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# Prevalence of depression and anxiety symptoms after stroke in young adults: A systematic review and meta-analysis

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ABSTRACT

*Background:* Young adults with stroke have distinct professional and social roles making them vulnerable to symptoms of post-stroke depression (PSD) and post-stroke anxiety (PSA). Prior reviews have examined the prevalence of anxiety and depression in stroke populations. However, there are a lack of studies that have focused on these conditions in young adults.

*Objective:* We performed a systematic review and meta-analysis of observational studies that reported on symptoms of PSD, PSA and comorbid PSD/PSA in young adults aged 18 to 55 years of age.

*Methods:* MEDLINE, EMBASE, SCOPUS and PsycINFO were searched for studies reporting the prevalence of symptoms of PSD and/or PSA in young adults with stroke from inception until June 23, 2023. We included studies that evaluated depression and/or anxiety symptoms with screening tools or interviews following ischemic or hemorrhagic stroke. Validated methods were employed to evaluate risk of bias.

*Results:* 4748 patients from twenty eligible studies were included. Among them, 2420 were also evaluated for symptoms of PSA while 847 participants were evaluated for both PSD and PSA symptoms. Sixteen studies were included in the random effects meta-analysis for PSD symptoms, with a pooled prevalence of 31 % (95 % CI 24–38 %). Pooled PSA symptom prevalence was 39 % (95 % CI 30–48 %) and comorbid PSD with PSA symptom prevalence was 25 % (95 % CI 12–39 %). Varying definitions of 'young adult', combinations of stroke subtypes, and methods to assess PSD and PSA contributed to high heterogeneity amongst studies.

*Conclusions:* We identified high heterogeneity in studies investigating the prevalence of symptoms of PSD and PSA in young adults, emphasizing the importance of standardized approaches in future research to gain insight into the outcomes and prognosis of PSD and PSA symptoms following stroke in young adults. Larger longitudinal epidemiological studies as well as studies on tailored interventions are required to address the mental health needs of this important population.

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## Introduction

Mood disorders are prevalent and can arise at any time point after stroke in all age groups.[1] Post-stroke depression (PSD) and post-stroke anxiety (PSA) affect 1 in 3 survivors in their first year.[2] PSD can be persistent in up to half of individuals with symptoms of depression soon after stroke.[1] While the literature on optimal evaluation and treatment of PSD and PSA continues to grow, they are often overlooked, especially in younger individuals.[3]

The Global Burden of Disease reports a 17 % decrease in age-standardized stroke incidence and a 6 % decrease in prevalence from 1990 to 2019.[4] This trend was noted in all age groups except in adults under 70 years old in whom the age-standardized stroke prevalence and incidence rates increased by 22 % and 15 % respectively.[4] This increase may be attributable to the rising prevalence of vascular risk factors in younger populations.[5]

Young adults are vulnerable to mood disorders post-stroke since they suffer from specific problems such as loss of employment, childcare difficulties, and reduced life satisfaction.[6] Qualitative studies suggest young adult stroke survivors prioritize life participation and return to work and social roles as their main rehabilitation goals.[7,8] Thus, it is important to screen for mood disorders in this population who disproportionately experience the personal, familial, and socioeconomic consequences of their illness.[9]

Prior meta-analyses on PSD and PSA excluded studies with age group restrictions.[1,2,10,11] The current literature on the prevalence of PSD and PSA in young adults with stroke is limited. A uniform definition for stroke in young adults is also lacking.[5,12] For this review, young adults were defined as between 18 and 55 years of age, since these individuals are deemed to have distinct family, social and professional roles.[13,14] Comprehending the epidemiology, pathophysiology and outcomes of PSD and PSA in young adults can pave the way to optimizing their psychological management strategies.

### *Aims*

We aimed to conduct a systematic review and meta-analysis of the literature on observational studies that evaluated symptoms of PSD, PSA and comorbid PSD/PSA in young adults. Our secondary objectives were to report the prevalence of these symptoms and describe the different methods of evaluation for symptoms of PSD and PSA.

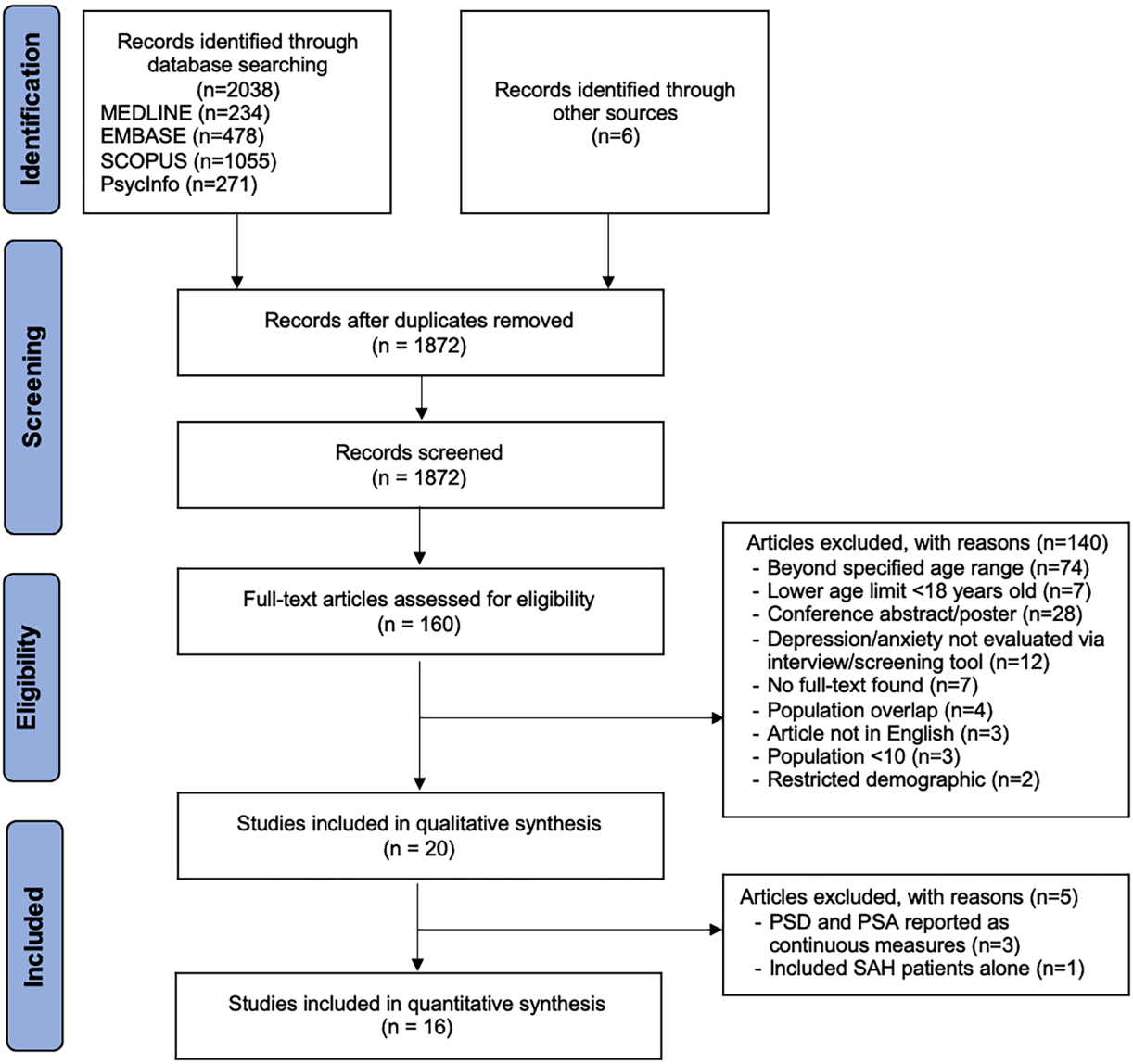


**Fig. 1.** PRISMA Flow diagram for study selection.

**Table 1**
Summary of the included studies.

| First Author, Year | Country, center | Design | Age range yrs (mean, SD) | Sample size | Females (%) | Time of screening post-stroke | PSD screening method (cut-off) | PSA screening method (cut-off) |
|---|---|---|---|---|---|---|---|---|
| Agbola 2020(51) | Nigeria, hospital | CS | 18–50 | 27 | NR | 3–24 mos | Interview (SCAN) | NR |
| AlQawasmeh 2022[20,37] | Jordan, hospital | Cohort | 18–55 (48.7, 5.3) | 38, | 26 % | 1 mo | PHQ-9 Arabic >4 mild PSD | NR |
| Barker-Collo 2007[37] | NZ, hospital | Cohort | 18–45 | 5–15* | NR | 0,3,6 mos | BDI-II >13 mild PSD | BAI >7 mild PSA |
| Bonner 2016[23] | India, hospital | CS | 18–55 (45.2,7.8) | 110 | 2.7 % | 7 mos (IQR 10) | HADS-D Malayalam (>10) | HADS-A Malayalam (>10) |
| Broomfield 2014[22] | UK, community | CS | 18–48 | 575 | NR | NR | HADS-D (>7) | HADS-A (>7) |
| Cho 2020[23] | S Korea, hospital | Cohort | 18–55 (45.6, 7.9) | 52 | 31 % | 2 mos | SGDS Korean (>5) | NR |
| Chun 2018[24] | Scotland, hospital | Cohort | 18–55 (48.8,6.0) | 22 | 27 % | 3 mos | Interview DSM-IV | Interview DSM-IV |
| Ellis 2012(52) | USA, community | CS | 18–49 | 1198 | NR | NR | PHQ-8 (>9) | NR |
| Hackett 2012[15] | Australia, hospital | Cohort | 18–55 | 204 | NR | 1 mo, 12 mos | HADS-D (>7) | HADS-A (>7) |
| Ignacio 2022[25] | Philippines, hospital | CS | 18–49 [38,7] | 114 | 10 % | 4 mos (IQR 11) | HADS-D (>6) | HADS-A (>6) |
| Jani 2014(53) | Scotland, community | Cohort | 18–45 | 562 | NR | 1 mo | HADS-D (>7) | NR |
| Kiphuth 2014[26] | Germany, hospital | Cohort | 18–55 (46.9,7.9) | 26 | 42 % | 3 mos | HADS-D (>7) | HADS-A (>7) |
| Maaijwe 2016[27] | Netherlands, hospital | Case control | 18–50 | 511 | 56 % | 0.2–31 yrs | HADS-D (>7) | HADS-A (>7) |
| McCarthy 2016[28] | USA, hospital | Cohort | 25–54 | 64 | 45 % | 3 mos | CES-D(>9) | NR |
| Noble 2014[31] | England, community | CS | 19–51 (40 IQR 10) | 306 | NR | 3 yrs (IQR 4) | HADS-D(>7) | HADS-A(>7) |
| Priya 2021[29] | India, hospital | CS | 18–45 (40 IQR 10) | 150 | 27 % | 24 mos (IQR 48) | CES-D Tamil (>16) | NR |
| Vitturi 2021[30] | Brazil, hospital | Cohort | 18–55 | 31 | NR | 12 mos | HADS-D Portuguese (>7) | HADS-A Portuguese (>7) |
| Samuelsson 2021[32] | Sweden, hospital | Cohort | 18–54 (43,9.3) | 142 | 43 % | 7 yrs | HADS-D† | HADS-A† |
| Xu 2021[33] | China, hospital | Case control | 18–45 (31.8,6.3) | 364, | 63 % | 3 mos | SCL-90-R† | SCL-90-R† |
| Yoon 2021[34] | S Korea, hospital | CS | 18–49 (46.7, 4.7) | 237, | 39 % | 19 mos (SD 13) | BDI† | NR |

*Abbreviations:* *sample population varied per time point of assessment; † no cut-offs used, PSD/PSA reported as continuous measures; BDI Beck Depression Inventory, BAI Beck Anxiety Inventory, CS cross sectional, CES-D Center for Epidemiologic Studies Depression Scale, HADS-A Hospital Anxiety and Depression Scale–Anxiety subscale, HADS-D Hospital Anxiety and Depression Scale–Depression subscale, PHQ Patient Health Questionnaire, SCL-90R Symptom Checklist-90 Revised and SGDS Short Geriatric Depression Scale.

## Methods

We conducted and reported this systematic review in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines[15] (Supplementary Tables 7 and 8) and the Checklist for Meta-analyses of Observational Studies (MOOSE; Supplementary Table 9). The study protocol was registered on PROSPERO (CRD42023438303 registered July 2, 2023).

### *Study selection criteria*

We included studies: 1) that reported on the symptom prevalence of depression and anxiety in young adults with a clinical diagnosis of stroke (including transient ischemic attack (TIA), infarct, intracranial hemorrhage (ICH) or subarachnoid hemorrhage (SAH)); 2) of participants aged 18 to 55 years; 3) of prospective or retrospective cohort, cross-sectional, case-control design and case series with ≥10 patients, and 4) published in English. We placed no restrictions on duration of follow-up. We also included studies that reported on PSD and/or PSA in all ages of adults but had specific data on young adults. Studies were excluded if they were: 1) restricted to a specific sex, stroke severity or stroke from cerebral venous sinus thrombosis, and 2) did not evaluate PSD or PSA using a validated screening tool or structured interview based on diagnostic criteria.

### *Search strategy and study selection*

We searched MEDLINE, EMBASE, PsycINFO and SCOPUS from inception to June 23, 2023. MeSH headings for "stroke" AND ("anxiety" OR "depression") AND "young adults" were combined in a Boolean search strategy (Supplementary Table 1). Two authors searched the databases independently. The selection criteria was applied to screen titles and abstracts. Full-text articles were scrutinized independently by two authors and disagreements were resolved by a third author. References of included studies were hand-searched for relevant articles, and we contacted authors of included papers to obtain primary data.

### *Data extraction*

Data from included studies were extracted by two authors independently; including data on study design, study setting, demographics of participants, inclusion and exclusion criteria, duration of follow-up, and psychiatric screening tools and diagnostic criteria used. We collected data on prevalent cases of PSD and PSA in young adults. Where available, we collected data on other outcomes including treatment of PSD and PSA (Supplementary Table 5).

### *Risk of bias and methodological quality assessments*

We used the Agency for Healthcare Research and Quality (AHRQ) tool for assessing risk of bias in descriptive cross-sectional studies.[16,17]

**Table 2**
Prevalence of PSD and PSA symptoms in individual studies

| First Author, Year | Total sample assessed for mood disorders (n) | PSD Symptom Prevalence (%) (Stroke subtype: PSD prevalence) | PSA Symptom Prevalence (%) (Stroke subtype: PSA prevalence) | Prevalence of comorbid PSD and PSA symptoms (%) (Stroke subtype: prevalence of PSD and PSA) |
|---|---|---|---|---|
| Agbola 2020 | 27 | 70.4 | NR | NR |
| Al Qawasmeh 2022 | 38 | 23.7<br>Ischemic: 25.0 (9/36)<br>ICH: 0 (0/2) | NR | NR |
| Barker-Collo 2007 | 15 | Admission: 26.7 (4/15)<br>1 mo: 60 (3/5)<br>3 mos: 20 (1/5) | Admission: 40.0 (6/15)<br>1 mo: 20 (1/5)<br>6 mos: 40 (2/5) | NR |
| Bonner 2016 | 110 | 22.7<br>Ischemic: 24.2 (22/91)<br>ICH: 15.8 (3/19) | 35.5<br>Infarct: 35.2 (32/91)<br>ICH: 36.8 (7/19) | 18.2<br>Ischemic: 18.7 (17/91)<br>ICH: 15.8 (3/19) |
| Broomfield 2014 | 575 | 38.6<br>TIA: 26.9 (32/119)<br>Ischemic: 41.7 (190/456) | 45.9<br>TIA: 42.0 (50/119)<br>Infarct: 46.9 (214/456) | 40.2<br>TIA: 35.3 (42/119)<br>Ischemic: 41.4 (189/456) |
| Cho 2020 | 52 | 38.5<br>Ischemic: 18.8 (3/16)<br>ICH: 48.5 (16/33)<br>Ischemic and ICH: 33.3 (1/3) | NR | NR |
| Chun 2018 | 22 | 36.4<br>TIA: 50.0 (2/4)<br>Ischemic: 26.7 (4/15)<br>ICH: 66.7 (2/3) | 50.0<br>TIA: 50.0 (2/4)<br>Ischemic: 40.0 (6/15)<br>ICH: 100.0 (3/3) | 36.4<br>TIA: 50.0 (2/4)<br>Ischemic: 26.7 (4/15)<br>ICH: 66.7 (2/3) |
| Ellis 2012 | 1198 | 31.1 | NR | NR |
| Hackett 2012 | 204 | 1mo: 16.2 (33/204)<br>1 yr: 14.4 (28/194) | 1 mo: 28.9 (59/204)<br>1 yr: 3.6 (7/194) | NR |
| Ignacio 2022 | 114 | 20.2<br>Ischemic: 17.9 (12/67)<br>ICH: 23.4 (11/47) | 34.2<br>Ischemic: 37.3 (25/67)<br>ICH: 29.8 (14/47) | 14.9<br>Ischemic: 16.4 (11/67)<br>ICH: 12.8 (6/47) |
| Jani 2014 | 562 | 8.4 | NR | NR |
| Kiphuth 2014 | 26 | TIA: 19.2 (5/26) | TIA: 50.0 (13/26) | TIA: 19.2 (5/26) |
| Maaijwe 2016 | 511 | 16.8<br>TIA: 12.4 (23/186)<br>Ischemic: 19.4 (63/325) | 23.1<br>TIA: 23.1 (43/186)<br>Ischemic: 23.1 (75/325) | NR |
| McCarthy 2016 | 64 | Ischemic: 46.9 (30/64) | NR | NR |
| Priya 2021 | 150 | Ischemic: 47.3 (71/150) | NR | NR |
| Vitturi 2021 | 31 | Ischemic: 48.4 (15/31) | Ischemic: 58.1 (18/31) | NR |

Abbreviations: ICH Intracranial hemorrhage; mo month; NR prevalence of comorbid anxiety and depression not reported; PSA post stroke anxiety; PSD poststroke depression; TIA transient ischemic attack, yr year

We appraised cohort and case-control studies using the Newcastle-Ottawa Scale (NOS).[18] For our review, studies with a low risk of bias had well-defined selection criteria, used structured interview or a validated screening tool to evaluate PSD or PSA, and were representative of young stroke survivors in a community. (Supplementary Tables 2–4).

### *Quantitative analysis: statistical methods*

We performed a random-effects meta-analysis of proportions to determine pooled estimates of the prevalence of PSD, PSA and comorbid PSD/PSA. Random effects modeling was selected given the anticipated high degree of heterogeneity amongst studies. R (version 4.2.2) with the *metaprop* package was used for the proportional meta-analysis. *A priori* statistical significance was set at an alpha of $<0.05$. We used $I^2$ tests to evaluate heterogeneity of pooled estimates. $I^2$ values of $>25$ %, $>50$ %, and $>75$ % were considered as low, moderate, and high degrees of heterogeneity, respectively. We assessed for publication bias by generating funnel plots and performing the Egger's test with R's *dmetar* package.[19]

## Data availability

The data associated with this research are available in the Supplementary Materials.

## Results

### *Search results and included studies*

We identified 1872 studies after removal of deduplicates from the four databases and through citation searching. Of these, 1712 studies were excluded based on title and abstract screening. Further 140 studies were excluded after full-text review. Twenty studies met the inclusion criteria and were included in the systematic review and sixteen studies were included in the meta-analysis (see Fig. 1).

### *Study characteristics*

Four studies used community-based recruitment methods while 16 recruited from hospitals. Included studies were conducted in 16 countries (sample sizes 15 to 1198) (Table 1).

Seventeen studies reported on stroke type and 15 studies provided stroke type proportions: ischemic stroke ($n = 1976$, 72 %), TIA ($n = 335$, 12 %), SAH ($n = 306$, 11 %), and ICH ($n = 122$, 4 %) (see Table 2).[20–30] Four studies included only incident strokes.[24,27,30,20] One study evaluated participants with only SAH.[31] Nine studies excluded participants with aphasia.[15,21,24,26–30, 20, 31–37] Three studies reported PSD and PSA symptoms as continuous scores and could not contribute prevalence data.[32–34]

### *Patient characteristics*

A total of 4,748 young adult stroke survivors were evaluated for PSD

**Table 3**
Summary of studies that reported severity of symptoms of PSD and PSA

| First Author, Year | PSD screening tool Cut-offs for severity | Prevalence of PSD symptoms by severity | PSA screening tool Cut-offs for severity | Prevalence of PSA symptoms by severity |
|---|---|---|---|---|
| AlQawasmeh 2022[20,37] | PHQ-9 5–9 mild; 10–14 moderate; 15–19 moderately severe; ≥20 severe depression | Mild: 2 of 38 Moderate: 6 of 38 Severe: 1 of 38 | NR | NR |
| Barker-Collo 2007[37] | BDI-II 14–19 mild; 20–28 moderate; ≥28 severe depression | On admission Mild: 1 of 15 Moderate: 1 of 15 Severe: 2 of 15 At 3 months Mild: 2 of 5 Moderate: 1 of 5 At 6 months: Moderate: 1 of 5 | BAI 8–15 mild; 16–25 moderate; ≥26 severe | On admission Mild: 5 of 15 Severe: 1 of 15 At 3 months Mild: 1 of 5 Moderate: 1 of 5 At 6 months Moderate: 1 of 5 Severe: 1 of 5 |
| Kiphuth 2014[26] | HADS-D 8–10 mild to moderate; ≥11 moderate to severe distress | Mild to moderate: 3 of 26 Moderate to severe: 2 of 26 | HADS-A 8–10 mild to moderate; ≥11 moderate to severe distress | Mild to moderate: 2 of 26 Moderate to severe: 4 of 26 |

*Abbreviations:* BDI Beck Depression Inventory, BAI Beck Anxiety Inventory, HADS-A Hospital Anxiety and Depression Scale–Anxiety subscale, HADS-D Hospital Anxiety and Depression Scale–Depression subscale, PHQ Patient Health Questionnaire

alone (8 studies), 2,420 participants were evaluated for PSD and for PSA (12 studies) and 847 participants were evaluated for comorbid PSD/PSA (5 studies).[21,22,24–26] Females were underrepresented comprising 2.7 to 56 % of the samples in 12 studies.

*Methods of assessment for symptoms of PSD and PSA*

Only two studies used interview methods to evaluate PSD/PSA symptoms using DSM IV criteria and the Schedules for Clinical Assessment in Neuropsychiatry.[35,36] The rest of the studies used screening tools. The Hospital Anxiety and Depression Scale-Depression (HADS-D) was the most common screening tool for PSD (14 studies) while the Hospital Anxiety and Depression Scale-Anxiety subscale (HADS-A) was the most common for PSA. We summarized the various sensitivities and specificities of these tools according to the available literature in Supplementary Table 6.

*Study prevalence and severity of PSD and PSA*

PSD symptom prevalence ranged from 8.4 % to 70.4 % (17 studies, 4005 participants) while PSA symptom prevalence ranged from 23.1 % to 50.0 % (10 studies, 1914 participants). Comorbid PSD and PSA was present in 14.9 % to 40.2 % (5 studies, 847 participants) (Table 2). Table 3 presents data from three studies, with low numbers of participants, which evaluated the severity of PSD and PSA symptoms.[20,26,37]

*Longitudinal assessment of PSD and PSA symptoms*

Only two cross-sectional studies evaluated PSD and PSA symptoms longitudinally. Barker-Collo et al. (2007) evaluated participants at three intervals following stroke: 2 weeks to 1 month poststroke, and at 3 and 6 months after. PSD symptoms were identified in 4 of 15, 3 of 5 and 1 of 5 participants at these respective time intervals. Meanwhile, PSA symptoms were identified in 6 of 15, 1 of 5 and 2 of 5 participants at these time intervals.[37] Hackett et al. (2012) assessed these symptoms at 28 days and 12 months post-stroke. PSD symptoms affected 16.18 % (32/204) and 14.43 % (28/194) of participants, respectively, while PSA symptoms affected 28.94 % (59/204) and 3.61 % (7/194) of participants, respectively.[14]

*Pooled prevalence of PSD, PSA and comorbid PSD and PSA*

Data from 16 studies ($n$ = 3699), indicate that the pooled PSD symptom prevalence in young adults was 31 % (95 % Confidence Interval [CI] 22–38 %) with high heterogeneity ($I^2$=96 %) while the pooled PSA symptom prevalence in 9 studies was 39 % (95 % CI 30–48 %; $I^2$=90 %, $n$ = 1608). The pooled prevalence of comorbid PSD and PSA symptoms in young adults was 25 % (95 % CI 12–39 %, $I^2$=93 %, $n$ = 847, 5 studies) (Fig. 2).

*Quality assessment and publication bias*

Three cohort studies had poor ratings due to concerns regarding selection of sample population and one cross-sectional study was rated poor due to lack of clear inclusion criteria. (Supplementary Tables 2–4.) We did not identify any publication bias (Supplementary Figures 1–3).

## Discussion

*Summary of findings*

We examined the prevalence of PSD and PSA symptoms in young adults. The pooled PSD symptom was 31 % while the pooled PSA symptom prevalence was 39 % in this population. Compared to PSD or PSA alone, the pooled prevalence of comorbid PSD and PSA symptoms was lower. The included studies varied in their design, screening tool, and methodologies which reflected on the reported prevalence of PSD and PSA symptoms.

*PSD symptom prevalence*

The prevalence of PSD at any time point was reported at 27 % and 31 % in recent meta-analyses on post stroke depression.[1,2] Meanwhile, prevalence ranged from 8.4 % to 70.4 % across the individual studies included in this review.[1] This is likely reflective of the high heterogeneity among the included studies. For example, some studies excluded patients with recurrent strokes, patients with aphasia or patients with prior mood disorders. Patients with varying stroke types and severities were also included in most studies despite these strokes having different pathophysiologies. Timing of assessment varied, and, aside from using different screening tools, studies also varied in terms of cut-off points to diagnose PSD and PSA. Varied study settings could have contributed to heterogeneity due to differences in mental health resources and perspectives across countries.

*PSA symptom prevalence*

In a recent meta-analysis of PSA in stroke patients, PSA prevalence was reported at 23.2 % by screening tools and 18.7 % by interview methods.[38] We observed a prevalence of PSA symptoms that ranged from 23.1 % to 50.0 % across individual studies. Chun et al. investigated subtypes of PSA and found that anxious patients were more avoidant in

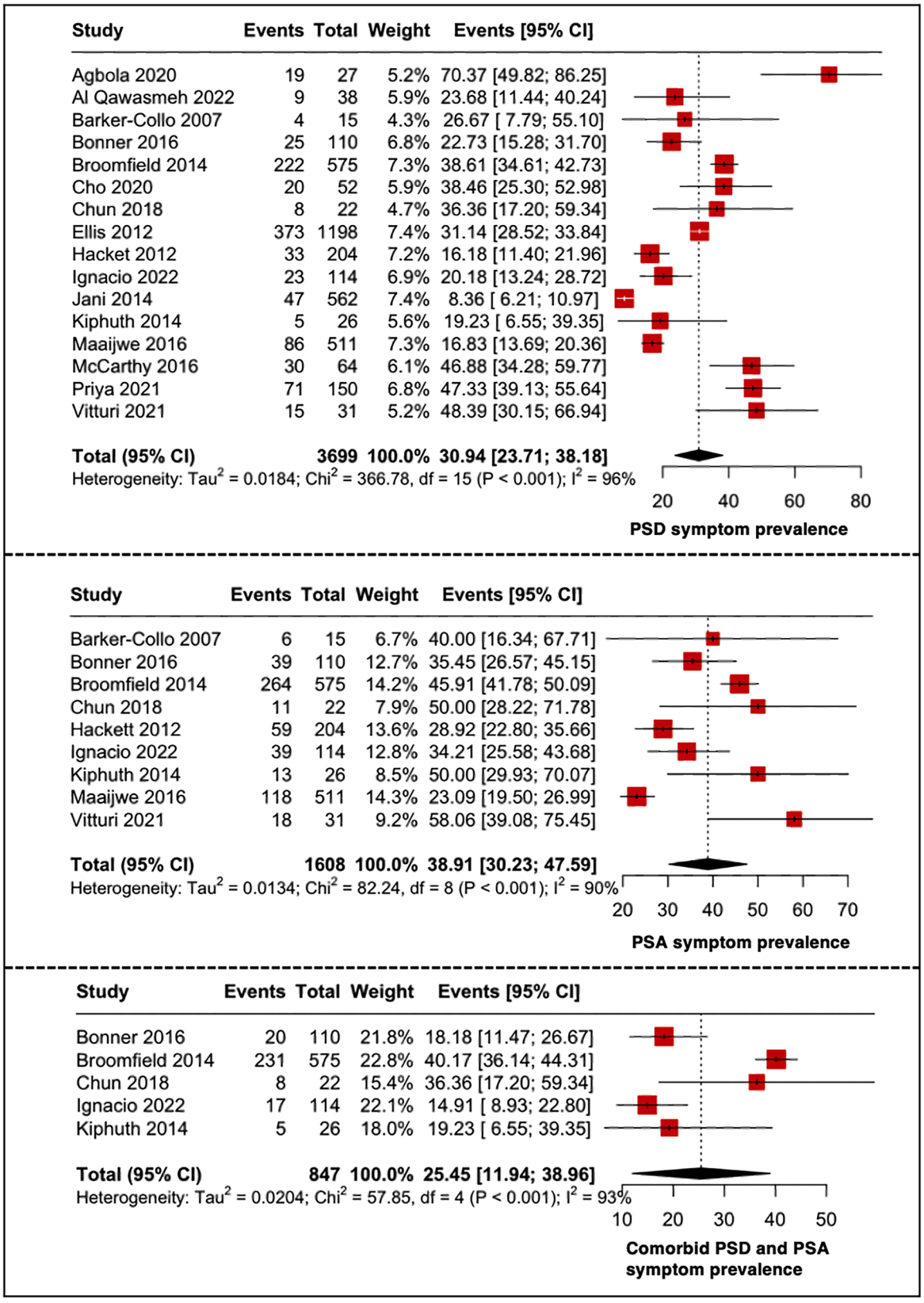


**Fig. 2.** Forest plots of pooled symptom prevalence of PSD, PSA and comorbid PSD/PSA.

social situations but also feared specific situations (e.g., stroke recurrence, physical exertion).[24] They also found that younger age was a predictor of developing PSA.[24,39] Similarly, Kapoor et al. identified younger age as a risk factor for PSA and proposed these individuals may experience greater loss of independence and functioning.[39] Further studies are needed to evaluate PSA in younger adults with stroke and to further understand its determinants.

*Screening tools for PSD and PSA symptom assessment*

Screening tools used differed across the studies but the most frequently utilized was the HADS. HADS is designed for hospital-based populations and does not include items about fatigue or changes in sleep that are included in tools used in general populations (e.g., BDI, BAI, SCL-90-R).[40] Screening tools reportedly have similar accuracy to DSM interviews in identifying depression, and, have high sensitivity and low specificity for the condition. (43–49) Unlike diagnostic gold standards such as the DSM, screening tools only identify those who may be at heightened risk of PSD and PSA. Our finding of the variable prevalence of symptoms of depression and anxiety following stroke reflect the need for improved diagnostic accuracy in this setting. While screening tools may identify those with symptoms, these should always be followed up with the application of formal diagnostic methods to inform the most appropriate course of management eg. counseling, cognitive behavioral therapy or pharmacologic treatment. Prior meta-analysis on depression and anxiety after stroke separately pooled PSD and PSA prevalence based on the methods of diagnosis – either via screening tools or via DSM interviews.[1,38] It may be important to distinguish that screening tools evaluate for symptoms of PSD and PSA and may not necessarily be diagnostic for these conditions.

*Longitudinal assessment of PSD and PSA symptoms*

All but two of the studies evaluated patients for symptoms of PSD and PSA at single time points. Based on the available data, it is difficult to determine if prevalence rates of PSD and PSA symptoms varied based on time from stroke symptom onset. Future studies should investigate this by assessing patients at multiple time points.[24,39]

*Severity and impact of PSD and PSA*

PSD and PSA negatively impact outcomes after stroke including those with minor deficits or even TIAs.[37,39] They are associated with poorer functional outcomes, loss of independence in activities of daily living, reduced quality of life and restricted social participation.[24,37,39] There is even evidence that early PSD may be associated with an increased risk for mortality.[41] A meta-analysis on the treatment of PSD showed that there is supporting evidence for pharmacotherapy in the remission of depression.[42] Early identification and management of PSD and PSA symptoms may improve outcomes although further research is required.[42]

*Strengths and limitations of the review*

We followed PRISMA guidelines for systematic reviews and included studies conducted in different countries where some used rating tools that were validated in their local language. Most of the studies used screening tools to evaluate for PSD and PSA, excluding patients unable to respond to these tools (i.e., those with severe cognitive impairment, aphasia). This meta-analysis may also be limited by the potential diagnostic misclassification bias that can arise with ascertaining presence of disease based on a screening tool as opposed to structured interviews eg. by DSM criteria.[43–49] The use of screening tools may have resulted in an over-estimation of prevalence as those who screen positive for PSA or PSD may not always meet formal diagnostic criteria. We also could not explore the degree of contribution of heterogeneity by screening tools, methods of assessment and sample sizes to the overall heterogeneity of the pooled estimates. Furthermore, we were unable to stratify studies based on time of evaluation which varied widely. One notable finding across included studies was an under inclusion of female participants, potentially limiting the generalizability of our findings to females. Lastly, most studies did not report on prognosis and treatment of PSD and PSA.[43–49]

*Recommendations for future studies*

Our study highlights the paucity of epidemiologic studies on PSD and PSA young adults. Larger studies with representative samples are needed to evaluate predictors of PSD and PSA in young adults, potential sex and gender differences, functional outcomes as well as treatment options for patients with these conditions. Studies investigating the most suitable screening tools for young adults with stroke should also be pursued. Finally, prospective studies determining PSD and PSA prevalence over time would also shed light on the natural history and prognosis of these conditions in young adults.

## Conclusion

Our review revealed a high heterogeneity in the reported symptom prevalence of PSD and PSA among studies that focused on young adults. The included studies varied widely in terms of their inclusion criteria, diagnosis methods, and evaluation timelines. We also identified a lack of longitudinal studies tracking psychiatric and functional outcomes over time. To better understand predictors and outcomes of PSD and PSA in young adult stroke survivors, well-designed, longitudinal prospective cohorts are essential.

## CRediT authorship contribution statement

**Katrina Hannah D. Ignacio:** Writing – review & editing, Writing – original draft, Validation, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ryan T. Muir:** Writing – review & editing, Writing – original draft, Validation, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jose Danilo B. Diestro:** Writing – review & editing, Validation, Supervision, Conceptualization. **Nishita Singh:** Writing – review & editing, Supervision, Methodology, Investigation. **Melody Hope Lim Lee Yu:** Writing – review & editing, Supervision, Methodology, Investigation. **Omar El Omari:** Validation, Methodology, Investigation, Data curation. **Rana Abdalrahman:** Validation, Methodology, Investigation, Data curation. **Suzanne L. Barker-Collo:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Investigation, Formal analysis, Conceptualization. **Maree L. Hackett:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis, Data curation. **Sean P. Dukelow:** Writing – review & editing, Writing – original draft, Validation, Supervision, Data curation, Conceptualization. **Mohammed A. Almekhlafi:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Data curation, Conceptualization.

## Declaration of competing interest

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## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jstrokecerebrovasdis.2024.107732.

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