**Frequency of anxiety after stroke: an updated systematic review and meta-analysis of observational studies**

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**Abstract**

**Background**

Anxiety is a common and distressing problem after stroke. A previous systematic review of observational studies [1] included 44 studies published to March 2011 and reported rates of anxiety as 18.3% when diagnosed by interview and 24.3% by rating scale. The review needed updating: there were known to be more recent primary studies of anxiety after stroke and some sub-group analyses had previously been based on small samples, with resultant imprecision.

**Aims**

To undertake an updated systematic review and meta-analysis of observational studies of anxiety after stroke and integrate the findings with those reported previously.

**Summary of review**

Multiple databases were searched to May 2018 and 53 new studies were included following dual independent sifting and data extraction. These were combined with 44 previous studies to form a combined dataset of 97 studies, comprising 22,262 participants. Studies using interview methods were of higher quality. Rates of anxiety by interview were 18.7% (95% CI 12.5, 24.9%) and 24.3% (95% CI 21.7, 26.9%) by rating scale. Rates of anxiety did not lower meaningfully up to 24 months after stroke. Eight different anxiety sub-types were also reported.

**Conclusions**

The updated review has confirmed that anxiety occurs in around 1 in 4 patients (by rating scale) and 1 in 5 patients (by interview). More research on anxiety sub-types is needed for an informed understanding of its effects and the development of interventions.

**Background**

Mood problems are common after stroke with reported rates of depression, apathy and distress significantly higher than in the general population [2,3]. Anxiety is common in the general population [4] but its presence in stroke patients has been relatively under-recognised both in clinical and research settings. A systematic review of observational studies [1] included 44 studies and reported rates of anxiety as 18.3% when diagnosed by interview and 24.3% by rating scale. The review reported that rates lowered with time after stroke, although they remained higher than in the general population [4]. However the inclusion of relatively small numbers of studies at some time points meant that there was considerable imprecision in rates. Furthermore studies had also used a number of different scales and cut-off scores to define anxiety, producing considerable uncertainty around the true rate.

More recent research has argued for the importance of subtypes of anxiety (for example, panic disorder; specific or simple phobias) for understanding its impact and for developing and delivering suitable interventions [5] or adapting those shown to be effective in the general adult population [6]. Our review in 2013 had recorded sub-types when they were reported in primary studies but this information was available in only 3 of the 8 relevant studies.

Our review of 44 studies had searched databases until March 2011 and we are aware of the publication since then of further, potentially relevant studies. Another recent review in this area [7] was limited to publications over 2011-17, from a small range of languages, and only those using self-report measures of anxiety. Consequently, updating the Campbell-Burton (2013) review [1] could have several potential benefits, not only making the findings more current but also potentially increasing the sample size and precision, particularly on sub-group analyses. Therefore the aims of this study were to undertake an updated systematic review of observational studies of anxiety after stroke; to integrate the findings with those previously reported [1]; and to disaggregate rates of anxiety by sub-type, rating scale and time after stroke.

**Method**

This review and the original systematic review [1] were both undertaken according to the PRISMA guidelines [8]. The review update protocol was registered on PROSPERO: CRD42018093718.

**Inclusion / exclusion criteria**

Studies were included if undertaken in populations or groups of patients with a clinical diagnosis of haemorrhagic or ischaemic stroke or transient ischaemic attack (TIA) and were assessed for symptoms of anxiety on a rating scale such as the Hospital Anxiety and Depression Scale (HADS) [9] or were diagnosed by clinical interview. We translated papers published in languages other than English if the title and abstract indicated potential eligibility. We excluded studies if they:

* used proxy measures of anxiety;
* were intervention studies;
* were limited to patients with subarachnoid haemorrhage or other specific stroke sub-types or demographic characteristics;
* were not designed to screen expressly for anxiety, or used non-specific measures of psychological distress;
* used retrospective recruitment or mood reporting;
* employed convenience sampling;
* reported anxiety as a continuous outcome and we could not derive a categorical assessment.

**Study identification and data extraction**

We searched the following digital databases: Medline, Embase, CINAHL, PsycINFO, Allied and Complementary Medicine and Proquest dissertation, using a search strategy developed in Medline (see Appendix 1) and adapted to the other databases. We restricted the search to studies published from January 2009 (to ensure relevant studies were not missed) to May 2018 and applied no language restrictions. The search was undertaken by one investigator (XXX) and screening of title and abstract was undertaken by XXX with a second reviewer (XX) and decisions taken against the selection criteria. Independent data extraction was performed by two reviewers (two of: XXX, XX, XX) for all eligible studies.

**Quality of evidence**

We extracted information on study design, setting and patient characteristics. Study quality was assessed using the Newcastle-Ottawa Scale (NOS) for cohort studies [10], see Appendix 2, which includes eight criteria. One criterion (comparability of cohorts) was recorded as not applicable because the included studies were all reporting prevalence rates derived from a single cohort. Study quality was not used to determine inclusion. Finally we assessed the quality of the 44 studies included in the original review using the NOS measure.

**Data synthesis**

We combined the studies reported in the 2013 review with those identified in the update.

Studies were grouped into two categories based on method of case ascertainment: those using clinical interview for diagnosis; and those using a rating scale. We also extracted data on rates: at five different time points after stroke (up to 1 month; 1-5 months; 6-12 months; 12-24 months; over 24 months) and did this separately for interview and rating scale studies; from different rating scales or different caseness thresholds on the same scale (using whatever had been used in the primary data study); and, for interview-based studies only, rates of anxiety sub-types.

We undertook several meta-analyses. We excluded from pooling one study [11] using the hierarchical diagnostic rule in the Diagnostic and Statistical Manual-III (DSM-III) [12], meaning that anxiety is not diagnosed in the presence of depression, which may falsely deflate the reported rate of anxiety. For studies using rating scales we used whatever caseness threshold had been used by the primary researchers. When studies reported rates of anxiety at more than one time period, we used the first-reported time period as the primary outcome prevalence rate.

The random effects model was used to summarize data. Chi-square was used to test for subgroup differences, and heterogeneity among the studies was assessed by the I-squared statistic. We used Review Manager 5.3 [13] for data analysis.

**Results**

The search from 2009 to 2018 produced 22,564 unique references (see Figure 1), of which 53 met the inclusion criteria and had not been included in the 2013 review, including three translated from non-English language publications. The following results are based on the integrated data set of 97 studies, comprising 44 studies from the original review [11, 14-58] and 53 studies from the update [59-114] (see Table 1).

**Study characteristics**

The 97 studies included 26,262 participants and had been published between 1984 and 2018. Most had recruited patients from hospital (52), while other settings were rehabilitation (19), general population (15), a combination of settings (2) or not reported (8). Most studies were cross-sectional (78) or longitudinal cohort in design (15), although one used a case-control design and the design was not reported in two cases. Cohort studies included a range of data collection time points: 2 time points (n=4); 3 time points (n=4); 4 time points (n=4); 5 time points (n=2); 13 time points (n=1). Anxiety was recorded in patients in a very wide range of time periods after stroke (from 2 weeks to 10 years).

The studies had been undertaken in 34 different countries: UK (18); Netherlands (5); Norway, Italy, China and Australia (4 each); Sweden, Nigeria, Japan, India, Ireland, New Zealand, and Bosnia & Herzogovina (3 each); Thailand, Switzerland, South Korea, USA, Hong Kong and Croatia (2 each); and Benin, Brazil, Spain, Ukraine, Bahrain, Turkey, Tanzania, Finland, Slovakia, Georgia, Russia, France and Germany (1 each). Two studies were undertaken in more than 1 country; the country of origin was not reported in 6 studies.

**Measurement and assessment of anxiety**

Clinical diagnoses of anxiety disorder were made in 10 studies in accordance with different versions of the DSM (3 studies used the DSM-III [12]; 2 the DSM-III-R [115]; 5 used the DSM-IV [116]). The remaining studies used other interview methods: Structured Clinical Interview for DSM-V (SCID) [117]; Schedules for Clinical Assessment in Neuropsychiatry (SCAN) [118]; Mini-International Neuropsychiatric Interview-Plus (MINI-Plus) [119]; and the CCND-3 [114]. Anxiety prevalence was reported in the interview studies from samples ranging from 50 to 350 participants (total 3,109; median 149.5).

Nine different standardised scales were used to identify anxiety symptoms and generate caseness rates in 78 studies: the Generalised Anxiety Disorder (GAD) [120] (n=1); Hospital Anxiety and Depression Scale (HADS)-Anxiety subscale [9] (n=50); Hamilton Anxiety Rating Scale (HAM-A) [121] (n=7); Neuropsychiatric Inventory (NPI) [122] (n=1); Zung Self-rated Anxiety Scale [123] (n=3); Irritability Depression and Anxiety Scale, Anxiety subscale (IDA-A) [124] (n=1); Beck Anxiety Inventory (BAI) [125] (n=2); Adult Manifest Anxiety Scale (AMAS) [126] (n=1); and the General Health Questionnaire (GHQ-60 anxiety sub-scale) [127] (n=1). In addition, one study used a single question measure of anxiety, and another used a series of five researcher-developed questions. Three of these scales (HADS-A; BAI; HAM-A) were used with more than one caseness threshold. In total 20 different combinations of standardised scales and thresholds were used in the included studies. Anxiety prevalence was reported in the rating scale studies from samples ranging from 15 to 4,079 participants (total 23,153; median 81).

**Anxiety prevalence**

The overall prevalence of anxiety when assessed by interview ranged from 0.6% to 33.3% in the primary studies. The updated pooled prevalence derived from the 18 included studies was 18.7% (95% confidence interval 12.5 to 24.9%), see Figure 2. Heterogeneity among the included studies was very high (97%).

The assessment of anxiety by rating scale produced rates in the range 4.8% to 63.6% in the 78 included studies. The overall frequency of anxiety ‘caseness’ by rating scale was 24.3% (95% CI 21.7 to 26.9%), see Figure 3. Heterogeneity among the included studies was very high (95%).

Given the difference in prevalence rates obtained from the interview and rating scale studies, it was decided not to calculate a rate combining data from the two study types.

**Pooled anxiety prevalence at different times after stroke**

Pooled rates of anxiety in the acute phase (within 1 month of stroke) were reported as 15.5% (95% CI 6.3 to 24.7%) in seven studies using interview, and as 26.3% (95% CI 18.8 to 33.8%) in 19 studies using rating scales.

At between 1 and 5 months after stroke rates of anxiety by interview were 21.4% (95% CI 19.2 to 23.5%) in eight studies using interview methods, and 24.0% (95% CI 19.3 to 28.6%) in 24 studies using rating scales.

In the 6-12 months period three studies used interviews methods and estimated the pooled prevalence as 31.8% (95% CI 17.8 to 27.3%), whereas 17 studies used rating scales and found the rate to be 22.0% (95% CI 16.7 to 27.3%).

At between 12 and 24 months only one study used interview methods to report a rate of 28.8% (95% CI 20.5 to 37.1%), whereas 10 studies used rating scale methods and found an overall rate of 11.0% (95% CI 3.5 to 18.5%).

In the period 24 months to 10 years the rate was reported in 3 studies using interview (20.4%; 95% CI 14.6 to 26.2%) and 10 studies using rating scales (26.0%; 95% CI 18.1 to 34.0%).

**Anxiety prevalence using different caseness thresholds on rating scales**

The rates obtained from meta-analysis were calculated for all combinations of standardised scales and thresholds; however in many cases only one or two studies were included per combination. Higher numbers per combination were available for the HADS-Anxiety scale, although seven different thresholds had been used and only two (>7 and >10) were reported in at least 10 studies. The reported pooled rates for each HADS-A caseness threshold are as follows: threshold >4, n=3 studies, 37.3% (17.8 to 56.8%); >5, n=2, 27.9% (0.4 to 55.3%); >6, n=1, 41.8% (34.0 to 49.6%); >7, n=28, 25.1% (20.6 to 29.7%); >8, n=2, 13.9% (-5.8 to 33.6%); >9, n=2, 29.1% (21.6 to 36.5%); >10, n=13, 18.9% (14.4 to 23.4%).

**Anxiety sub-type caseness**

Among the 19 studies that used interview methods to reach a definition of anxiety caseness, 10 also reported the rate of anxiety sub-types.

Agoraphobia was reported in four studies: 8.3% [43], 16.0% [45], 11.5% [47], 5.5% [103], and had a pooled prevalence of 8.4% (95% CI 6.5 to 10.4%; 1 squared =82%). Social phobia was reported just twice: 2.9% [47]; 2.1% [103], with a pooled prevalence of 2.3% (95% CI 0.9 to 3.7%; I squared 0%). Simple phobia was reported in three studies: 5.0% (OCSP-II), 8.7% [47], 2.1% [103], having a pooled prevalence of 2.1% (95% CI 1.5 to 4.3%; I squared 68%). Rates of Obsessive-Compulsive Disorder (OCD) were reported in two studies: 1.9% [47] and 2.1% [103], with a pooled prevalence of 2.0% (95% CI 0.8 to 3.2%; I squared 0%). Finally, panic disorder was reported in four studies: 2.0% [43], 17.3% [93], 10.6% [47] and 3.1% [103], with a pooled prevalence of 3.7% (95% CI 2.4 to 5.0%; I squared 90%).

Generalised Anxiety Disorder (GAD) was reported in eight studies [43, 45, 47, 59, 73, 81, 86, 103]. However, a pooled prevalence was not calculated because in some studies it is not clear if GAD had been reported as a sub-type of anxiety or as a generic anxiety diagnosis. Similarly rates were not pooled for Phobic Disorder, which was reported in three studies [59, 73, 101], because it is unclear whether the category ‘phobic disorder’ includes all types of phobias or is a distinct phobia sub-type.

**Quality ratings of studies**

Studies were rated on the seven relevant items of the NOS scale [10], with each item ranked as low or high risk of bias. Among the 97 studies low risk of bias was assigned to scale items ranging from 1 out of 7 to 6 out of 7 items (median 4/7). In studies using interview methods the range was 2/7 to 6/7 (median 4/7), and in studies using rating scale methods low risk of bias ranged from 1/7 to 5/7 items (median 4/7). Studies using interview methods had lower risk of bias than studies using rating scales (Mann-Whitney U = 436.5; z = -2.763; p = .0058). Rates of low risk of bias varied considerably across the seven scored items. All 97 studies had low risk for length of follow-up, 83 for ascertainment of exposure, and 81 for representativeness of the exposed cohort. Low risk was present for 62 studies on adequacy of follow-up. Few studies had low risk of bias for the remaining three items: outcome assessment (n=20); anxiety shown not to be present at the study start (n=10); and selection of the non-exposed cohort (n=4).

**Discussion**

**Brief summary of the findings**

This updated systematic review included 53 studies, which were combined with the 44 studies included in the 2013 review [1]. The 97 primary data studies included 19 studies using interview methods and 78 studies using rating scales. The pooled prevalence of anxiety after stroke was 18.7% when diagnosed by interview and 24.3% by self-report rating scale, confirming the rates reported in the previous review and also confirming the previously reported pattern of lower rates when using interview. Increasing the number of studies in the data pooling produced increased rate precision, particularly for interview studies. Rates of anxiety were relatively stable in the years after stroke.

**Strengths and weaknesses of the study**

The updated and combined review used a number of systematic review methods that increase review rigour and tend to reduce bias: searching of multiple databases; dual, independent screening used to determine entry criteria and for extraction; no language or date limits were applied; included studies were assessed for quality; and data pooling was used and reported when appropriate. We searched ProQuest for dissertations, and included conference abstracts, but otherwise did not search for unpublished studies

The included primary data studies varied in quality, although study quality was not used as an entry criterion to the review. Studies using interview methods tended to be higher quality. Primary studies were included from many countries, although all studies except three were reported in English; this reflects a common finding in systematic reviews, although it is unclear if this would produce a reporting bias similar to that reported in reviews of intervention studies.

Combining the studies found with those reported in the 2013 review allowed further data pooling, although in some cases the pooled estimates were based on small numbers of primary data studies, and levels of heterogeneity were often very high. Rates were reported using a range of different interview methods and ratings scales (and cut-off scores); data pooling for the overall prevalence calculations used whatever cut-off and timing had been reported in the primary study, which inevitably led to the combination of a variety of methods and reported rates. However it was thought that this potential disadvantage was offset by the advantage gained by increased overall sample size; the rates have now been calculated using aggregate samples of 3,109 (in interview studies) and 23,153 (in rating scale studies).

We excluded studies reporting proxy ratings of anxiety as the focus of the review was on self-rating. However one consequence is the exclusion of studies of patients with strokes causing severe cognitive or language impairment, limiting the review’s external validity.

**What this review adds**

Updating the review led to the addition of a large number of studies published up to 2018, allowing rates to be estimated from 19 studies (for interview) and 78 studies (for rating scale), resulting in increased precision in estimates. Caseness rates generated by interview are confirmed as meaningfully lower than those generated by rating scale (on average anxiety is shown to occur in 1 in 5 patients rather than 1 in 4), a direction of difference replicating that seen in depression after stroke [2,3]. The update confirmed that anxiety continues to be prevalent many years after stroke onset. The review update also allowed the calculation of rates for some anxiety sub-types such as panic disorder and phobias, which were shown to vary considerably, supporting the view [5] that this diagnostic detail is essential for an informed understanding of the phenomenon and development of effective interventions. However it is notable that only small numbers of studies reported sub-types; for example, rates of social phobia and OCD were based on just two studies with a combined sample size of 293. In some studies it was not clear whether sub-types were differentiated from a generic anxiety diagnosis.

**Implications for research**

This updated review has included almost 100 studies and 26,262 participants, reporting the rate of anxiety after stroke, although in the case of some primary studies, this was not their main objective. Almost 80 studies reported the rate of anxiety by rating scale and there seems little value in further new studies adding to this total. However there remains little evidence on rates of anxiety more than 12 and 24 months after stroke. A crucial advantage in future research would be gained by greater consensus on the rating scale (and its threshold for caseness) providing the most robust indication of anxiety after stroke: for example, receiver-operated characteristic (ROC) analysis of studies using interviews and rating scales could provide this. Further studies into anxiety sub-types (diagnosed by interview) would provide a useful addition to the published research. Similarly further studies assessing which factors tend to be associated with the onset and/or persistence of anxiety after stroke are warranted; quantitative and qualitative research could both make contributions to answering this important question.

**Implications for practice**

The updated review has confirmed the high rate of prevalence of anxiety after stroke and also confirmed that rates are sustained beyond the early months after stroke; that is, beyond what could be termed the initial reaction to stroke onset and discharge home after hospital admission. This suggests it is important to continue to assess or screen for anxiety 12 months or more after stroke onset, although the continued lack of evidence for interventions in this patient group does preclude evidence-based decisions about treatments if anxiety is identified [129]. Anxiety continues to be a problem for many patients, which also has implications for the mood and quality of life of unpaid carers [130], and its rate is similar to that of depression after stroke. Anxiety sub-types reported in this review tend to have a relatively low prevalence but their presence confirms the impact of mental health problems, which may compound any physical and cognitive effects of the stroke as well as cause distress.

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**Declaration of Conflicting Interests**

XXXXXXXXXX is an author on one study included in this review. Otherwise the authors have no conflicting interests to declare.

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**Figure 1. PRISMA flow diagram**

**Screening**

**Included**

**Eligibility**

**Identification**

Records identified through database searching
(n = 28,565)

Additional records identified through other sources
(n = 0)

Records after duplicates removed
(n = 22,564)

Records screened
(n = 22,564)

Records excluded
(n = 22,242)

Full-text articles assessed for eligibility
(n = 320)

Full-text articles excluded, with reasons
(n = 242)

* Reported anxiety score as continuous (n = 84)
* Did not measure prevalence of anxiety after stroke (n = 78)
* Limited to patients with SAH or some other select characteristic n = 32)
* Used non-representative or retrospective sampling (n = 16)
* Full text not available (n = 14)
* Non-English language (n = 11)
* Used non anxiety-specific measures (n = 4)
* Non-observational study (n = 3)
* Used retrospective sampling (n = 0)

Studies included
(n = 53)

**Appendix 1: Search strategy for MEDLINE database**

1. exp Cerebrovascular Disorders/
2. stroke\*.mp
3. (poststroke\* or post-stroke\* or cva\*).mp
4. (cerebrovasc\* or brain vasc\* or cerebral vasc\*).mp
5. ((cerebr\* or brain\* or cerebellar\* or cerebellum\* or vertebrobasilar\*) adj2 (infarct\* or ischemi\* or ischaemi\* or thrombo\* or emboli\* or apoplex\* or occlus\*)).mp
6. ((cereb\* or brain\* or intracereb\* or intracrani\* or subarachnoid) adj2 (haemorrhag\* or hemorrhag\* or h?ematoma\* or bleed\*)).mp
7. Hemiplegia/ or exp Paresis/
8. (hemipleg\* or hemipar\* or paresis or paretic).mp
9. Or/1-8
10. exp Adjustment Disorders/
11. exp Anxiety Disorders/
12. exp Neurotic Disorders/
13. Mental Disorders/
14. anxiet\*.mp
15. distress\*.mp
16. mood.mp
17. (affect or affective) adj2 disorder.mp
18. (neuros?s or neurotic\*).mp.
19. (depersonalization or depersonalisation or derealization or derealisation).mp.
20. fear.mp.
21. (worry\* or worri\* or apprehens\*).mp
22. (tension\* adj2 symptom\*).mp
23. ((avoidanc\* or avoidant\*) adj2 (behaviour or behavior or symptom\*)).mp.
24. (autonomic adj2 (arousal\* or symptom\*)).mp.
25. (hyperventil\* adj2 (symptom\* or syndrom\*)).mp.
26. (HADS or GHQ or STAI)
27. Or/10-26
28. 9 and 27

**Appendix 2: Newcastle-Ottawa Quality Assessment Scale: Cohort Studies (Wells et al, 2018)**

1) Representativeness of the exposed cohort

2) Selection of the non-exposed cohort

3) Ascertainment of exposure

4) Demonstration that outcome of interest was not present at start of study

5) Comparability of cohorts on the basis of the design or analysis

6) Assessment of outcome

7) Was follow-up long enough for outcomes to occur

8) Adequacy of follow up of cohorts

***Table 1: Risk of bias assessment for studies using interviews***

| Study name or author (year published) |  Representativeness of the exposed cohort |  Selection of the non-exposed cohort |  Ascertainment of exposure |  Demonstration that anxiety was not present at start of the study |  Comparability of cohorts |  Assessment of outcome |  Was the follow up long enough for outcomes to occur? |  Adequacy of follow up of cohorts | Scale score (low risk of bias / 7 items) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Ajiboye (2013) | ★ | ☆ | ★ | ☆ | N/A | ★ | ★ | ☆ | 4/7 |
| Astrom (1996) | ★ | ☆ | ★ | ☆ | N/A | ★ | ★ | ★ | 5/7 |
| Chinchaladze (2013) | ☆ | ☆ | ☆ | ☆ | N/A | ★ | ★ | ☆ | 2/7 |
| Chun (2018) | ★ | ☆ | ★ | ☆ | N/A | ★ | ★ | ☆ | 4/7 |
| Garikimukku (2015) | ☆ | ☆ | ☆ | ★ | N/A | ★ | ★ | ☆ | 3/7 |
| Kneebone (2016) | ★ | ☆ | ★ | ☆ | N/A | ★ | ★ | ☆ | 4/7 |
| Leppavuori (2003) | ★ | ☆ | ★ | ★ | N/A | ★ | ★ | ★ | 6/7 |
| Morris (1990) | ★ | ☆ | ★ | ☆ | N/A | ★ | ★ | ★ | 5/7 |
| Mumladze (2016) | ☆ | ☆ | ☆ | ☆ | N/A | ★ | ★ | ★ | 3/7 |
| OCSP (House 1991) and OCSP-II (Sharpe 1990) | ★ | ☆ | ★ | ★ | N/A | ★ | ★ | ★ | 6/7 |
| Oni (2016) | ★ | ★ | ★ | ☆ | N/A | ★ | ★ | ★ | 6/7 |
| PCSS (Burvill 1995) | ★ | ★ | ★ | ★ | N/A | ★ | ★ | ☆ | 6/7 |
| Petrova (2012) | ★ | ☆ | ★ | ☆ | N/A | ★ | ★ | ★ | 5/7 |
| Sagen (2009) | ★ | ☆ | ★ | ☆ | N/A | ★ | ★ | ☆ | 4/7 |
| Schottke (2015) | ★ | ☆ | ★ | ☆ | N/A | ★ | ★ | ☆ | 4/7 |
| Schultz (1997) | ★ | ☆ | ★ | ☆ | N/A | ★ | ★ | ☆ | 4/7 |
| Tang (2002) | ★ | ☆ | ★ | ☆ | N/A | ★ | ★ | ★ | 5/7 |
| Verma (2012) | ☆ | ☆ | ★ | ☆ | N/A | ★ | ★ | ★ | 4/7 |
| Zhang (2011) | ☆ | ☆ | ☆ | ☆ | N/A | ★ | ★ | ★ | 3/7 |
| **Key**: ★, low risk of bias; ☆, high risk of bias; N/A, not applicable |  |

***Table 2: Risk of bias assessment for studies using rating scales***

| Study name or author (year published) | Representativeness of the exposed cohort | Selection of the non-exposed cohort | Ascertainment of exposure | Demonstration that anxiety was not present at start of the study | Comparability of cohorts  | Assessment of outcome | Was the follow up long enough for outcomes to occur? | Adequacy of follow up of cohorts | Scale score (low risk of bias / 7 items) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Ahlsio (1984) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| South London Stroke Register(Crichton, 2016; Ayerbe, 2014)  | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Azanmasso (2017) | ☆ | ☆ | ☆ | ☆ | N/A | ☆ | ★ | ☆ | 1/7 |
| Barker-Collo (2007) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Barker-Collo (2017) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Beghi (2009) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Bergerson (2010) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Bovim (2016) | ☆ | ☆ | ☆ | ☆ | N/A | ☆ | ★ | ☆ | 1/7 |
| Bruggiman (2006) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Broomfield (2014) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Broomfield (2015) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Buijck (2012) | ★ | ☆ | ☆ | ☆ | N/A | ☆ | ★ | ☆ | 2/7 |
| Carod-Artal (2009) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Castellanos-Pinedo (2011) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Chanchaem (2013) | ☆ | ☆ | ☆ | ☆ | N/A | ☆ | ★ | ☆ | 1/7 |
| Crowley (2017) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| D’Alisa (2005) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| D’Aniello (2014) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| De Weerd (2011) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| De Weerd (2012) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Delva (2017) | ★ | ☆ | ☆ | ★ | N/A | ☆ | ★ | ☆ | 3/7 |
| DeWit (2008) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Donnellan (2010) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Donnellan (2016) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Elf (2016) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Field (2008) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Fure (2006) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Galligan (2016) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Gangstad (2005) | ★ | ☆ | ☆ | ☆ | N/A | ☆ | ★ | ★ | 3/7 |
| Ghika-Scmid (1999) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Giaquinto (1997) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Gillespie (1997) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| HSRS (Ueki, 1999) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Huzmeli (2017) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Ibrahimagic (2005)  | ☆ | ★ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Ibrahimagic (2013) | ☆ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 2/7 |
| Jones (2012) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Kim (2012) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Kootker (2016) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Knapp (1998) | ☆ | ☆ | ☆ | ☆ | N/A | ☆ | ★ | ★ | 2/7 |
| Langhorne (2000) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Li (2006) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Lincoln (1997) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Lincoln (2013) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Liu (2018) | ★ | ☆ | ★ | ★ | N/A | ☆ | ★ | ☆ | 4/7 |
| Macniven (2005) | ☆ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 3/7 |
| Masskulpan (2008) & Kuptniratsalkul (2009) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Mellon (2013) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Merriman (2007) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Mihalov (2016) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Moon (2004) | ★ | ☆ | ★ | ★ | N/A | ☆ | ★ | ★ | 5/7 |
| Morrison (2000; 2005) | ★ | ☆ | ☆ | ☆ | N/A | ☆ | ★ | ★ | 3/7 |
| Mulroy (2012) | ☆ | ☆ | ☆ | ☆ | N/A | ☆ | ★ | ☆ | 1/7 |
| Mutai (2017) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Nakling (2017) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| NEMSIS (Sturm, 2004; Paul, 2006) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Nijsse (2017) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Ojagbemi (2017) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Ponchel (2016) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ☆ | 3/7 |
| Raju (2010) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Sampson (2003)  | ★ | ★ | ★ | ☆ | N/A | ☆ | ★ | ★ | 5/7 |
| SELSS (Wilkinson, 1997) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Sembi (1998) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Solgajova (2017) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Stojanovic (2015) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Stone (2004)  | ☆ | ☆ | ★ | ☆ | N/A | ★ | ★ | ★ | 4/7 |
| Tang (2012) | ★ | ☆ | ★ | ★ | N/A | ☆ | ★ | ★ | 5/7 |
| Tang (2013) | ★ | ☆ | ★ | ★ | N/A | ☆ | ★ | ★ | 5/7 |
| Townend (2007) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Vicentini (2016) | ☆ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 3/7 |
| Vickery (2006) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Visser-Kelzer (2002) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Vuletic (2011) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Vuletic (2012) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| Watanabe (1997) | ☆ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 3/7 |
| Wu (2017) | ★ | ☆ | ★ | ★ | N/A | ☆ | ★ | ★ | 5/7 |
| Zalihic (2010) | ★ | ☆ | ☆ | ☆ | N/A | ☆ | ★ | ★ | 3/7 |
| Zhao (1999) | ★ | ☆ | ★ | ☆ | N/A | ☆ | ★ | ★ | 4/7 |
| **Key**: ★, low risk of bias; ☆, high risk of bias; N/A, not applicable |  |

***Table 3:*** ***Characteristics of included studies: interview methods***

| Study name or author,year published, Location | Setting/design/recruitment/year of study | Inclusion (I)/exclusion (E) | Mean age (% male) | Method of measuring anxie­­ty | Time post-stroke | n | Rate of anxiety (95% CI) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Ajiboye, 2013, Nigeria | Hospital/cross-sectional/all consecutive patients/Mar 2009 – Feb 2010 | I: stroke diagnosed by consultant neurologist, age ≥18E: past psychiatric history, too sick to be interviewed | 60.6 years (44.6) | SCAN (interview) | <1 to >5 years  | 83 | 10.8 (4.2, 17.5)GAD: 9.6 (3.3, 16.0) Phobic disorder: 1.2 (0, 3.6) |
| Astrom, 1996, Sweden | Hospital / cohort / consecutive / 1979-1981 | I: ischaemic, haemorrhagic & TIA (CT)E: congenital mental handicap  | 73 years (61) | DSM-III-R (GAD) | 2 weeks3 months1 year2 years3 years | 7170665748 | 2 weeks 28 (18–39)78 70 3 m 31 (21–42)83 66 1 y 24 (14–35)86 57 2 y 25 (13–36)86 48 3 y 19 (7·7–30) |
| Chinchaladze, 2013, NR | NR/NR/NR/NR | NR | NR | DSM-IV (interview) | NR | 294 | 31.0 (25.7, 36.2) |
| Chun, 2018, UK | Hospital/cohort/consecutive/NR | I: ≥18 years, new stroke or TIA (clinical diagnosis), mental capacity to give informed consent, able to communicate in English over telephone E: SAH, subdural or extradural haematoma, ocular TIA, terminal stage of illness; difficult to follow up due to no fixed abode, current illicit drug or alcohol dependence  | 70 years (60) | SCID (interview) | 3 months | 175 | 21.7 (15.6, 27.8)GAD only: 4.0 (1.1, 6.9)Phobic disorder only: 10.3 (5.8, 14.8)GAD + phobic disorder: 7.4 (3.5, 11.3) |
| Garikimukku, 2015, India | Hospital/cross-sectional/NR/2014 | I: ≥18 years, diagnosis of stroke E: other serious organic illness, previous history of psychiatric disorder, severe cognitive impairment | NR | MINI PLUS (interview) | Acute | 50 | 18.0 (7.4, 28.6)GAD: 18.0 (7.4, 28.6) |
| Kneebone, 2016, UK | Hospital/cross-sectional/all patients/NR | I: ≥65 years, inpatients with stroke two weeks to six months previously, medically stableE: significant cognitive impairment (AMT ≤8, MMSE ≤24, or opinion of lead physician), aphasia, comorbid psychiatric disorder other than anxiety or depression | 80 years (52) | SCID (interview) | 3 days (range 1-7) | 69 | 11.6 (4.0, 19.1)  |
| Leppavuori, 2003, Finland | Hospital / cross-sectional / consecutive / NR | I: Ischaemic stroke E: SAH, ICH, no clinical neurological examination, severe aphasia, refusal of psychiatric examination | 71 years (51) | DSM-IV\_GAD | 3-4 months  | 277 | 21 (16–26) |
| Morris, 1990, Australia | Hospital / cohort / consecutive / NR | I: ischaemia & haemorrhagic stroke (WHO) (CT)E: aphasia | 71 years (51) | DSM-III | 2 months 1 year | 9956 | 3·0 (0–6·4)5·4 (0–11) |
| Mumladze, 2016, Georgia | NR/cohort/NR/NR | NR | NR | DSM-IV (interview) | Acute | 168 | 17.3 (11.5, 23)  |
| OCSP, 1991, UKOCSP-II, 1990, UK | Community / cohort / registry / 1981-1986 | I: first-ever stroke (CT)E: recurrent stroke, TIA | 71 years (45) | DSM-III (GAD) | 1 month6 months1 year2-5 years | 8911911260 | 1·1 (0, 3)0·8 (0, 3)0 (0, 0)20 (10, 30)Agoraphobia 8·3 (1·3–15·3)GAD 5·0 (0–11)Simple phobia 5·0 (0–11)Panic disorder 2·0 (0–5) |
| Oni, 2016, Nigeria | Hospital/cross-sectional/consecutive/2013-2014 | I: adult stroke survivorsE: severe cognitive deficits | 57 years (54) | SCAN (interview) | 28 <1 year9 1-2 years33 >2 years | 70 | 10.0 (3.0, 17.0) |
| PCSS, 1995, Australia | Community / cohort / ideal case finding / 1995-1996 | I: first-ever or recurrent stroke or TIA (WHO) | 73 (56) | DSM-III | 4 months | 294 | 19 (14–23)Agoraphobia 16 (12–20)GAD 3 (1–5) |
| Petrova, 2012, Russia | Hospital / cohort / consecutive / NR | I: stroke, admitted within 24 hours of onset. E: significant co-morbidity, cancer, amnesia | 70 years (48) | DSM-IV | 1, 7, 14 and 28 days, and 3, 6 and 12 months post-stroke | 198 | (overall period)GAD 33.3 (26.8, 39.8)Phobias 22.2% |
| Sagen, 2009, Norway | Hospital/cohort/consecutive/2003-2005 | I: ischaemic strokeE: TIA, insufficient competence in Norwegian language, severe aphasia, psychosis, MMSE <20, terminal illness | 65 years (59) | SCID (interview) | 4 months | 104 | 23.1 (15.0, 31.2) GAD: 5.8 (1.3, 10.3)PTSD: 2.9 (0, 6.1)Specific phobia: 8.7 (3.3, 14.1)Social phobia: 2.9 (0, 6.1)Panic with agoraphobia: 7.7 (2.6, 12.8)Panic without agoraphobia: 2.9 (0, 6.1)Agoraphobia without panic disorder: 3.8 (0.2, 7.5)OCD: 1.9 (0, 4.6)Anxiety NOS: 1 (0, 2.8) |
| Schottke, 2015, Germany | Rehabilitation/ cross-sectional/NR/NR | I: acute cerebral infarction or intracerebral haemorrhage, neurological symptoms exceeding 24 hours, precise documentation of lesion, admission to rehabilitation cliniccapability to attend facilities and undergo structured interview in GermanE: severe communication disorders | 67 years (56) | SCID (interview) | 6 weeks  | 289 | 20.4 (15.8, 25.0) GAD: 4.8 (2.4, 7.3)Specific phobia: 3.8 (1.6, 6)Social phobia: 2.1 (0.4, 3.7)Panic with agoraphobia: 1 (0, 2.2)Panic without agoraphobia: 2.1 (0.4, 3.7)Agoraphobia without panic disorder: 4.5 (2.1, 6.9)OCD: 2.1 (0.4, 3.7) |
| Schultz, 1997, USA | Hospital / cohort, consecutive / NR | I: stroke | 58 years (57) | DSM-IV\_GAD | Acute phase3 months6 months12 months2 years | 14277797066 | 19 (13–25)77 3m 22 (13–31)79 6m 25 (16–35)70 12m 11 (4·0–19)66 2y 18 (8·9–27) |
| Tang, 2002, Hong Kong | Rehabilitation/ cross-sectional/consecutive / 1999–2000 | I: First-ever stroke (CT)E: TIA, SAH, history ofneurological impairment,comprehension andcommunication deficits, lengthof stay <2 weeks | 71 years (45) | DSM-III-R | 25 days | 157 | 0·6 (0–1·9) |
| Verma, 2012, India | Hospital/cross-sectional/NR/NR | NR | NR | NR | 1-6 months | 100 | 24.0 (15.6, 32.4) |
| Zhang, 2011, NR | Hospital/cross-sectional/NR/NR | NR | NR | CCND-3 (interview) | Acute | 350 | 10.0 (6.9, 13.1) |
|  |  |  |  |  |  |  |  |

***Table 2: Characteristics of included studies: rating scale methods***

| Study name or author,year published, Location | Setting/design/recruitment/year of study | Inclusion (I)/exclusion (E) | Mean age (% male) | Method of measuring anxie­­ty | Time post-stroke | n | Rate of anxiety (95% CI) |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Ahlsio, 1984, Sweden | Community/ cross-sectional/Consecutive / 1979 | I: CI, TIA, SAH (CT)E: Severe disability, aphasia,dementia | 71 years (60) | Self-report | 2 years | 53 | 26 (15–38) |
| South London Stroke Register (SLSR): Ayerbe, 2014, UKCrichton, 2016, UK | Population/cohort/all patients on register/Jan 1995 – Dec 2009 1995 – 2003 | I: stroke (WHO)E: severe cognitive or communication impairment | 53% male55%57%58%57%Median: 62 years (59) | HADS-A >7HADS-A >7 | 3 months1 year2 years3 years4 years5 years6 years7 years8 years9 years10 years10 years15 years | 11041231901109688965960447040129688409133 | At 3 months: 34.1 (31.3, 36.9)At 1 year: 32.9 (30.3, 35.5)At 2 years: 33.8 (30.7, 36.9)At 3 years: 31.9 (29.1, 34.7)At 4 years: 32.4 (30.8, 38.1)At 5 years: 34.4 (30.8, 38.1)At 6 years: 33.3 (29.5, 37.0)At 7 years: 34.0 (29.7, 38.3)At 8 years: 34.2 (28.0, 38.8)At 9 years: 33.4 (29.0, 38.8)At 10 years: 38.3 (31.9, 44.6)At 10 years: 31.4 (26.9, 36.3)At 15 years: 34.9 (26.8, 43.0) |
| Azanmasso, 2017, Benin | Hospital/cross-sectional/NR/NR | NR  | 54.3 years | HADS (cut off NR) | >6 months | 67 | 22.4 (12.4, 32.4) |
| Barker-Collo, 2007, New Zealand | Rehabilitation / cross-sectional / consecutive / NR | I: ischaemic or Haemorrhagic stroke (CT)E: aphasia, non-native language speaker | 52 years (55) | BAI>25 | 3 months  | 81 | 21 (11–32) |
| Barker-Collo, 2017, New Zealand | Population/ cohort/all new hospitalised or non-hospitalised patients/2011-2012 | I: stroke (WHO), resident of Auckland region, ≥16 yearsE: intracerebral haemorrhage, SAH, sensory or cognitive impairment, speech or language barrier, too unwell | 69.2 years(53) | HADS-A >7 | 2 weeks1 month6 months1 year | 208353346365 | 14.5 (10.9, 18.1)????? |
| Beghi, 2009, Italy | Hospital / cross-sectional / consecutive / 2000-2001 | I: strokeE: sufficient language for interview. MMSE > 18 | 70 years ((68) | HAMA >17 | > 2 years | 82 | 12.2 (5.1, 19.3) |
| Bergerson, 2010, Norway | Rehabilitation / cross-sectional / mail-out all patients / 1998-2001 | I: Ischaemic, ICH, SAHE: aphasia | 54 years (64) | HADS-A>10 | 2-5 years | 162 | 17 (11–22) |
| Bovim, 2016, NR | Hospital/cohort/NR/NR | I: >18 yearsE: receiving palliative care | 76.8 years | HADS-A >7 | ≤14 days | 390 | 63.6 (58.8, 68.4) |
| Broomfield, 2014, UK | Population/cohort/all consecutive patients/2012-2013 | I: on Glasgow LES databaseE: resident in care-home, housebound  | 70.3 years (57) | HADS-A >7 | NR | 4079 | 28.9 (27.5, 30.3) |
| Broomfield, 2015, UK | Community/cross-sectional/NR/2009-2010 | I: patients on primary care stroke registers, who agreed to an annual health check E: resident in nursing home, housebound, serious comorbidity | 70.4 years (55) | HADS-A >7 | NR | 3831 | 16.0 (14.8, 17.2) |
| Bruggiman, 2006, Switzerland | Community/ cross-sectional/ consecutive/ NR | I: First-ever ischemic orhemorrhagic strokeE: NIHSS>3, history ofpsychiatric illness, neurologiccomorbidity | 51 years (67) | HADS-A >7 | 1 year | 49 | 24 (12–37) |
| Buijck, 2012, Netherlands | Rehabilitation/cohort/all patients/2008 | I: all patientsE: expected to be discharged within two weeks, critically ill | 79 years (54) | NPI >0 | NR | 145 | 15.0 (9.2, 20.8) |
| Carod-Artal, 2009, Brazil | Rehabilitation / cross-sectional / consecutive / 2007-2008 | I: Ischaemic or haemorrhagic stroke (clinical diagnosis & radiological findings)E: TIA, subdural haematoma, dementia, aphasia, severe disability due to previous neurological disorder | 56 years (52) | HADS-A>10 | 20 months  | 300 | 24 (19–29) |
| Castellanos-Pinedo, 2011, Spain | Hospital/cohort/NR/2007-2008 | I: stroke (neuroimaging), patient has responsible caregiverE: previous dementia or cognitive decline (clinical record or IQCODE), cerebral haemorrhage or other suspected cause aetiology of brain injury, TIA, persistent coma or severe alteration of consciousness four weeks after stroke, death or appearance of new lesion before four weeks | 70 years (52) | HAMA >5 | 4 weeks | 89 | 33.7 (23.9, 43.5) |
| Chanchaem, 2013, Thailand | NR/cross-sectional/NR/2010-2012 | NR | 62.5 years  | HADS (cut off NR) | NR | 215 | 22.3 (16.7, 27.9) |
| Crowley, 2017, UK | Hospital-based acute unit and community-based stroke service /cohort/consecutive/NR | I: first stroke three months previous, able to communicateE: MMSE <18, dementia, significant premorbid psychiatric illness, premorbid alcohol or drug addiction  | 62 years (66) | HADS-A >7 | 3 months | 35 | 39.0 (22.8, 55.2) |
| D’Alisa, 2005, Italy | Rehabilitation / cross-sectional / consecutive / 2002-2004 | E: MMSE<24, aphasia | 63 years (60) | HADS-A>10 | 5 years  | 73 | 21 (11–30) |
| D’Aniello, 2014, Italy | Rehabilitation/cross-sectional/NR/NR | I: first or second diagnosis of strokeE: global aphasia, behavioural disorders, dementia | 62 years (59) | HADS-A >4 | 4 years (range 1-20) | 81 | 55.6 (44.8, 66.4) |
| De Weerd, 2011, Netherlands | Hospital/cohort/all patients/2006-2007 | I: all patients admitted to department of neurology E: <65 years, referral to nursing home, rehabilitation centre, or another department | 77 years (44) | HADS-A >7 | 12 months | 57 | 9.1 (1.6, 16.6) |
| De Weerd, 2012, Netherlands | Hospital/cohort/all patients/2007-2008 | I: all ischaemic stroke patientsE: <60 years, referral to nursing home, rehabilitation centre, or another department | 75 years (65) | HADS-A >7 | 12 months | 88 | 5.6 (0.8, 10.4) |
| Delva, 2017, Ukraine | NR/cohort/NR/NR | I: acute stroke E: major illness that could cause secondary fatigue, alcohol abuse, consciousness impairment or MMSE <24, depressive or anxious disorders (HADS-A >10), severe aphasia or dysarthria, impaired language or written ability, mRS ≥4 | 64 years (47) | HADS-A >4 | 6 months | 156 | 21.2 (14.8, 27.6) |
| DeWit, 2008, England, Belgium, Switzerland, Germany | Rehabilitation / cohort / consecutive / 2002-2004 | I: first-ever stroke (WHO) (CT), RMA-GP<12 and/or leg trunk function <9 and/or arm function <13E: neurological impairments, prestrike BI<50, subdural haematoma, admitted to rehab centre 6 or more weeks post-stroke | 70 years (53) | HADS-A >7 | 2 months 4 months6 months  | 491478467 | 25 (21–29)4m 23 (19–27)6m 21 (18–25) |
| Donnellan, 2010, Ireland | Hospital / cross-sectional / consecutive admissions / not stated | I: first or recurrent stroke (WHO, CT) & FAST ≥14 & Abbreviated Mental Test score ≥8E: TIA, SAH, traumatic intracranial haemorrhage, dementia, extreme critical illness  | Range 20-98 years [mean not reported](51) | HADS-A >7 | 1 month1 year | 10794 | 35 (26–44)32 (24 - 42) |
| Donnellan, 2016, Bahrain | Hospital/cohort/all consecutive/NR | I: ≥18 years, first or recurrent stroke, ability to participate in interview, FAST ≥14E: TIA or related syndromes, aphasia, medically unstable, vascular dementia or pre-stroke cognitive impairment, TBI or traumatic intracranial or subarachnoid haemorrhage, visual or hearing impairment, neurodegenerative disease | 61 years (67) | HADS (cut off NR) | 1-2 weeks | 64 | 27.0 (16.1, 37.9) |
| Elf, 2016, Sweden | Hospital/cohort/all patients/2006-2007 | I: living in community three months post-stroke E: NR | 62 years (56) | HADS-A >4 | 6 years | 102 | 36.3 (26.9, 45.6) |
| Field, 2008, UK | Hospital / cross-sectional / all patients meeting criteria | E: cognitive impairment, aphasia, acute medical problems | 72 years (53) | HADS-A >10 | <1 month | 81 | 21 (12–30) |
| Fure, 2006, Norway | Hospital / cross-sectional / consecutive / 2000-2002 | I: stroke (CT)E: TIA, moderate to severe aphasia, consciousness | 69 years (63) | HAD-A >7 | 1 week | 178 | 26 (20–33) |
| Galligan, 2016, Ireland | Mixed (clinic, hospital, and support group)/cross-sectional/NR/NR | I: ≥18 years, stroke (WHO) between one month and two years agoE: significant cognitive impairment, moderate to severe communication difficulties, major comorbid medical difficulties or acute health difficulties | 65 years (71) | HADS (cut off NR) | NR | 98 | 36.7 (27.2, 46.3) |
| Gangstad, 2009, UK | Rehabilitation/ cross- sectional/allpatients attending clinicapproached meetinginclusion/ NR | E: Cognitive impairment | NR (NR) | HADS-A>10 | 14 months | 15 | 6·7 (0–19) |
| Ghika-Schmid, 1999, Switzerland | Rehabilitation/cross- sectional/consecutive / NR | I: First-ever stroke only (CT or MRI) | 60 years (NR) | HAM-A>14 | 3 months  | 31 | 29 (13–45) |
| Giaquinto, 2007, Italy | Rehabilitation/ cross-sectional/consecutive/2004–2005 | I: First-ever stroke (CT or MRI)E: TIA, SAH, previous stroke butnot TIA, admission to rehab>three-week poststroke, severecomorbidity, mental orcomprehension impairment | 70 years (46) | HADS-A >5 | 10 days | 132 | 42 (33–50) |
| Gillespie, 1997, UK | Community/ cross-sectional/ mail-out to dischargedpatients/ NR | I: Stroke (WHO)E: Communication difficulties, cognitiveimpairment, significant comorbidity, recentmajor life event unrelated to stroke | 69 years (66) | HADS-A >8 | 7 months  | 44 | 25 (12–38) |
| HSRS, 1999, Japan | Community / cohort / registry / 187 | I: all strokes | 66 years (64) | GHQ-60 > 4 out of 7 on anxiety subscale | 2.5 years | 66 | 43 (29–57) |
| Huzmeli, 2017, Turkey | Hospital/cross-sectional/all patients/NR | I: all patients with hemiplegic symptomsE: NR | 61 years (73) | GAD-7 ≥15 | 6 months to 5 years  | 30 | 33.3 (16.4, 50.2) |
| Ibrahimagic, 2005, Bosnia and Herzegovina | Hospital / cohort / consecutive / NR | I: Ischaemic stroke (CT) and able to complete self-report questionnaire  | 65 years (50) | Zung ≥50 | 2 days2 weeks | 4040 | 30 (16–44)25 (12–38) |
| Ibrahimagic, 2013, Bosnia and Herzegovina | NR/cross-sectional/NR/NR | I: stroke (CT)E: NR | 65 years (50) | Zung SAS ≥50 | Acute | 40 | 30.0 (15.8, 44.2) |
| Jones, 2012, Tanzania | Community/cohort/all patients/2003-2007 | I: first of recurrent stroke (WHO)E: neurological deficit cause by infection or space-occupying lesion | 67 years (48) | HADS-A >7 | 36 months (range 6-60) | 51 | 21.6 (10.3, 32.9) |
| Kim, 2017, South Korea | Rehabilitation/cohort/NR/NR | I: ≥18 years, first stroke (clinical presentation and MRI), ICD-10 codes 160-164, satisfactory cognitive function E: MMSE ≤10, MMSE 11-23 with physician confirmation of cognitive incompetence, TIA, severe auditory or visual impairment | 60 years (58) | HADS-A >10 | 1 month | 214 | 20.6 (15.2, 26.0) |
| Knapp, 1998, UK | Hospital / cross-sectional / consecutive / NR | I: stroke within past month, sufficient language and cognition for interview, named carer also willing to participate, living independently pre-stroke | 69 years (53) | HADS-A >7 | < 1 month1 month post-discharge6 months post-discharge | 303030 | 47 (29–65)27 (11–43)30 (14–47) |
| Kootker, 2016, Netherlands | Hospital / cohort/ consecutive / 2011-2013 | I: Diagnosis of clinically confirmed cerebral stroke; aged >=18; sufficient knowledge of Dutch language to complete assessments; within first week post-strokeE: Serious comorbid condition that might influence study outcomes; pre-stroke Barthel Index <=17; pre-stroke Heteroanamnesis List Cognition >=1 | 67 years (65) | HADS-A >7 | 1 year | 395 | 24.0 (19.0, 29.0) |
| Langhorne, 2000, UK | Rehabilitation/ cohort/ multi-centreconsecutive/ NR | I: Stroke (WHO) withinseven-days of onset | 76 years (52) | Single question | 6 months post-discharge18 months post-discharge30 months post-discharge | 220181155 | 34 (28–40)44 (37–51)49 (41–57) |
| Li, 2006, China | Hospital / cross-sectional / random selection / 2000-2002 | I: Cerebral infarction | 53 years (53) | HADS-A >9 | NR | 91 | 31 (21–40) |
| Lincoln, 1998, UK | Community/ cross-sectional/ 74GP practices/ 1994–1996 | I: Stroke (WHO) | 76 years (67) | HADS-A >10 | 1 month | 84 | 26 (17–36) |
| Lincoln, 2013, Belgium, UK, Switzerland & Germany | Rehabilitation/cohort/consecutive/NR | I: age 40-85, first strokeE: admitted >6 weeks after stroke, comorbid neurological impairments, poor prestrike functional ability (BI <50)  | 68 years (54) | HADS-A >7 | 6 years | 220 | 29.0 (23.0, 35.0) |
| Liu, 2018, China | Hospital/cross-sectional/consecutive/2013-2014 | I: 18-80 years, admitted with seven days of first or recurrent stroke, absence of thrombolysis or interventional therapy; CAT, SOD, and MDA measured on admissionE: previous history or family history of psychiatric disorders, severe aphasia or dysarthria, significant physical illness (listed), history of antipsychotic medication or vitamins,  | 64 years (65) | HAMA >7 | 1 month | 203 | 24.0 (18.1, 29.9) |
| Macniven, 2005, UK | Rehabilitation/ cross-sectional/two-week audit of allpatients on ward/ NR | E: Language problems | 68 years (47) | HADS-A >7 | 58.5 days | 57 | 65 (42–87) |
| Masskulpan, 2008 &Kuptniratsaikul, 2009, Thailand | Rehabilitation/ cohort/ national registry / 2006 | I: Adult stroke patientsE: Severe medical comorbidities,inability to communicate,dementia, schizophrenia orpresent psychotic episode | 62 years (59) | HADS-A >10 | 24 days2 months | 327251 | 5·8 (3·3–8·4)26 (20–31) |
| Mellon, 2013, Ireland | NR/cohort/consecutive/NR | NR | NR | HADS (cut off NR) | 6 months | 256 | 32.0 (26.3, 37.7) |
| Merriman, 2007, UK | Hospital / cross-sectional / in-hospital and postal mail-out to discharged patients / NR | I: adults & 1-12 months post-stroke, able to complete self-report questionnaireE: dysphasia, acute medical problems | 74 years (56) | HAD-A > 10 | 1-12 months  | 102 | 20 (12–27) |
| Mihalov, 2016, Slovakia | Hospital/cohort/consecutive/2013-2014 | I: NRE: persistent severe aphasia or cognitive deficit, using antidepressants for >6 months | 68 years (64) | HADS-A >7 | 6 months | 47 | 17.0 (6.3, 27.7) |
| Moon, 2004, South Korea | Hospital / cross-sectional / consecutive / 2002 | I: stroke (MRI) | NR (62) | BAI>21 | 2 months  | 69 | 49 (37–61) |
| Morrison, 2000 & 2005, UK | Hospital / cohort / patient admitted to hospital / NR | I: residual disability, pass screening test for cognitive & communicative problems  | 69 years (51) | HADS-A>10 | <1 month2 months6 months3 years | 101787138 | 24 (15–32)21 (12–29)23 (13–32)26 (12–40) |
| Mulroy, 2012, NR | NR/cross-sectional/NR/NR | I: cognitively intact, mRS <3E: NR | 68 years (61) | HADS-A >7 | NR | 94 | 14.9 (7.7, 22.1) |
| Mutai, 2017, Japan | Hospital/cross-sectional/NR/2012-2013 | I: ischaemic or haemorrhagic stroke (clinical or radiological findings)E: severe confusion, severe aphasia, severe moto complications with immobility | 74 years (66) | HADS-A >10 | 2 weeks | 101 | 24.7 (16.3, 33.1) |
| Nakling, 2017, Norway | Hospital/cohort/all patients/2008-2011 | I: stroke (MRI/CT), home-dwelling, NIHSS 2-26 or <2 with mRS ≥2 E: severe psychiatric illness, alcohol or substance abuse, serious conditions interfering with rehabilitation process, insufficient knowledge of Norwegian language  | 69 years (58) | HADS-A >7 | 1 year | 105 | 13.6 (7.0, 20.2) |
| NEMSIS, 2004, Australia | Community / cohort / ideal case finding method | I: first and recurring stroke (WHO, CT or MRI) | Unclear | IDA-A (score 9-15) | 3 months1 year2 years5 years | 475498201424 | 13 (10–16)10 (7–13)11 (6–15)8·5 (6–11) |
| Nijesse, 2017, Netherlands | Hospital/cross-sectional/NR/2011-2013 | I: ≥18 years, stroke (clinically confirmed) in previous seven daysE: other serious condition expected to interfere with study outcomes, BI <18, insufficient Dutch language ability, ≥1 on HLC pre-stroke  | 67 years (64) | HADS-A >7 | 2 months | 350 | 20.4 (16.2, 24.6) |
| Ojagbemi, 2017, Nigeria | Hospital/cross-sectional/consecutive/NR | I: stroke (neuroimaging and clinical examination)E: severe communication difficulties or aphasia, dementia (CSID ≤20), mRS ≥3, significant comorbidity | 57 years (64) | HADS-A >10 | <1 month | 391 | 19.7 (15.8, 23.6) |
| Ponchel, 2016, France | Hospital/cohort/consecutive/NR | I: ≥18 years, admitted for stroke (MRI), MRI within 72 hours of symptom onsetE: prestrike dementia (IQCODE >64); malformed, traumatic, pure-meningeal or intraventricular haemorrhage; patient under legal care of guardianship, contraindicated for MRI, inability to speak and understand French, neurological deficits including aphasia severe enough to impact understanding of questionnaires or tests | 64 years (61) | HAMA >6 | 6 months | 153 | 41.8 (34, 49.6) |
| Raju, 2010, India | Hospital / cross-sectional / patients completing at least 1 month clinical follow-up / 2008-2010  | I: first-ever ischaemic & haemorrhagic stroke (WHO) (CT or MRI), at least 1 month post-strokeE: history of psychoactive substance abuse, dementia, psychiatric comorbidity, aphasia | 54 years (70) | HADS-A>10 | 1.5 years | 162 | 11 (6·3–16) |
| Sampson, 2003, UK | Hospital / case-control / recruit from 6 stroke units / NR | I: Ischaemic or haemorrhagic strokeE: Cognitive impairment, dysphasia, too unwell or with terminal illness, MRSA infection | NR | HADS-A>9 | NR | 69 | 26 (14–38) |
| SELSS, 1997, UK | Community / cohort/ registry / 1989-1990 | I: first-ever stroke in persons <75 including those who did not survive initial event.  | 71 (54) | HADS >9 | 5 years | 96 | 31 (22–41) |
| Sembi, 1998, UK | Rehabilitation/ cross-sectional/recruited from three rehabilitation sites/ 1995–1996 | I: adults, first-ever stroke orTIA, able to complete self-reportQuestionnaireE: Dysphasia | 66 years (NR) | HADS-A >10 | 18 months  | 61 | 15 (5·9–24) |
| Solgajova, 2017, NR | Hospital/cross-sectional/NR/2015-2016 | I: first stroke, lucid consciousness, oriented, informed consent givenE: aphasia | 67 years (60) | HADS-A >7 | NR | 74 | 16.0 (7.6, 24.4) |
| Stojanovic, 2015, Bosnia and Herzegovina | Hospital/cross-sectional/NR/NR | I: first stroke with macroscopic lesions in prosencephalon on CTE: comorbid state (heart decompensation, unstable angina, MI in previous year, infective, malignant, or immunological diseases), NIHSS, >10, moderate to severe dysphasia  | Range 44–87 (50)  | HAMA >13 | NR | 118 | 17.8 (10.9, 24.7) |
| Stone, 2004, UK | Hospital / nested cross-sectional / consecutive / 2004 | E: severe stroke with high risk of death, dementia, aphasia, cognitive impairment, patients living alone, carer unable to talk with researcher | 72 years (49) | HADS-A>7 | 1 month | 89 | 20 (12–29) |
| Tang, 2012, Hong Kong  | Hospital/cohort/all admissions/2004-2009 | I: first or recurrent acute ischaemic stroke with MRIE: history of CNS diseases or dementia, physical frailty, recurrent stroke within follow up period, aphasia, severe auditory or visual impairment, non-Chinese ethnicity or non-Cantonese speaking, MMSE <20, history of anxiety or other psychiatric disorder, history of alcohol or drug abuse | 66 years (61) | HADS-A >7 | 1-5 months | 693 | 6.1 (4.3, 7.9) |
| Tang, 2013, Hong Kong | Hospital / cross-sectional / consecutive / 2008-2011 | I: Chinese ethnicity; Cantonese as primary language; adult; confirmed stroke (CT) within 7 days of admission. E: TIA, SAH CH or SDH; history of other CNS condition; MMSE <20; aphasia; physical frailty; severe auditory or visual impairment; recurrent stroke.  | 66 years (59) | HAD-A >7 | 3 months | 374 | 23.0 (18.7, 27.3) |
| Townend, 2007, Australia | Hospital / cohort / consecutive / NR | I: Ischaemic or haemorrhagic strokeE: dysphagia, MMSE<20, reduced level of consciousness | 76 years (49) | HADS-A>8 | 5 days1 month3 months | 125112105 | 4·8 (1·1–8·6)8·0 (3·0–13)14 (7·6–21) |
| Vicentini, 2017, Brazil | Hospital/cross-sectional/NR/2014-2015 | I: 45-80 years, first ischaemic stroke (CT)E: severe aphasia or dysarthria, history of psychiatric or neurological disorders | NR | BAI >11 | Acute | 37 | 11.8 (1.4, 22.2) |
| Vickery 2006, USA | Rehabilitation/ cross-sectional/ sampleof admitted patients/ NR | I: StrokeE: history of comorbid dementia, Non-stroke neurological process, acute delirium, severe psychiatric disturbance | 69 years (45) | AMAS >64 | 20 days | 141 | 7·8 (3·4–12) |
| Visser-Keizer, 2002, Netherlands | Community/ cross-sectional/ 350GP clinics/ NR | I: First-ever ischemic stroke (CT)E: neurologic or psychiatric history, history of alcohol or drug abuse, insufficient language and cognitive ability for assessment, aphasia | 67 years (59) | HADS-A >5 | 3 months | 113 | 14 (7·7–21) |
| Vuletic, 2011, Croatia | Hospital/cross-sectional/all patients/2008 | I: first stroke (CT) in previous three monthsE: recurrent stroke, major medical illness, alcohol abuse, decreased level of consciousness, dysphasia, severe cognitive impairment | 62 years (57) | HADS (cut off NR) | 1-5 months | 35 | 37.0 (21, 53.0) |
| Vuletic, 2012, Croatia | Hospital/cross-sectional/all patients/2006 | I: first stroke (CT)E: TIA, previous emotional problems, severe aphasia, clouding of consciousness | 71 years (50) | HADS (cut off NR) | 3-5 days | 40 | 40.0 (24.8, 55.2) |
| Watanabe, 1984, Japan | Hospital / cross-sectional / random selection/ NR | E: aphasia, dementia | 57 years (57) | TMAS | 6 months | 35 | 51 (35–68) |
| Wu, 2017, China | Hospital/cross-sectional/NR/2013-2014 | I: 18-80 years, acute stroke (CT/MRI)E: decreased consciousness, severe cognitive dysfunction, aphasia, dysarthria, history of anxiety or other psychiatric disorders, history of stroke or other CNS disease | 63 years (63) | HAMA >7 | ≤7days | 226 | 26.5 (20.7, 32.3) |
| Zahilic, 2010, NR | NR/cross-sectional/NR/2008-2009 | I: first cerebral stroke E: comorbidity which could influence development of depression, “both cerebral and heart stroke”  | 72 years (55) | HADS-A >7 | NR | 202 | 28.2 (22, 34.4) |
| Zhao, 1999, China | Hospital / cross-sectional / consecutive / NR | I: first-ever stroke (Chinese cerebral vascular disease symposium of 1995 definition)E: aphasia, mental disorder, epilepsy, mental retardation, cerebral trauma | 63 years (61) | Zung SAS>49 | 1 month | 206 | 18 (13–24) |
| Abbreviations: AMT, Abbreviated Mental Test; BAI, Beck Anxiety Inventory; BI, Barthel Index; CAT, catalase; CCND-3, China psychiatric disorders classification and diagnosis standard version 3; CNS, central nervous system; CSID, Community Screening Interview for Dementia; CT, computed tomography used to diagnose stroke; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, 4th Edition; FAST, Frenchay Aphasia Screening Test; GAD-7, General Anxiety Disorder 7-item scale; HADS, Hospital Anxiety and Depression Scale; HAMA, Hamilton Anxiety Rating Scale; HLC, Heteroanamniesis List Cognition; ICD-10, International Classification of Diseases, 10th Edition; IQCODE, Informant Questionnaire on Cognitive Decline in the Elderly; LES, Local Enhanced Service; MDA, malondialdehyde; MINI PLUS, Mini-International Neuropsychiatric Interview-Plus; MMSE, Mini Mental State Examination; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; NPI, Neuropsychiatric Inventory; NR, not reported; SCAN, Schedule for Clinical Assessment 2.1; SCID, Structured Clinical Interview for DSM-IV Disorders; SOD, superoxide dismutase; WHO, World Health Organisation definition of stroke; Zung SAS, Zung Self-rated Anxiety Scale |  |

**Figure 1: Meta-analysis of anxiety prevalence when diagnosed by interview**

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**Figure 2: Meta-analysis of anxiety prevalence when diagnosed by rating scale**

