The effect of perioperative psychological interventions on persistent pain, disability, and quality of life in patients undergoing spinal fusion

European Spine Journal
https://doi.org/10.1007/s00586-022-07426-1

REVIEW ARTICLE

The effect of perioperative psychological interventions on persistent pain, disability, and quality of life in patients undergoing spinal fusion: a systematic review

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Received: 16 January 2022 / Revised: 25 September 2022 / Accepted: 11 October 2022

Abstract

Purpose Patients undergoing spinal fusion are prone to develop persisting spinal pain that may be related to pre-existent psychological factors. The aim of this review was to summarize the existing evidence about perioperative psychological interventions and to analyze their effect on postoperative pain, disability, and quality of life in adult patients undergoing complex surgery for spinal disorders. Studies investigating any kind of psychological intervention explicitly targeting patients undergoing a surgical fusion on the spine were included.

Methods We included articles that analyzed the effects of perioperative psychological interventions on either pain, disability, and/or quality of life in adult patients with a primary diagnosis of degenerative or neoplastic spinal disease, undergoing surgical fusion of the spine. We focused on interventions that had a clearly defined psychological component. Two independent reviewers used the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) to perform a systematic review on different databases. Risk of bias was evaluated using the Downs and Black checklist. Given study differences in outcome measures and interventions administered, a meta-analysis was not performed. Instead, a qualitative synthesis of main results of included papers was obtained.

Results Thirteen studies, conducted between 2004 and 2017, were included. The majority were randomized-controlled trials (85%) and most patients underwent lumbar fusion (92%). Cognitive behavioral therapy (CBT) was used in nine studies (69%). CBT in the perioperative period may lead to a postoperative reduction in pain and disability in the short-term follow-up compared to care as usual. There was less evidence for an additional effect of CBT at intermediate and long-term follow-up.

Conclusion The existing evidence suggests that a reduction in pain and disability in the short-term, starting from immediately after surgery to 3 months, is likely to be obtained when a CBT approach is used. However, there is inconclusive evidence regarding the long-term effect of a perioperative psychological intervention after spinal fusion surgery. Further research is necessary to better define the frequency, intensity, and timing of such an approach in relation to the surgical intervention, to be able to maximize its effect and be beneficial to patients.

Keywords Pain, postoperative · Spinal fusion · Cognitive behavioral therapy · Psychological intervention

Introduction

Fusion of the spine can be performed in many different ways at various levels (cervical, dorsal and lumbosacral) to treat pathologies like trauma, infections, neoplastic, and degenerative diseases. In recent years, there has been a rapid increase in the use of spinal fusion techniques [1]. However, despite the well-defined role of fusion procedures in reducing pain and disability in selected cases [2, 3], a certain percentage of patients develop persisting spinal pain (PSP) and disability after surgery, with consequent deterioration in quality of life. In a multicenter, prospective observational study on 3120 patients enrolled in an European registry, Fletcher et al. [4] found that 56,5% of patients undergoing spinal surgery experienced mild to moderate pain 12 months after the procedure.

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In the last twenty years, research has attempted to understand the causes of PSP after spinal surgery [5, 6]. These efforts have caused a transition from a dualistic model of pain, based on the concept that the mind and the body work separately, to a biopsychosocial model, where emotions and cognitions interact with neurobiological factors to generate pain experiences [7]. Based on this model, several risk factors for an unfavorable outcome after spinal surgery have been identified, among which psychological factors [8–10], such as preoperative anxiety [11], depression [12], and negative cognitions about pain [13]. Of these, pain catastrophizing, that is an adverse coping mechanism that produces an exaggerated response to pain, has been identified as a key factor for developing PSP after spinal surgery [14, 15].

Psychological factors are modifiable and can be a target for intervention. This intervention can be implemented in the preoperative [16] and/or postoperative [17] phase. However, despite the presence of solid evidence regarding the effect of psychological techniques like cognitive behavioral therapy (CBT) in patients suffering from chronic lumbar pain [18], the literature is not conclusive about the effect of CBT before and/or after spinal surgery, and specifically spinal fusion surgery. In particular, there is uncertainty regarding the type of psychological intervention, the intensity needed to obtain an effect, and the type of professional that should be administering the intervention.

The main goal of this systematic review is to determine the effect of perioperative psychological interventions on pain, disability and health-related quality of life (HRQOL) in patients undergoing spinal fusion surgery at any level of the spine, at short-term (≤ 3 months), intermediate-term (> 3 months but < 12 months) and long-term (≥ 12 months) follow-up. The secondary goal was to analyze the effect on use of pain medication (MED), patient's global impression of change (PGIC), return to work (RTW), and patient satisfaction.

Methods

This systematic review was conducted according to the guidelines outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement [19]. A protocol was created in advance and uploaded to the PROSPERO online platform (CRD42020187047).

Data sources and search strategy

The following databases were systematically searched by two independent reviewers (PS and WvS), without any limitations in study design, for articles in English, Dutch or Italian published prior to March 31, 2020: Pubmed, Embase, PsycINFO, Cinahl, Cochrane database of systematic reviews and Cochrane Central register of controlled trials. Initial search terms included spinal fusion, spondylosyndes*, ankylosis, pedicle screw, bone screws, cognitive behavioral therapy, behavioral therapy, acceptance and commitment therapy, mindfulness, guided imagery, and relaxation training, in various permutations.

Eligibility criteria and study selection

Articles were considered for inclusion if they met the following criteria: (1) primary research article in a peer-reviewed journal; (2) participant sample included adult patients (18-year-old or above) with a primary diagnosis of degenerative or neoplastic spinal disease, undergoing a spinal fusion surgery; (3) a psychological intervention was administered in the perioperative period (starting between 3 months before and 3 months after surgery); (4) outcomes measuring either pain, disability and/or HRQOL were reported. Qualitative and quantitative studies investigating any kind of psychological intervention explicitly targeting patients undergoing a surgical fusion on the spine were included, independently of the design of the study.

We excluded: (1) reviews, meta-analyses, letters to the editor, expert opinions, and studies that did not describe any treatment parameters; (2) articles that included patients with a primary diagnosis of idiopathic scoliosis and (3) studies that did not include analyses of clinical efficacy.

Psychological interventions were defined as interventions that use psychological techniques to decrease psychological distress or modify emotions and/or cognitions into a desirable direction. Interventions delivered in person, by telephone, online or by mobile applications, or a combination of these methods, were included. In addition, interventions could be delivered individually or in groups, and there was no restriction on who delivered the intervention. A brief description of these techniques is provided in Table 1. Music therapy and hypnosis were excluded. We also excluded studies where psychological intervention was combined with another active intervention (e.g., physical therapy), unless the same additional intervention was also part of the control intervention. Moreover, if the intervention was compared to other arms, as for example in randomized controlled studies (RCTs), there was no restriction on the type of comparator used.

A meta-analysis was not performed due to the limited statistical power as a result of methodological variation and a small number of studies. Outcomes of the reviewed studies are reported as they were presented in the original manuscript.

Two authors (PS and WvS) independently screened the titles and abstracts and potential eligible studies were screened on the in- and exclusion criteria in full text. References cited in eligible studies that were considered to be

Table 1 Definition of the most common psychological treatments considered in this review

Psychological perioperative treatments
Cognitive-behavioral therapies
Psychosocial interventions aimed at identifying and challenging maladaptive thoughts, positively modifying feelings and behaviors, and thereby experiences; interventions may focus on the cognitive component or directly influence behavioral responses [55]
Acceptance and commitment therapy
Interventions focused on fostering committed engagement with valued life activities, while promoting mindfulness and acceptance of difficult private experiences, such as pain [56]
Relaxation techniques
Physical and cognitive treatments (such as progressive muscle relaxation, simple relaxation, breathing practices, music relaxation) aimed at reducing sympathetic arousal, increasing the feeling of calm, and improving self-control [57]
Mindfulness-based interventions
Psychological interventions inspired by religion-based practices of meditation and contemplation; these presuppose patient engagement in the relevant aspects of the present experience in a non-judgmental manner [55, 58]
Psychoeducation
Interventions that accompany the individual with difficulty of adaptation (depression, behavioral problem, relational difficulty, etc.) so that he / she can adjust to his/her environment (friends, school, family, workplace, etc.). The specificity of psychoeducational intervention is that it takes place in the natural environment of the person where all the moments of everyday life are then used to allow the individual to acquire the necessary skills to achieve his objectives [59]
Guided-imagery
Mind-focused techniques ranging from visualization and direct imagery-based suggestion through metaphor and storytelling. They affect almost all major physiologic control systems of the body, including respiration, heart rate, and blood pressure [60]

relevant were also retrieved and assessed in full text. In case of disagreement between authors, a third investigator (MP) resolved the disagreement through discussion.

Data extraction

Two authors (PS and WvS) independently extracted the following data from each included study: 1) Study characteristics: lead author, publication year, country of publication, publication type and study design; (2) Patient information: population description, inclusion and exclusion criteria, sample size, mean age, percentage of women, site of pain, baseline scores of outcome variables, type of condition for which participants were operated; (3) Characteristics of the psychological and control interventions: type of intervention, group or individual intervention, targeted at at risk patients or not, intensity (number and duration of sessions, time span of treatment), mode of delivery, person delivering the intervention, efficacy of intervention, other treatments received; (4) Surgical procedure: site of surgery, indication (degenerative/neoplastic), surgical technique; (4) Outcome information: which outcome assessed, assessment instrument, time points for measurement. A descriptive statistic was obtained for each primary and secondary outcome. Differences between the two authors were resolved by a third author (MP) after discussion. The full extraction scheme can be found in Online Resources 1 and 2.

Risk of bias assessment

The risk of bias was assessed by two authors (PS and WvS) independently using a modified version of Downs and Black checklist for randomized and non-randomized studies [20]. It consists of 27 items that are distributed between five subscales (reporting, external validity, bias, confounding and power). Each item is scored 0 or 1, except for one item in the reporting subscale, which is scored 0 to 2. The total maximum score is 28. Justification for each score is available in Online Resource 3. Downs and Black score ranges were given quality levels as previously reported [21]: excellent (26–28); good (20–25); fair (15–19); and poor ($<$ or $=$ 14).

Results

Figure 1 illustrates the PRISMA flowchart for the process of study retrieval and inclusion. The search identified 1132 records. After duplicates removal, 849 were screened for potential eligibility. In total 22 papers were assessed in full text for final eligibility and 13 papers were included in the qualitative synthesis. Table 2 shows a summary of the studies included in this review. All studies were conducted between 2004 and 2017. The vast majority were RCTs, (85%). Twelve studies analyzed a psychological intervention related to lumbar fusion surgery (92%), one also to cervical fusion surgery. CBT, alone or in combination with another intervention, was used in nine studies (69%)),

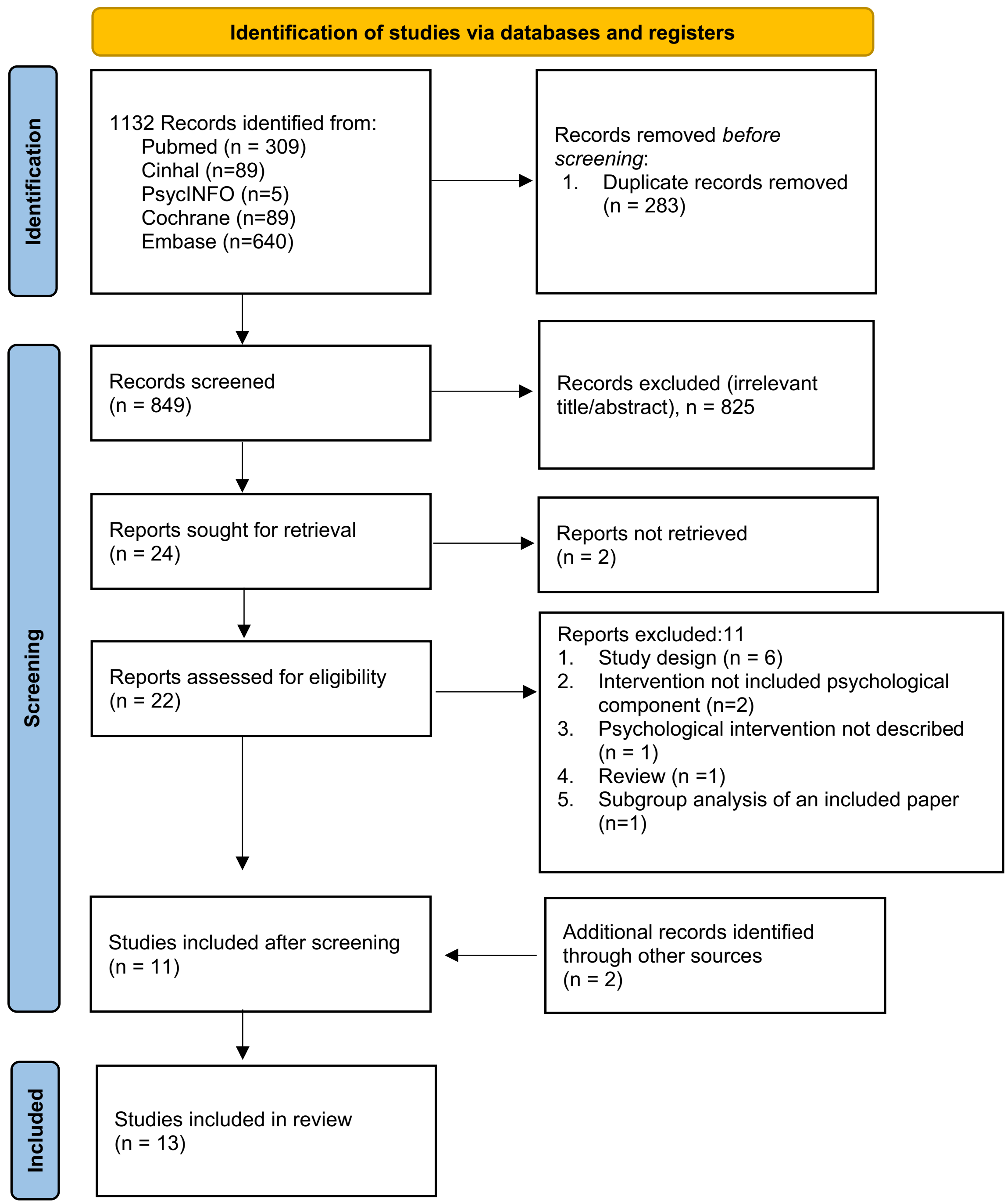

Fig. 1 PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only

mindfulness-based cognitive therapy in two studies (15%), and relaxation and psychoeducation each in one study (8%).

Comparators were physiotherapy in 9 studies, while in 4 studies the characteristics of the control intervention were not specified. The rehabilitation program varied between studies: in four studies, an educational session with preoperative information about the upcoming operation and the anesthetic procedure, medication, and information about the postoperative rehabilitation and physical restrictions after surgery was performed, together with a non-structured physiotherapy program; in three studies, the patients followed a structured perioperative program, with planned sessions conducted in person and/or by telephone and a manual or diary to follow along with the study therapists, while in the remaining two studies, only non-supervised physiotherapy was performed.

Table 2 Study characteristics

Study/country/design	Recruitment period	Surgery type	Type of psychological intervention	Primary outcomes			Secondary outcomes				Risk of bias
				Pain	Disability	HRQOL	Satisf	PGIC	MED	RTW	Downs and black score
Abbott et al. [23] Sweden RCT	2005–2007	Lumbar fusion for degenerative disease	CBT and relaxation	VAS	ODI	EQ-5 SF-36	Treatment satisfaction at 2–3 Y		Analgesic consumption Y/N at 2–3 Y	Work status at 2–3 Y	23 (Good)
Archer et al. [22] USA RCT	2012–2013	Lumbar fusion for degenerative disease	CBT	BPI	ODI	SF-12	–	–	–	–	27 (Excellent)
Gavin et al. [32] USA RCT	2004–2005	Cervical discectomy and fusion, lumbar laminectomy, or lumbar fusion	Relaxation therapy	NRS	–	–	–	–	Narcotic demand (milligrams of IV morphine equivalent)	–	21 (Good)
Lotzke et al. [33] Sweden RCT	2014–2017	Lumbar fusion for degenerative disease	CBT	VAS	ODI	EQ-5					25 (Good)
Monticone et al.[24] Italy RCT	2008–2010	Lumbar fusion for degenerative disease	CBT	NRS	ODI	SF-36		Global perceived effect (GPE) of treatment using a 5-point scale (1 = helped a lot; 5 = made things worse) at 4 W			24 (Good)

Table 2 (continued)

Study/country/design	Recruitment period	Surgery type	Type of psychological intervention	Primary outcomes			Secondary outcomes				Risk of bias
				Pain	Disability	HRQOL	Satisf	PGIC	MED	RTW	Downs and black score
Von der Hoeh et al. [34] Germany Qualitative/Uncontrolled	2007–2010	Patients with with chronic nonspecific low back pain who received inpatient treatment for multidisciplinary pain program and surgery for degenerative conditions of the lumbar spine	CBT	NRS	Other	–					10 (Poor)
Reichart et al. [25] Germany RCT	NS	Lumbar fusion for degenerative disease	CBT	VAS	Other	–					17 (Fair)
Rolving et al. [28] Denmark RCT	2011–2013	Lumbar fusion for degenerative disease	CBT	Other	ODI					Data on RTW obtained from the Danish registry for evaluation of margin-alization (DREAM) at each time point	25 (Good)
Rolving et al. [29] Denmark RCT	2011–2013	Lumbar fusion for degenerative disease	CBT	NRS	–	–			Consumption of rescue analgesics (i.e., analgesic consumption beyond the standardided analgesic protocol)		23 (Good)

Table 2 (continued)

Study/country/design	Recruitment period	Surgery type	Type of psychological intervention	Primary outcomes			Secondary outcomes				Risk of bias
				Pain	Disability	HRQOL	Satisf	PGIC	MED	RTW	Downs and black score
Rolving et al. [30] Denmark RCT	2011–2013	Lumbar fusion for degenerative disease	CBT		ODI	Quality-adjusted life years (QALY), based on the EQ-5D scores			Prescription medicine was recorded uniquely per patient in the Danish National Prescription Registry and was valued using market prices	The number of weeks of sick leave was obtained from the Danish Register for the Evaluation of Marginalization (DREAM)	21 (Good)
Strøm et al. [31] Denmark RCT	2015–2017	Lumbar fusion for degenerative disease	Psychoeducation	Low Back Pain Rating Scale (LBPRS)	ODI	EQ-5					24 (Good)
Yi et al. [27] USA Quasi-experimental	2016–2017	Lumbar fusion for degenerative disease	Mindfulness based cognitive therapy and mindfulness-based stress reduction	VAS	ODI	EQ-5			Morphine equivalent dosing per day		20 (Good)
Chavez et al. [26] USA Quasi-experimental	2016–2017	Lumbar fusion for degenerative disease	Mindfulness based cognitive therapy and mindfulness-based stress reduction	VAS	ODI	–			Morphine equivalent dosing per day		18 (Fair)

The most frequently investigated outcomes were pain (92%, Visual Analog Scale-(VAS), Numeric Pain Rating Scale (NRS) and other scores), disability (77%, Oswestry Disability Index-ODI and other scores) and HRQOL (61.5%, EQ-5D, SF-36 and SF-12). MED was evaluated in six studies, PGIC in two, RTW in three, and patient satisfaction in one.

A total of 830 patients (Table 3) were included in the studies, with a mean age of 59 years for both the intervention and control group. Three papers studied the effects of a psychological intervention that was administered preoperatively, three postoperatively and six both pre- and post-operatively (not specified in one study). The intensity (duration and timespan) of the interventions varied considerably, ranging from 60 to 960 min (1 to 16 h) in a timeframe between 5 days and 6 months. There was also variability in the professional that delivered the intervention, the most frequent provider being a physiotherapist with or without a psychologist supervision (4 studies) followed by health professionals' teams (3 studies), online support groups or internet platforms (3 studies), a psychologist (2 studies), and a surgeon (1 study). In one study [22], the intervention was targeted toward patients that presented an increased risk of developing persisting pain. Individual interventions were performed in four studies, group interventions in three studies, while in six studies this information was not available.

Information on relevant findings and timing of surgical outcomes in the selected studies are reported in Table 4. Follow-up duration varied considerable between the studies. Twelve studies reported a short-term follow-up (≤ 3 months), seven studies an intermediate follow-up (> 3 months but < 12 months), and six studies a long-term follow-up (≥ 12 months). Only three studies evaluated patients at short, intermediate and long-term follow-up.

Of the thirteen studies included in the review, nine (69%) showed an effect of a psychological intervention on one or more primary outcomes. In particular, six out of 12 studies demonstrated a statistically significant reduction in postoperative pain on any timepoint; this was in 5 out of 11 at short-term follow-up [23–27], in 2 out of 6 at intermediate follow-up [22, 23] and in 1 out of 5 [24] at long-term follow-up.

Eight out of 11 studies demonstrated a statistically significant reduction in disability scores due to psychological therapies at short-term follow-up [22–26, 28–30]; in five of them [22–24, 26, 30] an effect was also demonstrated at intermediate and/or long-term follow-up. Four out of seven studies [22–24, 30] showed a positive effect on HRQOL; in three of these, the effect was seen at long-term follow-up [23, 24, 30], and in one [22] at short term follow-up.

Overall, pain and disability were the most frequently reported outcomes. For these outcomes, a short-term follow-up was more often at 3 months, whereas a long-term was at 12 months. At 3 months, an effect of a psychological intervention was demonstrated in 3 studies out of 6 for pain, and in 5 studies out of 7 for disability. At 12 months, in 2 studies out of 6 for pain and the same for disability.

In terms of analgesic consumption, a lower consumption was observed after preoperative CBT in one out of five studies [29], although the difference between groups was only significant on postoperative day 2. One study out of two showed an effect on RTW at long-term follow-up [23], and in another one (the only one that explored this outcome) [24], PGIC was significantly better after a postoperative psychological intervention at short-term follow-up. One study [23] explored the effect of psychological treatment on patient satisfaction, and found no difference at 2–3 years follow-up.

Despite the large heterogeneity in treatments and protocols to evaluate their efficacy in the included studies, some factors seem to influence the effect of a perioperative psychological treatment. Intensity and frequency of intervention possibly moderate postoperative pain at short term-follow-up; in the five studies where an effect on short-term postoperative pain was demonstrated [23–27], mean frequency and duration of the psychological treatment were 6 sessions and 546 min (range 60–960), versus 5 sessions and 476 in the other 6 where no effect was shown (range 60–1080). With regards to disability, of the four studies that did not find any effect on this outcome, two were using online platforms without verification whether the patients completed the sessions or not [27, 31]. On the other hand, more intensive interventions were related to decreased disability [22, 23, 28, 30]

Other moderators may be type and timing of intervention. Seven studies out of nine where any effect was demonstrated on pain or disability made use of CBT and included postoperative sessions [22–25, 28–30]. Two out of four studies that did not find any effect used interventions other than CBT (namely relaxation therapy [32] and an internet support group [31], one [33] mainly had preoperative sessions, and in another one [34] timing of the intervention was not specified.

For all other variables (intervention provider, modality of the intervention and tailoring of the intervention toward patients at risk) there was large heterogeneity and not enough data to draw any conclusion.

Risk of bias assessment

The vast majority of the included studies had a low risk of bias. Eleven out of the 13 studies had a score > 20 on the modified Downs and Black checklist, meaning a good or excellent quality level (Table 2).

Table 3 Patient and intervention characteristics

Study	Sample	Timing of psychological intervention	Intensity (duration* and timespan)	Professional who delivered the intervention
Abbott et al. [23]	Intervention: n = 53 (Females 66%); age 50 ± 10 Control: n = 54 (Females 57%); age 51 ± 11	Post-surgery	3 sessions (270 min) 12 weeks	Physiotherapist
Archer et al. [22]	Intervention: n = 43 (Females 58%); age 57 ± 11 Control: n = 43 (Females 53%); age 58 ± 13	Post-surgery	6 sessions (210 min) 6 weeks	Physiotherapist
Gavin et al.[32]	Intervention: n = 31 (Females 74%); age 56 ± 16 Control: n = 27 (Females 68%); age 56 ± 18	Pre and post-surgery	2 sessions (60 min) 1 week	Primary researcher (surgeon)
Lotzke et al.[33]	Intervention: n = 59 (Females 56%); age 45 ± 8 Control: n = 59 (Females 51%); age 47 ± 8	Pre and post-surgery	4 sessions pre-surgery (240 min) and 1 session post-surgery (90 min) 14 weeks	Physiotherapist
Monticone et al.[24]	Intervention: n = 65 (Females 68%); age 59 ± 12 Control: n = 65 (Females 54%); age 56 ± 14	Post-surgery	8 sessions (480 min) 4 weeks	Physiotherapist with psychologist supervision
Von der Hoeh et al. [34]	Intervention: n = 7 (Females 80%); age 64 (38–82) No control group	NS	NS	Psychologist
Reichart et al.[25]	Intervention: n = 19 (Females 58%); age 59 Control: n = 20 (Females 55%); age 59	Pre and post-surgery	1 session pre-surgery (30 min) and 1 session post-surgery (30 min) 5 days	Psychologist
Rolving et al. [28]	Intervention: n = 59 (Females 61%); age 51 ± 9 Control: n = 31 (Females 48%); age 48 ± 9	Pre and post-surgery	4 sessions pre-surgery (720 min) and 2 sessions post-surgery (360 min) 6 months	Health professionals' team
Rolving et al.[29]	See Rolving et al. [28]	Pre-surgery	4 sessions (720 min) NS	Health professionals' team
Rolving et al. [30]	See Rolving et al. [28]	Pre and post-surgery	4 sessions pre-surgery (720 min) and 2 sessions post-surgery (360 min) 6 months	Health professionals' team
Strøm et al. [31]	Intervention: n = 48 (Females 54%); age 53 (29–77) Control: n = 51 (Females 75%); age 55 (30–79)	Pre and post-surgery	Free sessions Variable timespan	Internet support group
Yi et al. [27]	Intervention: n = 53 (Females 66%); age 50 ± 10 Control: n = 54 (Females 57%); age 51 ± 11	Pre-surgery	9 sessions (960 min) NS	Online platform
Chavez et al. [26]	Intervention: n = 24 (Females 54%); age 61 ± 7 Control: n = 24 (Females 54%); age 63 ± 8	Pre-surgery	9 sessions (960 min) NS	Online platform

*The duration of the intervention is considered as the multiplication of the time per session and the number of sessionsdelivered

Discussion

This systematic review is the first that summarizes the effects of psychological interventions on pain, disability, and quality of life in adult patients undergoing surgical fusion of the spine. Compared to recent reviews [35, 36], we focused on interventions that had a clearly defined psychological component, and excluded studies that analyzed patients

Table 4 Summary of relevant findings for selected studies

Study/Country/Design	Outcomes	Follow-up dates			Relevant findings	Intervention effective?
		Short	Intermediate	Long		
Abbott et al. [23] Sweden RCT	Pain, Disability, HRQOL, Satisfaction, Analgesics consumption, Work status	3 M	6 M	12,24,36 M	Both CBT and exercise therapy significantly improved in all outcome measures from baseline to 2 to 3 years after surgery. Analysis of covariance showed that CBT group scores for ODI, SES, BBQ, and TSK improved significantly more than for the exercise therapy group scores at 3, 6, 12 months, and 2 to 3 years after the operation Furthermore, the CBT group's back pain VAS at 3 and 6 months, EQ-5D at 12 months, CSQ-CAT at 6 months and 2 to 3 years as well as CSQ-COP and CSQ-ADP at 3, 6, and 12 months, significantly improved more than the exercise therapy group. Significantly more patients in the CBT group were employed 2 to 3 years after surgery and fewer had sickness leave duration of longer than 6 months after surgery compared with the control group	Yes
Archer et al. [22] USA RCT	Pain, Disability, HRQOL	3 M	6 M	NA	CBT participants demonstrated greater improvement in back and leg pain and pain interference with activity Improvement in back and leg intensity was statistically significant, but not clinically meaningful, which may be due to the relatively low pain scores after surgery Disability and general health (SF-12) improvement in the CBT group were evaluated immediately post-intervention (8 weeks) and 3 months later (approx. 5 months after surgery): both were statistically significant better than in controls and clinically significant based on published MCID values. Group differences in pain, disability and general health were statistically significant at latest follow-up ($P < .05$), but not posttreatment The mean change from pretreatment to latest follow-up for the CBPT group was above MCID for the BPI pain interference score (1.7 points; 95% CI = 2.4 to 1.1) and ODI score (17.3; 95% CI = 20.3 to 14.4)	Yes

Table 4 (continued)

Study/Country/Design	Outcomes	Follow-up dates			Relevant findings	Intervention effective?
		Short	Intermediate	Long		
Gavin et al.[32] USA RCT	Pain and Narcotics demand	POD 1–2	NA	NA	The average pain score on POD 1 was higher in the relaxation group (4.8 ± 1.7; CI,1.5–8.1) versus the control group (3.9 ± 1.7; CI,0.6–7.2), but was lower on POD 2 (3.9 ± 1.9; CI,0.2–7.6 vs 4.1 ± 1.9; CI,0.4–7.8) Using morphine dose administered in the PACU as a covariate, analysis of covariance yielded a significant (P = 0.01) main effect on narcotic demand (milligrams per hour) for the preparation condition such that demand was higher in the relaxation group on POD 1 and POD 2 The data demonstrated no statistically significant difference in reported pain, but significantly higher narcotic demand among those patients who received relaxation training versus those who did not over the first 2 days postoperatively	No
Lotzke et al.[33] Sweden RCT	Pain, Disability, HRQOL	2,3 M	6 M	NA	No statistically significant difference was found between groups in ITT analyses for primary hypothesis (patients who received the active intervention would experience a greater reduction in disability levels after surgery than ones receiving conventional care at 6 M) Among secondary outcome measures, a statistically significant interaction effect was seen for EQ5D in the ITT analyses. The ODI change from baseline to 6 months was statistically significant in each group separately. Moreover, at 8 weeks postoperatively, ODI had already decreased by at least 8 points For secondary outcomes, the change from baseline to 6 months was statistically significant for almost all variables in each group separately. Both groups reached a stable plateau of change in primary and secondary outcomes by 8 weeks postoperatively (ie, no further change after 8 weeks). Also, by 8 weeks postoperatively, both groups had reached the MIC value in several secondary outcome measures	No
Monticone et al.[24] Italy RCT	Pain, Disability, HRQOL and PGIC	1 M	NA	12 M	The primary endpoint was the pre- and post-treatment difference (T2-T1) in total ODI scores. T2 was 4 W postop The effect of treatment was significantly greater in the experimental group than in the control group (T2-T1 mean change 26.8 vs. 15.4) Regarding secondary outcomes, all the scores significantly improved between T1 and T3 in the experimental group, whereas there was less change in the control group	Yes

Table 4 (continued)

Study/Country/Design	Outcomes	Follow-up dates			Relevant findings	Intervention effective?
		Short	Intermediate	Long		
Von der Hoeh et al. [34] Germany Qualitative/Uncontrolled	Pain, Disability	NA	6 M	12 M	Only two patients from the spine group improved in their overall values. One patient even reported a worsened pain level. Eight patients in this group maintained their levels throughout the 12-month follow-up period	No
Reichart et al.[25] Germany RCT	Pain, Disability	6 W	NA	NA	There was a statistically significant main effect of the factor Time $p < 0.001$, but no significant effect of the factor Group ($p = 0.667$) on mean pain intensity. For the outcome "highest pain intensity", the main effect of the factor Group showed an overall trend toward lower intensities in the intervention group. No significant main effect of factor Time and Group for fear-avoidance beliefs and disability. However, there was a statistically significant Group x Time interaction for physical fitness that was used as disability measure. The effect was due to a statistically significant deterioration in physical fitness from T1 to T2 in the control group	Yes
Rolving et al. [28] Denmark RCT	Pain, Disability, HRQOL and RTW	3 M	6 M	12 M	Addition of a preoperative CBT intervention to usual care did not produce significantly better results in terms of reduced disability 1 year after surgery However, the CBT group achieved significant functional recovery already at 3 months and they maintained this throughout the first year after surgery. Mean reduction of ODI was 14 points, less than Monticone et al. Similar improvements at 1 year concerning psychological variables were obtained in the 2 groups. No effect was shown for other secondary outcomes including pain, HRQOL and RTW To be noted: compliance in CBT group was 83%. An as-treated analysis (with the non-compliant patients analyzed as control patients) resulted in a significant difference between groups on the primary outcome ODI (− 18 points [− 28 to − 8] vs. − 5.5 points [− 18 to 4] $P = 0.003$	Yes

Table 4 (continued)

Study/Country/Design	Outcomes	Follow-up dates			Relevant findings	Intervention effective?
		Short	Intermediate	Long		
Rolving et al.[29] Denmark RCT	Pain, analgesics consumption and LOS	POD 4	NA	NA	For the primary outcome the CBT group reported a median back pain severity of 5.6 (range 1.7–10.0), which was no different from that of the control group of 5.3 (range 1.1–7.7) ($P = 0.73$). With regards to postoperative mobility patients in the CBT group performed superiorly on the measured activities during the first 3 postoperative days. Thus, independent walking ability was achieved by 39% (n = 23) versus 16% (n = 5) ($P < 0.026$) on day 2, and by 73% (n = 43) versus 48% (n = 15) of patients on day 3 ($P < 0.02$) In terms of analgesic consumption, a lower consumption was observed in the CBT group, although the difference between groups was only significant on postoperative day 2	Yes
Rolving et al. [30] Denmark RCT	ODI, HRQOL	3 M	6 M	12 M	At 1-year follow-up a significant difference of 0.071 QALY (95% CI: 0.001; 0.139) was seen in favor of the CBT group (P 0.045). With regards to ODI the CBT group achieved significantly larger reductions in disability from baseline to 3 months (P 0.003), and from baseline to 6 months (P 0.047) At 1 year this difference between groups had evened out	Yes
Strøm et al. [31] Denmark RCT	Pain, Disability, HRQOL	3 M	6 M	NA	Comparing the two groups, no significant differences were found between the groups in the overall changes of ODI, LBPRS, and EQ-5D-5L at 2 days or 3 or 6 months after surgery	No
Yi et al. [27] USA Quasi-experimental	Pain, Disability, HRQOL, analgesic consumption,	1 M	NA	NA	At 30-day follow-up, the mean MED per day was not significantly different between groups For patient-reported outcomes, only mean VAS-BP was significantly different, with the comparison group having higher scores (3.864 vs. 1.870; P ¼ 0.004). For the change in mean patient-reported outcomes from baseline, there were no statistically significant differences between groups The change in mean MED per day at 30 days compared with preoperatively was not significantly different between groups	Yes

Table 4 (continued)

Study/Country/Design	Outcomes	Follow-up dates			Relevant findings	Intervention effective?
		Short	Intermediate	Long		
Chavez et al. [26] USA Quasi-experimental	Pain, Disability, HRQOL	3 M	NA	12 M	Participants who underwent a preoperative MBSR course reported improved PROs postoperatively. Although initial results showed that the intervention group had only less back pain at 30 days, at 3 months the intervention group had less disability, higher physical function, and lower pain interference. At 12 months, significantly lower pain interference persisted in the intervention group, and pain interference continued to be significantly lower compared with baseline	Yes

undergoing less painful surgical procedures, like discectomy or lumbar decompression. Our work suggests that a psychological intervention in the perioperative period leads to a postoperative reduction of disability in the short-term follow-up compared to usual care, including rehabilitation with or without an educational component, and may lead to a postoperative reduction of pain. There is less evidence that these interventions have an additional effect at intermediate and long-term follow-up. Health-related quality of life was analyzed in seven papers; the majority of these showed some effect of a psychological intervention, and interestingly in three out of four papers this effect was seen at long-term follow-up.

Only few studies examined the effect of psychological intervention on MED and RTW. One study observed a lower consumption of analgesics after pre-operative CBT at postoperative day 2 [29]. However, studies assessing longer term effects found no effect on analgesic use [23, 26, 27]. Regarding RTW, one study [23] reported that significantly more patients were employed 2 to 3 years after surgery and fewer were on long-term sickness leave after postoperative CBT with relaxation, but another study found no effect [28].

PGIC and patient satisfaction were only studied in one study each [23, 24], and therefore no conclusions can be drawn for these aspects.

PSP after spinal fusion procedures pose significant problems in terms of quality of life, and in recent years many efforts have been made to identify patients at risk. The exact mechanism that leads to the development of chronic pain remains uncertain: however, psychosocial factors like catastrophizing, anxiety and depression have been shown to modulate postoperative pain in these patients [37], and therefore a perioperative psychological intervention targeting these factors could be effective in reducing the incidence of PSP.

Although various researches have shown a positive effect of psychological treatments like CBT on low back pain in general [38], few have specifically investigated the effect of these interventions applied around the time of spinal surgery. In a recent meta-analysis, Janssen et al. [35] explored the effectiveness of prehabilitation programs in adult patients suffering from degenerative diseases, and scheduled for spine surgery. After meta-analysis, they found no additional effect of prehabilitation on any outcome when compared to usual care. Analyzing the type of interventions, authors stated that most of them included CBT. However, seven studies out of the 15 included (46%) did not include a psychological component targeting cognitive aspects, and where mainly based on education and counseling. Moreover, there was considerable heterogeneity regarding the surgery type, as 6 studies (40%) included patients submitted to simple decompression procedures and microdiscectomy, other than lumbar fusion. Previous research [39] has suggested that psychosocial factors, and pain catastrophizing in particular, are dynamic constructs, subject to change, in association with the improvement of pain and disability. As such, it is possible that patients treated for lumbar spinal stenosis or disk herniations encounter a different evolution of postoperative pain, and therefore of pain catastrophizing. This different postoperative pain pattern makes comparison of the results between different (preoperative) surgical conditions more difficult.

In another recent meta-analysis, Parrish et al. [36] summarized the evidence using CBT pre- and/or post-operatively in patients undergoing different types of lumbar spinal surgery, including disk surgery, decompression and fusion. The authors collected data on different patient-reported outcomes (PROs) 2–3 months postoperatively and at final assessment of each study. Out of 11 studies included in the qualitative analysis, six favored CBT. Comparators were qualified as "usual care" only in 9 studies, "exercise group" in one study, and "education" in another one. Notably, when comparing CBT to these interventions, the largest effect size was shown shortly after surgery for disability and back pain, while at long-term follow-up differences for psychological health outcomes and HRQL were more significant.

This finding is similar to what was found in this review, in which the effect of a perioperative psychological treatment is more evident on pain and disability in the short-term, and on HRQL in the long-term. Many variables may influence quality of life after spinal surgery [40]. Among them, causal linkages have been identified between different types of patient outcome measurements [41]. Psychological symptoms as well as functional status seem to have a strong influence on HRQOL at long-term. As psychological interventions in combination with perioperative rehabilitation have been demonstrated to significantly increase level of physical activity one year after spinal fusion [33, 42], it is likely that these interventions may have a positive influence on quality of life.

Moreover, meta-analysis of all included RCT outcomes in the review from Parrish et al. suggests that the effect of CBT may be sustained over time, showing effects for the majority of the outcomes at long-term follow-up. This finding could be only partially confirmed in the present review, given that for disability three [23, 24, 26] out of five studies found that the effect persisted at 12 months. Another difference with the present study concerns the design, as Parrish et al. focused only on RCTs with one type of psychological intervention (CBT) before lumbar spinal surgery, while our search included various kinds of psychological interventions in patients submitted to more invasive surgical procedures, represented by fusions. These procedures are associated with a higher rate of complications compared to non-instrumented surgery [43], that may increase the postoperative healthcare cost [44] even if the incidence of PSP was found to be similar in a recent study [45].

Previous systematic reviews and metanalyses aimed at assessing the effects of psychological interventions in the context of cardiac, abdominal or orthopedic surgery. Most of these reviews found psychological interventions to be effective [46–49], while others showed mixed results with no effect on postoperative pain [50–52]. A recent meta-analysis [53] explored the utility of a perioperative psychological intervention in different types of surgery including orthopedic surgery, general surgery, cardiac surgery, urologic surgery and spinal surgery. Authors analyzed data from 1880 patients included in 21 RCTs, the majority of them (57%) using CBT, and found significant effects of a psychological treatment on both acute and persistent pain and disability, (> 3 months). Effect sizes were small to moderate and there was substantial heterogeneity in the effects.

This important heterogeneity has also been found in our review, despite the fact that we restricted the analysis to patients submitted to spinal fusion surgery. In particular, significant variations were detected in timing and intensity of intervention, as well as in the professional who delivered the intervention (physiotherapist, psychologist or other team members). In 3 out of 13 studies, the intervention was delivered online through a platform, or an internet support group. No firm conclusions on the influence of these factors can be drawn, but our qualitative analysis did show a tendency that studies in which postoperative efficacy was detected had used psychological interventions with a higher intensity and frequency of sessions [22–24, 54].

Moreover, the present review suggests that psychological interventions obtain a long-term effect on pain and disability when they are implemented in the postoperative period, and when they are combined with an exercise therapy protocol. Abbott et al. [23] in a randomized trial on 107 patients scheduled for lumbar fusion were able to show a significant improvement in various PROs including disability at 12 months using a psychomotor therapy protocol in the postoperative period, with 3 sessions over 12 weeks. This protocol included both a physical component as well as CBT. Similarly, Monticone et al. [24] showed a greater improvement in disability using a postoperative protocol that included CBT and exercise therapy over 4 weeks, in comparison to standard care.

Limitations

In this study, we were limited by many factors that precluded a meta-analysis, mainly related to heterogeneity in the psychological protocols.

Moreover, as already underlined by Parrish et al. [36], postoperative PROs like pain, disability and quality of life are influenced by many perioperative factors. Important information regarding surgical technique, perioperative complications and comorbidities were lacking in most of the studies that were included and represent a further confounding effect that could not be assessed.

Conclusion

Patients undergoing spinal fusion surgery are at risk of developing persisting spinal pain. Since psychological interventions have been shown to reduce post-surgical pain after various types of surgery, these patients could benefit from such an approach. Despite numerous limitations related to the heterogeneity of protocols, the present review suggests that among psychological treatments, CBT and mindfulness-based cognitive therapy are likely to have a positive effect on pain and disability in the short term after surgery, while few data were available to demonstrate an effect in the long-term. Furthermore, to achieve this effect, the data suggest that the protocol should be performed with high intensity and frequency, preferably in the postoperative phase. However, more research is necessary to furtherly elucidate what specific aspects of CBT make it most effective in this patient population.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00586-022-07426-1.

Authors' contributions: PS, WVS, EK, AS, HVS, and MLP made substantial contributions to the conception and the design of the work. PS, WVS and MLP made substantial contributions to the acquisition, analysis, and interpretation of data. PS drafted the work and MLP, EK, AS, HVS revised it critically for important intellectual content. All authors approved the version to be published and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Funding The authors did not receive support from any organization for the submitted work. No funding was received to assist with the preparation of this manuscript. No funding was received for conducting this study. No funds, grants, or other support were received.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose. The authors have no conflicts of interest to declare that are relevant to the content of this article. All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript. The authors have no financial or proprietary interests in any material discussed in this article.

Ethics approval No ethics approval was needed for this study.

Trial registration number This review was registered in PROSPERO database under the number PROSPERO 2020 CRD42020187047.

References

1. Kepler CK, Vaccaro AR, Hilibrand AS et al (2014) National trends in the use of fusion techniques to treat degenerative spondylolisthesis. Spine (Phila Pa 1976) 39:1584–9. https://doi.org/10.1097/BRS.0000000000000486
2. North American Spine Society 7075 Veterans Blvd. Burr Ridge I 60527 (2015) NASS Coverage Policy Recommendations: Cervical fusion.
3. North American Spine Society 7075 Veterans Blvd. Burr Ridge I 60527 (2021) NASS Coverage Policy Recommendations: Lumbar fusion.
4. Fletcher D, Stamer UM, Pogatzki-Zahn E et al (2015) Chronic postsurgical pain in Europe: an observational study. Eur J Anaesthesiol 32:725–734. https://doi.org/10.1097/EJA.0000000000000319
5. Gatchel RJ (2004) Comorbidity of chronic pain and mental health disorders: the biopsychosocial perspective. Am Psychol 59:792–794. https://doi.org/10.1037/0003-066X.59.8.795
6. Peters ML, Sommer M, De Rijke JM et al (2007) Somatic and psychologic predictors of long-term unfavorable outcome after surgical intervention. Ann Surg 245:487–494. https://doi.org/10.1097/01.sla.0000245495.79781.65
7. Gatchel RJ, Peng YB, Peters ML et al (2007) The biopsychosocial approach to chronic pain: scientific advances and future directions. Psychol Bull 133:581–624. https://doi.org/10.1037/0033-2909.133.4.581
8. Alodaibi FA, Minick KI, Fritz JM (2013) Do preoperative fear avoidance model factors predict outcomes after lumbar disc herniation surgery? A systematic review Chiropr Man Therap 21:40. https://doi.org/10.1186/2045-709X-21-40
9. Den Boer JJ, Oostendorp RAB, Beems T et al (2006) A systematic review of bio-psychosocial risk factors for an unfavourable outcome after lumbar disc surgery. Eur Spine J 15:527–536. https://doi.org/10.1007/s00586-005-0910-x
10. Mannion AF, Elfering A, Staerkle R et al (2007) Predictors of multidimensional outcome after spinal surgery. Eur Spine J 16:777–786. https://doi.org/10.1007/s00586-006-0255-0
11. Wilhelm M, Reiman M, Goode A et al (2015) Psychological predictors of outcomes with lumbar spinal fusion: a systematic literature review. Physiother Res Int 22:e1648. https://doi.org/10.1002/pri.1648
12. Kalakoti P, Sciubba DM, Pugely AJ et al (2018) Impact of psychiatric comorbidities on short-term outcomes following intervention for lumbar degenerative disc disease. In: Spine (Phila. Pa. 1976). pp 1363–1371
13. Coronado RA, George SZ, Devin CJ et al Pain Sensitivity and Pain Catastrophizing Are Associated With Persistent Pain and Disability After Lumbar Spine Surgery. Arch Phys Med Rehabil 96:1763–1770.
14. Kim HJ, Park JW, Chang BS et al (2015) The influence of catastrophising on treatment outcomes after surgery for lumbar spinal stenosis. Bone Jt J 97B:1546–1554. https://doi.org/10.1302/0301-620X.97B11.36016
15. Tuna T, Boz S, Van Obbergh L et al (2018) Comparison of the pain sensitivity questionnaire and the pain catastrophizing scale in predicting postoperative pain and pain chronicization after spine surgery. Clin Spine Surg 31:E432–E440. https://doi.org/10.1097/BSD.0000000000000694
16. Le Roy B, Selvy M, Slim K (2016) The concept of prehabilitation: What the surgeon needs to know? J Visc Surg 153:109–112. https://doi.org/10.1016/j.jviscsurg.2016.01.001
17. Archer KR, Coronado RA, Haug CM et al (2014) A comparative effectiveness trial of postoperative management for lumbar spine surgery: changing behavior through physical therapy (CBPT)

study protocol. BMC Musculoskelet Disord 15:325. https://doi.org/10.1186/1471-2474-15-325

18. Williams ACDC, Fisher E, Hearn L, Eccleston C (2020) Psychological therapies for the management of chronic pain (excluding headache) in adults. Cochrane Database Syst Rev. https://doi.org/10.1002/14651858.CD007407.pub4
19. Page MJ, McKenzie JE, Bossuyt PM et al (2021) The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. https://doi.org/10.1136/bmj.n71
20. Korakakis V, Whiteley R, Tzavara A, Malliaropoulos N (2018) The effectiveness of extracorporeal shockwave therapy in common lower limb conditions: a systematic review including quantification of patient-rated pain reduction. Br J Sports Med 52:387–407. https://doi.org/10.1136/bjsports-2016-097347
21. Hooper P, Jutai JW, Strong G, Russell-Minda E (2008) Age-related macular degeneration and low-vision rehabilitation: a systematic review. Can J Ophthalmol 43:180–187. https://doi.org/10.3129/I08-001
22. Archer KR, Devin CJ, Vanston SW et al (2016) Cognitive-behavioral-based physical therapy for patients with chronic pain undergoing lumbar spine surgery: a randomized controlled trial. J Pain 17:76–89. https://doi.org/10.1016/j.jpain.2015.09.013
23. Abbott AD, Tyni-Lenné R, Hedlund R (2010) Early rehabilitation targeting cognition, behavior, and motor function after lumbar fusion: a randomized controlled trial. Spine (Phila Pa 1976) 35:848–857. https://doi.org/10.1097/BRS.0b013e3181d1049f
24. Monticone M, Ferrante S, Teli M et al (2014) Management of catastrophising and kinesiophobia improves rehabilitation after fusion for lumbar spondylolisthesis and stenosis. A randomised controlled trial. Eur Spine J 23:87–95. https://doi.org/10.1007/s00586-013-2889-z
25. Reichart R, Vogel I, Weiss T et al (2012) Short psychological intervention as a perioperative pain reduction treatment in spinal neurosurgery. J Neurol Surgery Part A Cent Eur Neurosurg 73:387–396. https://doi.org/10.1055/s-0032-1313642
26. Chavez JL, Porucznik CA, Gren LH et al (2020) The impact of preoperative mindfulness-based stress reduction on postoperative outcomes in lumbar spine degenerative disease: 3-month and 12-month results of a pilot study. World Neurosurg 139:e230–e236. https://doi.org/10.1016/j.wneu.2020.03.186
27. Yi JL, Porucznik CA, Gren LH et al (2019) The impact of preoperative mindfulness-based stress reduction on postoperative patient-reported pain, disability, quality of life, and prescription opioid use in lumbar spine degenerative disease: a pilot study. World Neurosurg 121:e786–e791. https://doi.org/10.1016/j.wneu.2020.03.186
28. Rolving N, Nielsen CV, Christensen FB et al (2015) Does a preoperative cognitive-behavioral intervention affect disability, pain behavior, pain, and return to work the first year after lumbar spinal fusion surgery? Spine (Phila Pa 1976) 40:593–600. https://doi.org/10.1097/BRS.0000000000000843
29. Rolving N, Nielsen CV, Christensen FB et al (2016) Preoperative cognitive-behavioural intervention improves in-hospital mobilisation and analgesic use for lumbar spinal fusion patients. BMC Musculoskelet Disord 17:217. https://doi.org/10.1186/s12891-016-1078-8
30. Rolving N, Sogaard R, Nielsen CV et al (2016) Preoperative cognitive-behavioral patient education versus standard care for lumbar spinal fusion patients: economic evaluation alongside a randomized controlled trial. Spine (Phila Pa 1976) 41:18–25. https://doi.org/10.1097/BRS.0000000000001254
31. Strøm J, Nielsen CV, Jørgensen LB et al (2019) A web-based platform to accommodate symptoms of anxiety and depression by featuring social interaction and animated information in patients undergoing lumbar spine fusion: a randomized clinical trial. Spine J 19:827–839. https://doi.org/10.1016/j.spinee.2018.11.011
32. Gavin M, Litt M, Khan A et al (2006) A prospective, randomized trial of cognitive intervention for postoperative pain. Am Surg 72:414–418. https://doi.org/10.1177/000313480607200510
33. Lotzke H, Brisby H, Gutke A et al (2019) A person-centered prehabilitation program based on cognitive-behavioral physical therapy for patients scheduled for lumbar fusion surgery: a randomized controlled trial. Phys Ther 99:1069–1088. https://doi.org/10.1093/ptj/pzz020
34. von der Hoeh NH, Voelker A, Gulow J et al (2014) Impact of a multidisciplinary pain program for the management of chronic low back pain in patients undergoing spine surgery and primary total hip replacement: a retrospective cohort study. Patient Saf Surg 8:1–7. https://doi.org/10.1186/s13037-014-0034-5
35. Janssen ERC, Punt IM, Clemens MJ et al (2021) Current prehabilitation programs do not improve the postoperative outcomes of patients scheduled for lumbar spine surgery: a systematic review with meta-analysis. J Orthop Sports Phys Ther 51:103–114. https://doi.org/10.2519/jospt.2021.9748
36. Parrish JM, Jenkins NW, Parrish MS et al (2021) The influence of cognitive behavioral therapy on lumbar spine surgery outcomes: a systematic review and meta-analysis. Eur Spine J 30:1365–1379. https://doi.org/10.1007/s00586-021-06747-x
37. Dunn LK, Durieux ME, Fernández LG et al (2018) Influence of catastrophizing, anxiety, and depression on in-hospital opioid consumption, pain, and quality of recovery after adult spine surgery. J Neurosurg Spine 28:119–126. https://doi.org/10.3171/2017.5.SPINE1734
38. Richmond H, Hall AM, Copsey B et al (2015) The effectiveness of cognitive behavioural treatment for non-specific low back pain: a systematic review and meta-analysis. PLoS ONE 10:e0134192. https://doi.org/10.1371/journal.pone.0134192
39. Kim HJ, Kwon OH, Chang BS et al (2018) Change in pain catastrophizing in patients with lumbar spinal surgery. Spine J 18:115–121. https://doi.org/10.1016/j.spinee.2017.06.028
40. Saban KL, Penckofer SM, Androwich I, Bryant FB (2007) Health-related quality of life of patients following selected types of lumbar spinal surgery: a pilot study. Health Qual Life Outcomes 5:71. https://doi.org/10.1186/1477-7525-5-71
41. Wilson IB, Cleary PD (1995) Linking clinical variables with health-related quality of life: a conceptual model of patient outcomes. JAMA J Am Med Assoc. https://doi.org/10.1001/jama.1995.03520250075037
42. Lotzke H, Jakobsson M, Gutke A et al (2018) Patients with severe low back pain exhibit a low level of physical activity before lumbar fusion surgery: a cross-sectional study. BMC Musculoskelet Disord 19:365. https://doi.org/10.1186/s12891-018-2274-5
43. Lonstein JE et al. (1999) Complications associated with pedicle screws. J Bone Jt Surg - Am 81(A):1519–1528
44. Weir S, Samnaliev M, Kuo TC et al (2017) The incidence and healthcare costs of persistent postoperative pain following lumbar spine surgery in the UK: A cohort study using the Clinical Practice Research Datalink (CPRD) and Hospital Episode Statistics (HES). BMJ Open 7:e017585. https://doi.org/10.1136/bmjopen-2017-017585
45. Weir S, Samnaliev M, Kuo TC et al (2020) Persistent postoperative pain and healthcare costs associated with instrumented and non-instrumented spinal surgery: a case-control study. J Orthop Surg Res 15:1–5. https://doi.org/10.1186/s13018-020-01633-6
46. McDonald S, Page MJ, Beringer K et al (2014) Preoperative education for hip or knee replacement. Cochrane Database Syst Rev. https://doi.org/10.1002/14651858.CD003526.pub3
47. Somers TJ, Blumenthal JA, Guilak F et al (2012) Pain coping skills training and lifestyle behavioral weight management in patients with knee osteoarthritis: A randomized controlled study. Pain 153:1199–1209. https://doi.org/10.1016/j.pain.2012.02.023

48. Cai L, Gao H, Xu H et al (2018) Does a program based on cognitive behavioral therapy affect kinesiophobia in patients following total knee arthroplasty? A randomized, controlled trial with a 6-month follow-up. J Arthroplasty 33:704–710. https://doi.org/10.1016/j.arth.2017.10.035
49. Villa G, Lanini I, Amass T et al (2020) Effects of psychological interventions on anxiety and pain in patients undergoing major elective abdominal surgery: a systematic review. Perioper Med 9:1–9. https://doi.org/10.1186/s13741-020-00169-x
50. Riddle DL, Keefe FJ, Ang DC et al (2019) Pain coping skills training for patients who catastrophize about pain prior to knee arthroplasty: a multisite randomized clinical trial. J Bone Jt Surg - Am 101:218–227. https://doi.org/10.2106/JBJS.18.00621
51. Birch S, Stilling M, Mechlenburg I, Hansen TB (2020) No effect of cognitive behavioral patient education for patients with pain catastrophizing before total knee arthroplasty: a randomized controlled trial. Acta Orthop 91:98–103. https://doi.org/10.1080/17453674.2019.1694312
52. Szeverenyi C, Kekecs Z, Johnson A et al (2018) The use of adjunct psychosocial interventions can decrease postoperative pain and improve the quality of clinical care in orthopedic surgery: a systematic review and meta-analysis of randomized controlled trials. J Pain 19:1231–1252. https://doi.org/10.1016/j.jpain.2018.05.006
53. Nadinda PG, van Ryckeghem DML, Peters ML (2021) Can perioperative psychological interventions decrease the risk of post-surgical pain and disability? A systematic review and meta-analysis of randomized controlled trials. Pain. https://doi.org/10.1097/j.pain.0000000000002521
54. Rolving N, Nielsen CV, Christensen FB et al (2014) Does a preoperative cognitive-behavioural intervention affect postsurgical pain, mobilisation and length of hospitalisation in lumbar spinal fusion patients? Eur spine J 23:S572. https://doi.org/10.1007/s00586-014-3448-y
55. Hadley G, Novitch MB (2021) CBT and CFT for chronic pain. Curr Pain Headache Rep 25:2–5. https://doi.org/10.1007/s11916-021-00948-1
56. Abid Azam M, Weinrib AZ, Montbriand J et al (2017) Acceptance and commitment therapy to manage pain and opioid use after major surgery: preliminary outcomes from the toronto general hospital transitional pain service. Can J Pain 1:37–49. https://doi.org/10.1080/24740527.2017.1325317
57. LaMontagne LL, Hepworth JT, Cohen F, Salisbury MH (2003) Cognitive-behavioral intervention effects on adolescents' anxiety and pain following spinal fusion surgery. Nurs Res 52:183–190. https://doi.org/10.1097/00006199-200305000-00008
58. Gaylord S, Palsson OS, Garland E, et al (2011) Therapeutic impact of mindfulness meditation on irritable bowel syndrome (IBS): results of a randomized controlled trial. Gastroenterology 140:S-50. https://doi.org/10.1016/S0016-5085(11)60203-5
59. Bonsack C, Rexhaj S, Favrod J (2015) Psychoéducation: définition, historique, intérêt et limites. Ann Med Psychol (Paris) 173:79–84. https://doi.org/10.1016/j.amp.2014.12.001
60. Forward JB, Greuter NE, Crisall SJ, Lester HF (2015) Effect of structured touch and guided imagery for pain and anxiety in elective joint replacement patients—a randomized controlled trial: M-TIJRP. Perm J 19:18–28. https://doi.org/10.7812/TPP/14-236

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