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Systematic Review

The effect of psychological factors on pain, function and quality of life in patients with rotator cuff tendinopathy: A systematic review

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ABSTRACT:

Background: Psychological factors may affect the pain level, shoulder function and quality of life in patients with rotator cuff tendinopathy.
Objective: To systematically review the prevalence of psychological factors reported in patients with rotator cuff tendinopathy; and to determine the association between psychological factors and pain, function and quality of life in patients with rotator cuff tendinopathy.
Study design: Systematic review
Methods: Pubmed, Embase, CINAHL and Web of Science were systematically searched from inception to June 2019. Studies that investigated patients with signs and symptoms suggestive of rotator cuff tendinopathy, and reported psychological variables and patient-reported outcome measures including pain, shoulder function or disability and quality of life.
Results: A total of 14 studies were included. Our results showed that 22.8%–26.2% of patients with rotator cuff tendinopathy reported depression; 23% reported anxiety; and 70.2%–89% of patients reported sleep disturbance or insomnia. Overall, nine psychological factors were identified to be associated with pain, function and quality of life in patients with rotator cuff tendinopathy. Low-to-moderate quality of evidence suggests that various psychological factors are associated with pain, function and quality of life in patients with rotator cuff tendinopathy
Conclusion: This review identified various psychological factors may affect the pain level, shoulder function and quality of life in patients with rotator cuff tendinopathy, and the causal relationship warrants future high-quality prospective studies.

1. Introduction

Shoulder pain is a common musculoskeletal disorder with an annual prevalence of 47% and a lifetime prevalence of up to 70% (Luime et al., 2004). Rotator cuff tendinopathy is a commonly-used clinical description encompassing various shoulder conditions affecting subacromial structures including shoulder impingement syndrome, subacromial bursitis, rotator cuff tendinitis/tendinosis, as well as rotator cuff partial and full-thickness tears (Cook et al., 2018; Desjardins-Charbonneau et al., 2015; Lewis et al., 2015; De Baets et al., 2019; Leong et al., 2019; Minns Lowe et al., 2014). Individuals with rotator cuff tendinopathy often present with pain, weakness and functional limitations (Lewis et al., 2015) which often require medical management (Minns Lowe et al., 2014; Smith et al., 2000; Virta et al., 2012). Rotator cuff tendinopathy is refractory to treatments, and current evidence falls short of identifying the optimal conservative and surgical interventions for rotator cuff tendinopathy. Indeed, approximately 60% of patients responded satisfactorily to conservative treatments with more than half exhibiting recurrence of symptoms and persistent pain in the long term (Brox et al., 1999; Holmgren et al., 2012; Ludewig and Borstad, 2003; Winters et al., 1999). Considering the high prevalence of rotator cuff tendinopathy and substantial socio-economic burden due to loss of work and treatment costs (Smith et al., 2000; Virta et al., 2012), it is essential to have a better understanding of the factors that may influence patient-reported outcome measures such as pain, function recovery and quality of life in individuals with rotator cuff tendinopathy in order to identify the optimal management of rotator cuff tendinopathy.

Psychological factors play a vital role in mediating individuals'

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subjective experience of pain and disability as well as objective pathologies (Vranceanu et al., 2009). Depression has been demonstrated as a strong predictor of health status across diseases (Moussavi et al., 2007), with anxiety being an important risk factor for chronic pain and disability (Hadjistavropoulos and Hadjistavropoulos, 2003). A high prevalence of depression, anxiety and sleep disturbance have been reported in patients with rotator cuff tendinopathy (Austin et al., 2015; Cho et al., 2013, 2015). Indeed, recent evidence showed that various psychological factors such as lower emotional or mental healthd and fear-avoidance beliefs were associated with great pain and disability in patients with rotator cuff tears (Coronado et al., 2018; Kromer et al., 2014; Mallows et al., 2017). Psychological factors have also been found to be associated with physiotherapy outcomes for people with shoulder pain (Chester et al., 2018). Therefore, identifying the psychological factors associated with rotator cuff tendinopathy is important and may open treatment options to improve patient-reported outcomes and treatment outcomes. Previous systematic reviews have reported the association between psychological factors and patient-reported outcomes in patients with nonspecific shoulder pain (Kooijman et al., 2015; Kuijpers et al., 2004; Struyf et al., 2016) and individuals with rotator cuff tears (Coronado et al., 2018). However, no systematic review has been conducted to summarize the prevalence of psychological factors reported in patients with rotator cuff tendinopathy, and how these psychological variables may affect pain, function and quality of life in patients with rotator cuff tendinopathy.

Hence, the aims of this study were (1) to systematically review the prevalence of psychological factors reported in patients with rotator cuff tendinopathy; and (2) to determine the association between psychological factors and patient-reported outcomes including pain, function and quality of life in patients with rotator cuff tendinopathy.

2. Methods

2.1. Protocol

A systematic review was performed using a predetermined protocol in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Moher et al., 2009). Our review has been registered with the PROSPERO database (registration number CRD42020134637)(CfRa).

2.2. Data sources and search strategy

An electronic database search of EMBASE, MEDLINE/Pubmed, CINAHL and Web of Science was performed from inception to June 2019. The keywords used are shown in Table 1. The electronic search was supplemented by hand searching from the reference lists of the articles identified. The search results were imported into reference-manager software (Endnote X8; Thomson, New York, USA) to avoid duplication of records.

2.3. Study selection

A study was included if (1) the participants were aged above 18 years and presented with signs and symptoms suggestive of rotator cuff tendinopathy/tendinosis/tendinitis, partial or full thickness tear, shoulder impingement syndrome, or subacromial bursitis diagnosed by clinical tests and/or imaging (Leong et al., 2019); (2) the study reported psychological variables such as depression, anxiety, catastrophizing, fear-avoidance, distress, sleep disturbance, insomnia and pain catastrophizing, etc.; (3) the study reported patient-reported outcome measures including pain, shoulder function or disability, and quality of life, etc.; (4) the study design was cross-sectional, case-control, prospective, and retrospective analyses; and (5) the study report was published in English and full-text peer-reviewed articles. A study was excluded if (1) the shoulder pain of the participants originated from acute trauma (e.g. fracture, luxation of shoulder region), other systemic diseases (e.g. rheumatic disease), vascular disorders (e.g. heart attack), neurological disorders (e.g. stroke, dementia), musculoskeletal disorders (frozen shoulder, adhesive capsulitis, non-specific shoulder problems or shoulder symptoms referred from the neck), post-operative conditions and/or non-musculoskeletal disorders (e.g. neoplasm, carcinoma); (2) the study population involved animal models or cadavers; and (3) the study report was published as editorials, commentaries, opinion-based papers or reviews (systematic and narrative). Relevant studies were accessed for full-text review before inclusion in the systematic review. Two reviewers screened all titles and/or abstracts for duplication and relevance. Disagreements were resolved by a third reviewer when required.

Table 1
Keywords used in the PubMed database.

	Search terms
1.	Shoulder [All fields]
2.	Glenohumeral [MeSH Terms]
3.	Subacromial [MeSH Terms]
4.	Rotator cuff [MeSH Terms]
5.	1 OR 2 OR 3 OR 4
6.	Tendin* [MeSH Terms]
7.	Tendinitis [MeSH Terms]
8.	Tendonitis [MeSH Terms]
9.	Tendinopathy [MeSH Terms]
10.	Impingement [MeSH Terms]
11.	Pain [All fields]
12.	Bursitis syndrome [MeSH Terms]
13.	Rupture [All fields]
14.	Tear [All fields]
15.	6 OR 7OR 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14
16.	Psycholog* [All fields]
17.	Psychological distress* [All fields]
18.	Depress* [All fields]
19.	Anxiety* [All fields]
20.	Sleeping disturbance* [All fields]
21.	Sleep* [All fields]
22.	Insomnia* [All fields]
23.	Fear-avoidance* [All fields]
24.	Kinesiophobia* [All fields]
25.	Pain catastroph* [All fields]
26.	Psychosocial* [All fields]
27.	Stress [All fields]
28.	Fear [All fields]
29.	Emotion* [All fields]
30.	Expect* [All fields]
31.	Irrit* [All fields]
32.	Mood* [All fields]
33.	16 OR 17 OR 18 OR 19 OR 20 OR 21 OR 22 OR 23 OR 24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31 OR 32
34.	Patients-reported outcome measures [All fields]
35.	Pain [All fields]
36.	Function [All fields]
37.	Disability [All fields]
38.	Quality of life [All fields]
39.	Health [All fields]
40.	Recovery [All fields]
41.	34 OR 35 OR 36 OR 37 OR 38 OR 39 OR 40
42.	5 AND 15 AND 33 AND 41 limited to English language, full text

2.4. Risk of bias assessment

Two reviewers independently assessed the risk of bias of the included studies using the Newcastle Ottawa Scale (NOS) (Lo et al., 2014). The NOS has been shown to be valid and reliable to assess the quality of non-randomized studies (cohort and case-control studies) (Stang, 2010). The NOS uses a star rating system and the scale ranges from zero to nine stars (Stang, 2010). Ratings of the NOS are based on the selection of participants, comparability of study groups and outcome of interest (cohort studies) or attainment of exposure (case-control studies) (McPheeters et al., 2012). Based on the risk of bias assessment (NOS),

the score of each study was calculated by dividing the number of stars by the number of items. Each study was graded as low, moderate and high quality based on the score, with cut-off points of 0.00–0.44 representing low risk of bias, 0.45–0.70 representing moderate risk of bias and 0.71–1.00 representing high risk of bias. Disagreements in the awarding of a star were resolved by a third reviewer when required. Intra-class correlation coefficient (ICC) two-way mixed-effects analysis was calculated using SPSS Version 24 for Windows (SPSS Inc, Chicago, IL.) to measure the interrater agreement between the two reviewers for quality assessment.

2.5. Data extraction and data synthesis

All data were extracted by two reviewers and verified by a third reviewer. A data extraction form was used to obtain relevant data from each article including (1) Study characteristics (Authors, years, design); (2) study participants (sample population, sample size, gender and age); (3) Diagnostic criteria; (4) psychological factors; (4) prevalence/incidence; (5) patient-reported outcome measures; and (6) reported significant correlation results.

Narrative synthesis was used to summarize the prevalence of psychological factors reported in patients with rotator cuff tendinopathy, and to categorize the identified psychological factors that were associated with patient-reported outcome measures in patients with rotator cuff tendinopathy. To assess the overall quality of evidence, the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) approach was used (Guyatt et al., 2008). The GRADE approach has five domains to establish the quality of evidence, including 1) limitations in study design; 2) inconsistency of results; 3) indirectness of evidence; 4) imprecision; and 5) reporting bias. The identified psychological factors that were associated with patient-reported outcomes measures in patients with rotator cuff tendinopathy were classified into four levels of evidence (Andrews et al., 2013): 1) High evidence: Randomized trials; or double-upgraded observational studies; 2) Moderate evidence: Downgraded randomized trials; or upgraded observational studies; 3) Low evidence: Double-downgraded randomized trials; or observational studies; 4) Very low evidence: Triple-downgraded randomized trials; or downgraded observational studies; or case series/case reports.

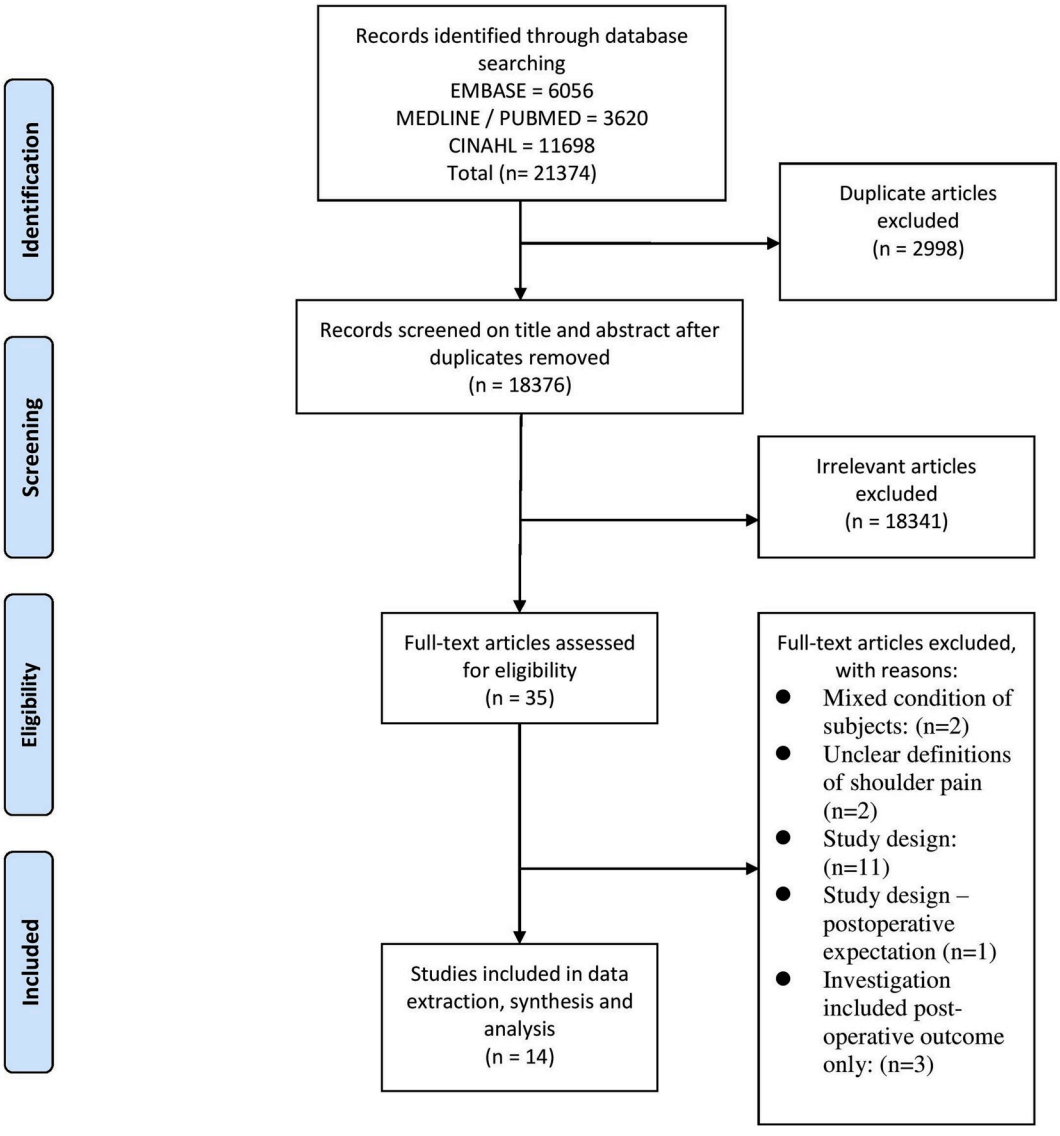

Fig. 1. Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) flow diagram of the search strategy.

3. Result

3.1. Identification of studies

The electronic search identified 21,374 studies with 2998 duplicates (Fig. 1). After screening titles and abstracts, 18341 irrelevant articles were excluded and the remaining 35 articles were obtained for their full text. After screening the articles based on the inclusion and exclusion criteria, a total of 14 articles were included in this systematic review.

3.2. Risk of bias assessment scores

The results of the risk of bias assessment using the NOS are shown in Table 2. From the rating system, there were four studies of high quality and ten studies of moderate quality. The intraclass correlation coefficient for the interrater agreement between the two reviewers was 0.729 (95% CI 0.156–0.913).

3.3. Study characteristics

The 14 included studies were published between 2004 and 2018. The characteristics of the included studies are shown in Table 3. The studies consisted of four prospective cohorts, nine cross-sectional and one case-control studies. The sample size ranged from 47 to 452. The mean age of the participants ranged between 42.9 and 62.7 years old. Clinical diagnostic tests were performed in three studies to determine the diagnosis of rotator cuff tendinopathy, three studies used intraoperative diagnosis, four studies used imaging (Magnetic Resonance Imaging (MRI), Ultrasound), one study combined the use of MRI and intraoperative diagnosis, and three studies combined the use of clinical diagnostic test and imaging to confirm the diagnosis of rotator cuff tendinopathy. Of the included studies, four studies investigated depression assessed by Hospital Anxiety and Depression Scale – Depression (HADS-D) (Cho et al., 2013, 2015; Thorpe et al., 2018; Alizadehkhaiyat et al., 2017), four studies investigated anxiety assessed by Hospital Anxiety and Depression Scale – Anxiety (HADS-A) (Cho et al., 2013, 2015; Thorpe et al., 2018; Alizadehkhaiyat et al., 2017), two studies investigated fear of pain or fear-avoidance belief assessed by Fear of Pain Questionnaire (FPQS-III) or Fear-Avoidance Beliefs Questionnaire (FABQ) (Kromer et al., 2014; George and Hirsh, 2009), one study investigated pain self-efficacy assessed by Pain Self-Efficacy Questionnaire (FSEQ) (Thorpe et al., 2018), three studies investigated pain catastrophizing assessed by Pain Catastrophizing Scale (PCS) (Kromer et al., 2014; Thorpe et al., 2018; George and Hirsh, 2009), one study investigated distress assessed by Modified Zung Depression Scale & the Modified Somatic Perception Questionnaire (Potter et al., 2014), one study investigated emotion well-being assessed by Western Ontario Rotator Cuff Index (WORC) (Barlow et al., 2016), three studies investigated sleep disturbance assessed by Pittsburgh Sleep Quality Index (PSQI) (Austin et al., 2015; Cho et al., 2015; Khazzam et al., 2018), two studies investigated expectation assessed by Musculoskeletal Outcomes Data Evaluation and Management System (MODEMS) (Oh et al., 2012; Tashjian et al., 2004), and two studies investigated mental health assessed by Short Form-36 questionnaire (SF-36 – mental component summary). (Piitulainen et al., 2012; Wylie et al., 2016).

3.4. Prevalence

Of the included studies, three studies reported the prevalence of psychological factors in patients with rotator cuff tendinopathy (Table 4). The overall prevalence of depression ranged from 22.8% to 26.2% (Cho et al., 2013, 2015), and approximately 23% of patients reported anxiety (Cho et al., 2013, 2015). Besides, 70.2%–89.0% of patients reported sleep disturbance or insomnia (Austin et al., 2015; Cho et al., 2015).

3.5. Associations between psychological factors and patient-reported outcome measures

The associations between psychological factors and patient-reported outcome measures in patients with rotator cuff tendinopathy are summarized in Table 5. Overall, nine psychological factors were found to be associated with patient-reported outcome measures in patients with rotator cuff tendinopathy:

1. **Depression and anxiety**: Conflicting evidence from three studies suggests that depression and anxiety may possibly be associated with pain level and functional ability in patients with rotator cuff tendinopathy (Cho et al., 2013, 2015; Thorpe et al., 2018). One moderate-quality study suggests that depression and anxiety are negatively associated with quality of life in patients with rotator cuff tendinopathy (Cho et al., 2013).
2. **Fear of pain/fear-avoidance belief/kinesiophobia:** One low-quality study suggests that fear of pain is correlated with lower experimental pain sensitivity in patients with rotator cuff tendinopathy (George and Hirsh, 2009). Patients with higher fear of pain also demonstrated a lower pain tolerance and threshold when compared to patients with no fear of pain (George and Hirsh, 2009). Two moderate-quality studies suggest that fear-avoidance belief is associated with poor shoulder function in patients with rotator cuff tendinopathy (Kromer et al., 2014; Thorpe et al., 2018).
3. **Pain catastrophizing:** One low-quality study suggests that pain catastrophizing is correlated with clinical pain intensity in patients with rotator cuff tendinopathy (George and Hirsh, 2009). In addition, pain catastrophizing was reported to be a predictor of clinical pain intensity (George and Hirsh, 2009).

Table 2
Risk of bias assessment using the Newcastle-Ottawa Scale (NOS).

Authors	Selection	Comparability	Exposure/Outcome	Total stars	Risk of bias
Alizadehkhaiyat et al., 2017 (Alizadehkhaiyat et al., 2017) (Cross-sectional)	***	*	**	6	Moderate
Austin et al., 2015 (Austin et al., 2015) (Case series)	***	*	**	6	Moderate
Barlow et al., 2016 (Barlow et al., 2016) (Cross-sectional)	***	*	**	6	Moderate
Cho et al., 2013 (Cho et al., 2013) (Cross-sectional)	****	*	**	7	High
Cho et al., 2015 (Cho et al., 2015) (Prospective cohort study)	***	*	**	6	Moderate
George and Hirsh, 2009 (George and Hirsh, 2009) (Cross-sectional)	***	*	**	6	Moderate
Khazzam et al., 2018 (Khazzam et al., 2018) (Cross-sectional)	****	*	**	7	High
Kromer et al., 2014 (Kromer et al., 2014) (Cross-sectional)	****	*	***	8	High
Oh et al., 2012 (Oh et al., 2012) (Prospective cohort study)	***	*	**	6	Moderate
Piitulainen et al., 2012 (Piitulainen et al., 2012) (Cross-sectional)	***	*	**	6	Moderate
Potter et al., 2014 (Potter et al., 2014) (Prospective cohort)	***	*	**	6	Moderate
Tashjian et al., 2004 (Tashjian et al., 2004) (Cross-sectional)	***	*	**	6	Moderate
Thorpe et al., 2018 (Thorpe et al., 2018) (Prospective cohort study)	***	*	***	7	High
Wylie et al., 2016 (Wylie et al., 2016) (Cross-sectional)	***	*	**	6	Moderate

Table 3
Study characteristics of included studies (N = 14).

Study (Authors, years, design)	Participants (Sample size, population, gender, age)	Diagnostic criteria	Rotator cuff tendinopathy categories	Psychological factors (measure)	Patients-reported outcome (measure)
Alizadehkhaiyat et al., 2017 (Alizadehkhaiyat et al., 2017) Cross sectional study	N = 75 General population Male = 40; Female = 35 Mean age = 55	Physical examination: 1. Pain >12 weeks 2. Positive clinical tests (Painful arc, Neer's, Hawkin's, Lift Off, Empty Can)	Shoulder impingement syndrome	Anxiety (HADS-A) Depression (HADS-D)	Pain intensity (MPQ) Function (CS, OSS, DASH, ULFI, FIT-HaNSA Quality of life (SF-12)
Austin et al., 2015 (Austin et al., 2015) Case series	N = 56 General population Male = 27; Females = 29 Mean age: 59.8	Intra-operative diagnosis 1. Age ≥18 years 2. Full-thickness rotator cuff tear undergoing arthroscopic rotator cuff repair surgery	Full-thickness tear	Sleep quality (PSQI);	Pain intensity (VAS) Function (SST & SANE)
Barlow et al., 2016 (Barlow et al., 2016) Cross sectional study	N = 452 General population Gender = N/A Mean age = N/A	MRI 1. Patients with MRI-documented, symptomatic, atraumatic full-thickness rotator cuff tears	Full-thickness tear	Emotion (WORC)	Pain intensity (WORC - Pain level) Function (ASES, SANE & Shoulder Activity Scale) Qualify of life (SF-12)
Cho et al., 2013 (Cho et al., 2013) Cross sectional study	N = 107 General population Male = 47; Female = 60 Mean age = 58.5 years	MRI 1. A diagnosis of rotator cuff tear confirmed by magnetic resonance (MR) imaging 2. Conservative treatment for more than 3 months that was unsuccessful 3. No history of a psychiatric disorder	Partial or full-thickness tear	Anxiety (HADS-A) Depression (HADS-D)	Pain intensity (VAS) Function (ASES & KSS) Quality of life (WHOQOL-BREF)
Cho et al., 2015 (Cho et al., 2015) Longitudinal study	N = 47 General population Male = 20; Female = 27 Mean age: 57.0	Intra-operative diagnosis 1. Nonoperative treatment such as medication, injection, or physical therapy had failed after 3 months 2. Undergoing complete repair for a rotator cuff tear 3. Not undergone previous shoulder surgery 4. No history of a psychiatric disorder	Rotator cuff tear	Anxiety (HADS-A) Depression (HADS-D) Sleep Quality (PSQI)	Pain intensity (VAS) Function (UCLA scale; ASES); Quality of life (WHOQOL-BREF)
George and Hirsh, 2009 (George and Hirsh, 2009) Cross sectional study	N = 59 General population Male = 35; Female = 24 Mean age = 50.4	Clinical examinations & Imaging, 1. Age between 18 and 85 years 2. Complaint of pain limited to anterior, lateral, or posterior shoulder 3. Documented or suspected rotator cuff tendinopathy (evidence from clinical examination or imaging studies) including small (<1 cm), medium (1–3 cm), and large (3–5 cm) tears	Rotator cuff pathology	Fear of pain (FPQS-III); Pain catastrophizing (PCS);	Pain intensity (NRS)
Khazzam et al., 2018 (Khazzam et al., 2018) Cross sectional study	N = 391 General population Male = 182; Female = 209 Mean age = 56.8	Physical examination & MRI 1. Age ≥18 years 2. A clinical diagnosis of either impingement or symptomatic full-thickness rotator cuff tear.	Rotator cuff tear	Sleep quality (PSQI)	Pain intensity (VAS) Function (ASES & SANE)
Kromer et al., 2014 (Kromer et al., 2014) Cross sectional study	N = 90 General population Male = 44; Female = 45 Mean age = 51.0	Physical examination 1. Age between 18 and 75 years 2. Symptoms >4 weeks 3. Main complaints in the glenohumeral joint region or the proximal segments of the arm 4. Presence of one of the following signs indicating SPS: Neer impingement sign, Hawkins-Kennedy impingement test, or painful arc with active abduction or flexion 5. Pain during one of the following resistance tests: external rotation, internal rotation, abduction or flexion	Full thickness tear	Pain catastrophising (PCS); Fear-avoidance beliefs (FABQ)	Pain intensity (VAS) Function (SPADI)
Oh et al., 2012 (Oh et al., 2012) Cohort study	N = 95 Male = 41; Female = 49 Mean age = 62.7	MRI and Intra-operative diagnosis 1. Failure of >3 months of conservative management before rotator cuff surgery, 2. Intraoperatively confirmed full-thickness rotator cuff tear	Rotator cuff tear	Expectation (MODEMS) Concerns (Likert Scale)	Function (SST & CMS) Quality of life (SF-36)

(*continued on next page*)

Table 3 (*continued*)

Study (Authors, years, design)	Participants (Sample size, population, gender, age)	Diagnostic criteria	Rotator cuff tendinopathy categories	Psychological factors (measure)	Patients-reported outcome (measure)
Piitulainen et al., 2012 (Piitulainen et al., 2012) Cross sectional study	N = 67 General population Male = 38; Female = 29 Mean age = 54	Clinical examination & MRI 1. Age between 18 and 64 years 2. Rotator Cuff Tear of >5 cm	Rotator cuff tear	Mental health (SF-36: Mental Component Summary)	Pain intensity (VAS) Function (ASES)
Potter et al., 2014 (Potter et al., 2014) Cross sectional study	N = 85 General population Male = 64; Female = 21 Mean age = 62	MRI 1. Age ≥18 years 2. Scheduled a shoulder arthroscopy for a primary symptom of shoulder pain secondary to a reparable full-thickness rotator cuff tear. 3. Indications for surgery included shoulder pain and weakness in patients who had MRI consistent with a reparable full-thickness rotator cuff tear.	Rotator cuff tear	Distress (Modified Zung Depression Scale & the Modified Somatic Perception Questionnaire)	Pain intensity (VAS) Function (SST & ASES)
Tashjian et al., 2004 (Tashjian et al., 2004) Cross sectional study	N = 199 General population Gender: N/A Mean age = 56	Intraoperative diagnosis 1. A chronic rotator cuff tear, 2. Symptoms >3 months 3. Confirmed at the time of operative intervention	Full-thickness tear	Expectation (MODEMS)	Pain intensity (VAS) Function (DASH & SST) Quality of life (SF-36)
Thorpe et al., 2018 (Thorpe et al., 2018) Cohort study	N = 124 General population Male = 28; Female = 18 Mean age = 54 years	Physical examination 1. Scheduled for surgery for rotator cuff repair with or without subacromial decompression for partial or full-thickness tears and arthroscopic subacromial decompression	Rotator cuff related shoulder pain or rotator cuff tear	Depression, Anxiety and Stress (DASS) Pain catastrophising (PCS) Pain Self-Efficacy (PSEQ) Kinesiophobia (TSK-11)	Function (ASES)
Wylie et al., 2016 (Wylie et al., 2016) Cross sectional study	N = 169 General population Male = 123; Female = 34 Mean age = 62.3	MRI 1. Age ≥18 years 2. MRI confirmed full-thickness rotator cuff tear 3. Documentation of a complete pre-treatment evaluation	Full thickness tear	Mental health (SF-36: Mental Component Summary)	Pain intensity (VAS) Function (VAS, SST & ASES)

Abbreviations: DASS = Depression, Anxiety and Stress scale; FABQ=Fear-Avoidance Beliefs Questionnaire; FPQS-III=Fear of Pain Questionnaire; HADS-A = Hospital Anxiety and Depression Scale-Anxiety; HADS-D = Hospital Anxiety and Depression Scale-Depression; MODEMS = Musculoskeletal Outcomes Data Evaluation and Management System; PCS=Pain Catastrophizing Scale; PSEQ=Pain Self-Efficacy Questionnaire; PSQI=Pittsburgh Sleep Quality Index; SF-36 = Short Form-36; TSK-11 = Tampa Scale of Kinesiophobia; WORC=Western Ontario Rotator Cuff Index.

Table 4
Prevalence of psychological factors associated with rotator cuff tendinopathy.

Study (Authors, years)	Participants (Sample size, population, gender, age)	Diagnostic criteria	Psychological factors	Patients-reported outcome measures	Results
Austin, L. et al., 2015 (Austin et al., 2015) Case series	N = 56 with arthroscopic rotator cuff repair for full-thickness tears General population Gender: 29 Females & 27 Males Mean age: 59.8	Intra-operative diagnosis	Sleep quality (PSQI);	Pain intensity (VAS) Function (SST & SANE)	89% of patients reported sleep disturbance
Cho et al., 2013 (Cho et al., 2013) Cross sectional study	N = 107 with partial or full-thickness rotator cuff tear General population Gender: 60 Females & 47 Males Mean age: 58.5	MRI	Anxiety (HADS-A) Depression (HADS-D)	Pain intensity (VAS) Function (ASES & KSS) Quality of life (WHOQOL-BREF)	26.2% were found to have depression (mild = 12.2%; moderate = 14.0%) 23.4% had anxiety (mild = 15.0%; moderate = 7.5%; severe = 0.9%)
Cho et al., 2015 (Cho et al., 2015) Longitudinal study	N = 47 with arthroscopic rotator cuff repair for rotator cuff tears General population Gender: 27 Females & 20 males Mean age: 57.0	Intra-operative diagnosis	Anxiety (HADS-A) Depression (HADS-D) Sleep quality (PSQI)	Pain intensity (VAS) Function (UCLA & ASES) Quality of life (WHOQOL-BREF)	22.8% of subjects reported depression 23.4% of them reported anxiety 70.2% of them reported insomnia

Abbreviations: HADS-A = Hospital Anxiety and Depression Scale-Anxiety; HADS-D = Hospital Anxiety and Depression Scale-Depression; PSQI=Pittsburgh Sleep Quality Index.

4. **Emotion:** One moderate-quality study showed that a worse emotional score was associated with higher pain levels in patients with rotator cuff tendinopathy (Barlow et al., 2016).
5. **Distress:** One moderate-quality study suggested that a higher distress score was associated with a higher pain level and lower functional ability in patients with rotator cuff tendinopathy (Potter et al., 2014). Higher pain levels were reported in patients with rotator cuff tendinopathy compared to those without (Potter et al., 2014).
6. **Mental health:** One moderate-quality study suggested that a higher mental health component score was associated with lower pain levels in patients with rotator cuff tendinopathy (Wylie et al., 2016). Two moderate-quality studies suggested that a higher mental health score was associated with better shoulder function in patients with rotator cuff tendinopathy (Piitulainen et al., 2012; Wylie et al., 2016). One moderate-quality study suggested that patients with higher mental health status were associated with a higher health-related quality of life (Piitulainen et al., 2012).
7. **Poor sleep-quality:** Two moderate-quality studies suggests that poor sleep quality may possibly be associated with pain levels in patients with rotator cuff tendinopathy (Austin et al., 2015; George and Hirsh, 2009).
8. **Expectation:** Two moderate-quality studies suggested that lower expectation was associated with poorer functional abilities in individuals with rotator cuff tendinopathy (Oh et al., 2012; Tashjian et al., 2004). One moderate-quality study suggests that patient expectation has a moderate negative association with quality of life (Tashjian et al., 2004).
9. **Concerns:** One moderate-quality study suggests that patients with rotator cuff tendinopathy with high concerns were found to have poorer mental scores (Oh et al., 2012).

4. Discussion

This systematic review investigated the prevalence of psychological factors reported in patients with rotator cuff tendinopathy and its association with patient-reported outcome measures in rotator cuff tendinopathy. Approximately 1/4 of patients with rotator cuff tendinopathy reported to have depressive and anxious symptoms, and almost 90% of patients report poor sleep quality or insomnia. Overall, nine psychological factors were identified to be associated with patient-reported outcome measures in patients with rotator cuff tendinopathy including depression and anxiety, fear of pain or kinesiophobia, pain catastrophizing, emotion, distress, mental health, poor sleep-quality, expectation, and concerns.

4.1. Prevalence

Our review showed that over 1/4 of patients report to have depressive and anxious symptoms, and almost 90% of patients report poor sleep quality or insomnia. (Austin et al., 2015; Cho et al., 2013, 2015). Our findings are similar to those in the study by Tekeoglu et al. (2013), who reported that shoulder disorders were associated with depression, anxiety, and poor sleep quality. A recent systematic review also showed that psychological factors were associated with an increased risk of symptomatic rotator cuff tendinopathy (Leong et al., 2019). The current findings may suggest that the presence of psychological symptoms may be associated with rotator cuff tendinopathy.

4.2. Associations between psychological factors and patient-reported outcome measures

Our review demonstrates that low-to-moderate evidence suggests that various psychological factors are associated with pain, function and quality of life in patients with rotator cuff tendinopathy. Similar to our findings, previous studies have reported an association between psychosocial factors and patient-reported outcomes in patients with nonspecific shoulder pain (Kooijman et al., 2015; Kuijpers et al., 2004; Struyf et al., 2016; Bruls et al., 2015). Coronado et al. (2018), also found weak-to-moderate associations between emotional/mental health and function/disability and pain in patients with rotator cuff tears. Previous studies have also shown that psychological factors such as fear-avoidance beliefs have a predictive role in surgical treatment outcomes (Thorpe et al., 2018; Jain et al., 2018). Indeed, patients with higher fear-avoidance behaviour experience more shoulder pain and impaired function at 18 months follow up after surgery (Jain et al., 2018). Such result demonstrates that treatment solely targeting physical symptoms is insufficient for an ideal treatment outcome. Nevertheless, symptoms of depression and anxiety are common comorbidities of pain (Nicolson et al., 2009). Other psychological factors including positive personality traits were found to play a mediating role in experiencing pain (Hood et al., 2012; Pulvers and Hood, 2013), and higher self-efficacy levels were found to be associated with lower levels of pain and disability in chronic musculoskeletal pain (Martinez-Calderon et al.,

Table 5
Associations between psychological factors and patient-reported outcome measures in patients with rotator cuff tendinopathy.

Study (Authors, years)	Psychological factors	Psychological factors association with			Quality of evidence
		Pain intensity	Function/disability	Quality of life	
Austin, L. et al., 2015 (Austin et al., 2015) Case series	Sleep quality (PSQI)	Moderate correlation between sleep quality and pain (r = 0.453, P < 0.0001)	Moderate correlation between sleep quality and function (r = 0.490, p < 0.001)	–	Moderate
Barlow et al., 2016 (Barlow et al., 2016) Cross sectional study	Emotion (WORC)	Worse emotion was associated with higher pain levels (−18.9; 95% CI, −20.2 to −11.6; p < 0.0001)	Worse emotion was associated with lower functions (6.2; 95% CI, 2.5–9.95; p = 0.0012)	–	Moderate
Cho et al., 2013 (Cho et al., 2013) Cross sectional study	Depression (HADS-D)	HADS-D score was positively correlated with VAS pain intensity (r = 0.191, p = 0.048)	HADS-D score was negatively correlated with function (ASES: r = −0.270, p = 0.005; KSS: r = −0.227, p = 0.004)	HADS-D score was negatively correlated with SF36 score quality of life (r = −0.419, p < 0.0001)	Moderate
	Anxiety (HADS-A)	No significant correlation with VAS score	Anxiety was negatively correlated with the shoulder function (ASES: r = −0.206, p = 0.034; KSS: r = −0.202, 0 = 0.037)	Anxiety was negatively correlated with quality of life (r = −0.332, p < 0.0001)	Moderate
Cho et al., 2015 (Cho et al., 2015) Longitudinal study	Depression (HADS-D)	No significant correlation	No significant correlation with UCLA or ASES score	–	Low
	Anxiety (HADS-A)	No significant correlation	No significant correlation with UCLA or ASES score	–	Low
	Sleep Quality (PSQI)	No significant correlation	No significant correlation with UCLA or ASES score	–	Low
George and Hirsh, 2009 (George and Hirsh, 2009) Cross sectional study	Fear of pain (FPQS-III);	Fear of pain (beta = −0.42, p < 0.01) was associated with lower experimental pain sensitivity	–	–	Low
	Pain catastrophizing (PCS);	Pain catastrophizing was correlated with clinical pain intensity in patients with rotator cuff tendinopathy (r = 0.464, p < 0.01). Pain catastrophizing was reported to be a predictor of clinical pain intensity (beta = −0.43; p < 0.01)	–	–	Low
Khazzam et al., 2018 (Khazzam et al., 2018) Cross sectional study	Sleep quality (PSQI)	Fair correlation coefficients in the impingement group, including pain VAS (r = 0.27; p = 0.004)	No significant correlation	–	Moderate
Kromer et al., 2014 (Kromer et al., 2014) Cross sectional study	Fear-avoidance beliefs (FABQ-PA)	–	Fear-avoidance significantly contributed to SPADI-F score (b = 0.287, p = 0.006)	–	Moderate
	Pain catastrophizing (PCS)	–	Insignificant contribution	–	Moderate
Oh et al., 2012 (Oh et al., 2012) Cohort study	Expectation (MODEMS)	–	High-expectation showed lower shoulder disabilities (preoperative Constant-Murley scores: OR: 0.868, p < 0.001)	–	Moderate
	Concerns (Likert Scale)	–	–	High-concern group was associated with poorer score on the SF-36 Mental Component Summary category (OR, 0.95, p = 0.009)	Moderate
Piitulainen et al., 2012 (Piitulainen et al., 2012) Cross sectional study	Mental health (SF-36: Mental Component Summary)	–	The relationship between functional disability and the mental health was r = 0.37 (95% CI: 0.16 to 0.54, p < 0.003)	Patients with better shoulder functions demonstrated higher Health-related quality of life (HRQoL) (Physical functioning: p < 0.001; Role-physical: p < 0.001; Role-emotional: p < 0.001)	Moderate
Potter et al., 2014 (Potter et al., 2014) Cross sectional study	Distress (Modified Zung Depression Scale & the Modified Somatic Perception Questionnaire)	Distress correlated with higher pain level (beta = 4.3; p = 0.001)	Function was lower in the distressed group compared with controls (p = 0.001) Distress correlated with lower shoulder function (b = - 2.2; p < 0.00 1; b = −20.5; p < 0.001)	–	Moderate
Tashjian et al., 2004 (Tashjian et al., 2004) Cross sectional study	Expectation (MODEMS)	–	Higher expectation was associated with higher physical function (r = −0.3177, p < 0.0001)	Higher expectation was associated with higher general health (r = −0.3753, p < 0.001), social function (r = −0.2504, p = 0.004) and role-emotional (r = −0.2604, p = 0.0003)	Moderate
Thorpe et al., 2018 (Thorpe et al., 2018) Cohort study	Depression, Anxiety and Stress (DASS)	–	Poorer psychologic functioning was found to be independently associated with worse ASES score (regression coefficient for ASES: before surgery −9, p = 0.011)	–	Moderate
	Pain catastrophizing (PCS)		Poorer psychologic function exhibited moderate levels of		

(*continued on next page*)

Table 5 (*continued*)

Study (Authors, years)	Psychological factors	Psychological factors association with			Quality of evidence
		Pain intensity	Function/disability	Quality of life	
	Pain Self-Efficacy (PSEQ) Kinesiophobia (TSK-11)		depression (9.5, $p < 0.001$) and stress (15.5, $p < 0.001$), high levels of kinesiophobia (28.8, $p < 0.001$), mild to moderate levels of catastrophizing(rumination: 7.5, $p < 0.001$; magnification: 4, $p < 0.001$; helplessness: 8.5, $p < 0.001$), and low levels of pain self-efficacy(26.5, $p < 0.001$)		
Wylie et al., 2016 (Wylie et al., 2016) Cross sectional study	Mental health (SF-36: Mental Component Summary)	Mental health had the strongest negative correlation of shoulder pain ($r = -0.09$; $p < 0.001$)	Mental health had the strongest negative correlation of shoulder function ($r = -0.07$, $p < 0.001$) A positive correlation between mental health and the shoulder functions ($r = 0.79$, $p < 0.001$; $r = 0.09$, $p < 0.001$)	–	Moderate

Abbreviations: ASES = American Shoulder and Elbow Surgeons scale; DASS = Depression, Anxiety and Stress scale;; FABQ-PA=Fear-Avoidance Beliefs Questionnaire-Physical Activity; FPQS-III=Fear of Pain Questionnaire; HADS-A = Hospital Anxiety and Depression Scale-Anxiety; HADS-D = Hospital Anxiety and Depression Scale-Depression; KSS=Korean Shoulder Scale; MODEMS = Musculoskeletal Outcomes Data Evaluation and Management System; SPADI-F=Shoulder Pain and Disability Index-Function; PCS=Pain Catastrophizing Scale; PSEQ=Pain Self-Efficacy Questionnaire; PSQI=Pittsburgh Sleep Quality Index; SF-36 = Short Form-36; TSK-11 = Tampa Scale of Kinesiophobia; UCLA=University of California Los Angeles Scale; VAS=Visual Analogue Scale; WORC=Western Ontario Rotator Cuff Index.

2018). Therefore, when treating patients with rotator cuff tendinopathy, psychological factors should be considered and addressed as different psychological factors affect patient-reported outcomes as well as treatment outcomes.

4.3. *Clinical implications*

Understanding the interplay between psychological factors and rotator cuff tendinopathy is essential for clinicians, surgeons, and physiotherapists in order to educate patients about the possible effects of psychological factors on their physical pain. Clinicians, surgeons, and physiotherapists correcting maladaptive beliefs and who encourage patients during treatment may contribute to more optimal treatment outcomes. For more severe cases, consulting clinical psychologists or psychiatrists may be considered and patients could be referred to subsequent specialists if necessary. Currently, multidisciplinary biopsychosocial interventions have been developed to treat patients with chronic low back pain, particularly those with severe conditions (van Erp et al., 2019). Under this framework, cognitive behavioural strategies, such as acceptance and commitment therapy, are used to improve treatment effects (Hayes, 2016; Trompetter et al., 2015). In light of treating patients with rotator cuff tendinopathy, which is similar to chronic low back pain, a biopsychosocial framework with cognitive behavioural strategies and education could be incorporated into the treatment plan for patients with rotator cuff tendinopathy (Vlaeyen and Linton, 2000).

4.4. *Limitations*

The current review has several limitations that need to be considered. (1) Inconsistency in the diagnostic criteria for rotator cuff tendinopathy may result in large heterogeneity across studies. (2) This review reported the association between psychological factors and patient-reported outcomes in patients with rotator cuff tendinopathy, and the causal relationship warrants future high-quality prospective studies. (3) Distress, fear of pain and pain catastrophizing were evaluated by a self-administered questionnaire (Alizadehkhaiyat et al., 2017; George and Hirsh, 2009). As there were no pre-screening or structural psychological interviews conducted for patients with rotator cuff tendinopathy in the included studies, misclassification of psychological distress could occur. Thus, lacking of the knowledge of the understanding of the psychological questionnaire is the obstacle interfering the analyses between different studies. (4) Due to the small number of studies and large heterogeneity across studies, conducting a meta-analysis was impossible. Further high-quality prospective studies are required to identify the psychological factors that may affect the patient-reported outcomes in patients with rotator cuff tendinopathy.

5. Conclusion

This systematic review showed that approximately 1/4 of patients with rotator cuff tendinopathy report to have depressive and anxious symptoms, and almost 90% of patients report poor sleep quality or insomnia. Low-to-moderate quality of evidence suggest that various psychological factors may be associated with pain, function and quality of life in patients with rotator cuff tendinopathy, and the causal relationship warrants future high-quality prospective studies. Biopsychosocial interventions with cognitive-behavioural strategies and educating patients with rotator cuff tendinopathy on the effects of psychological factors should be considered and warrants further investigation.

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Appendix A. Supplementary data

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APPENDIX

*Appendix 1. Quality of evidence using the GRADE approach*Appendix 1

Appendix 1
Quality of evidence using the GRADE system

Authors	Quality of study					Overall quality of evidence
	Risk of bias	Inconsistency	Imprecision	Indirectness	Publication bias	
Alizadehkhaiyat et al., 2017 (Alizadehkhaiyat et al., 2017) (Cross-sectional)	Not serious	Not serious	Serious	Not serious	Undetected	Moderate
Austin et al., 2015 (Austin et al., 2015) (Case series)	Not serious	Not serious	Serious	Not serious	Undetected	Moderate
Barlow et al., 2016 (Barlow et al., 2016) (Cross-sectional)	Serious	Not serious	Not serious	Not serious	Undetected	Moderate
Cho et al., 2013 (Cho et al., 2013) (Cross-sectional)	Serious	Not serious	Not serious	Not serious	Undetected	Moderate
Cho et al., 2015 (Cho et al., 2015) (Prospective cohort study)	Serious	Not serious	Serious	Not serious	Undetected	Low
George and Hirsh, 2009 (George and Hirsh, 2009) (Cross-sectional)	Serious	Not serious	Serious	Not serious	Undetected	Low
Khazzam et al., 2018 (Khazzam et al., 2018) (Cross-sectional)	Serious	Not serious	Not serious	Not serious	Undetected	Moderate
Kromer et al., 2014 (Kromer et al., 2014) (Cross-sectional)	Not serious	Not serious	Serious	Not serious	Undetected	Moderate
Oh et al., 2012 (Oh et al., 2012) (Prospective cohort study)	Serious	Not serious	Not serious	Not serious	Undetected	Moderate
Piitulainen et al., 2012 (Piitulainen et al., 2012) (Cross-sectional)	Not serious	Not serious	Serious	Not serious	Undetected	Moderate
Potter et al., 2014 (Potter et al., 2014) (Prospective cohort)	Serious	Not serious	Not serious	Not serious	Undetected	Moderate
Tashjian et al., 2004 (Tashjian et al., 2004) (Cross-sectional)	Serious	Not serious	Not serious	Not serious	Undetected	Moderate
Thorpe et al., 2018 (Thorpe et al., 2018) (Prospective cohort study)	Serious	Not serious	Not serious	Not serious	Undetected	Moderate
Wylie et al., 2016 (Wylie et al., 2016) (Cross-sectional)	Serious	Not serious	Not serious	Not serious	Undetected	Moderate

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