.5 (3.5)	0.17
SF-36 emotional	69.8 (14.9)	61.0 (16.1)	48.8 (13.1)	26.0 (2.8)	0.01*

Note: Statistical significant at * $P < 0.05$.

Table 7 Variables Influencing the Hospital Anxiety and Depression Scale

HADS Discharge	Adjusted Ratio (AORs)	CI 95%	P-Value
Length of stay	0.98	0.94–1.0	0.60
FIM discharge	0.95	0.86–1.04	0.31
NIHSS initial	0.99	0.84–1.17	0.95
SF-36 physical	0.97	0.94–1.00	0.06
SF-36 emotional	0.93	0.89–0.98	0.01*

Note: Statistical significant at * $P < 0.05$.

Factors Influencing Discharge Hospital Anxiety and Depression Scale Scores

A binary logistic regression was used to determine factors that may increase the likelihood of depression or anxiety based on the HADS discharge scores. Table 7 illustrates the variables, showing that SF-36 emotional health scores significantly increased the likelihood of depression or anxiety (OR = 0.93, CI = 0.89–0.98, $p = 0.01$).

Discussion

This study explored the frequency and severity of depression and anxiety among stroke patients admitted to a neurorehabilitation unit, alongside factors associated with these mental health outcomes at discharge. Consistent with the previous literature, we observed a high prevalence of mood disorders at admission, with 59.5% of patients exhibiting symptoms of depression and/or anxiety.^{24,41} This aligns with previous research that identified stroke survivors as being at an elevated risk of mood disorders due to the physical and psychological burden of the condition.^{27,28} The previous literature showed that the prevalence of PSD varies widely, ranging between 20% and 65%, depending on the population studied, the assessment measures used, and the definitions of depression applied.^{9,41,42} However, significant improvements were observed in anxiety and depression levels, with a reduction in the admission to discharge rate in our findings. Initially, most participants reported mild to moderate symptoms, which shifted to predominantly mild symptoms by discharge. Furthermore, functional independence measure scores showed significant improvement during rehabilitation. While no

associations were found between initial HADS scores and variables such as age or stroke severity, emotional health, as measured by the SF-36, was significantly correlated with HADS scores at discharge.

Our findings are particularly consistent with studies conducted in the Saudi Arabia context, where high rates of PSD have been reported. For example, Abuadas et al⁴² reported that more than two-thirds (70.6%) of a sample of stroke survivor patients in Saudi Arabia experienced depression, and Alharbi et al⁴³ reported comparable results. These findings underscore the significant psychological burden experienced by stroke survivors in the region and highlight the importance of culturally contextualized research and interventions.

Rehabilitation was associated with a statistically significant reduction in depression and anxiety symptoms, with the rate dropping to 40.5% at discharge. Most participants moved from moderate to mild severity levels, suggesting that structured neurorehabilitation can effectively mitigate mood disturbances. Improvements in functional independence likely contributed to this positive trend, with an average gain of 9.5 points from admission to discharge.

This is in line with the work of a recent study that involved 1,440 stroke survivors and demonstrated that moderate- or high-intensity physical activity correlates with lower levels of depressive symptoms in stroke survivors. This suggests that non-pharmacological approaches, particularly those emphasizing physical and social engagement, may therefore play a pivotal role in emotional recovery.⁴⁴

Interestingly, our study found no significant association between initial HADS scores and clinical factors such as age, NIHSS, or initial FIM scores. This enhancement in physical functionality likely contributes to the reduction in depression and anxiety symptoms, as greater independence can foster a sense of accomplishment and control, which are critical for mental well-being. However, emotional health, as assessed by the SF-36, emerged as a predictor of depression and anxiety outcomes at discharge. Binary logistic regression analysis confirmed that higher SF-36 emotional well-being scores were associated with a lower likelihood of depressive and anxious symptoms. However, this finding should not be a surprise, given that the SF-36 emotional items have some similarity with the HADS items, which can cause correlation between both outcomes.

Multiple studies reported that the rehabilitation program helps alleviate depressive symptoms, with better functional outcomes leading to improvement in PSD.^{45,46} However, evidence has illustrated that the efficiency of functional recovery for stroke patients with PSD is poorer than for those without depression. This suggests that PSD has an impact on functional recovery.^{47,48} In addition, the severity of depression measure via HADS can contribute to the functional outcomes with better functional outcomes in patients with mild or low severity scores.⁴⁹

In terms of clinical implications, our results emphasize the need for routine screening and the management of depression and anxiety in stroke patients, particularly during admission and discharge from rehabilitation programs. Implementing targeted psychological interventions, such as cognitive-behavioral therapy (CBT) or stress management techniques, alongside physical rehabilitation, could further enhance patient outcomes. Moreover, the significant role of emotional health as a predictor of mood disturbances underscores the value of integrating psychosocial support into stroke care plans. Moreover, it is recommended to train rehabilitation staff on how to identify signs of depression and or anxiety as well as the impact on mental well-being on the client's performance in rehabilitation sessions.

This study has some strengths: it examined patients at an early rehabilitation stage, followed up with participants pre and post rehabilitation, and administered self-reported assessments at two points in time.

Limitation

This study also has several limitations. The small sample size (n=37) limits the generalizability of its findings. The use of a non-probability convenience sampling method may have introduced selection bias. The study's strict inclusion criteria contributed to the small sample size and excluded stroke patients who may have PSD. The correlation between SF-36 emotion and HADS scores can overlap; the similarity of the items in both assessments may limit the impact of the findings. Another limitation is the lack of consideration of participants past medical and mental health history, social support networks, medication use (including antidepressants), lesion location, or stroke laterality, all of which are known to influence the development and severity of post-stroke depression, which could have influenced the rate and severity of depression and anxiety. Furthermore, this study was conducted in a single tertiary rehabilitation center, which may have limited the generalizability of the findings across other healthcare settings, including rural or non-specialized facilities.

Future research should include larger, more diverse samples and adopt longitudinal designs to better understand the temporal dynamics of mood disorders in stroke survivors.

Past medical history can play an important part in the results, for example insomnia and the history of lack of sleep are linked to PDS. Evidence supports the link that pre-stroke insomnia may predict PSD.^{50,51} Moreover, patients with insomnia are more likely to have a more depression symptoms post stroke.^{52,53} Thus, future studies should explore the association between insomnia pre, post stroke and PSD in the Saudi population.

Our results suggest the importance of screening stroke patients for depression and anxiety prior to rehabilitation to optimize stroke recovery in patients in Saudi Arabia. In addition, these results support enhancing the rehabilitation team's awareness of depression and/or anxiety for early identification and potential referral to a specialist.

Conclusion

In conclusion, this study highlights the high prevalence of depression and anxiety among stroke patients upon admission and the significant improvements associated with inpatient rehabilitation. Emotional health emerged as a key factor influencing mental health outcomes, reinforcing the need for integrated, holistic approaches to stroke care. Routine screening, early intervention, and enhanced team awareness are recommended to optimize both emotional and functional recovery.

Abbreviations

PSD, Post-Stroke Depression; PSA, Post Stroke Anxiety; NRU, Neurorehabilitation Unit; NIHSS, National Institute of Health Stroke Scale; FIM, Functional Independence Measure; SF-36, 36-item Short Form Health Survey; HDAS, Hospital Anxiety and Depression Scale; CBT, Cognitive-Behavioral Therapy.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethical Approval and Consent to Participation

All methods were performed in accordance with the ethical standards established in the Declaration of Helsinki and its subsequent amendments or comparable ethical standards. This study was approved with approval and consent of the Ethics Committee of King Abdullah International Medical Research Center (IRB approval number: SP34R/055/05). Informed consent was obtained from all participants before their involvement in the study, ensuring that they were fully aware of the study's purpose, procedures, potential risks, and benefits. Informed consent was obtained from all subjects involved in the study.

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Disclosure

The authors report no conflicts of interest in this work.

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