




Person-Centered Approaches for Identifying Subgroups of Post-Stroke Depression: A Systematic Review of Observational Studies

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Background: Current management for post-stroke depression (PSD) mainly relies on the severity of depression, insufficiently capturing PSD's clinical heterogeneity. No previous systematic review has jointly synthesized cross-sectional and longitudinal observational studies using person-centered approaches to identify PSD subgroups. This systematic review synthesizes evidence from these studies employing person-centered approaches to characterize PSD subgroups.

Methods: Comprehensive searches were conducted in nine databases from the inception to September 2025. Observational studies using person-centered approaches to subgroup PSD were included. Two reviewers independently performed data extraction and study quality assessment using the National Institutes of Health Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies.

Results: Eleven articles (9 unique cohorts; N = 6729) were included. Cross-sectional studies (4 studies; N = 1400) identified four symptom-based subgroups: low depressive symptoms (46.6%), emotional depressive symptoms (9.4%), atypical depressive symptoms (23.2%), and widespread depressive symptoms (20.8%). Longitudinal studies (5 studies; N = 5329) revealed four trajectory-based subgroups: low and stable/decreasing (59.7%), low but increasing (17.8%), high and stable/increasing (13.6%), and initially high/moderate but declining (8.9%). Latent transition analysis (2 studies; N = 886) showed greater subgroup fluidity within 6-month post-stroke, followed by increasing stability. Predictors of more severe/persistent subgroups included social-demographic, clinical and physiological factors. One study found that all non-low-stable trajectories were associated with significantly increased 10-year mortality (hazard ratios: 1.38–2.62).

Conclusion: Person-centered approaches can effectively delineate latent subgroups of PSD characterized by distinct symptom manifestations and trajectories. Findings of this review support a shift away from one-size-fits-all, total-score-based management toward a more nuanced, symptom- and trajectory-informed framework for PSD.

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Keywords: post-stroke depression, person-centered analysis, heterogeneity, latent class analysis, symptom trajectories, precision psychiatry

Background

Post-stroke depression (PSD) represents a prevalent psychological complication among stroke survivors, with a prevalence of approximately one-third across stroke phases.^{1,2} Beyond its psychological burden, PSD hinders physical functional recovery, impairs health-related quality of life, elevates the risk of stroke recurrence, and increases the risk of mortality among stroke survivors.^{3–6} Given these adverse consequences, the effective management of PSD is clinically imperative.

Current clinical management of PSD typically follows severity-based stepped-care models that rely on total scores from depression scales to guide interventions.^{7,8} While these severity-oriented paradigms have informed guideline-concordant practice, they may insufficiently capture the clinical complexity and heterogeneity of PSD. Research increasingly underscores



that stroke survivors with similar total depression scores can demonstrate distinct symptom profiles and longitudinal courses.^{9,10} Moreover, patients with depressive symptoms vary in their response patterns to interventions,^{11–13} suggesting the existence of latent depression subgroups that differ in phenotypic characteristics and treatment needs. Efforts have been made to delineate PSD subgroups in addition to the depression severity, PSD subtypes have been explored using both variable-centered and person-centered analytical frameworks.

Variable-centered approaches presume that all individuals within a sample are derived from a single population; accordingly, group-level “average” parameters are estimated to represent the sample as a whole.¹⁴ By contrast, person-centered approaches allow for population heterogeneity by testing whether the sample comprises distinct latent subpopulations characterized by different sets of parameters.^{14,15} Person-centered approaches for cross-sectional data identifies subgroups of individuals based on their pattern of responses across multiple variables at a single time point, while those for longitudinal data identifies subgroups of individuals based on their pattern of change in a single variable over multiple time points.¹⁶ The appeal of person-centered approaches lies in its potential to create nuanced subgroups derived from a comprehensive array of information, encompassing the multifaceted nature of depression. Through these approaches, PSD may be differentiated into subgroups with distinct characteristics; however, such subgrouping should currently be regarded as exploratory and hypothesis-generating, and whether these derived subgroups can inform individualized PSD interventions remains to be established.

Despite growing interest, the literature synthesizing PSD subgroups through person-centered methodologies remains limited. In the context of acquired brain injury (including stroke), a recent systematic review identified four longitudinal depressive symptom trajectories—stable low, persistent high, increasing, and decreasing—highlighting substantial symptom progression heterogeneity.¹⁷ Notably, this review primarily included longitudinal studies using group-based trajectory modelling analysis, which is typically univariate and based on a single variable’s trajectory (such as, depression score), thereby offering a relatively narrow view.¹⁶

A comprehensive synthesis of person-centered analyses of PSD – encompassing both cross-sectional subgroups and longitudinal trajectories – has the potential to illuminate the full extent of heterogeneity across stroke populations, reveal robust subgroup structures, and guide the development of targeted interventions in clinical care. To date, no review has systematically synthesized person-centered studies that examine both cross-sectional PSD subgroups based on symptom profiles and longitudinal PSD subgroups based on trajectories, together with their predictors and clinical outcomes.

Therefore, this systematic review aims to (1) characterize PSD subgroups identified through person-centered approaches in observational studies; (2) synthesize factors (eg, demographic, clinical, and social) associated with subgroup membership, and (3) summarize outcomes (eg, functional recovery, quality of life, and mortality) associated subgroup membership.

Methods

This study was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).¹⁸ The protocol was prospectively registered in PROSPERO (CRD420251273568).

Search Strategy

A comprehensive search was conducted to identify literature reporting the use of person-centered approaches to identify PSD subgroups. The following electronic databases were searched from the inception to September 2025: British Nursing Index, Cumulative Index to Nursing and Allied Health Literature (CINAHL), MEDLINE, Embase, PsycINFO, Scopus, Web of Science Core Collection, China National Knowledge Infrastructure (CNKI), and WanFang Data. In addition, the ProQuest Dissertations and Theses Global (PQDT Global), WanFang Data Theses, Grey Literature Exploitation (<http://www.opengrey.eu>) and Grey Literature Report (<http://greylit.org/home>) were used for the grey literature search. Reference lists of all included studies and relevant reviews were also screened to identify additional eligible studies. Search terms related to stroke, depression, and person-centered approaches were used in titles, abstracts, keywords and medical subject headings. Search strategies were adapted for each database. Adjacent operators were applied where supported by the database. Detailed search strategies for databases are provided in [Supplementary material 1](#).

Eligibility Criteria

Studies were included if they (1) included adult (≥ 18 years) stroke survivors, (2) assessed PSD using validated assessment scales or diagnostic criteria for depression, (3) were observational studies, including cross-sectional and longitudinal studies, (4) adopted person-centered approaches, including cluster analysis (eg, hierarchical or k-means), latent class analysis, latent profile analysis, longitudinal mixture methods (eg, group-based trajectory modelling, latent class growth analysis, and growth mixture modelling), and latent transition analysis, and (5) were published in English or Chinese. Observational studies were targeted because person-centered subgroup identification in PSD has primarily been investigated using observational data, and the aim of this review was to synthesize naturally occurring depressive symptom patterns and trajectories rather than treatment effects. Articles were excluded if they used PSD as one indicator together with other indicators,^{19,20} such that depressive symptom subgroups could not be isolated. Study protocols, ongoing studies, case reports, conference abstracts, editorials, letters, and commentaries were excluded from this review.

Study Selection

All retrieved records were imported into Endnote, and duplicates were removed. Two independent reviewers (DS and MZ) screened the titles and abstracts of retrieved records, followed by full-text assessments for eligibility according to the eligibility criteria. The two reviewers jointly reviewed the set of records considered potentially eligible or ambiguous and discussed each until consensus was reached regarding inclusion for full-text review. Discrepancies were resolved by consultation with the third reviewer (LZ) if necessary.

Data Extraction

Two reviewers (DS and MZ) independently extracted data using a structured form developed for this review. Extracted information included study characteristics (author, year, country, and study design), participants (sample size, age, and sex, stroke type, stroke phase, and stroke incidence), outcome measurements (measures and assessment timepoints), analytical methods and results (type of person-centered approaches, model selection criteria, and number, labels, prevalence and description of identified subgroups), predictors, and outcomes. Any discrepancies in extracted data were resolved by discussion or, if needed, consultation with the third reviewer (LZ).

Data Synthesis

To facilitate comparison across studies using different subgroup labels, we harmonized the identified subgroups descriptively based on overall symptom severity, dominant symptom profile, trajectory pattern, and scale threshold information when available. Overall proportion for each synthesized subgroup was calculated descriptively by summing the number of participants assigned to that subgroup across relevant studies and dividing by the total number of participants from those studies contributing data to that subgroup classification.

Study Quality Assessment

Two reviewers (MZ and LZ) independently assessed the study quality using the National Institutes of Health Quality Assessment Tool for Observational Cohort and Cross-Sectional Studies.²¹ The tool includes 14 items targeting critical bias sources, including the clarity of study design and objectives, appropriateness of study population sampling, accuracy of exposure/outcome measurement, identification and control of confounders, rigor of data analysis and reporting, and sufficiency of follow-up duration and completeness. Each item was rated as “Yes”, “No”, “Cannot determine” or “Not applicable”. Based on these ratings, an overall quality judgment (good, fair or poor) was assigned to each study. Disagreements were resolved by discussion, with involvement of the third reviewer (DS) when necessary.

Results

Study Selection

The systematic search of electronic databases yielded 4758 records. After removal of duplicates, 3051 records were screened by titles and abstracts. Of these, 2912 were excluded as not meeting eligibility criteria. The remaining 139 studies underwent

full-text review, leading to the inclusion of 11 articles. No additional eligible studies were identified through grey literature searches or screening reference lists of included studies. Consequently, this review included 11 articles (Figure 1. PRISMA Flowchart). Inter-rater agreement for this decision stage was 97.3%, with Cohen’s kappa of 0.78, indicating substantial agreement.

Among these 11 included articles, two reported findings from the same cohort in China,^{9,22} and another two analyzed the same dataset from the Health and Retirement Study in the USA.^{23,24} To avoid redundancy in sample descriptions, we treated these as originating from 9 unique cohorts in subsequent narrative synthesis.

Study Characteristics

The 9 included studies were published between 2016 and 2025, with approximately two-thirds (n=6) published since 2023. These included studies were conducted in China,^{9,10,25–27} the USA,^{24,28} the UK,²⁹ and Singapore.³⁰ The summary of study characteristics is presented in Table 1.

Characteristics of Participants

A total of 6729 stroke survivors were included in this review, and 52.6% (3539/6729) were males. Individual study sample sizes ranged from 172³⁰ to 2313.²⁹ All studies reported age, with the mean or median ranging from 59.0 years²⁶ to 74.9 years.¹⁰ Three studies provided age ranges of participants ranging from 25 to 91 years.^{9,10,27}

Regarding clinical characteristics, six studies reported stroke incidence. In these, the vast majority of survivors (96.2%; 5516/5731) experienced a first-ever stroke.^{9,10,24,26,27,29} Stroke phase at baseline was reported in eight studies and ranged from within 2 weeks of stroke onset^{10,26,27} to 39 months post-stroke.²⁵ Furthermore, five studies reported stroke type and indicated that most survivors (89.2%; 1563/1753) had ischemic stroke.^{10,22,25,26,28}

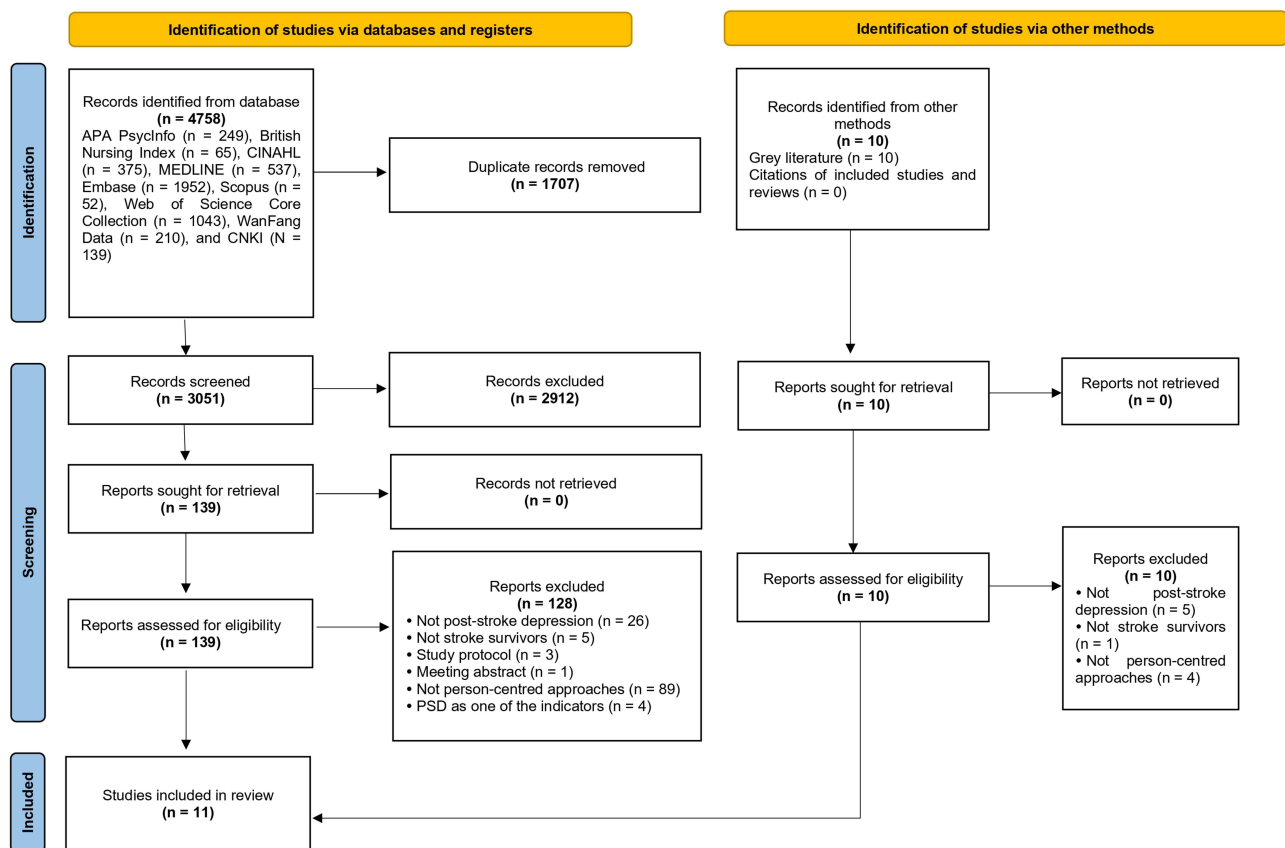


Figure 1 Study selection flow diagram (according to PRISMA 2020 flow diagram for new systematic reviews).

Table 1 Characteristics of Included Studies

Study No.	Author/ Year/ Country	Stroke Type/ Times/Phase	Sample Size/ Male (%)/Age: Mean/Median	Design/Analysis Techniques	Depression Measurement	Original Subgroups		Subgroups in This Review
						No.	Original Label (%)	
1	Ayis ²⁹ 2019 UK	NI first-ever acute	2313 1275 (55.1%) Male: 65.1 (13.3) Female: 68.9 (15.7)	Longitudinal GBTM	HADS 3m, 1y, 2y, 3y, 4y, 5y	3 (M)	Low and stable symptoms (42.1%)	Low and stable/ decreasing
							Moderate increasing symptoms (46.5%)	Low but increasing
							Severe persistent symptoms (11.4%)	High and stable/ increasing
						4 (F)	Low symptoms (29.1%)	Low and stable/ decreasing
							Moderate symptoms (49.8%)	Low and stable/ decreasing
							Severe symptoms (16.3%)	High and stable/ increasing
							Very severe symptoms (4.8%)	High and stable/ increasing
2	Han ¹⁰ 2025 China	Ischemic first-ever acute	276 168 (60.9%) 74.9 (12.2)	Cross-sectional LPA	SDS	3	Mild depression weak somatization (48.6%)	Low depressive symptoms
							Moderate depression moderate somatization (35.6%)	Low depressive symptoms
							Severe depression strong somatization (15.9%)	Widespread depressive symptoms
3	Hart ²⁴ 2025 USA	NI first-ever from pre-stroke	2298 989 (43.0%) 71.2 (10.0)	Longitudinal LGMM	CESD-20 within 2y pre-stroke, 0-2y, 2-4y, 4-6y post-stroke	4	Stable low symptoms (resilient) 65.5%	Low and stable/ decreasing
							Consistently high symptoms (chronic) (10.7%)	High and stable/ increasing
							Initially high but gradually declining symptoms (recovery) (13.5%)	Initially high/ moderate but declining
							Initially low but gradually increasing symptoms (delay) (10.3%)	Low but increasing
4	Huang ²⁵ 2024 China	Ischemic 82 (68.9%) NI acute	119 40 (33.6%) 66 [57, 66]	Longitudinal LGMM	PROMIS SF- Depression baseline, 3m, 6m	2	Moderate level decreasing (37.8%)	Initially high/ moderate but declining
							High level increasing (62.2%)	HIGH and stable/ increasing
5	Liming ²⁸ 2021 USA	Ischemic 595 (91.8%) NI 3m post-stroke	707 358 (50.6%) 65.6 (11.2)	Longitudinal LTA	PHQ-8 3m, 6m, 1y	4	Severe/all symptom group	Widespread depressive symptoms
							Mild/no symptom group	Low depressive symptoms
							Affective symptom group	Emotional depressive symptoms
							Predominant sleep disturbance and fatigue symptom group	Atypical depressive symptoms

(Continued)

Table 1 (Continued).

Study No.	Author/ Year/ Country	Stroke Type/ Times/Phase	Sample Size/ Male (%)/Age: Mean/Median	Design/Analysis Techniques	Depression Measurement	Original Subgroups		Subgroups in This Review
						No.	Original Label (%)	
6.1	Liu ²² 2021 China	Ischemic 211 (94.2%) first-ever 110 (49.1%) within 1y post-stroke 113 (50.4%)	224 143 (63.8%) 62.5 (9.8)	Cross-sectional LPA	PHQ-9	4	Emotional depression (9.4%)	Emotional depressive symptoms
							Widespread depression (13.8%)	Widespread depressive symptoms
							Low risk depression (58.0%)	Low depressive symptoms
							Physiological-emotional depression (18.8%)	Emotional depressive symptoms
6.2	Liu ⁹ 2024 China	Ischemic 167 (93.3%) first-ever 133 (74.3%) within 6m post-stroke 138 (77.1%)	179 121 (67.6%) 52.8 (7.5)	Longitudinal LTA	PHQ-9 baseline, 1m, 3m, 6m post-discharge	3	Mild symptoms	Low depressive symptoms
							Grief-sleep-fatigue symptoms	Atypical depressive symptoms
							Severe symptoms	Widespread depressive symptoms
7	Malhotra ³⁰ 2016 Singapore	NI NI mean 4.7w	172 84 (48.8%) 71.6 (12.2)	Longitudinal GBTM	CESD-20 baseline, 3m, 6m	3	Low and decreasing (47.6%)	Low and stable/ decreasing
							Low and increasing (43.1%)	Low but increasing
							High and increasing (9.3%)	high and stable/ increasing
8	Su ²⁷ 2025 China	Ischemic first-ever acute	193 116 (60.1%) 59.4 (12.0)	Cross-sectional LCA	PHQ-9	3	Low depressive symptoms (44.6%)	Low depressive symptoms
							Melancholic depression (15.0%)	Emotional depressive symptoms
							Atypical depression (40.4%)	Atypical depressive symptoms
9	Sun ²⁶ 2024 China	Ischemic first-ever 346 (81.0%) acute	427 340 (79.6%) 59 [51, 65]	Longitudinal LCGA	HDRS baseline, 3m, 6m, 1y	4	Stable-low (55.5%)	Low and stable/ decreasing
							High-remitting (28.1%)	Initially high/ moderate but declining
							Late-onset (10.3%)	Low but increasing
							High-persistent (6.1%)	High and stable/ increasing

Abbreviations: CESD-20, the Center for Epidemiologic Studies Depression Scale-20; HADS, the Hospital Anxiety and Depression Scale; HDRS, 17-item Hamilton Depression Rating Scale; GBTM, group-based trajectory modeling; LCA, latent class analysis; LCGA, latent class growth analysis; NI, no information; LGMM, latent growth mixture modeling; LPA, latent profile analysis; LTA, latent transition analysis; PHQ-8, the 8-item Patient Health Questionnaire; PHQ-9, the 9-item Patient Health Questionnaire; PROMIS, the Patient-Reported Outcome Measurement Information System; SDS, Self-rating Depression Scale.

Depressive Symptom Manifestations-Based Subgroups

Four studies involving 1400 stroke survivors examined PSD subgroups based on manifestations of depressive symptoms using latent class analysis^{27,28} or latent profile analysis.^{10,22} These studies used the items of assessment scales for depression as

indicators, including the Self-rating Depression Scale¹⁰ and Patient Health Questionnaire.^{22,27,28} Models with three^{10,27} to four classes^{22,28} were identified. Classes were labelled based on the overall manifestations of depressive symptoms or distinguished symptoms according to mean value of items^{10,22} or conditional probability of each item.^{27,28} This review synthesized these classes into four distinct symptom-based subgroups: low depressive symptoms, emotional depressive symptoms, atypical depressive symptoms, widespread depressive symptoms. A detailed summary is provided in [Table 1](#).

Low Depressive Symptoms

All four studies identified a subgroup characterized by uniformly low scores or low conditional probabilities across all depressive symptoms. The “low depressive symptoms” subgroup was the largest in each study, with prevalence ranging from 42.8%²⁸ to 58.0%.²² Pooled across studies, this group comprised 46.6% (652/1400) of stroke survivors.

Emotional Depressive Symptoms

Three studies identified a subgroup marked primarily by elevated emotional symptoms (eg, sadness, loss of interest, guilt, worthlessness), with or without somatic or vegetative symptoms.^{22,27,28} Liu et al²² distinguished between an “emotional depression” subgroup and a “physiological-emotional depression” subgroup; given that both were characterized by prominent emotional symptoms, they were synthesized into a single “emotional depressive symptoms” subgroup in this review. The prevalence of this group ranged from 5.6%²⁸ to 28.2%,²² with an overall prevalence of 9.4% (132/1400).

Atypical Depressive Symptoms

Two studies reported a subgroup characterized by preserved mood reactivity alongside atypical features such as increased appetite or weight, psychomotor retardation and persistently low self-esteem.^{27,28} We designated this group the “atypical depressive symptoms” subgroup, adopting terminology analogous to atypical depression specifiers in the Diagnostic and Statistical Manual of Mental Disorders (fifth edition), though formal diagnostic criteria were not applied. Prevalence of this group ranged from 34.9%²⁸ to 40.4%.²⁷ This subgroup accounted for an overall prevalence of 23.2% (325/1400).

Widespread Depressive Symptoms

Three studies identified a subgroup with elevated scores or high conditional probabilities across most or all depressive symptom domains.^{10,22,28} In one study,¹⁰ a class termed “moderate depression moderate somatization” showed mean item scores above half the maximum possible for most symptoms and was therefore classified within this subgroup. Prevalence of this group ranged from 13.8%²² to 51.5%,¹⁰ with an overall prevalence of 20.8% (291/1400).

Subgroup Transitions and Stability

Two studies involving 886 stroke survivors examined the longitudinal changes in symptom-based subgroups over time using latent transition analysis.^{9,28} Liming et al²⁸ followed survivors from 3 to 12 months post-stroke, while Liu et al⁹ followed survivors from baseline to 6 months post-discharge.

Overall, these studies revealed high subgroup stability, with 83.3–88.8% of participants remaining in the same subgroup between adjacent timepoints.⁹ The “low depressive symptoms” subgroup was particularly stable, with 85% to 96.7% of individuals remaining in this subgroup over time.^{9,28}

Transitions among other subgroups demonstrated various patterns. The “emotional depressive symptoms” and “atypical depressive symptoms” subgroups tended to either remain in their initial subgroup or transition to the “low depressive symptoms” subgroup. Individuals in the “widespread depressive symptoms” subgroup mostly remained in that subgroup or transitioned to “emotional depressive symptoms” or “atypical depressive symptoms” subgroups, with relatively few direct transitions to the “low depressive symptoms” subgroup. Transitions towards the “low depressive symptoms” subgroup were more frequent between 3- and 6-months post-stroke than between 6 and 12 months. After 6 months post-stroke, the “widespread depressive symptoms” subgroup exhibited a higher likelihood of maintaining its pattern, indicating increased stability over time.

Depressive Symptom Trajectories-Based Subgroups

Five longitudinal studies (reported in six articles) involving 5329 stroke survivors explored depressive symptom trajectories-based subgroups using group-based trajectory modelling,^{29,30} latent class growth analysis,²⁶ and latent growth mixture modelling.^{23–25} The number of assessment timepoints ranged from three to six, and follow-up durations spanned from 6 months^{25,30} to 6 years post-stroke.²⁴

The PSD subgroups were defined based on baseline depression severity and longitudinal progression. The number of subgroups varied across studies, ranging from two to four. This review synthesized these subgroups into four distinct trajectories: low and stable/decreasing, low but increasing, high and stable/increasing, and initially high/moderate but gradually declining. A detailed summary is provided in [Table 1](#).

Low and Stable/Decreasing

Four studies identified a trajectory characterized by low baseline depressive symptoms that remained stable or decreased slightly over time.^{24,26,29,30} Ayis et al²⁹ identified two subgroups – “low symptoms” and “moderate symptoms” – among female stroke survivors. As mean scores for both subgroups remained below the cut-off of assessment scales at all timepoints, both were categorized as “low and stable/decreasing” subgroup in this review. Prevalence of this subgroup ranged from 42.1% to 78.9% across studies,²⁹ with an overall prevalence of 59.7% (3180/5329).

Low but Increasing

Four studies identified a subgroup with initially low depressive symptoms that increased over time.^{24,26,29,30} Prevalence of this group ranged from 10.3%^{24,26} to 46.5%,²⁹ with an overall prevalence of 17.8% (948/5329).

High and Stable/Increasing

All five studies reported a trajectory characterized by high baseline depressive symptoms that remained persistently high or worsened over time. One study²⁹ identified two subgroups – “severe symptoms” and “very severe symptoms” – among female stroke survivors. As mean scores for both subgroups remained above the cut-off of assessment scales at all timepoints, both were categorized as “high and stable/increasing” in this review. Prevalence of this subgroup ranged from 6.1%²⁶ to 62.2%,²⁵ with an overall prevalence of 13.6% (726/5329).

Initially but Gradually Declining

Three studies identified a subgroup with high or moderate depressive symptoms at baseline that decreased over follow-up.^{24–26} Prevalence of this subgroup ranged from 13.5%²⁴ to 37.8%,²⁵ with an overall prevalence of 8.9% (475/5329).

Predictors of PSD Subgroups

Across studies, multiple predictors of subgroup membership were identified, including social-demographic, clinical, and physiological factors.

Social-Demographic Factors

Marital status, socioeconomic status, sex, age, and social support were reported as predictors of PSD subgroup. Unmarried, divorced or widowed survivors were more likely to belong to the “widespread depressive symptoms” subgroup and demonstrated a trajectory of “high and stable/increasing”.^{10,25} Compared with survivors with monthly income of 1000–5000 yuan, those with monthly income < 1000 yuan were more likely to be in the “high and stable/increasing” trajectory subgroup.²⁵ Male sex and older age predicted membership in the “low and stable/decreasing” trajectory subgroup.²⁴ Higher levels of perceived social support were associated with membership in the “low depressive symptoms” subgroup.²⁴

Clinical Factors

Stroke type, stroke severity, and recovery in functional disability were reported as predictors of PSD subgroup. Compared with ischemic stroke, hemorrhagic stroke was associated with membership in the “high and stable/increasing” trajectory subgroup.²⁵ Being conscious at admission and higher baseline working memory predicted greater likelihood of being in “low depressive symptoms” subgroup and demonstrating a trajectory of “low and stable/decreasing depressive

symptoms”.^{10,24} Stroke survivors with muscle strength of the affected limb \leq Grade 2 were more likely to be grouped into the “widespread depressive symptoms” subgroup.¹⁰ Stroke survivors with mild neurological deficits were more likely to be categorized as “emotional depressive symptoms”.²⁷ Increase in stroke survivors’ functional disability over time was associated with a significant upward shift of the depressive symptom trajectory of the “low and increasing group”.³⁰

Physiological Factors

One study identified inflammatory markers as predictors of PSD subgroup.²⁶ Elevated fibrinogen levels at admission increased the risk of belonging to the “high and stable/increasing” trajectory subgroup. Chronic elevation of innate immune markers was associated not only with higher risk of being in the “high and stable/increasing” trajectory subgroup, but also with increased likelihood of membership in the “low but increasing” trajectory subgroup.

Outcomes Associated with PSD Subgroups

Only one included study examined long-term mortality outcomes in relation to PSD trajectories.²⁹ This study reported that compared with the “low and stable/decreasing” trajectory subgroup, all other trajectories were associated with significantly increased 10-year all-cause mortality, with hazard ratios ranging from 1.38 to 2.62 ($p < 0.05$).

Study Quality Assessment

Results of the quality appraisal of individual studies are reported in Table 2. All included studies clearly stated a research question or objective and clearly defined the study population, and all recruited participants from similar populations using prespecified inclusion and exclusion criteria. A participation rate of at least 50% was reported in eight of the nine studies (88.9%), whereas one study did not provide sufficient information to judge the response rate. Just over half of the studies (55.6%) provided a sample size justification, power calculation, or variance/effect size estimate. Among studies for which follow-up was relevant, loss to follow-up of 20% or less (item 13) was reported in only two of seven studies (28.6%), whereas the remaining studies either exceeded this threshold or did not report attrition. Key potential confounders were measured and adjusted for in eight of the nine studies (88.9%). Overall, five studies were rated as fair quality and four studies were rated as good quality.

Table 2 Quality Assessment for Included Studies

Study	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Overall
Ayis 2019 ²⁹	Y	Y	Y	Y	Y	Y	Y	NA	Y	NA	Y	NA	NR	Y	Good
Han 2025 ¹⁰	Y	Y	Y	Y	Y	N	N	NA	Y	NA	Y	NA	NA	Y	Good
Hart 2025 ²⁴	Y	Y	NR	Y	NR	N	Y	NA	Y	NA	Y	NA	N	Y	Fair
Huang 2024 ²⁵	Y	Y	Y	Y	NR	Y	Y	NA	Y	NA	Y	NA	Y	Y	Fair
Liming 2021 ²⁸	Y	Y	Y	Y	NR	Y	Y	NA	Y	NA	Y	NA	N	N	Fair
Liu 2024 ⁹	Y	Y	Y	Y	Y	Y	Y	NA	Y	NA	Y	NA	N	Y	Fair
Malhotra 2016 ³⁰	Y	Y	Y	Y	NR	Y	Y	NA	Y	NA	Y	NA	Y	Y	Fair
Su 2025 ²⁷	Y	Y	Y	Y	Y	N	N	NA	Y	NA	Y	NA	NA	Y	Good
Sun 2024 ²⁶	Y	Y	Y	Y	Y	Y	Y	NA	Y	NA	Y	NA	N	Y	Good

Notes: 1 = Was the study question or objective clearly stated?; 2 = Was the study population clearly specified and defined?; 3 = Was the participation rate of eligible persons at least 50%; 4 = Were all the subjects selected or recruited from the same or similar populations (including the same time period)? Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?; 5 = Was a sample size justification, power description, or variance and effect estimates provided?; 6 = For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?; 7 = Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?; 8 = For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (eg, categories of exposure, or exposure measured as continuous variable)?; 9 = Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?; 10 = Was the exposure(s) assessed more than once over time?; 11 = Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?; 12 = Were the outcome assessors blinded to the exposure status of participants?; 13 = Was loss to follow-up after baseline 20% or less?; 14 = Were key potential confounding variables measured and adjusted for?; N = no, NA = not applicable NR = not reported, Y = yes.

Discussion

This systematic review synthesized current evidence from nine observational studies involving 6729 stroke survivors that applied person-centered approaches to identify PSD subtypes. The findings reveal that PSD can be categorized into latent subgroups based on symptom manifestations and longitudinal trajectories. Critically, limited studies demonstrated that these subgroups are predicted by specific social-demographic, clinical, social, and physiological factors, and are associated with 10-year adjusted mortality. These insights have significant implications for advancing targeted management for PSD.

Heterogeneity of PSD Revealed by Person-Centered Approaches

The consistent identification of multiple PSD subgroups across diverse international cohorts provides robust evidence that PSD represents not a monolithic clinical entity, but rather a heterogeneous collection of symptom manifestations and longitudinal trajectories. This finding aligns with contemporary precision psychiatry literature, which increasingly recognizes that major depressive disorder encompasses substantial etiological and pathophysiological heterogeneity.³¹ Person-centered methodologies have proven particularly adept at capturing this complexity, as they permit the identification of naturally occurring subpopulations characterized by distinct patterns of symptom manifestation and longitudinal change.^{32,33}

Cross-sectional analyses delineated four subtypes based on depressive symptom manifestations: low depressive symptoms (prevalence 46.6%), emotional depressive symptoms (9.4%), atypical depressive symptoms (23.2%), and widespread depressive symptoms (20.8%). These classifications reflect underlying differences in depressive symptom manifestations, which may correspond to distinct pathophysiological mechanisms. The emotional depressive symptoms subgroup, characterized by prominent affective dysregulation may reflect focal vascular lesions or secondary network-level changes within limbic-cortical circuits, particularly altered connectivity between prefrontal control regions and limbic structures.^{34–36} Conversely, the atypical depressive symptoms subgroups—characterized by preserved mood reactivity, hyperphagia, and psychomotor retardation—may reflect a distinct monoaminergic profile following stroke, with plausible involvement of dopaminergic and noradrenergic dysfunction within post-stroke affective regulatory pathways.^{37,38} The widespread depressive symptoms subgroup, characterized by pervasive symptomatology across cognitive, affective, and somatic domains, potentially reflects more severe neurobiological perturbation.

Critically, latent transition analyses revealed that PSD subgroup membership demonstrates substantial temporal fluidity during the acute-to-subacute post-stroke period, followed by progressive stabilization beyond 6 months post-stroke.^{9,28} This temporal pattern suggests that the early post-stroke period may represent a potential intervention window, but this interpretation remains hypothesis-generating and requires confirmation in future intervention studies. The observation that the majority of stroke survivors in the low depressive symptoms subgroup remain stable longitudinally, while the widespread depressive symptoms subgroup exhibits minimal spontaneous remission, underscores the prognostic significance of early symptom classification. The findings align with the meta-analysis of 18 longitudinal studies which indicated that more than half of patients who had PSD within three months of stroke would have persistent PSD until one-year post-stroke.²

Longitudinally, PSD delineated four trajectories: low and stable/decreasing (59.7%), low but increasing (17.8%), high and stable/increasing (13.6%), and initially high but gradually declining (8.9%). The findings further highlight that PSD is not a static condition but evolves dynamically over time. Notably, the high and stable/increasing subgroup comprised approximately one-seventh of the cohort and demonstrated early and persistent stability. This trajectory aligns with longitudinal studies documenting persistent depression in 17.5% of stroke survivors, with depression persisting even at 5-year follow-up.³⁹

Multifactorial Predictors of Subgroup Membership

The identification of specific social-demographic, clinical, and physiological predictors of subgroup membership provide empirical scaffolding for understanding the multivariate etiology of PSD heterogeneity. Survivors with low-income level, unmarried status, male sex, older age, or limited social support demonstrated substantially increased risk for membership in severe or persistent depression trajectory. This finding is in line with the extensive literature documenting the impacts of social-demographic factors on PSD.^{40,41} Clinical variables, including stroke type, stroke severity, and recovery in functional

disability demonstrated robust associations with subgroup membership. Patients with preserved consciousness at admission and higher baseline working memory showed significantly elevated likelihood of remaining in low depressive symptom trajectories. Conversely, severe neurological impairment (eg, muscle strength \leq Grade 2) predicted membership in the “widespread depressive symptoms” subgroup. Similar findings were found in systematic reviews identifying predictors of PSD.^{40,41} Elevated fibrinogen levels at admission predicted membership in the high and stable/increasing trajectory, while chronic elevation of inflammatory markers associated with high and stable/increasing trajectory.²⁶ The emerging evidence regarding biological markers may implicate neuroinflammatory pathways in PSD heterogeneity.³⁸

Strengths and Limitations

This review has several strengths. First, we conducted a comprehensive literature search across multiple international databases, including both English- and Chinese-language sources, which reduced the risk of language and publication bias and enhanced the inclusiveness of the evidence base. Second, by focusing specifically on person-centered approaches, we systematically synthesized evidence from both cross-sectional and longitudinal studies. This enabled an integrated examination of depressive symptom profiles and temporal patterns, thereby extending beyond prior reviews that primarily focused on univariate severity trajectories.

Several limitations should also be acknowledged. First, substantial methodological heterogeneity existed across studies, including differences in depression scales, assessment timepoints, and follow-up duration. This heterogeneity limits direct comparability of subgroup structures across studies. Second, the included studies used different person-centered analytic approaches, and the resulting subgroup solutions are inherently model-dependent. Variations in model assumptions, indicator selection, and sample characteristics may have influenced the number and nature of the identified classes, limiting the direct comparability of subgroup structures across studies. In addition, most subgroup structures were identified within single cohorts and have not been validated across independent samples, which limits confidence in their stability and generalizability. Third, most included studies originated from China and Western high-income countries. The underrepresentation of low- and middle-income settings and diverse racial and ethnic populations may restrict the generalizability of the findings, particularly given known cultural differences in the expression and reporting of depressive symptoms. Fourth, many predictors were derived from individual studies; replication across multiple cohorts is essential to establish their robustness. Finally, evidence regarding clinical outcomes associated with PSD subgroups was limited. Only one study examined long-term mortality. Future longitudinal studies incorporating standardized outcome measures are needed to clarify the prognostic significance of person-centered PSD subgroups.

Conclusions

This systematic review demonstrates that person-centered approaches can effectively delineate latent subgroups of PSD characterized by distinct symptom manifestations and trajectories. These subgroups differ in social-demographic, clinical, and physiological factors. One longitudinal cohort reported differences in 10-year mortality across different PSD trajectories. Evidence further suggests that the early post-stroke period, particularly the first six months, constitutes a potential window during which depressive symptom patterns are most dynamic and potentially modifiable, with relative stabilization thereafter. Collectively, these findings support a shift away from one-size-fits-all, total-score-based management toward a more nuanced, symptom- and trajectory-informed framework for PSD. However, the current evidence base is still limited, and therefore the strength of these recommendations should be interpreted with caution. Further well-designed longitudinal and interventional studies are needed.

Abbreviations

PSD, Post-Stroke Depression; PRISMA, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Data Sharing Statement

All data generated or analyzed during this study are included in this article and its [supplementary information files](#).

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