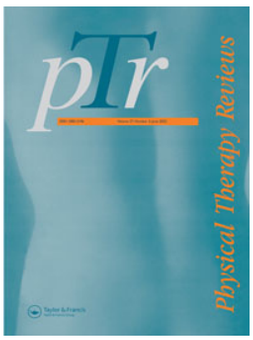

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Risk and associated factors for hemiplegic shoulder pain in people with stroke: a systematic literature review

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ABSTRACT

Introduction: Hemiplegic shoulder pain (HSP) is reported in up to 40% of people with stroke and has been associated with spasticity and glenohumeral subluxation. The frequency of HSP has reduced in the last two decades which is most likely due to improved therapy and nursing care. The aim of this systematic literature review was to explore the risk and associated factors for HSP for studies published between 2005 and 2020.

Methods: A systematic online search was conducted of CINAHL, AMED, MEDLINE and the Cochrane library databases using four key terms (risk factors, hemiplegia, shoulder pain and stroke). The search was supplemented by hand searching of relevant journals and citation tracking of the retrieved papers. All primary studies published in English language fulfilling the review's inclusion criteria were included. Five reviewers extracted the data and independently appraised the methodological quality of the selected studies. Any discrepancies were resolved following discussions.

Results: Of the 50 articles that were identified, 21 studies met the criteria. The common risk factors for HSP were: poor motor function (odds ratio (OR) 0.58–3.19; 95% confidence interval (CI), 1.1–7.7); glenohumeral subluxation (OR 2.48–3.5, 95% CI 1.38–9.37) and reduced range of movement at the shoulder (OR 0.14–4.46, 95% CI 0.99–64).

Conclusion: Despite methodological flaws, complete loss of motor function in the affected arm and glenohumeral subluxation has been recognized as frequently reported risk factors for HSP. Further rigorously designed cohort studies are required to explore the risk factors for HSP.

KEYWORDS

Stroke; hemiplegic shoulder pain; poor motor function; glenohumeral subluxation; reduced range of movement; soft tissue injuries

Introduction

Stroke is one of the largest causes of disability in the western world [1]. Upper limb impairment is a common feature [2] and shoulder problems are the most important component of upper extremity complications [3]. The shoulder is a highly mobile and less stable joint [4] that is vulnerable to a range of post-stroke secondary musculoskeletal complications such as pain, subluxation and restricted joint range of movement [5].

Hemiplegic shoulder pain (HSP) is one of the common medical complications after a stroke [6, 7] with the reported incidence of 1.6 to 40% [8]. HSP is difficult to define and is often used to describe a collection of complex problems and diagnoses [9]. Early occurrence of HSP can have adverse effects on rehabilitation [10] and later, on health-related quality of life [11]. Several causes of HSP have been identified and can be broadly classified into neurological (paralysis, spasticity, altered sensation and neuropathic pain) and mechanical factors (glenohumeral subluxation, rotator cuff injury, muscle imbalance and altered scapula position) [10].

Given the implications of HSP on rehabilitation, recent systematic reviews have focused on the effectiveness of varied treatment approaches including physiotherapy, massage therapy, strapping, slings and other supports to minimize glenohumeral subluxation, and local interventions such as nerve blocks and botulinum toxin type A (BTx-A) intramuscular injections for spasticity [12]. Unfortunately, optimal treatment modalities for various types of HSP remain unclear in the literature [10] and, in practice, linking causation with the most effective intervention/s remains problematic [13].

A better understanding of the multifactorial risk and associated factors for HSP will allow improved management and could potentially aid establishment of early preventative measures for hemiplegic shoulder pain [10]. Two recently published systematic reviews have explored the risk factors for hemiplegic

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shoulder pain [8, 14]. One review [8] focused on incidence and prevalence, however, did not include risk factors in the search terms. Holmes et al. [14] included studies if (a) they were prospective cohort studies, (b) they measured any potential risk factor within the first month after stroke, and (c) they measured pain as a key outcome within 1 year after stroke. Also, both reviews included studies from the date of inception.

In the last two decades, the incidence rate of HSP has reduced [11] in comparison to 16 to 72% in a review published in 2001 [15]. A recent systematic review [8] confirms this decline in incidence rate and one of the potential reason could be due to improved nursing and therapy care. According to a recent UK wide survey of therapists, routine screening for HSP was undertaken by 59 (89%) respondents [16]. Education (positioning, appropriate handling of the affected limb) was provided by 51 (77%) respondents. Therefore, the aim of this systematic literature review was to explore the risk and associated factors for HSP in people with stroke for studies published from 2005–2020.

Methods

Search strategy

The structure of the review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [17]. A systematic literature search was performed using the search platforms Medscape, OT Seeker, OVID online, PEDro, and Science Direct. The databases searched included AMED, MEDLINE, CINAHL and Cochrane library and the grey literature was searched using Google Scholar.

The four key terms included: risk factors, hemiplegia, shoulder pain and stroke. A search string was constructed combining the key terms: 'stroke or cerebrovascular accident or CVA or CVE or hemiplegia' and 'shoulder or glenohumeral or upper extremity or upper limb or arm' AND 'risk' or factor or determinant or cause or predictor or pathogenesis or predispose or associate or 'correlat' or 'etiolog' or incidence or attribute AND range of movement or ROM or spasticity or flexibility or loss of muscle strength or muscle atrophy or severity of stroke or shoulder subluxation' AND 'shoulder pain or frozen shoulder or glenohumeral joint pain or rotator cuff pain or GHJpain'. Truncations specific to the databases were also used to widen the search and to ensure that all forms of searched words were hit by the search engine. Finally, reference lists of relevant articles were scanned to identify further relevant studies that had not been identified by the initial search.

Articles were selected based on the following inclusion criteria: (1) Studies published between 2005 and 2020, (2) published in the English language, (3) cohort (prospective, retrospective), case-control and cross-sectional studies, (4) all stroke types, (5) any care settings. Studies which had participants below the age of 18 and non-stroke conditions were excluded. Case reports and case series were also excluded as these types of studies might have a high potential for bias.

Study selection process

Five researchers were involved in the study selection process. The title and abstract of each study were read independently by all the researchers to determine relevance. Relevant full papers were then independently scrutinized to check for the eligibility criteria and to confirm final inclusion of the articles into the review. Any discrepancies were discussed until consensus was reached and where appropriate an independent scrutiniser was involved and only the articles deemed relevant by all the research group members were included for the review purpose.

Quality assessment

To select the quality appraisal tool, each reviewer independently critiqued a randomly selected article (not included in the final review) using widely recognised tools such as Critical Appraisal skills programme (CASP) [18], the Scottish intercollegiate Guidelines Network (SIGN) [19] and the Joanna Briggs Institute Critical Appraisal tool [20]. The Joanna Briggs institute critical appraisal tool was finally selected after group discussion. The methodological quality of each of the selected studies was independently appraised by each reviewer. Any discrepancies were discussed until consensus was reached.

Results

The database search returned 195 studies with a title that related to shoulder pain in people with stroke. There were no articles returned from the Cochrane database and Google Scholar. A further 12 potential articles were identified by searching the reference lists of articles. Of these, 50 potential studies were obtained and scrutinized of which 21 [11, 21–40] met the selection criteria. Figure 1 summarizes the results of the search strategy, including the reasons for exclusion of studies from the review.

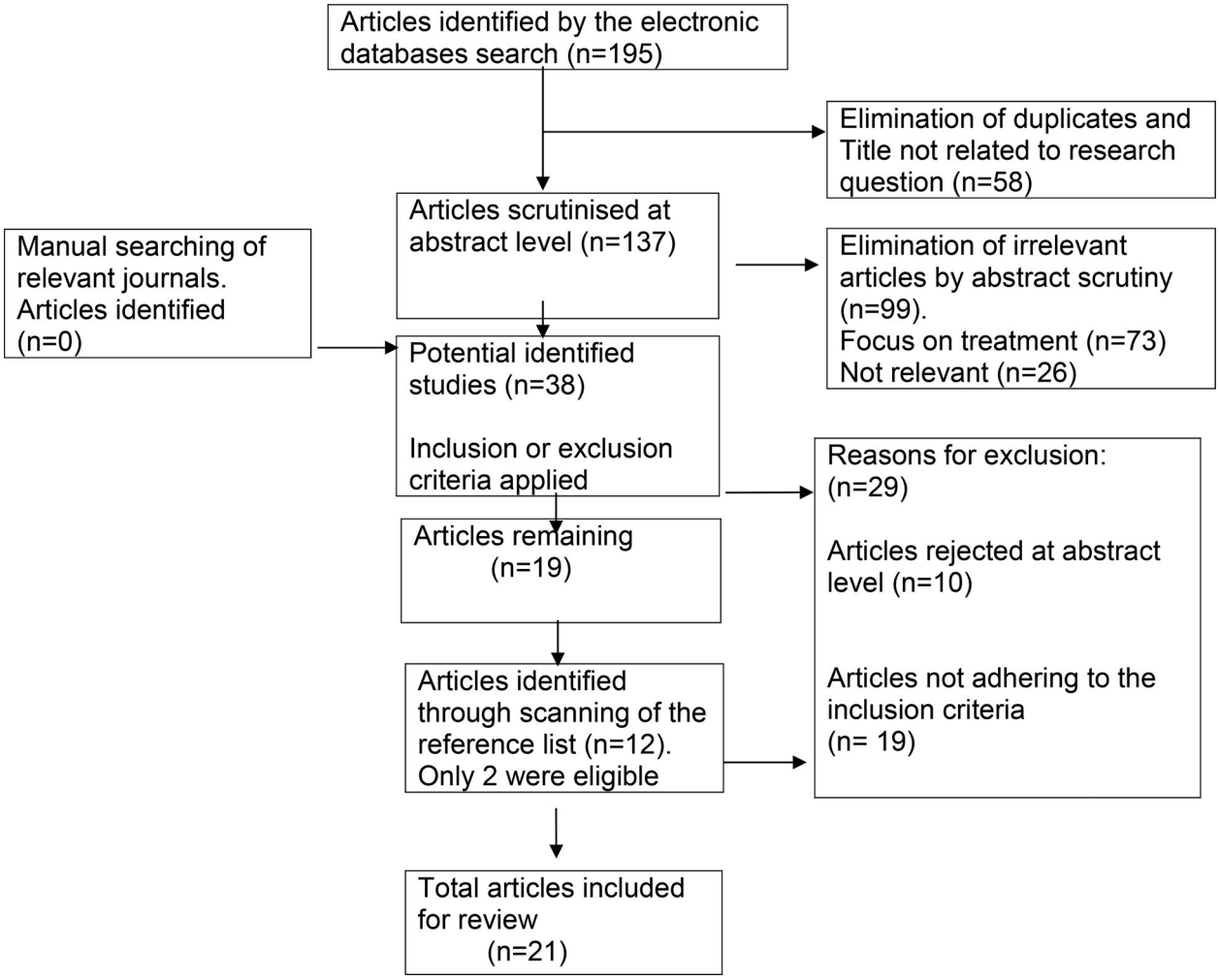

Figure 1. Flow chart depicting the inclusion of studies for the review.

Description of the studies

The research designs varied considerably across the studies. Seven studies used a cohort design [11, 22, 23, 25, 33, 34, 36], six used a case-control design [21, 24, 30–32, 37], another six used a cross-sectional design [26, 27, 29, 35, 38, 40], and two others used a retrospective design [28, 39].

Participants

Although all 21 studies included patients with stroke, several studies did not specify the type of stroke (infarction or haemorrhage). The time since onset of stroke varied from one week to 82 weeks. The time of follow up across the included cohort studies ranged from four to 70 weeks. The age of the patients ranged from 18 to 102 years across the studies and the mean age varied considerably: between 50–59 years in six studies, 60 and 65 years in 9 studies, 66–70 in three studies and 71–74 years in three studies. All studies had strict inclusion criteria, but the criteria varied considerably across the studies. Sample size varied considerably with the largest sample consisting of 416 patients [22] and smallest consisting of nine [32].

Methodological quality

The methodological quality of the studies varied considerably and some of the studies had serious methodological flaws (Table 1). Six out of 21 studies had a sample size ranging from 100–400, but the remaining had a sample size ranging from 9 to 72 and none of the studies provided justification for this. Furthermore, several studies did not state clear participant recruitment criteria, did not justify the rationale for their study design and did not administer appropriate statistical tests; only six studies reported odds ratio [11, 23, 28, 34, 36, 37] and three [21, 22, 25] used logistic regression analysis to identify risk factors. Although most studies specified the outcome measures used, only two [31, 36] reported using blinding assessment procedures.

Outcome measures

A wide range of outcome measures were used in the studies reviewed. Upper limb motor recovery was assessed by Brunnstrom's motor arm score [23, 24, 26, 27, 29, 33, 36, 37, 39], upper limb motor function (question 5) from the National Institute of Health Stroke Scale (NIHSS) [11, 22, 36].

Table 1. Quality assessment of included studies in the order of publication.

Author and year	Sample size justified	Were the patients demographics clearly described?	Appropriate inclusion/ exclusion criteria	Appropriate outcome measures	Were there methods to minimize bias?	Were confounding factors identified?	Appropriate statistical analysis	Were the results of this study directly applicable to the patient group targeted?
Paci et al. (2007) [21]	No	Yes	Yes	Yes	Unclear	Yes	Yes	Yes
Lindgren et al. (2007) [22]	No	Yes	No	Yes	Yes	Yes	No	Yes
Suethanapornkul et al. (2008) [23]	No	Yes	Yes	Yes/no	Unclear	No	Yes	Yes
Niessen et al. (2008) [24]	No	Yes	No	Yes	Unclear	Unclear	No	Unclear
Hadianfard and Hadianfard (2008) [25]	No	No	No	Yes	No	No	Yes	Yes
Barlak et al. (2009) [26]	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Lee et al. (2009) [27]	No	No	No	No	No	No	No	Yes
Blennerhassett et al. (2010) [28]	No	Yes	No	Unclear	No	No	Yes	Yes
Huang et al. (2010) [29]	No	Yes	Yes	Yes	No	Unclear	Yes	Yes
Távora et al. (2010) [30]	No	Yes	Yes	Yes	Unclear	Yes	No	Yes
Pompa et al. (2011) [31]	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Hardwick et al. (2011) [32]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lindgren et al. (2012) [33]	No	Yes	No	Yes	No	Unclear	Yes	Yes
Pong et al. (2012) [34]	No	Yes	Yes	Yes	Yes	No	No	Yes
Zeilig et al. (2013) [35]	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Kim et al. (2014) [36]	No	Yes	No	Yes	No	No	Yes	Yes
Karaahmet et al. (2014) [37]	No	Yes	Yes	Yes	No		No	Yes
Adey-Wakeling et al. (2015) [11]	No	Yes	Unclear	Yes	Yes	Yes	Yes	Yes
Zeilig et al. (2016) [38]	No	Yes	Yes	Yes	Yes	No	Yes	Yes
Lin (2018) [39]	No	Yes	No	Yes	No	Yes	No	Yes
Hadianfard and Hadianfard (2018) [40]	No	No	Yes	Yes	No	No	Yes	Yes

Assessment methods used to assess GHS included radiographic measures [26, 30, 36], and clinical palpation method [21–23, 28, 29, 33, 34, 37]. Passive range of movement (PROM) at the shoulder was assessed using goniometery in two studies [25, 28, 34], while other studies did not specify. Soft tissues in the shoulder were evaluated using sonography [27, 29, 33, 36, 39], and magnetic resonance imaging [30]. The Modified Ashworth Scale (MAS) was used to assess muscle tone [23, 24, 26, 29, 32–39]. To quantify movement of the shoulder, arm and thorax, an electromagnetic tracking device was used in one study [24] and a computer-based kinematic technique was used in another study [32].

Similarly, a wide range of assessment methods were used to identify HSP. The majority of the studies used vertical visual analogue scale (VAS), however, eight of these used 0–10 scale [25, 29, 31, 37, 40], while three studies used 0–100 scale [11, 22, 26, 34]. Other assessment approaches included numerical rating scale (NRS) [32, 36], pain on rest and during passive movement recorded as present or absent [21, 29, 30, 37], and three studies did not specify [23, 27, 39].

Study results

A variety of risk and associated factors were identified in the included studies (Table 2). The most frequent risk factors for HSP were poor arm motor function [11, 22, 28, 36, 37], glenohumeral subluxation [21, 23, 36], reduced passive range of movement at the shoulder flexion [28], and shoulder abduction [34].

In one of the largest longitudinal studies of 226 patients, absence of arm motor function was strongly associated with the risk of HSP (odds ratio (OR) 3.19; 95% confidence interval (CI), 1.77–6.9) [11]. Similar findings were reported by another longitudinal study of 51 patients that found poor arm motor function as indicated by a poor NIHSS item 5 score (OR = 3.0; 95% CI, 1.1 to 7.7) was a risk factor for HSP [36]. The findings support those of other prospective [22], case-control [37], and retrospective [28] studies that found that poor initial motor function was an independent factor associated with HSP.

Of the studies that identified a link between GHS and HSP, one of the largest prospective studies of 327 patients reported an odds ratio (OR) of 2.48 (95% confidence intervals, 1.38–4.46) suggesting GHS as a potential risk factor for HSP [23]. Similar findings were reported by a longitudinal study that reported an OR = 3.5; 95% CI = 1.4–9.3 at baseline and OR = 2.6; 95%CI = 1.0–6.6 at follow-up [36]. Similarly, a case–controlled study of 107 stroke patients reported that that HSP was significantly higher in the subluxed group and that GHS was independently associated with HSP at follow-up ($R^2 = 0.458$; $p < 0.001$) [21]. The findings support those of several other longitudinal [22], cross-sectional [38], studies which found an association between GHS and HSP. However, two studies [26, 37] reported GHS was not independently associated with HSP.

Reduced ROM was reported as a risk factor for HSP. Decreased passive abduction at 4 months (OR 4.46; 95% CI 0.99–20.10) was reported as a significant risk factor in a prospective study [32]. Similarly, in a retrospective study [28], reduced passive shoulder flexion ROM was found as a risk factor (OR = 0.14, 95% CI 3 to 64) for HSP.

The other risk factors were soft tissue injuries (bicipital tendonitis and rotator cuff tears) [36], premorbid shoulder pain [11], left-sided hemiparesis [34], frequency of pain [34], longer duration of disease [37], late initiation of rehabilitation [37], adhesive capsulitis [36], complex regional pain syndrome (CRPS) [26], positive baseline objective assessments (passive external rotation, hand behind neck, the modified Neer test) [11], increased light touch and vibration threshold [25]. In addition, other factors associated with HSP were: spasticity [29, 33, 38] diabetes mellitus [40], self-perceived ill health [22, 25] reduced external rotation ROM at shoulder [29, 32], loss of proprioception [29], and higher pain thresholds [35, 38].

Discussion

The aim of this systematic literature review was to explore the risk and associated factors for HSP for studies published between 2005 and 2020. The most frequently reported risk factors were poor arm motor function, glenohumeral subluxation, and reduced passive range of movement. The other associated factors were adhesive capsulitis, soft tissue injuries, spasticity, higher pain thresholds and self-perceived ill-health.

Five studies reported that patients with poor or reduced arm motor function had a significantly greater risk of developing HSP on the stroke affected side [11, 22, 28, 36, 37]. However, the time points when this was measured varied considerably across the studies. Irrespective of that, the loss of motor function could alter the kinetics and kinematics around the shoulder complex. The suboptimal performance of scapula kinesis and the reduced control of forces around the humeral head on the glenoid has the potential to lead to harmful effects on anatomical structures around the shoulder [41]. Post-stroke loss of motor function can lead to

Table 2. Summary of included studies in the order of publication.

Authors/study design/Country	Research aim	Participants	Time since onset of stroke	Follow-up	Inclusion/ Exclusion criteria	Outcome measures	Key reported Findings including statistical analysis
Paci et al. (2007) [21] Case-control study *Italy*	To investigate the relationship between GHS and HSP within 3 months of stroke	$N = 107$, Subluxed group $= 52$, mean age: 71 years $M = 26$, $F = 26$ $L = 33$, $R = 19$ Non-subluxed group $= 55$, Mean age:72 years $M = 27$, $F = 28$ $L = 30$; $R = 25$	Mean 2.5 weeks (both groups)	4–5 weeks following discharge	Inclusion: (1) first and recent stroke (<30 days); (2) no previous shoulder damage; (3) no severe aphasia; (4) no severe cognitive impairment	Pain: On movement (flexion/Abduction/ internal/external rotation) and on rest (sitting position) Subluxation: palpation	Incidence of HSP significantly higher in subluxed group ($p = 0.001$). **Risk factor:** GHS was independently associated with HSP ($R^2 = 0.458$; $p < 0.001$) (Multiple regression analysis)
Lindgren et al. (2007) [22] Prospective cohort study *Sweden*	To investigate the predictors of shoulder pain in patients with first-ever stroke	$N = 416$; HSP $n = 71$ $M = 45$, $F = 26$, mean age $= 72$ yrs $I = 65$; $H = 6$ Non-HSP $n = 256$ $M = 150$, $F = 106$ mean age $= 73$ yrs $I = 227$, $H = 28$ Undefined $= 1$	16 weeks (first follow-up assessment Assessed $n = 305$	64 weeks, 2nd follow-up assessment	Inclusion: 1st stroke confirmed by CT. Exclusion: not stated	Pain: VAS (0–100). GHS: palpation Motor Assessment Scale NIHSS	**Risk factors: (Logistic regression analysis):** At follow-up 1: (1) Low general health status at baseline (NIHSS) ($p = 0.008$). (2) Loss or reduction of arm motor function at baseline (NIHSS item 5) ($p = 0.03$) At follow-up 2. Loss or reduction of arm motor function at baseline ($p = 0.001$). **Association: ($p < 0.001$)** GHS, Sensory disturbance for light touch; self-perceived ill health
Suethanapornkul et al. (2008) [23] Prospective cohort study *Bangkok*	To determine the occurrence of shoulder pain and subluxation after stroke and identify associated factors.	$N = 327$, $M = 193$, $F = 134$, mean age $= 62$ yrs (range 21–93 years). $L = 176$, $R = 142$, bilateral $= 7$ $I = 235$, $H = 92$	Mean 12 weeks	44 weeks	Inclusion: stroke, aged. 18 years, follow one-step command, able to sit for 30 min. Exclusion: severe medical conditions, communication problems, dementia or any psychiatric problem	Subluxation: palpation. Pain: not specified MAS Brunnstrom's stages. 5 point Thai Mental State Examination Barthel Index	**GHS:** 122/327 (37.3%). **HSP:** 62 patients (19%) **Risk factor** GHS (OR:2.48, 95% CI:1.38–4.46, $p < 0.05$) Duration after stroke onset (days) $>$ 180 (OR:4.00, 95% CI:2.06–7.79, $p < 0.05$)
Niessen et al. (2008) [24] Case-control study *The Netherlands*	To identify a possible relationship between post-stroke shoulder pain, scapula resting position and Shoulder motion.	$N = 27$ With HSP $n = 13$ ($M = 10$, $F = 3$) Mean age $= 59$ years, $L = 10$, $R = 3$ Without HSP 14 ($M = 7$; $F = 7$) Mean age $= 57$ yrs $L = 5$, $R = 9$, Healthy control $N = 10$, age $= 49$ yrs	HSP group 14.4 weeks Non-HSP group 13.0	N/A	Inclusion: First stroke, no history of shoulder complaints prior to the stroke. Able to perform all the required physical, cognitive and communicative tests for this study.	Pain: VAS MAS Brunnstrom's motor stage An electromagnetic tracking device for shoulder kinematics. Passive and Active elevation	**Associated factors:** More lateral rotation of the scapula (at rest, during abduction and flexion) in people with HSP compared to control participants ($p = 0.0$) but not when compared to patients without HSP ($p = 0.25$) Shoulder elevation was decreased in HSP patients during passive abduction compared to controls and non-HSP participants (both $p = 0.03$).
Hadianfard and Hadianfard (2008) [25] Prospective Cohort	To explore the factors that predict HSP	$N = 152$ ($M = 75$, $F = 77$. Mean age $= 61$ yrs	Not specified	Every 8 weeks for 52 weeks	Patients with CVA and history of shoulder pain on the affected side > 5 on VAS	Pain–VAS (0–10) ROM-goniometer Kenny Self-Care Evaluation	**Risk factors: logistic regression** 1. ADL ($R = 0.31$, $p = 0.0001$) 2. Increased light touch threshold ($R = 0.16$, $p = 0.009$) 3. Increased

(*continued*)

Table 2. Continued.

Authors/study design/Country	Research aim	Participants	Time since onset of stroke	Follow-up	Inclusion/ Exclusion criteria	Outcome measures	Key reported Findings including statistical analysis
study *Iran*						Nottingham Sensory Assessment Scale Light touch threshold Vibration threshold	vibration threshold ($R = 0.13$, $p = 0.024$) **Associated factors:** (1) ADL disability(ph$i = 0.884$;$p < 0.001$); (2) Anxiety ph$i = 0.277$, $p = 0.001$); (3) Decreased motivation for rehabilitation (ph$i = 0.626$, $p = 0.0001$); (4) Depression (ph$i = 0.259$, $p = 0.001$); (5) Communication disorder (ph$i = 0.465$, $p = 0.0001$); (6) Age (ph$i = 0.385$, $p = 0.0001$)
Barlak et al. (2009) [26] Cross-sectional study *Turkey*	To investigate the causes of HSP, and identify its correlation with functional outcomes	$N = 187$,with HS$p = 114$; mean age 62 yrs, $M = 61$, $F = 53$, $I = 85$, $H = 29$; $R = 53$, $L = 61$ Without HS$p = 73$; mean age 60 yrs, $M = 31$, $F = 42$, $I = 53$ $H = 20$; $R = 41$, $L = 32$	Mean 17.7 weeks (with HSP); mean 12.6 weeks (without HSP)	N/A	Inclusion: 1st and unilateral stroke. Exclusion: history of shoulder pain and trauma before stroke	Pain: VAS (100 points). GHS: AP radiographs, Brunnstrom's stages. 5 point MAS	**Associated factors:** Adhesive capsulitis ($p = 0.01$) and CRPS type 1 ($p = 0.001$). No correlation between HSP and GHS, spasticity, impingement syndrome or thalamic pain.
Lee et al. (2009) [27] Cross-sectional study *Korea*	To evaluate the relationship between the sonographic findings, HSP and the motor recovery stages	$N = 72$ Age—mean age, 60 years (23–78yrs), $M = 46$, $F = 26$ $I = 49$, $H = 23$ $L = 38$, $R = 34$	12.1 weeks (range, 2.2–64 weeks).	N/A	Inclusion: Patients with stroke Exclusion: hemiplegia other than CVA, with shoulder dislocation as seen on radiographs.	Pain—Not specified Brunnstrom stages of motor recovery Sonography of the shoulder	**Associated factors:** Abnormal sonographic findings in participants with HSP were higher compared to those without HSP ($p = 0.007$). No correlation between the grade of sonographic findings and the Brunnstrom stages ($p = 0.183$)
Blennerhassett et al. (2010) [28] Retrospective study *Australia*	To determine factors that predict HSP during inpatient rehabilitation	$N = 94$; HSP group $N = 33$, $M = 22$, $F = 11$, mean age 54 yrs; $I = 27$, $H = 6$ $L = 16$, $R = 15$, bilateral $= 2$ Non-HSP group $N = 61$, $M = 39$, F22, mean age—63 yrs $I = 47$, $H = 14$; $L = 35$, $R = 19$, bilateral = 7	3 weeks	N/A	Inclusion: Patients with stroke	Passive ROM—a goniometer or Visual; sensation GHS-palpation HSP–ADL's or analgesia Motor Assessment Scale	**Risk factors:** (1) Reduced passive shoulder flexion (OR = 0.14, 95% CI 3 to 64) (2) Motor Assessment Scale Upper Arm item score (OR = 0.64, 95% CI 43 to 96).
Huang et al. (2010) [29] Cross-sectional Study *Taiwan*	To investigate correlation between HSP and the physical findings of hemiplegic shoulder	$N = 57$ The PMF group $N = 34$, ($M = 19$, $F = 15$; mean age 60 yrs; $I = 24$, $H = 10$, $L = 21$, $R = 13$ GMF group: $n = 23$ $M = 15$, $F = 8$; mean	3 weeks (PMF group); 2.6 weeks (GMF group)	4.4 weeks (PMF group); 4 weeks (GMF group)	Inclusion: 1st and unilateral stroke Exclusion: history of rotator cuff injuries or shoulder pain, frozen shoulder, shoulder surgery, cognitive impairment,	Pain: VAS 10-cm) at rest/ passive ROM GHS: palpation Shoulder Sonography Brunnstrom's motor recovery stages, MAS proprioception, pin-prick and light touch	**Associated factors**: ($p < 0.05$) (1) Loss of proprioception (2) Spasticity (3) GHS, (4) Shoulder internal and external rotation (5) Brunnstrom motor recovery stages

(*continued*)

Table 2. Continued.

Authors/study design/Country	Research aim	Participants	Time since onset of stroke	Follow-up	Inclusion/ Exclusion criteria	Outcome measures	Key reported Findings including statistical analysis
		age 65 yrs *I* = 18, *H* = 5 *L* = 16, *R* = 7			neuromuscular disorders		(6) Soft tissue injuries Moderate correlation between above variables and VAS scores of HSP ($r = 0.34–0.65$; $p < 0.01$)
Távora et al. (2010) [30] Case-control *Brazil*	To evaluate the magnetic resonance imaging (MRI) findings in people with HSP	With HS*p* = 45 *M* = 25, *F* = 20, Mean age = 61 yrs Without HS*p* = 23 *M* = 12, *F* = 11Mean age 64 years.	Mean 68 weeks for both groups	N/A	Inclusion: First CVA confirmed with CT, HSP triggered by passive motion	Pain: HSP sustained on passive motion MRI of the shoulder GHS: AP radiographs	**Associated factors:** Adhesive capsulitis ($p < 0.001$)
Pompa et al. (2011) [31] Case-control study *Italy*	To identify possible predisposing factors for HSP and to evaluate its impact on motor recovery.	**HSP, *n* = 25** *M* = 21, *F* = 4, mean age—62 yrs, *I* = 21, *H* = 4, *L* = 14, *R* = 11 **Non-HSP, *n* = 16** *M* = 6, *F* = 10, mean age—58 yrs, *I* = 13, *H* = 3, *L* = 10, *R* = 6	4 weeks both groups	N/A	Inclusion: first stroke Exclusion: Patients with DM, shoulder trauma, cervical disk disease and thyroid disease, thalamic pain, unable to provide consent	VAS Barthel Index Rivermead mobility index US-soft tissue MRI GHS-Palpation Blind assessors	**Associated factors:** Adhesive capsulitis ($p < 0.003$; rho = 0.476)
Hardwick and Lang (2011) [32] Case-control study *USA*	To explore the relationships between pain and scapular and humeral movement patterns	HS*p* = 9 *M* = 5, *F* = 4 Mean age—56yrs Healthy control*s* = 12 *M* = 7, *F* = 5 Mean age—54yrs	28 weeks	N/A	Inclusion: (1) diagnosis of stroke, (2) onset of HSP following their stroke, (3) able to move the affected limb against gravity. Exclusion: (1) history of shoulder pain, (2) unable to provide consent.	NPRS–pain at rest and on movement MAS SPDI Hand Function subscale. Computer-based kinematic techniques	**Associated factors:** (1) Reduced external rotation ($p = 0.003$) (2) Inverse relationship with upward scapular rotation ((r = −0.84, $p < 0.05$)
Pong et al. (2012) [33] Prospective cohort study *Taiwan*	To investigate the correlation between HSP and physical findings, to analyse soft tissue injuries during both acute and chronic stages of stroke.	*N* = 76 *M* = 46, *F* = 30 Mean age 60 (range 30–87 years)	Acute stage 6.3 weeks Chronic stage—31 weeks	6 months after discharge	Inclusion: first stroke resulting in unilateral hemiplegia Exclusion: cognitive Impairment (2) history of shoulder injuries, or shoulder surgery; frozen shoulder; and any neuromuscular disorders	VAS; Brunnstrom's motor recovery stages, MAS; Shoulder ROM; Sensation (proprioception, pinprick, and light touch); GHS-palpation Sonography	**Associated factors:** (1) Shoulder motor function level ($r = −0.30$; $p = 0.01$); (2) Shoulder ROM limitation ($r = −0.25$ to $−0.57$; $p < 0.01$) (**Acute Phase** and **Chronic Phase**); (3) Shoulder spasticity ($r = 0.28$; $p = 0.02$); (4) Bicipital tendinopathy ($r = 0.24$; $p = 0.03$); (5) Supraspinatus tendinopathy ($r = 0.25$; $p = 0.03$) (**Chronic phase**)
Lindgren et al. (2012) [34] Prospective cohort study *Sweden*	To assess factors at 4 months after stroke predict shoulder pain 1 year later.	*N* = 58, **HSP, *n* = 42,** *M* = 25, *F* = 17, mean age 74 yrs *I* = 39, *H* = 3 *L* = 29, *R* = 13 **Non-HSP**, *n* = 16, *M* = 12, *F* = 4, mean age—65 yrs	16 weeks	70 weeks	Inclusion: sensory-motor dysfunction function in UE at stroke onset and HSP 4 months after stroke onset Exclusion: not stated	VAS—0 to 100 mm Passive ROM—Goniometer MAS, Motor Assessment Scale for motor function. GHS-Palpation	**Risk factors: (Logistic regression)** 1) Left-sided hemiparesis at stroke onset ($p = 0.01$; OR—10.47; 95% CI 1.92–57.05); (2) Pain frequency ($p = .02$; OR 6.85; 95% CI 1.46–32.14); (3) Decreased passive abduction at 4 months ($p = .05$; OR 4.46; 95% CI 0.99–20.10); (4)

(*continued*)

Table 2. Continued.

Authors/study design/Country	Research aim	Participants	Time since onset of stroke	Follow-up	Inclusion/ Exclusion criteria	Outcome measures	Key reported Findings including statistical analysis
		I = 15, *H* = 1 *L* = 5, *R* = 11					Age (p = .07; OR 1.05; 95% CI 1.0–1.12).
Zeilig et al. (2013) [35] Cross-sectional study *Israel*	To explore the possible neuropathic components in HSP, and if identified, whether they are specific to the shoulder or characteristic of the entire affected side.	**HSP,** *n* = 16, *M* = 11, *F* = 5, mean age—61 yrs; *I* = 12, *H* = 4 *L* = 5, *R* = 11 **Non-HSP,** *n* = 14, *M* = 6, *F* = 8, mean age—59 yrs *I* = 9, *H* = 5, *L* = 4, *R* = 10 Healthy Controls *n* = 15	HSP group 52 weeks Non-HSP group 82 weeks	N/A	Inclusion: (1) unilateral stroke; (2) at least 6 months after the stroke; (3) no history of shoulder pain prior to the stroke; (4) absence of neuropathy in UE Exclusion: (1) medical conditions other than stroke, (2) skin lesions in the tested regions, (3) vasomotor changes in UL, (4) psychiatric conditions	VAS McGill Pain Questionnaire MAS DN4 Questionnaire	**Associated factors:** (1) Parietal lobe damage ($p < 0.05$). (2) Higher heat-pain thresholds in both the affected shoulder ($p < 0.001$) and leg ($p < 0.01$) (3) Higher rates of hyperpathia in both these regions (each $p < 0.001$) (4) Chronic pain throughout the affected side ($p < 0.001$)
Kim et al. (2014) [36] Prospective cohort study *Korea*	To identify baseline risk factors associated with HSP during the first 6 months after a stroke and to investigate changes in these risk factors over time.	**HSP,** *n* = 51 Age—66 yrs *M* = 24, *F* = 27, *L* = 30, *R* = 21 *I* = 41, *H* = 10 **Non-HSP**, *n* = 43 Age—65 yrs *M* = 25, *F* = 18; *L* = 21, *R* = 22 *I* = 33, *H* = 10	4 weeks (T0)	12 weeks (T1) and 26 weeks (T2) Assessments were conducted by blind assessors	Inclusion: Acute stroke patients within 1 month, diagnosis confirmed by MRI. Exclusion: history of shoulder pain or shoulder surgery before stroke, recurring or bilateral stroke, cognitive problems, an unstable medical condition.	Pain: NRS (10 point scale) at rest or during passive movement GHS-bilateral radiographs Sonography of shoulder Brunnstrom's motor recovery stage; Fugl-Meyer arm score. NIHSS, MAS	**Risk factors:** (1) Poor FM arm score (*OR* = 2.6; 95% *CI* = 1.1–6.2; $p = 0.024$), (2) poor NIHSS item 5 score (*OR* = 2.9; 95% *CI* = 1.2–6.9; $p = 0.014$), (3) long head of biceps tendon effusion (*OR* = 2.7; 95% *CI* = 1.1–6.4; $p = 0.023$), (4) supraspinatus tendon tendinosis/ tear (*OR* = 3.1; 95% *CI* = 1.3–7.5; $p = 0.010$), (5) No response of MEP *OR* = 4.2; 95%*CI* = 1.3–13.9, (6) GHS (*OR* = 3.5; 95%*CI* = 1.4–9.3, (7) Adhesive capsulitis (*OR* = 2.7; 95%*CI* = 1.1–6.8
Karaahmet, et al. (2014) [37] Case-control *Turkey*	To investigate the incidence of and the factors associated with HSP in patients with hemiplegia	*N* = 55; *M* = 30, *F* = 25, Mean age: 61 yrs (range, 39–85 years), *L* = 40, *R* = 15; *I* = 40 ha, *H* = 5, HSP: *N* = 29 at admission and *n* = 34 at follow-up	Mean 7.2 weeks (1–26 weeks) HSP group—mean 9 weeks	Mean for all patients: 16 weeks	Inclusion: CV*A* < 120 days; Brunnstrom's stage 1–4; Exclusion: Unconscious patients and patients with recurrent stroke or bilateral hemiplegia.	Pain: At rest and during PROM; FAT; FIM; MAS; FAST; BDI; Fugl Meyer; US GHS-Palpation; Shoulder-hand syndrome	**Risk factors:** (1) Immobilization after stroke [$\chi 2(1, N = 55) = 9{,}359$; $p = .002$) (2) Late start to rehabilitation [$\chi 2(1, N = 55) = 5{,}723$; $p = .017$). (3) Poor initial motor function (FAT scores) (*OR* = 0.582, 95% *CI* = 0.370 0.914$p = 0.023$), (4) Longer duration of disease (*OR* = 1.041; 95% CI 1.005 1.078; $p < 0.023$).
Adey-Wakeling (2015) [11] Prospective cohort	To provide an epidemiological perspective of the clinical profile,	*N* = 226, mean age: 72 years, M—124, F—102. *L* = 122, *R* = 104	1 week Baseline *N* = 198	18 weeks *N* = 156 and 52 weeks *n* = 148	Part of a larger study. Only data that were truly prospective were included for analyses.	VAS (score range, 0–100), UE motor function-NIHSS Objective tests (1)The	**Risk factors:** (1) Absence of UL motor function-OR 3.19; 95% CI, 1.77–6.9; $p = 0003$). (2) Premorbid shoulder

(*continued*)

Table 2. Continued.

Authors/study design/Country	Research aim	Participants	Time since onset of stroke	Follow-up	Inclusion/ Exclusion criteria	Outcome measures	Key reported Findings including statistical analysis
study *Australia*	frequency, and determinants of post stroke HSP.	$I = 200$, $H = 20$ Unknown = 6				modified Neer test, (2) passive HBN test, (3) passive external rotation	pain (OR—8.09 (3.16–20.75; <.0001). (3) Positive baseline objective assessments, $OR = 3.22$ (95% CI, 1.01–10.27). (4) Upper limb deficit demonstrated an odds ratio of 2.13 (95% CI, 0.54–8.35)
Zeilig et al. (2016) [38] Cross-sectional study *Israel*	To compare the clinical and sensory profile of individuals with HSP to that with established central neuropathic pain (CNP)	**HSP group**: $n = 16$ $M = 11$, $F = 5$, mean age—61 yrs; $I = 12$; $H = 4$; $L = 5$, $R = 11$ **CNP Group** $N = 18$ Mean 56 yrs **Group 3**: $n = 18$ healthy controls, mean age 56 ± 13 years. $M = 10$, $F = 8$	HSP group: 52 weeks	N/A	Inclusion: unilateral stroke, absence of neuropathy in UE Exclusion: (1) medical conditions other than stroke, (2) skin lesions in the tested regions, (3) vasomotor changes in UL (4) psychiatric conditions	VAS McGill Pain Questionnaire MAS DN4 Questionnaire GHS-Sulcus sign	**Associated factors:** (1) Heat-pain threshold ($r = 0.42$) (2) GHS ($r = 0.66$) (3) Spasticity ($r = 0.54$, $r = 0.70$).
Lin (2018) [39] Retrospective cross-sectional *Taiwan*	To examine the sonographic findings of HSP in people with stroke.	$N = 26$; $M = 18$, $F = 8$ Mean age = 67 yrs (39–91 years). $L = 16$, $R = 10$ $I = 20$, $H = 6$	10.1 weeks	N/A	Inclusion: a new-onset stroke. Exclusion: any humeral fracture or shoulder dislocation.	MAS Brunnstrom Stage Sonography of shoulder	No significant relationship between HSP and other factors
Hadianfard and Hadianfard (2018) [40] Cross-sectional study *Iran*	To investigate the relationship of DM and hyperlipidemia, with HSP.	$N = 152$, $M = 75$, $F = 77$. Mean age = 61 yrs HSP $N = 49$	Not specified	Every 8 weeks for 52 weeks	Patients with CVA Exclusion: Patients with other causes of hemiplegia and profound cognitive problems.	Pain-VAS (0–10), Fasting blood sugar (FBS)	**Associated factors:** HSP and DM (probability ratio: 31/472; $p < 0.001$)

Note: n = number; CVA = Cerebrovascular accident; CT = computed tomography; MRI = Magnetic Resonance imaging; HSP = Hemiplegic shoulder pain; GHS = Glenohumeral subluxation; AP = Anterior-posterior; M = Male; F = Female; R = Right, L = Left; I = Infarction, H = Haemorrhagic, UD = Undefined; GMF = Good motor Function; PMF = Poor motor function; MAS = Modified Ashworth Scale; VAS = Visual Analogue Scale; r = Pearson correlation; x2 = Chi-square; R2, adjusted regression coefficient; US = Ultrasound; rho = Spearman's correlation coefficient; NPRS = Numeric pain rating scale; SPDI = Shoulder Pain and Disability Index pain subscale; MRC = Medical Research Council; N/A = Not applicable; UE = Upper Extremity; FAT = Frenchay arm test; FIM = Functional independence measure; CI = Confidence Intervals; OR = Odds Ratio; PROM = Passive Range of Movement; FAST = Frenchay aphasia screening test; BDI = Beck depression inventory; NIHSS = National Institute of Health Stroke Scale; CMSA = Chedoke McMaster Stroke Assessment; HBN = Hand Behind Neck; DM = Diabetes Mellitus.

shoulder instability and immobility, which can cause pain directly or place the capsule at risk of trauma, subsequently leading to pain [42].

GHS was a potential risk factor for HSP as reported by three studies [21, 23, 36]. GHS appears to be caused by a lack of adequate support of the shoulder while the patient is in the upright position [43]. A previous systematic review reported that complete loss of motor function/severity of arm paralysis and apparent absence of supraspinatus contraction are potential risk factors for GHS [44]. The most important function of supraspinatus is to stabilize the humeral head in the glenoid cavity [45]. Tissue damage in the shoulder region may be related to the increase in joint space due to GHS causing passive overstretching and resultant injury and pain [22]. There is some evidence from randomized controlled trials to support the effectiveness of therapeutic interventions including electrical stimulation/functional electrical stimulation of supraspinatus muscle that can reduce/prevent/delay GHS [46]. Two studies had a sound methodology using a prospective design [23, 36], a large sample size [23], appropriate statistical tests [21, 23, 36] and followed patients between 26–64 weeks [23, 36]. However, the assessors were not blind, and the outcome measures were not clearly described.

Limited passive range of movement (flexion/abduction) was another reported risk factor for HSP but only two studies reported odds ratio [28, 34]. Patients with severe impairment and activity limitations in the upper limb early after stroke are significantly associated with poorer upper limb outcomes [47]. Over time, the central nervous system as well as muscle tissue of the arm adapt to this state of inactivity, often resulting in hypertonia [48, 49] and contractures [50] resulting in reduced passive range of movement.

Soft tissue abnormalities (biceps tendon effusion and supraspinatus tendinosis/tear) as assessed using ultrasonography were associated risk factors for HSP [33, 36]. The tendon of the supraspinatus runs under the acromion [45] and is susceptible to compression. Degenerative changes are common in rotator cuff muscles and the prevalence of rotator cuff tears increases in people with stroke [51]. A recent study reported that patients with stroke ($n = 55$) with muscle strength ≤ 3 on the Medical Research Council grading scale were more likely to have shoulder pain and rotator cuff tears [50]. In addition, Haung et al. [52] found that GHS lateral distance, measured by physical examination, was a predictor for supraspinatus tendonitis. Ultrasound, in addition to diagnosing soft-tissue injuries has the potential to assess GHS by measuring the acromion-greater tuberosity distance, as it may be more sensitive than physical examination [53] and thus can facilitate management of HSP.

Adhesive capsulitis was another risk factor for HSP. The reported incidence of adhesive capsulitis in people with HSP is up to 57% [54, 55]. A painful hemiplegic shoulder can develop adhesive capsulitis due to immobilization, disuse atrophy, contracture, or varying degrees of disability [26]. A recent study on patients with stroke ($n = 23$) reported that rotator cuff tears and adhesive capsulitis might be linked to CRPS [56], while others have found a link between loss of motor control and CRPS [26]. These finding suggests that, to address the multifactorial nature of HSP, attention should be focused on maintaining shoulder ROM and improving muscle strength.

Poor handling was earlier considered as a contributing factor to HSP in patients who needed help with transfers [15]. In a recent online survey of UK therapists ($n = 66$), it was reported that positioning ($n = 62$, 94%), education ($n = 51$, 77%) regarding appropriate handling to staff, carers/family members was one of the key interventions for HSP [16]. This SLR did not identify poor handling as a potential factor to the HSP suggesting improved awareness among staff and family members regarding appropriate handling.

Overall methodological quality of the studies also needs to be considered, when determining the outcome. A major limitation of the studies reviewed was a lack of description of the methods used to justify sample size. In addition, most of the studies do not report appropriate statistical analysis undertaken to investigate the risk factors. Furthermore, a wide variety of outcome measures were used in the studies reviewed for various clinical outcomes. While most studies assess HSP by visual analogue [25, 29, 31, 37, 40] or numerical rating scale [32, 36], some do not specify the method used to assess pain [23, 27, 39]. Measuring pain in people with stroke is a challenge because of its inherently subjective nature. Visual analogue scales are generally reported to have high reliability and validity, however, the validity of their use in stroke patients has been questioned [57, 58]. A structured process is therefore required that will facilitate people with HSP to comprehensively describe the nature and impact of their problem. Accurate clinical assessment is vital as this will help improve patient-clinician communication and help establishing targeted management plans [59].

Limitations of this review

The current literature review included all primary data collection studies with all types of study design

that were relevant to the aims of the review. The heterogeneity of the studies has made comparability between studies very challenging. The articles published in a language other than English were not included, language bias therefore cannot be excluded.

Implications for practice

People with stroke with persistent motor impairment should be educated regarding positioning and appropriate handling of the affected arm. Patients with little voluntary function may benefit from neuromuscular electrical stimulation. A recent randomized controlled trial (RCT) reported improvement in pain but not in joint range of motion, arm function and activities of daily living after application of electrical stimulation in 36 patients with stroke [60]. Also, given the role of rotator cuff muscles (supraspinatus, infraspinatus, teres minor) in shoulder stability, early rehabilitation programmes should target these muscles to both prevent and reduce secondary complications such as HSP. Evidence from people with shoulder pain in the general population suggests that using concentric and eccentric exercises to rotator cuff muscles are effective in reducing shoulder pain [61, 62].

Implications for future research

This systematic literature review has highlighted an apparent paucity in appropriately designed clinical studies on risk factors for HSP. Further rigorously designed research studies using longitudinal cohort design, conducted at multiple rehabilitation centres and over a longer period of time are required. Pain may change over time and therefore their prevalence could be different according to the stage of recovery following stroke. In addition, studies should consider using appropriate statistical tests such as logistic regression analysis/odds ratio to identify potential risk factors for HSP. By doing a robust holistic assessment on symptoms and impact of HSP, other biopsychosocial issues associated with HSP may also be identified that would otherwise be missed.

Conclusion

Despite Hemiplegic shoulder pain being a recognised complication post-stroke, only 21 articles, with heterogeneous designs were identified which investigated the risk factors for HSP, indicating a lack of high-quality research in this area. Despite methodological flaws, complete loss of motor function in the affected arm and glenohumeral subluxation has been recognized as frequently reported risk factors for HSP. Further rigorously designed epidemiology studies (cohort design) are required to explore the risk and associated factors for HSP.

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