Can perioperative psychological interventions decrease the risk of post-surgical pain and disability?

Systematic Review and Meta-Analysis

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Can perioperative psychological interventions decrease the risk of postsurgical pain and disability? A systematic review and meta-analysis of randomized controlled trials

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Abstract

Many patients experience pain after surgery. Psychological factors such as emotion and cognition are shown to be associated with the development of acute and chronic postsurgical pain (CPSP). Therefore, the question arises whether targeting these psychological factors can reduce negative postsurgical outcomes. The aim of the current review was to investigate the efficacy of perioperative psychological interventions in reducing (sub)acute postsurgical pain and CPSP and disability in adults. Randomized controlled trials were identified through 4 databases (Web of Science, PsychINFO, PubMed, and Cumulative Index to Nursing and Allied Health Literature [CINAHL]). The outcomes of interest were (sub)acute (ie, within 3 months after surgery) and chronic (>3 months after surgery) pain and disability. After screening, 21 studies were included in the final analyses. It was found that psychological interventions significantly reduced (sub)acute pain ($d = -0.26$, 95% confidence interval [CI] [−0.48 to −0.04]) and disability ($d = -0.43$, 95% CI [−0.84 to −0.03]) as well as CPSP ($d = -0.33$, 95% CI [−0.61 to −0.06]) and disability ($d = -0.43$, 95% CI [−0.68 to −0.18]). In addition, interventions delivered after surgery and interventions delivered by a psychologist tended to be more effective than interventions delivered before surgery and interventions delivered by another healthcare provider. Furthermore, the current review points to the need for more research to determine which specific type of intervention may be most beneficial for surgical patients. Finally, the current review identified that research in this domain has concerns regarding bias in missing outcome data due to withdrawal and drop out.

Keywords: Psychological interventions, Pain, Disability, Surgery

1. Introduction

Millions of surgeries are performed worldwide each year.[66] Common clinical problems after surgery include insufficiently controlled pain in the acute postoperative phase and/or pain that persists beyond the expected time of healing. Despite advances in pharmacological management of acute postsurgical pain, a considerable proportion of patients experience moderate to severe pain in the first days after surgery.[13,51] Unrelieved acute postsurgical pain increases the risk that it develops into chronic pain.[8,28] Although the exact incidence of chronic postsurgical pain (CPSP) is unknown and varies depending on the specific type of surgery performed,[47] an indication of its widespread occurrence comes from a survey conducted in 11 European countries.[17] Across any type of surgery, around 35% of postsurgical patients reported at least some pain 1 year later, of which 12% reported moderate to severe pain, which was accompanied by functional impairments.

Prospective studies have identified various risk factors for both early and late postsurgical pain, including psychological factors.[23,40,41,50] Systematic reviews and meta-analyses have summarized the available evidence and concluded that emotional and cognitive factors are significantly associated with both acute postsurgical pain[25,49,69] and CPSP.[19,26,58] Therefore, the question arises whether high and persistent levels of postsurgical pain, and concomitant functional impairments, can be prevented by intervening on psychological risk factors. Psychological interventions such as cognitive behavioral therapy (CBT) and acceptance and commitment therapy (ACT) have been proven to be effective in the management of chronic pain[16,24,35,46,62,67] and could possibly mitigate the risk of early and persistent postsurgical pain and disability.

The aim of this article was to synthesize the evidence from randomized controlled trials that have examined the effects of perioperative psychological interventions on pain and disability after surgery. A comprehensive review with meta-analysis is timely because the available reviews on this topic have largely been descriptive reviews, focused on a mixture of

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psychological and nonpsychological interventions, or were limited in scope. A previous systematic review by Nicholls et al.[36] included only 6 articles reporting data from 5 trials, whereby 2 examined early outcomes and 4 examined chronic outcomes. Authors concluded that there was preliminary evidence that CBT reduces CPSP and disability. A meta-analysis of Wang et al.[65] included 8 trials evaluating the effects of psychological interventions (CBT, but also relaxation) and 7 trials evaluating the effects of educational interventions on CPSP. They concluded that psychological interventions significantly reduced CPSP and disability, whereas education was ineffective. The current meta-analysis article is more comprehensive than these previous reviews because it is the first to meta-analyze the effects of perioperative interventions separately on (sub)acute postsurgical pain and CPSP and disability. Furthermore, owing to a recent boost in research in the field, the current meta-analysis includes a substantial number of additional randomized controlled trials. This allows for applying a more stringent definition of psychological intervention, excluding, for instance, interventions merely using relaxation. Furthermore, using moderator analyses, we aim to identify factors influencing the efficacy of interventions. We expect that interventions that are targeted towards patients selected on psychological risk factors will be more effective than interventions that are delivered to an unselected surgical sample. More exploratory, we examine the moderating role of the type of psychological intervention (CBT-based vs other interventions), timing of the intervention (preoperatively or postoperatively, or both), intervention provider (ie, the person delivering the intervention: psychologist vs other), and total length of the intervention. We also examine whether treatment efficacy differs across different types of surgeries and/or according to whether patients have presurgical chronic pain. In doing so, the current study can inform healthcare practitioners on the potential benefits of psychological interventions in the surgical context, identify gaps in the research field, and guide the design of future clinical trials.

2. Methods

In accordance to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guideline,[30] the protocol of the meta-analysis was registered at the international prospective register of systematic reviews (PROSPERO CRD42020175806; March 2020). The research protocol outlines the objectives, research questions, screening, search strategy, study selection, and data extraction method. All analyses were performed according to the ad hoc protocol. Deviations from the meta-analysis protocol are discussed.

2.1. Search strategy and inclusion or exclusion criteria

Studies were searched through electronic databases (PsychINFO, PubMed, Web of Science, and Cumulative Index to Nursing and Allied Health Literature [CINAHL]) using the following search terms: "psychological interventions," "surgery," "pain," and its variations. A detailed description of the search strategy can be found in Supplementary File 1 (supplemental digital content 1, http://links.lww.com/PAIN/B526). In addition, the reference lists of previous reviews in the field[36,65] were screened for articles that fulfil the inclusion criteria. Finally, the research team invited experts in the domain of postsurgical pain to review the final list of studies and to provide references to missing studies.

Studies were considered eligible when they met the following inclusion criteria:

(1) The study was a randomized controlled trial comparing psychological interventions to treatment as usual or an active control group. Moreover, the study included at least 1 trial arm implementing a psychological intervention, in which psychological interventions were defined as "the informed and intentional application of clinical methods and interpersonal stances derived from established psychological principles for the purpose of assisting people to modify their behaviors, cognitions, emotions, and/or other personal characteristics in directions that the participants deem desirable.[37]" Interventions were only considered to be psychological interventions if (1) they were informed by empirical psychological principles[37] and (2) contained at least 50% of psychological elements that target cognition, emotion, and/or behavior. Specifically, (elements of) the following psychological interventions were considered: CBT, ACT, mindfulness-based interventions, cognitive therapy, and psychoeducation.
(2) The study reported on at least 1 psychological intervention that was administered within the perioperative period, meaning that it was administered before surgery, after surgery (starting no longer than 2 weeks after surgery), or both before and after surgery.
(3) Participants in the study were 18 years and older (based on study mean age), undergoing any type of surgery.
(4) The study reported on postsurgical pain, disability, and/or health-related quality of life (HRQOL) outcomes. Disability outcomes could consist of measured impairments, activity limitations, participation restriction,[68] and/or functional capacity. For HRQOL outcomes, only physical health outcomes were included which were categorized as activity limitations (disability outcomes).
(5) The study reported unique data, that is, data that are not already reported in a different research article. However, in cases where additional data were reported from the same study sample (eg, additional outcomes and time points), data were considered as dependent data[44,45] and described as a single study.
(6) The study includes data that allow for the computation of effect sizes or data were provided by the study authors on request. In particular, for 10 of the 21 eligible studies, authors were contacted to request additional data. The data requested consisted of mean and SD values for pain, disability, and HRQOL outcomes. Responses were received from all study authors. Although 1 study author could not provide means and SDs requested for one of the disability outcomes,[3] transformations were used to calculate Cohen *d*, allowing the study outcomes to be included in our meta-analysis. Furthermore, another study author declined to provide the requested means and SDs[55] because their study was still ongoing. For this study, only the available means and SDs of outcomes were included.

The electronic databases were searched for references on March 12, 2020, and updated on May 25, 2021. A 2-step procedure was used. In the first step, 2 reviewers independently screened all abstracts of studies for possible inclusions. Reviewers were not blind for authors, institutions, journals, and results. Each reviewer provided a reason as to why the study was included or excluded based on the criteria mentioned above. In case of disagreements, a third reviewer was contacted, and the final decision was made based on consensus between reviewers. In the second step, 2 independent reviewers obtained the full text to complete a final screening of the inclusion criteria.

2.2. Data extraction and coding decisions

The authors developed a data extraction form that included study variables deemed relevant for the current meta-analysis. The draft of the form was pilot tested on 1 selected article by 3 reviewers independently. The form was then revised on sections that were unclear, as exhibited through the data extraction process of the selected article. In the final form, data concerning source characteristic (author, publication year, country of publication, and journal name), sample characteristics (sample sizes, mean age, sex, and pain characteristics at baseline), outcomes of interest, and intervention characteristics were extracted.

For outcomes, we extracted outcomes related to pain, disability, and HRQOL and coded them as pain, disability—activity limitation, disability—functional capacity, disability—participation, disability—impairments, and HRQOL. In addition, we extracted the tools assessing each outcome and the time points of assessment. For intervention characteristics, we extracted the type of surgery (eg, total knee arthroplasty, mastectomy or lumpectomy, and coronary artery bypass graft), type of psychological intervention (CBT, ACT, psychoeducation, mindfulness-based, and other), whether the intervention was targeted at an at-risk population (ie, patients who were selected because of an increased risk of developing CPSP), the intensity of the intervention (ie, duration per session [minutes] and number of sessions), total duration of the intervention (weeks), timing of the intervention (preoperative, postoperative, preoperative and postoperative), person delivering the intervention (eg, trained psychologist, nurse practitioner, or physiotherapist), and intervention efficacy in changing risk factors (assessed—effective, assessed—not effective, or not assessed). Data extraction and coding were conducted for each article by 2 independent reviewers. A third reviewer was consulted in case of disagreements, and the final decision was made based on consensus of all 3 reviewers (see Supplementary File 2 for the coding scheme, supplemental digital content 1, http://links.lww.com/PAIN/B526).

Some additional data extraction and coding decisions were made based on the availability of data. First, we determined the cutoff time points for (sub)acute and chronic outcomes. Following the current definition of CPSP,[48] (sub)acute outcomes are defined as outcomes measured less than 3 months after surgery, and chronic or persistent outcomes as outcomes measured at least 3 months after surgery. In addition, some post hoc grouping was performed on moderator variables to reduce the number of categories. In particular, for coding of "type of intervention," we grouped interventions together into 2 categories: CBT-based (ie, CBT and ACT) vs other interventions (psychoeducation, etc). "Intervention provider" was categorized into 2 categories: intervention delivered by (at least 1) psychologist vs other healthcare provider (eg, nurse or physiotherapist). "The presence of presurgical pain" was reduced to the presence of chronic pain or no presence of chronic pain (ie, no or acute presurgical pain). The presence of chronic pain was mostly related to the indication for surgery (ie, osteoarthritis, spondylolisthesis, spinal stenosis, and degenerative disk disease) while (sub)acute pain was due to traumatic injury (ie, fractures and torn ligaments). Finally, for the moderator "type of surgery," we created 5 categories: surgeries involving the hip and knee (eg, total knee arthroplasty and total joint arthroplasty), surgeries involving the back (eg, spinal surgery), cardiac surgery (ie, coronary artery bypass graft), breast surgery (eg, mastectomy or lumpectomy), and other surgery (eg, fractures, prostatectomy, and mixed surgery).

2.3. Risk of bias assessment

Risk of bias (ROB) was assessed using the ROB 2.0 tool for randomised controlled trials by Cochrane Reviews.[54] By answering the signaling questions in each of the domain of the tool using the answers: "yes," "probably yes," "probably no," "no," and "no information," the tool elicits a ROB judgment of the study as having "low risk of bias," "some concerns," or "high risk of bias."[54] Risk of bias was assessed under the dimensions of bias arising from the randomization process such as random sequence generation, allocation sequence concealment, and baseline imbalances; deviations from intended interventions such as blinding of participants, researchers, and outcome assessor; bias in outcome measurements; bias in missing outcome data (including loss to follow-up, exclusions, attrition, and withdrawals); and selective reporting of outcomes.

2.4. Data synthesis and analysis

To address the research questions of this article, we performed 4 separate sets of meta-analyses. In particular, a separate set of meta-analyses were conducted per outcome (ie, pain and disability) and for (sub)acute and chronic time points separately. Within each of these 4 sets of meta-analyses, the efficacy of perioperative psychological interventions (ie, comparison between perioperative psychological intervention groups and control groups) and potential variables moderating this relationship were examined. For all analyses, similar procedures were used. Specifically, effect sizes were calculated using Cohen *d* by calculating the main difference between 2 groups (ie, psychological intervention group vs control group), divided by the pooled SD.[9] Random-effects models were used to combine the effect sizes of the studies.[5] To maintain independence of our data, whenever necessary, effect sizes were averaged across groups (ie, in cases where multiple time points [eg, multiple outcomes measured at least 2 months after surgery] and/or multiple outcomes measured [eg, visual analogue scale score and Numerical Rating Scale of pain rating] were reported in the same category).

In the event that studies used 2 control groups (treatment as usual and active control group), the overall effect size was calculated using the available formula in the Cochrane Handbook[22] and assigned the pooled mean and SD in the meta-analysis. If studies report both baseline and posttest scores, we only used posttest scores of the outcomes (pain/disability), rather than change scores (difference between baseline and posttreatment). Thereby, the final scores (ie, only posttest data) were also used to report the effect sizes for all studies.[22] This approach also reduces the risk of selective reporting because the choice of whether to report, or not to report the change or final values, might depend on the result.[61] Finally, considering that intention-to-treat (ITT) data provide values for all participants randomized, only ITT data were assessed in studies that report both ITT analyses and per protocol or as treated data,[44,45] thus reducing bias due to selective drop out and patient exclusion.

Cochran's *Q* was computed to determine the degree of heterogeneity in effect sizes.[5] To address whether variations in effect sizes can be explained by categorical coded variables, the following moderator variables were examined: "type of intervention," "targeted vs nontargeted intervention," "intervention provider," "presence of presurgical pain," "timing of intervention," and "type of surgery." For all moderator analyses, we used a mixed-effects model using nonpooled within-group estimates of tau-squared to explain heterogeneity between studies. For these

moderator analyses, a group was only taken into account if at least 3 studies were available in the group.[60,61] For the continuous coded variable "duration of intervention," we performed meta-regressions using the methods of moments procedure[59] with the Knapp–Hartung correction, where the slope (β) and its *P* value indicate the importance of this moderator variable in understanding linear changes in effect sizes. We calculated the total duration of intervention by multiplying the duration per session (in minutes) by the number of sessions. For studies that reported a range for durations of the intervention, an average duration was calculated. In addition, Egger's regression intercept[15] was used to analyze publication bias.

Finally, sensitivity analyses were performed for (1) type of control group, in which separate analyses were performed for treatment as usual and active control as comparison groups, and (2) a different cutoff point for chronic pain in which a 2-month cutoff instead of a 3-month cutoff was used to define (sub)acute and chronic outcomes (see Supplementary File 3, supplemental digital content, http://links.lww.com/PAIN/B526). All analyses and computations were performed using Comprehensive Meta-Analysis software, version 3.3070 (Biostat Inc, Englewood, NJ). Effect sizes of ≥0.20 are considered small effects, ≥0.50 are considered moderate, and ≥0.80 are considered large effects.[9]

3. Results

3.1. Study search results

Searches from the databases resulted in 2785 studies. After removing duplicates, we reviewed 2588 studies based on title and abstract. We also evaluated the studies included in previous systematic reviews and meta-analyses that had examined the effects of perioperative psychological interventions on post-surgical outcomes.[36,65] Scholars in the field were contacted to add suggestions to the list of possible studies. In total, we evaluated the full text of 90 studies (**Fig. 1**). After excluding studies based on reasons listed in **Figure 1**, the final list of studies consisted of 21 studies (**Table 1**).

3.2. Description of studies included

The total number of patients randomized, gender, and mean age of participants in each study is presented in **Table 1**. Twelve studies evaluated (sub)acute outcomes,[2,7,11,12,18,21,29,32,39,44,45,55] and all but 2 studies[2,18] evaluated chronic outcomes. Nine studies were conducted in the United States,[2,6,10–12,20,21,39,42] 3 studies were conducted in Denmark,[4,44,45] 2 studies in the United Kingdom,[3,33] 2 in China,[7,55] and 1 each in Australia,[14] the Netherlands,[18] Germany,[43] Sweden,[29] and Italy.[32] For surgery type, 6 studies evaluated patients undergoing total knee arthroplasty,[4,6,7,33,42,55] 4 studies evaluated spinal fusion surgery,[29,32,44,45] 3 studies evaluated mastectomy or lumpectomy,[11,18,21] and 1 study each evaluated total joint arthroplasty,[14] hip surgery,[3] anterior cingulate ligament reconstruction,[10] coronary bypass graft surgery,[43] orthopedic surgery,[12] upper or lower fracture fixation,[2] prostatectomy,[39] and mixed surgeries.[20] Regarding psychological interventions, 12 of the included studies evaluated the effects of CBT,[4,6,7,20,29,32,33,39,42,44,45,55] 3 studies evaluated ACT,[2,12,21] and 1 study each evaluated psychoeducation,[11] mindfulness-based stress reduction,[14] or other psychological interventions such as expectation manipulation,[43] pain management,[3] relaxation and guided imagery (containing psychological elements such as pain management, coping skills, and anxiety reduction),[10] and stress management training.[18] Furthermore, of those psychological interventions, 16 studies conducted individual interventions,[2,4,6,7,10,11,18,20,21,29,32,33,39,42,43,55] 3 studies conducted group interventions,[3,44,45] and 2 studies used a combination of individual and group sessions.[12,14] Nine of the studies were targeted interventions that selected patients on the risk factors pain catastrophizing, kinesiophobia, anxiety, depression, age, and/or presurgical pain.[4,6,7,12,14,21,33,42] Fourteen studies delivered the intervention in person,[3,4,6,7,10,14,18,21,32,33,39,44,45,55] whereas 6 studies delivered the intervention through telephone,[20,42] text messaging,[2] online,[11] or mixed media.[12,29,43] For outcomes, 16 studies reported both pain and disability outcomes. Three studies reported only pain outcomes,[12,18,21] and 2 studies reported only disability outcomes.[39,43] Of the disability outcomes, 6 studies included objective measures of disability outcomes in addition to subjective measures of disability outcomes.[3,4,10,29,42,55]

3.3. Risk of bias assessment

The result of the ROB assessment are presented in **Figure 2**. For bias from randomization procedure, 85% of studies showed low ROB, whereas 10% studies showed some concerns, and only 1 study (5%) was evaluated as having high ROB[18] due to an unclear block randomization procedure. Regarding selection bias, we evaluated 60% of studies as having low ROB, 35% of studies as having some concerns due to missing protocols, and 5% of studies as having high ROB due to possible selective reporting from multiple eligible analyses. Regarding bias in measurement of the outcome, 90% of studies were judged as having some concerns because outcomes were based on self-report measures and participants might have been aware of their assigned condition. In addition, double blinding was not possible as the person delivering the intervention was always aware of the condition the participants was in. Two studies (10%) were judged as having low ROB in this domain because these 2 studies did not have treatment as usual as a control group. When an active control intervention is used as the comparator condition instead of usual care, there may be a lower ROB because participants may not have a priori beliefs that one of the interventions is more beneficial than the other.[54] For the missing outcome data domain, 8 studies (40%) were judged as having low ROB for missing outcomes because they reported outcomes data for (nearly) all the participants in their study. For 40% of the studies, the raters had some concerns, and 20% had high ROB due to high dropout rates and/or lack of sensitivity analyses. Finally, for bias arising from deviation from the intended interventions, most of the studies (60%) were judged as having low ROB. For 30% of the studies, the raters reported some concerns. Finally, 3 studies (10%) were judged to have performed inadequate analysis and therefore deemed as having high ROB.

3.3.1. Publication bias

Publication bias was evaluated for all outcomes except (sub)acute disability outcomes as there were less than 10 studies evaluating this outcome.[53] Publication bias evaluated through the Egger's regression intercept did not show significant effects for studies evaluating (sub)acute pain outcomes (1-sided P value = 0.25), chronic pain outcomes (1-sided P value = 0.13), and chronic disability outcomes (1-sided P value = 0.09), indicating no publication bias.

3.4. (Sub)acute outcomes

3.4.1. Main analyses

For (sub)acute pain outcomes, analyses were performed with 11 studies, where a negative effect size indicates that the outcome

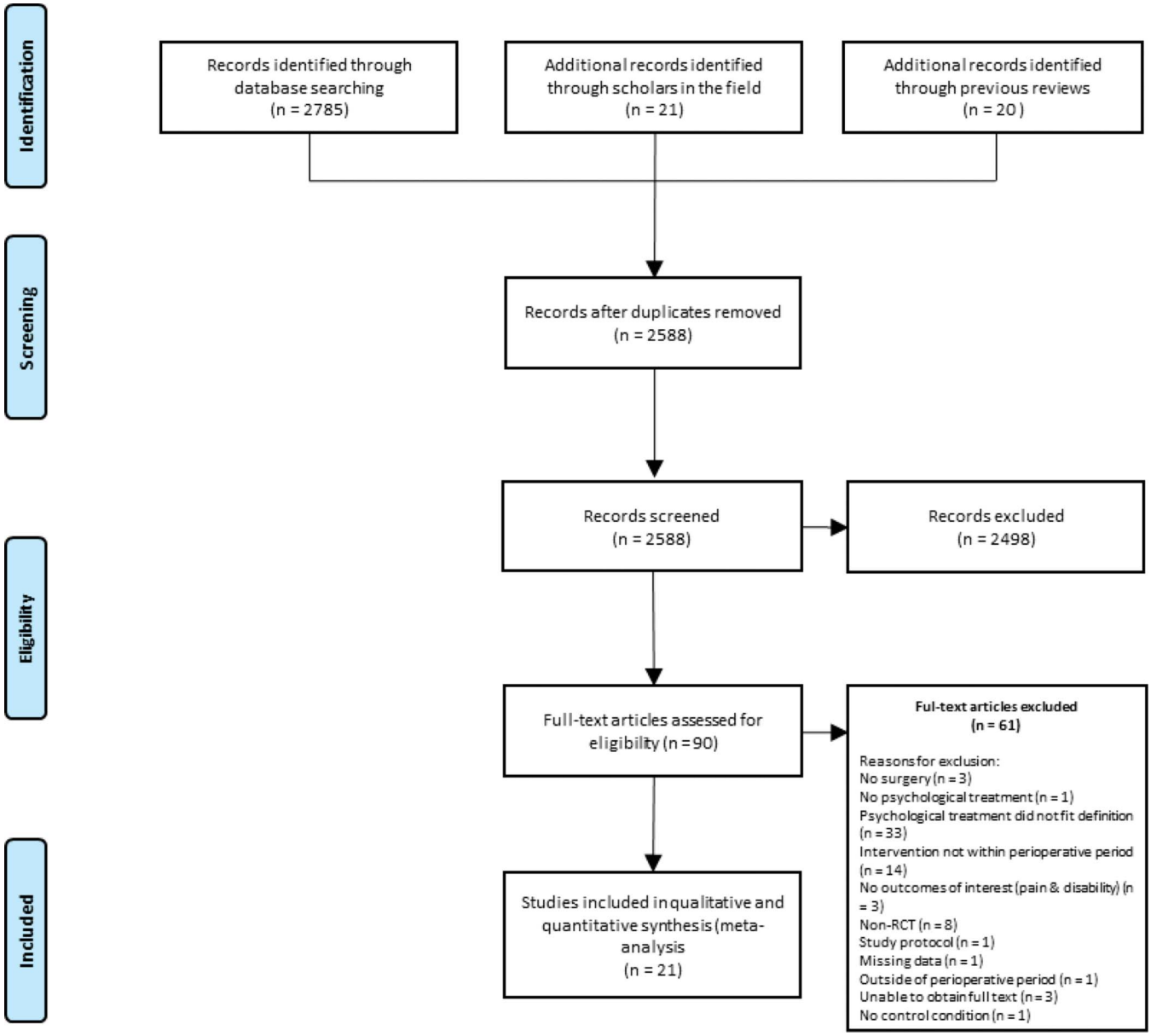

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flowchart. RCT, randomised controlled trial.

favors the psychological intervention group and a positive effect size indicates that the outcome favors the control group (**Fig. 3A**). The results indicated that the effects of psychological interventions on (sub)acute postoperative pain were significant with a small effect size ($d = -0.26$, $P = 0.02$, 95% confidence interval [CI] [−0.48 to −0.04]) indicating that (sub)acute pain outcomes were lower in the psychological intervention group than in the control group. However, the results indicated substantial heterogeneity ($Q_{10} = 30.29$, $P = 0.001$).

For (sub)acute disability outcomes, analyses were performed with 9 studies (**Fig. 3B**). The results showed that the effects of psychological interventions on postoperative disability were significant with a small to moderate effect size ($d = -0.43$, $P = 0.03$, 95% CI [−0.84 to −0.03]), indicating that (sub)acute disability outcomes were lower in the psychological intervention group than in the control group. Yet, again, the results revealed substantial heterogeneity for (sub)acute disability outcomes ($Q_8 = 78.71$, $P < 0.001$). To investigate the impact of a single study, analyses were performed repeatedly with one different study removed. This did not change the significance of the effects.

3.4.2. Moderator analyses

To address the between-study variability in the main analysis for both (sub)acute postoperative pain and disability outcomes, moderator analyses were performed to address sources of heterogeneity. Effect sizes and heterogeneity indices for all moderator groups are reported in **Table 2**.

3.4.2.1. Targeted vs nontargeted interventions

For (sub)acute pain, 4 studies performed an intervention in a group targeting patients selected on psychological risk factors (ie, only including patients at increased risk of developing CPSP), whereas 7 studies performed an intervention directed at an unselected sample. In contrast to expectation, no difference was

Table 1

Characteristics of studies included in the current meta-analysis.

Study	*Ns*	*Nf*	Participants					Type of surgery	Psychological intervention	Comparison	Timing of assessment (percentage of dropout %)	Outcome measures	
			Control		Intervention		Presence of presurgical pain					Pain	Disability
			Age (mean)	Gender (female %)	Age (mean)	Gender (female %)							
Anthony et al.[2]	82	76	TAU: 48.7	TAU: 19	45.5	22	Yes—acute pain	Upper or lower fracture operative fixation	*Intervention*: acceptance and commitment therapy *Nontargeted* intervention *Timing:* postoperative *Delivered by*: psychologist *Total duration*: 28 min	TAU: treatment as usual	2 wk after surgery (7%)	PROMIS Pain 1A; PROMIS Pain 3A	PROMIS Pain Interference 8A
Berge et al.[3]	44	33	TAU: 71	TAU: 79	71.6	63	Yes—chronic pain	Hip surgery	*Intervention:* pain management program *Nontargeted* intervention *Timing:* preoperative *Delivered by:* clinical psychologist, occupational therapist, and physiotherapist *Total duration:* 1290 min	TAU: waiting list without treatment	2-12 mo after hip replacement (25%)	NRS	NRS; AIMS; 4-Minute Walk
Birch et al.[4]	67	53	TAU: 66	TAU: 62	66	71	Yes—chronic pain	Total knee arthroplasty	*Intervention*: CBT *Targeted* at patients with high pain catastrophizing scores *Timing*: preoperative and postoperative *Delivered by*: physiotherapist *Total duration:* 315 min	TAU: usual care	3 mo (20%) and 12 mo (20%) after surgery	VAS; KOOS	OKS; 6-Minute Walk Test ; Sit to Stand in 30 Seconds
Buvanendran et al.[6]	80	68	TAU: 62	TAU: 68	66	65	Yes—chronic pain	Total knee arthroplasty	*Intervention:* CBT *Targeted* at patients with high pain catastrophizing scores *Timing:* preoperative and postoperative *Delivered by:* clinical psychologist *Total duration:* 300 min	TAU: treatment as usual	3 mo after surgery (15%)	Pain at rest; pain during movement; WOMAC pain	WOMAC physical function
Cai et al.[7]	111	100	TAU: 66.2	TAU: 60	65.3	64	Yes—chronic pain	Total knee arthroplasty	*Intervention:* CBT *Targeted* at patients with kinesiophobia and pain catastrophizing *Timing*: postoperative *Delivered by:* physiotherapist and psychologist *Total duration:* 120 min	TAU: standard care	4 wk and 6 mo after surgery (10%)	NRS	Hospital for Special Surgery Knee Rating Scale

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Table 1 (*continued*)

Study	Ns	Nf	Participants				Presence of presurgical pain	Type of surgery	Psychological intervention	Comparison	Timing of assessment (percentage of dropout %)	Outcome measures	
			Control		Intervention							Pain	Disability
			Age (mean)	Gender (female %)	Age (mean)	Gender (female %)							
Cupal and Brewer[10]	30	30	Overall: 28.2		Overall: 46.7		Yes—acute pain	Anterior cruciate ligament reconstruction	*Intervention:* relaxation and guided imagery *Nontargeted* intervention *Timing:* postoperative *Delivered by:* clinician *Total duration:* 475 min	AC: placebo-delivering attention, encouragement, and support TAU: physical therapy	24 wk after surgery (0%)	NRS	Cybex 3000 Isokinetic Dynamometer (knee strength)
Darnall et al.[11]	127	84	AC: 51.2	AC: 100	51.3	100	No pain	Lumpectomy or mastectomy	*Intervention:* psychoeducation *Nontargeted* intervention *Timing:* preoperative *Delivered by:* psychologist *Total duration:* 90 min	AC: online health education	2 wk, 4 wk, 8 wk, and 12 wk after surgery (34%)	PROMIS Pain Intensity	PROMIS Pain Interference; Global Health Physical Function
das Nair et al.[33]	50	25	TAU: 66.7	TAU: 36	65.7	56	Yes—chronic pain	Total knee arthroplasty	*Intervention:* CBT *Targeted* at patients with anxiety and depression *Timing:* preoperative *Delivered by:* psychologist *Total duration:* 330 min	TAU: Standard care	4 mo (40%) and 6 mo (50%) after surgery	ICOAP scale; WOMAC pain	WOMAC physical function
Dindo et al.[12]	88	66	TAU: 63	TAU: 0	62.2	12	Yes pain	Orthopedic surgery	*Intervention:* ACT *Targeted* at patients with preoperative pain, anxiety, and depression *Timing:* preoperative and postoperative *Delivered by:* clinical psychologist *Total duration:* 300 min	TAU: nurse-led education and analgesia	Every day for 15 d, and 3 mo after surgery (25%)	Pain log using the NRS; BPI	NA
Dowsey et al.[14]	127	100	TAU: 65.1	TAU: 66.1	65.8	78.5	Yes—chronic pain	Total joint arthroplasty	*Intervention:* mindfulness-based stress reduction *Targeted* at patients with a score of <40 on the short form-12 mental component *Timing:* preoperative and postoperative *Delivered by:* qualified nurses, psychiatrists, and orthopedic surgeons as MBSR facilitators *Total duration:* 2040 min	TAU: physiotherapy	3 mo (25%) and 12 mo (21%) after surgery	WOMAC pain	WOMAC physical function ; VR-12; Health Survey Physical Function

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Table 1 (*continued*)

Study	*Ns*	*Nf*	Participants					Type of surgery	Psychological intervention	Comparison	Timing of assessment (percentage of dropout %)	Outcome measures	
			Control		Intervention		Presence of presurgical pain					Pain	Disability
			Age (mean)	Gender (female %)	Age (mean)	Gender (female %)							
Garssen et al.[18]	85	70	TAU: 54	TAU: 100	52	100	No pain	Lumpectomy or mastectomy	*Intervention:* stress management training *Nontargeted* intervention *Timing:* preoperative and postoperative *Delivered by:* clinical psychologist *Total duration:* 210 min	TAU: no contact with psychologist	2 and 5 d after surgery (18%)	NRS	NA
Hadlandsmyth et al.[21]	62	54	TAU: 50.7	TAU: 100	55.7	100	No pain	Lumpectomy or mastectomy	*Intervention:* ACT *Targeted* at patients younger than 50y with preexisting chronic pain condition, elevated anxiety, depression, and pain *Timing:* postoperative *Delivered by:* clinical psychologist/advanced counseling psychology doctoral student *Total duration:* 120 min	TAU: treatment as usual	1 wk and 3 mo after surgery (13%)	NRS	NA
Hadlandsmyth et al.[20]	110	84	TAU: 66.2	TAU: 4	64.2	7	Yes—chronic pain	Mixed surgeries	*Intervention:* perioperative pain self-management (CBT-based) *Nontargeted* intervention *Timing:* preoperative and postoperative *Delivered by:* psychologist *Total duration:* 130 min	TAU: treatment as usual	3 mo after surgery (24%)	NRS; BPI—worst pain; BPI—average pain	BPI—pain interference
Lotzke et al.[29]	118	39	TAU: 46.7	TAU: 50.8	44.8	55.9	Yes—chronic pain	Lumbar fusion surgery	*Intervention:* CBT *Targeted* at patients with chronic presurgical pain *Timing:* preoperative and postoperative *Delivered by:* physiotherapist trained in CBT *Total duration:* 300 min	TAU: conventional intervention	3 wk (27%), 8 wk (41%), 3 mo (53%), and 6 mo (67%) after surgery	VAS	ODI; VAS; PSFS; digital triaxial accelerometer; time spent in moderate to vigorous physical activity; time spent in light physical activity; 5-minute walking; 15-meter fast walk; Timed Up and Go; 1 minute stair climbing; one leg stand with eyes open; one leg stand with eyes closed

(*continued on next page*)

Table 1 (*continued*)

Study	*Ns*	*Nf*	Participants					Type of surgery	Psychological intervention	Comparison	Timing of assessment (percentage of dropout %)	Outcome measures	
			Control		Intervention		Presence of presurgical pain					Pain	Disability
			Age (mean)	Gender (female %)	Age (mean)	Gender (female %)							
Monticone et al.[32]	130	117	AC: 55.9	AC: 67.6	58.8	53.8	Yes - chronic pain	Lumbar fusion surgery	*Intervention:* CBT *Nontargeted* intervention *Timing:* postoperative *Delivered by:* physiatrist, psychologist, and physiotherapist *Total duration:* 480 min	AC: exercise training	4 wk (6%) and 12 mo (10%) after surgery	NRS	ODI; SF-36 Physical Functioning Component, Physical Role Component, Bodily Pain Component should actually be under pain, not disability. So move to the left column.
Parker et al.[39]	159	101	TAU: 60.9 AC: 60.7	TAU: 0 AC: 0	59.8	0	No pain	Prostatectomy	*Intervention:* stress management (CBT-based) *Nontargeted* intervention *Timing:* preoperative and postoperative *Delivered by:* psychologist *Total duration:* 300 min	AC: supportive attention TAU: standard care	6 wk (33%), 6 mo (32%), and 12 mo (58%) after surgery	NA	SF-36 physical component
Riddle et al.[42]	402	346	TAU: 62.7 AC: 50	TAU: 64 AC: 63	62.6	72	Yes—chronic pain	Total knee arthroplasty	*Intervention*: pain coping skills training (CBT-based) *Targeted* at patients with high pain catastrophizing scores *Timing:* preoperative and postoperative *Delivered by*: physiotherapist *Total duration:* 400 min	AC: arthritis education TAU: usual care	2 mo (17%), 6 mo (17%) and 12 mo after surgery (14%)	WOMAC—pain; NRS	WOMAC—physical function; SPPB; 6-minute walk test
Rief et al.[43]	124	108	TAU: 67.1 AC: 64.6	TAU: 12.2 AC: 19	65.8	13.5	No pain	Coronary artery bypass graft	*Intervention*: expectation manipulation intervention *Nontargeted* intervention *Timing:* preoperative and postoperative *Delivered by:* psychologist *Total duration:* 160 min	AC: standard medical care and support TAU: standard medical care	6 mo after surgery (13%)	NA	PDI; IPAQ; subjective working ability; SF-12 Physical Quality of Life Component
Rolving et al.[44]	96	83	TAU: 47.7	TAU: 48	51.4	61	Yes—chronic pain	Lumbar fusion surgery	*Intervention:* CBT *Nontargeted* intervention *Timing:* preoperative and postoperative *Delivered by:* psychologist, occupational therapist, physiotherapist, social worker, and spinal surgeon *Total duration:* 1080 min	TAU: standard course of treatment	1-7 d, 3 mo (10%), 6 mo (10%), and 12mo after surgery (14%)	LBPRS	ODI

(*continued on next page*)

Table 1 (*continued*)

Study	*Ns*	*Nf*	Participants					Type of surgery	Psychological intervention	Comparison	Timing of assessment (percentage of dropout %)	Outcome measures	
			Control		Intervention		Presence of presurgical pain					Pain	Disability
			Age (mean)	Gender (female %)	Age (mean)	Gender (female %)							
Rolving et al.[45]	96	83	TAU: 47.7	TAU: 48	51.4	61	Yes—chronic pain	Lumbar fusion surgery	*Intervention:* CBT *Nontargeted* intervention *Timing:* preoperative and postoperative *Delivered by:* psychologist, occupational therapist, physiotherapist, social worker, and spinal surgeon *Total duration:* 1080 min	TAU: standard course of treatment	1-7 d, 3 mo (10%), 6 mo (10%), and 12mo after surgery (14%)	NRS	CAS
Sun et al.[55]	100	80	TAU: 60.2	TAU: 55	57.8	45	Yes—chronic pain	Total knee arthroplasty	*Intervention:* CBT *Nontargeted* intervention *Timing:* preoperative and postoperative *Delivered by:* physiotherapist *Total duration:* 180 min	TAU: standard nursing procedure	5 d, 1 wk, 3 mo, and 12 mo after surgery (20%)	VAS during activity	OKS; Knee ROM; HSS Knee Rating Scale

AC, active control; ACT, acceptance and commitment therapy; AIMS, Arthritis Impact Measurement Scale; BPI, Brief Pain Inventory; CAS, Cumulated Ambulation Score; CBT, cognitive behavioral therapy; HSS, hospital for special surgery; ICOAP, Intermittent and Constant Osteoarthritis Pain; IPAQ, International Physical Activity Questionnaire; KOOS, Knee Osteoarthritis Outcome Scale; LBPRS, Low Back Pain Rating Scale; Nf, number of participants at final follow-up; NRS, numerical rating scale; Ns, number of participants at start of intervention; ODI, Oswestry Disability Index; OKS, Oxford Knee Score; PDI, Pain Disability Index; PROMIS, Patient-reported Outcomes Measurement Information System; PSFS, Patient-Specific Functioning Scale; ROM, range of motion; SF-12, 12 Item Short Form Survey; SF-36, 36 Item Short Form Survey; SPPB, short physical performance battery; TAU, treatment as usual; VAS, visual analogue scale; VR-12, Veterans Rand 12 Item Health Survey; WOMAC, Western Ontario and McMaster Universities Arthritis Index.

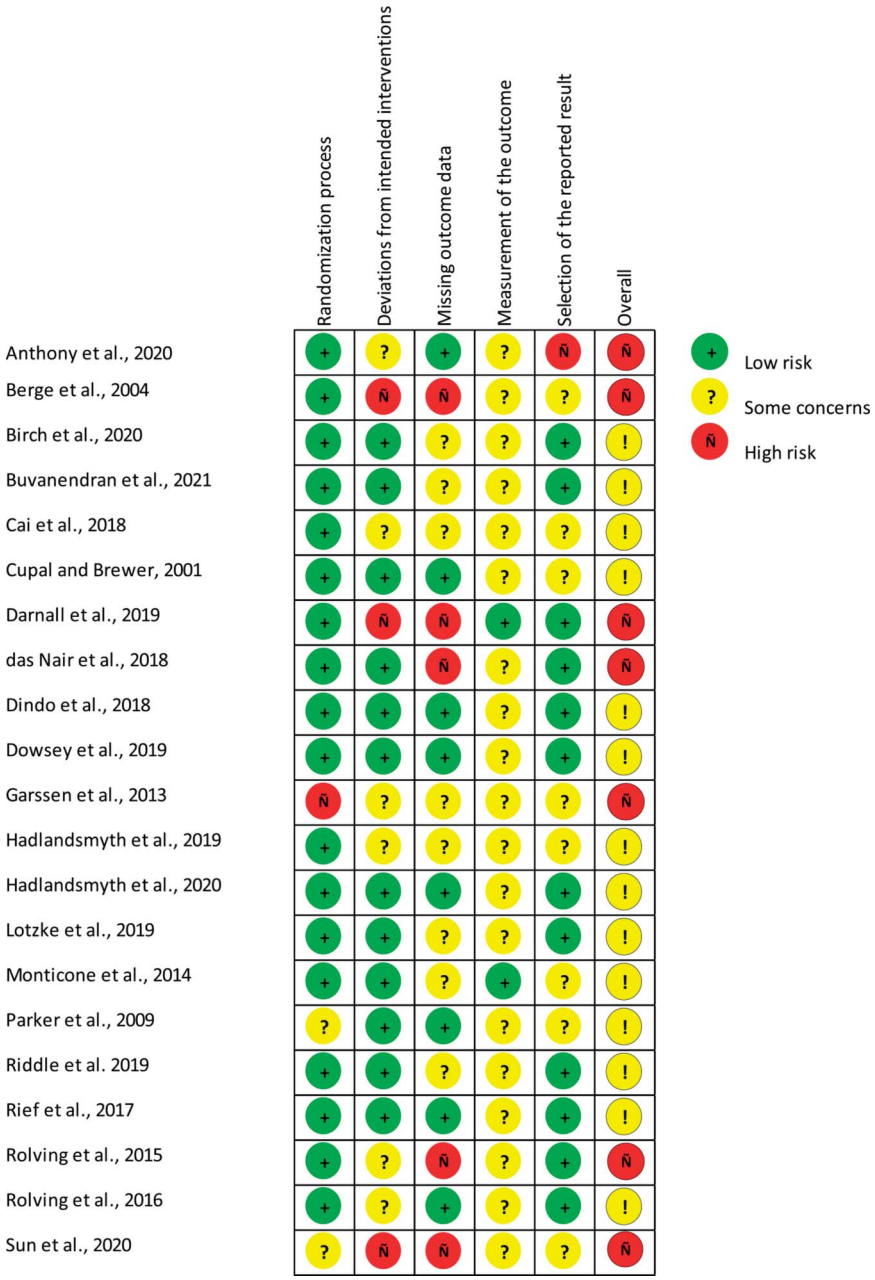

Figure 2. Risk of bias. Summary of risk of bias judgements in each domain for studies included in the current meta-analysis.

found in efficacy of targeted vs nontargeted interventions for (sub) acute pain outcomes (Q_1 = 1.39, P = 0.24). For (sub)acute disability outcomes, only 2 studies administered psychological interventions in a group of at-risk patients, whereas 7 studies administered psychological interventions to an unselected surgical sample, leaving an insufficient number of studies to perform the moderator analysis.

3.4.2.2. Type of intervention

For (sub)acute pain outcomes, 9 studies made use of CBT-based interventions, whereas 2 made use of other interventions, and thus, no moderator analyses were performed. For (sub)acute disability outcomes, all but 1 study made use of CBT, also leaving an insufficient number of studies to perform the moderator analysis.

3.4.2.3. Intervention provider

For (sub)acute pain outcomes, psychological interventions were delivered by (at least one) psychologist in 8 studies, whereas in 3 studies, interventions were delivered by another healthcare provider. No difference was found in efficacy of the intervention based on the intervention provider (Q_1 = 0.25, P = 0.61). For (sub) acute disability outcomes, 6 studies delivered the intervention by (at least one) psychologist, and in 3 studies, the intervention was delivered by another healthcare provider. The results showed a significant moderator effect (Q_1 = 5.30, P = 0.02), indicating that some of the variance between studies might be explained by the intervention provider. Interventions delivered by a psychologist had a significant effect on (sub)acute disability outcomes (d = −0.64, P = 0.02), whereas interventions delivered by another healthcare provided did not (d = 0.04, P = 0.67).

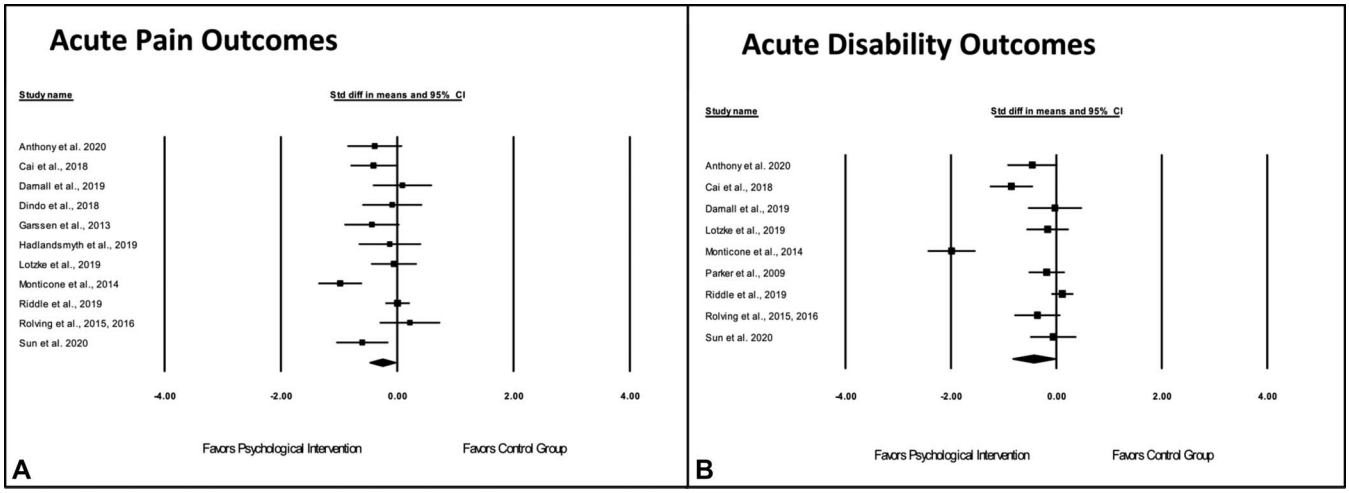

Figure 3. (Sub)acute outcomes forest plot. Standard differences in means (Cohen *d*) and 95% CI of the effects of psychological interventions on (sub)acute postsurgical pain and disability outcomes. CI, confidence interval.

3.4.2.4. Presence of presurgical pain

The moderator analysis for (sub)acute pain outcomes showed no significant differences between studies including patients with ($k = 7$) or without ($k = 4$) chronic pain before surgery ($Q_1 = 0.05$, $P = 0.82$). Moderator analysis for (sub)acute disability outcomes also showed no significant difference between studies including patients with (k = 6) or without (k = 3) chronic pain before surgery ($Q_1 = 0.97$, $P = 0.33$).

3.4.2.5. Timing of intervention

For (sub)acute pain outcomes, only 1 study investigated the impact of a preoperative intervention, whereas 4 studies investigated the impact of postsurgical interventions. Most studies ($k = 6$) addressed the impact of a combined preoperative and postoperative intervention on (sub)acute pain outcomes. Comparison of studies with combined preoperative and postoperative intervention with those delivering postoperative interventions exclusively indicated no significant effects for (sub)acute pain outcomes ($Q_1 = 2.68$, $P = 0.10$). For (sub)acute disability outcomes, 1 study investigated the effects of preoperative interventions, 3 studies investigated the impact of postsurgical interventions, and 5 studies addressed the impact of a combined presurgical and postsurgical interventions. The results indicated a moderating effect of timing of intervention ($Q_1 = 5.09$, $P = 0.02$) indicating that some of the variance between studies could be explained by timing of the intervention. Interventions delivered postoperatively had a significant effect on (sub)acute pain outcomes ($d = -1.10$, $P = 0.01$) while interventions delivered both preoperatively and postoperatively did not ($d = -0.07$, $P = 0.41$).

3.4.2.6. Type of surgery

For (sub)acute pain outcomes, 4 studies investigated the impact of perioperative interventions in a population undergoing hip and knee surgery, 3 studies in a back surgery population, 3 studies in a population undergoing breast surgery, and 1 study in a population undergoing other types of surgery. Moderator analysis only considering groups with at least 3 studies available in a moderator group indicated no difference for (sub)acute pain outcomes ($Q_2 = 0.15$, $P = 0.93$). For (sub)acute disability outcomes, 1 study investigated the effects of perioperative interventions in patients undergoing breast surgery, 3 studies in patients undergoing back surgery, 3 studies in patients undergoing hip and knee surgery, and 2 studies in patients undergoing other types of surgery. Moderator analysis only considering moderator groups with sufficient studies indicated no difference for (sub)acute disability outcomes ($Q_1 = 0.83$, $P = 0.36$).

3.4.2.7. Duration of intervention

For both (sub)acute pain and (sub)acute disability outcomes, the duration of the intervention ranged from 28 to 1080 minutes. Two meta-regressions were performed to investigate the impact of intervention duration on (sub)acute pain and disability outcomes. The results indicated that for both (sub)acute pain ($F(1,9) = 0.56$, $P = 0.47$) and (sub)acute disability ($F(1,7) = 0.11$, $P = 0.75$), the duration of the intervention did not impact on its efficacy (see also Supplementary File 4, supplemental digital content, http://links.lww.com/PAIN/B526).

3.5. Chronic outcomes

3.5.1. Main analyses

For chronic pain outcomes, analyses were performed with 16 studies (**Fig. 4A**), whereby a negative effect size indicates that the outcome favors the psychological intervention group and a positive effect size indicates that the outcome favors the control group. The results indicated that the effects of psychological interventions on chronic pain were significant with a small effect size ($d = -0.33$, $P = 0.02$, 95% CI [−0.61 to −0.06]), indicating that chronic pain outcomes were reduced in the psychological intervention group compared with the control group. Furthermore, the results did also indicate substantial heterogeneity between studies ($Q_{15} = 87.86$, $P < 0.001$).

For chronic disability outcomes, analyses were performed with 16 studies (**Fig. 4B**). Similar to chronic pain outcomes, the effects of psychological interventions were also significant with a small to moderate effect size for chronic disability outcomes ($d = -0.43$, $P = 0.001$, 95% CI [−0.68 to −0.18]), indicating that chronic disability was lower in the psychological intervention group than in the control group. Furthermore, significant heterogeneity was found between studies evaluating chronic disability outcomes

Table 2

Effect sizes of individual moderator groups and subgroups for (sub)acute postsurgical pain and disability outcomes.

Moderator group	Pain							Disability						
	Sample	Effect size			Heterogeneity			Sample	Effect size			Heterogeneity		
	k	*d*	*P*	95% CI	I^2	Q_W-value	*P*	*k*	*d*	*P*	95% CI	I^2	Q_W-value	*P*
Overall	11	−0.26	0.02	−0.48 to −0.04	66.98	30.29	0.001	9	−0.43	0.03	−0.84 to −0.03	89.84	78.71	<0.001
Targeted vs nontargeted interventions														
Targeted	4	−0.10	0.29	−0.28 to 0.08	9.19	3.30	0.35	2	−0.35	0.47	−1.30 to 0.59	94.11	16.99	<0.001
Nontargeted	7	−0.32	0.05	−0.65 to 0.00	72.29	21.65	0.001	7	−0.46	0.07	−0.95 to 0.03	88.92	54.15	<0.001
Type of intervention														
CBT-based	9	−0.28	0.03	−0.53 to −0.02	71.49	28.06	<0.001	8	−0.48	0.03	−0.92 to −0.04	90.99	77.68	<0.001
Other	2	−0.18	0.49	−0.69 to 0.33	54.25	2.19	0.14	1	−0.03	0.92	−0.54 to 0.49	0.00	0.00	1.00
Intervention provider														
Psychologist	8	−0.29	0.04	−0.57 to −0.01	65.25	20.15	0.005	6	−0.64	0.02	−1.20 to −0.09	89.86	49.33	<0.001
Other	3	−0.18	0.31	−0.51 to 0.16	65.57	5.81	0.06	3	0.04	0.67	−0.13 to 0.21	0.00	1.67	0.44
Presence of presurgical pain														
Preexisting chronic pain	7	−0.28	0.08	−0.59 to 0.03	78.17	27.48	<0.001	6	−0.54	0.07	−1.13 to 0.05	93.49	76.81	<0.001
Other*	4	−0.23	0.07	−0.48 to 0.12	0.00	2.80	0.42	3	−0.22	0.08	−0.46 to 0.02	0.00	1.55	0.46
Timing of intervention														
Preoperative	1	0.09	0.73	−0.42 to 0.60	0.00	0.00	1.00	1	−0.03	0.92	−0.54 to 0.49	0.00	0.00	1.00
Postoperative	4	−0.50	0.007	−0.87 to −0.13	64.27	8.40	0.04	3	−1.10	0.01	−1.97 to −0.22	91.39	23.22	<0.001
Preoperative and postoperative	6	−0.14	0.21	−0.37 to 0.08	45.44	9.16	0.10	5	−0.07	0.09	−0.25 to 0.10	22.20	5.14	0.27
Type of surgery														
Hip and knee surgery	4	−0.24	0.11	−0.54 to 0.06	61.05	7.70	0.05	3	−0.25	0.40	−0.84 to 0.33	88.23	17.00	<0.001
Back surgery	3	−0.29	0.44	−1.01 to 0.44	88.52	17.43	<0.001	3	−0.83	0.14	−1.94 to 0.28	94.97	39.76	<0.001
Breast surgery	3	−0.17	0.28	−0.48 to 0.14	10.11	2.23	0.33	1	−0.03	0.92	−0.54 to 0.49	0.00	0.00	1.00
Other	1	−0.39	0.11	−0.86 to 0.09	0.00	0.00	1.00	2	−0.28	0.05	−0.56 to 0.001	0.00	0.84	0.36

CBT, cognitive behavioral therapy; CI, confidence interval; *d*, standardized mean difference; *k*, number of studies;

* Acute or no preexisting chronic pain. A random-effects model was used to combine effect sizes; where more than 1 value used in the study, outcomes were averaged Cochran *Q* and I^2 values are reported as an indices of heterogeneity (Borenstein et al., 2009).

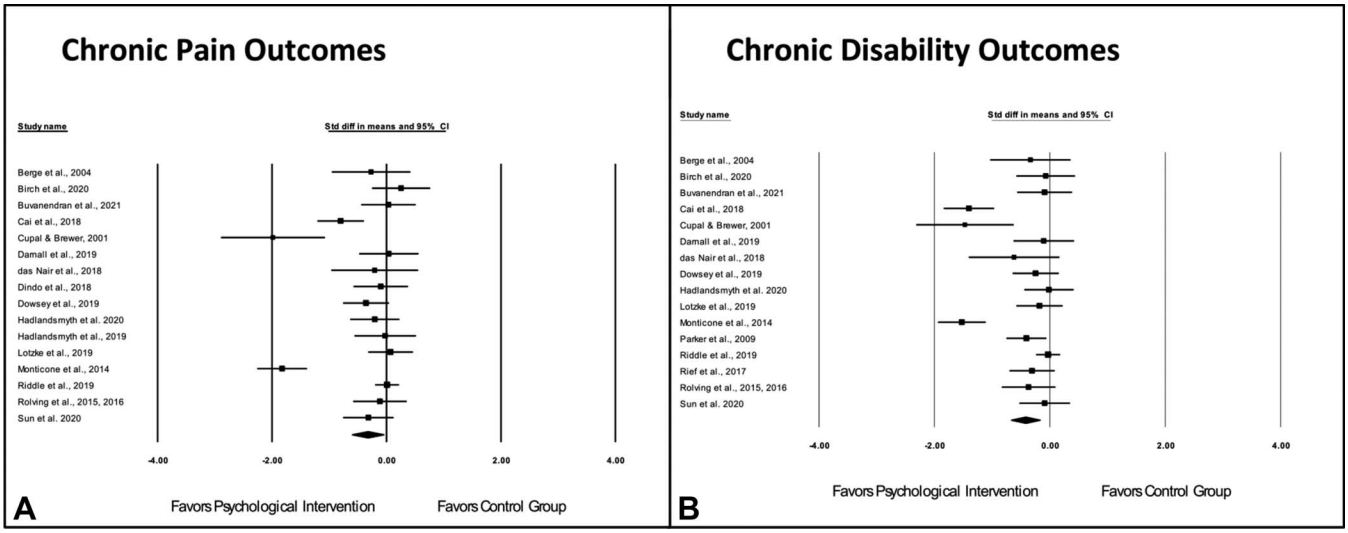

Figure 4. Chronic outcomes forest plot. Standard differences in means (Cohen *d*) and 95% CI of the effects of psychological interventions on chronic postsurgical pain and disability outcomes. CI, confidence interval.

($Q_{15} = 76.96$, $P < 0.001$). To investigate the impact of a single study, analyses were again performed repeatedly with 1 different study removed. This did not change the significance of the effects.

3.5.2. Moderator analyses

To address the between-study variability in the main analysis for both chronic pain and disability outcomes, moderator analyses were performed. Effect sizes and heterogeneity indices for all moderator groups are reported in **Table 3**.

3.5.2.1. Targeted vs nontargeted interventions

For chronic pain outcomes, half of the studies ($k = 8$) performed an intervention that targeted patients selected on psychological risk factors, whereas the other half performed an intervention that was not directed at an at-risk patient group. For chronic disability outcomes, 6 studies administered psychological interventions to a group of at-risk patients, whereas 10 studies did not target an at-risk patient group. In contrast to expectation, no difference was found in efficacy of targeted vs nontargeted interventions for either chronic pain outcomes ($Q_1 = 1.71$, $P = 0.19$) or chronic disability outcomes ($Q_1 = 0.04$, $P = 0.84$).

3.5.2.2. Type of intervention

For chronic pain outcomes, 12 studies made use of CBT-based interventions, whereas 4 studies made use of other interventions. For chronic disability outcomes, 11 studies made use of CBT and 5 studies made use of other interventions. No difference was found in efficacy of the type of intervention for either chronic pain outcomes ($Q_1 = 0.58$, $P = 0.45$) or chronic disability outcomes ($Q_1 = 0.03$, $P = 0.86$).

3.5.2.3. Intervention provider

For both chronic pain and chronic disability outcomes, psychological interventions were delivered by (at least one) psychologist in 10 studies, whereas it was delivered by another healthcare provider in 6 studies. No difference was found in the efficacy of the psychological intervention depending on the type of provider for either chronic pain ($Q_1 = 0.16$, $P = 0.69$) or chronic disability outcomes ($Q_1 = 1.99$, $P = 0.16$).

3.5.2.4. Presence of presurgical pain

For chronic pain outcomes, no significant differences were found between studies including patients with ($k = 13$) or without ($k = 3$) the presence of chronic pain before surgery ($Q_1 = 0.28$, $P = 0.60$). Similarly, for chronic disability, the moderator analysis showed no significant differences between studies including patients with chronic presurgical pain ($k = 12$) or without chronic presurgical pain ($k = 4$) outcomes ($Q_1 = 0.03$, $P = 0.86$).

3.5.2.5. Timing of intervention

For chronic pain outcomes, 3 studies investigated the impact of a preoperative intervention, 4 studies addressed the impact of postsurgical interventions, and 9 studies researched the impact of a combined presurgical and postsurgical intervention. The results showed that the moderator effect just failed to reach significance ($Q_2 = 5.82$, $P = 0.05$), indicating that some of the variance between studies might be explained by timing of the intervention. Interventions delivered postoperatively had a significant effect on chronic pain outcomes ($d = -1.13$, $P = 0.01$), but not preoperatively ($d = -0.10$, $P = 0.58$) nor combined preoperative and postoperative interventions ($d = -0.06$, $P = 0.32$). For chronic disability outcomes, 3 studies investigated the impact of presurgical interventions, 3 studies investigated the impact of postsurgical interventions, and 10 studies investigated the effects of a combined presurgical and postsurgical intervention. The results again indicated a significant moderator effect ($Q_2 = 70.03$, $P < 0.001$). There was a significant effect for interventions delivered postoperative ($d = -1.47$, $P < 0.001$) and preoperative and postoperative ($d = -0.16$, $P = 0.007$), but not for interventions delivered preoperative only ($d = -0.29$, $P = 0.13$).

3.5.2.6. Type of surgery

For chronic pain outcomes, 10 studies investigated the impact of perioperative interventions in a population undergoing hip and knee surgery, 3 studies in a back surgery population, 2 studies in a breast surgery population, and 1 study in a population undergoing

Table 3

Effect sizes of individual moderator groups and subgroups for chronic postsurgical pain and disability outcomes.

Moderator group	Pain							Disability						
	Sample	Effect size			Heterogeneity			Sample	Effect size			Heterogeneity		
	k	*d*	*P*	95% CI	I^2	Q_W-value	*P*	*k*	*d*	*P*	95% CI	I^2	Q_W-value	*P*
Overall	16	−0.33	0.02	−0.61 to −0.06	82.93	87.86	<0.001	16	−0.43	0.001	−0.68 to −0.18	80.51	76.96	<0.001
Targeted vs nontargeted interventions														
Targeted	8	−0.15	0.20	−0.39 to 0.08	56.99	16.28	0.02	6	−0.40	0.08	−0.83 to 0.04	84.65	32.58	<0.001
Nontargeted	8	−0.54	0.05	−1.07 to −0.01	88.92	63.19	<0.001	10	−0.45	0.005	−0.77 to −0.14	78.50	41.87	<0.001
Type of intervention														
CBT-based	12	−0.27	0.09	−0.59 to 0.04	84.78	72.28	<0.001	11	−0.43	0.009	−0.76 to −0.11	85.53	69.09	<0.001
Other	4	−0.55	0.10	−1.21 to 0.10	79.41	14.57	0.002	5	−0.39	0.02	−0.72 to −0.05	49.21	7.88	0.10
Intervention provider														
Psychologist	10	−0.36	0.08	−0.76 to 0.04	84.13	56.70	<0.001	10	−0.53	0.004	−0.88 to −0.17	82.38	51.09	<0.001
Other	6	−0.25	0.18	−0.61 to 0.11	77.92	22.64	<0.001	6	−0.21	0.10	−0.46 to 0.04	54.44	10.98	0.05
Presence of presurgical pain														
Preexisting chronic pain	13	−0.30	0.05	−0.59 to −0.006	83.34	72.02	<0.001	12	−0.41	0.009	−0.72 to −0.10	84.09	69.13	<0.001
Other*	3	−0.58	0.26	−1.61 to 0.44	87.35	15.81	<0.001	4	−0.46	0.02	−0.84 to −0.07	60.42	7.58	0.06
Timing of intervention														
Preoperative	3	−0.10	0.58	−0.47 to 0.26	0.00	0.59	0.75	3	−0.29	0.13	−0.66 to 0.08	0.00	1.17	0.56
Postoperative	4	−1.13	0.01	−1.98 to −0.27	90.50	31.57	<0.001	3	−1.47	<0.001	−1.75 to −1.19	0.00	0.16	0.92
Preoperative and postoperative	9	−0.06	0.32	−0.19 to 0.06	0.00	6.40	0.60	10	−0.16	0.007	−0.28 to −0.04	0.00	5.61	0.78
Type of surgery														
Hip and knee surgery	10	−0.30	0.04	−0.58 to −0.02	71.96	32.09	<0.001	9	−0.44	0.01	−0.79 to −0.09	80.51	41.05	<0.001
Back surgery	3	−0.62	0.31	−1.81 to 0.57	95.63	45.72	<0.001	3	−0.69	0.11	−1.54 to 0.15	91.51	23.55	<0.001
Breast surgery	2	0.01	0.96	−0.36 to 0.38	0.00	0.03	0.87	1	−0.11	0.69	−0.63 to 0.42	0.00	0.00	1.00
Cardiac surgery	—	—	—	—	—	—	—	1	−0.31	0.12	−0.70 to 0.08	0.00	0.00	1.00
Other	1	−0.20	0.35	−0.64 to 0.23	0.00	0.00	1.00	2	−0.23	0.23	−0.61 to 0.15	47.68	1.91	0.17

CBT, cognitive behavioral therapy; CI, confidence interval; *d*, standardized mean difference; *k*, number of studies;

* Acute or no preexisting chronic pain. A random-effects model was used to combine effect sizes; where more than 1 value used in the study, outcomes were averaged Cochran *Q* and I^2 values are reported as an indices of heterogeneity (Borenstein et al., 2009).

another type of surgery. Moderator analysis only considering groups with at least 3 studies available in a moderator group indicated no difference for chronic pain outcomes ($Q_1 = 0.27$, $P = 0.60$). For chronic disability outcomes, 9 studies evaluated the effects of perioperative interventions in patients undergoing hip and knee surgery, 3 studies in patients undergoing back surgery, 1 study in patients undergoing breast surgery, 1 study in patients undergoing cardiac surgery, and 2 in patients undergoing other types of surgery. Moderator analysis only considering groups with at least 3 studies available in a moderator group also indicated no difference for chronic disability outcomes ($Q_1 = 0.30$, $P = 0.59$).

3.5.2.7. Duration of intervention

For both chronic pain and chronic disability outcomes, the duration of the intervention ranged from 90 to 2040 minutes. Two meta-regressions were performed to investigate the impact of intervention duration on chronic pain and disability outcomes. The results indicated that the duration of the intervention had no impact on the intervention efficacy for both chronic pain ($F(1,14) = 0.06$, $P = 0.81$) and chronic disability outcomes ($F(1,14) = 0.02$, $P = 0.89$), (Supplementary File 4, supplemental digital content, http://links.lww.com/PAIN/B526).

3.6. Additional analyses

We performed additional analyses to examine whether the results of the meta-analyses depend on what comparison group was used. Fifteen studies compared psychological interventions with treatment as usual only, 2 studies compared psychological interventions with an active control group only, and 4 studies compared psychological interventions with both treatment as usual and an active control group.

3.6.1. Treatment as usual

We found significant effects with a small effect size for (sub)acute pain outcomes ($d = -0.20$, $P = 0.02$, 95% CI [−0.37 to −0.03]) when psychological interventions were compared with treatment as usual. Similarly, the effect for (sub)acute disability outcomes also reached significance when psychological intervention was compared with treatment as usual with a small effect size ($d = -0.34$, $P = 0.04$, 95% CI [−0.65 to −0.01). The results did not indicate heterogeneity for (sub)acute pain outcomes ($Q_8 = 11.23$, $P = 0.19$) but did for (sub)acute disability outcomes ($Q_5 = 21.37$, $P = 0.001$). Furthermore, we found significant effects with small to moderate effect sizes for chronic pain outcomes ($d = -0.20$, $P = 0.04$, 95% CI [−0.38 to −0.01]) and chronic disability outcomes ($d = -0.42$, $P = 0.001$, 95% CI [−0.67 to −0.17]) when psychological intervention was compared with treatment as usual. The results also showed heterogeneity for chronic pain outcomes ($Q_{13} = 28.04$, $P = 0.009$) and chronic disability outcomes ($Q_{12} = 44.64$, $P < 0.001$).

3.6.2. Active control intervention

No significant effects were found when psychological interventions were compared with an active control group for (sub) acute pain ($d = -0.29$, $P = 0.41$, 95% CI [−0.97 to 0.39]) and disability outcomes ($d = -0.48$, $P = 0.30$, 95% CI [−1.40 to 0.43]). However, the results did indicate significant heterogeneity for (sub)acute pain outcomes ($Q_2 = 21.23$, $P < 0.001$) as well as disability outcomes ($Q_3 = 68.57$, $P < 0.001$). Similarly, we found no significant effects for chronic pain outcomes ($d = -0.97$, $P = 0.08$, 95% CI [−2.08 to 0.13]). However, we found significant effects with a moderate effect size for disability outcomes ($d = -0.61$, $P = 0.02$, 95% CI [−1.13 to −0.09]) when psychological intervention was compared with an active control group. Again, the results showed significant heterogeneity for both chronic pain ($Q_4 = 67.04$, $P < 0.001$) and disability outcomes ($Q_5 = 43.55$, $P < 0.001$).

4. Discussion

This meta-analysis demonstrated that perioperative psychological interventions had small to medium effects in reducing both (sub)acute and CPSP and disability, compared with a control group. These effects were replicated in follow-up analyses where the intervention was compared with treatment as usual. However, when compared with an active control group, effects were only significant for chronic disability outcomes.

4.1. Effect sizes and moderators

The overall effect sizes for the reduction in (sub)acute pain, disability, and chronic pain were small, whereas medium effect sizes were found for disability at chronic time points. These effect sizes compare favorably with those found in meta-analyses of psychological therapies for the management of existing chronic pain groups[67] where for both pain and disability, very small to small effect sizes were found. Current findings may suggest that preventing pain before it becomes chronic is more effective than treating it after it develops into a persisting problem.

When looking at individual studies, 3 of them showed large effect sizes for all or most of their outcomes.[7,10,32] Aside from the fact that all 3 studies used an intervention that was delivered after surgery, there was no other feature that set these studies apart from the other studies. In line with this, one of the significant moderators that we identified was "timing of intervention." Interventions that included postoperative sessions were shown to be more effective in reducing chronic disability than interventions delivered preoperatively only. Interventions that were delivered before surgery only tended to have a shorter overall duration and could therefore possibly be less effective. However, our findings need to be taken with some caution because there were only 3 studies examining interventions that were delivered preoperatively, compared with 13 studies that were delivered both preoperatively and postoperatively, and 5 studies that were delivered postoperatively. Moreover, regarding intervention provider, effect sizes were larger for all outcomes when the intervention was delivered by a psychologist, but the moderation effect only reached significance for (sub)acute disability outcomes. Although the results of individual studies show that interventions delivered by other healthcare providers can be effective, psychologists might nevertheless still be in the best position to deliver a psychological intervention.

Next, we performed analyses to examine whether effect sizes differed according to the type of control group. Different control groups have been shown to affect effect sizes of randomized controlled trials in which smaller effect sizes can be found in studies that include an active control group compared with studies with treatment as usual as their control group.[31] Active control groups are assumed to better account for nonspecific treatment effects such as attention or expectancy than treatment as usual control groups. However, our results did not give evidence that effects sizes were larger in studies using the treatment as usual control groups only. If anything, effect sizes were larger in the comparisons with active control groups. However, it should be noted that when compared with an active

control group, the effects of psychological interventions were only significant for chronic disability outcomes, and there were only 6 studies that evaluated the effects of psychological interventions in comparison to an active control group.

4.2. Comparison with other reviews

The current meta-analysis extends the work of previous reviews on the effects of psychological interventions on postsurgical pain and disability. Most of the previous reviews have examined the effects of psychological interventions for specific types of interventions, such as orthopedic surgery, cardiac surgery, or abdominal surgery,[52,56,64,70] and/or limited the outcomes to the acute postoperative period.[1,34,52,56] The review of Nicholls et al.[36] is similar to ours in that they evaluated the effects of psychological interventions across different types of surgeries and examined both (sub)acute and chronic pain and disability. However, their search only yielded 6 articles—1 examining acute postoperative outcomes and 5 examining chronic outcomes. No meta-analyses were performed. Four of the 5 studies focusing on chronic outcomes found a significant reduction in both pain and disability. The 1 article focusing on pain during the first week after surgery did not find a significant improvement. Although authors aimed to include studies using ACT and mindfulness as well, only studies using CBT as their psychological approach were found. Our review identified not only substantially more articles but also articles examining a broader range of psychological interventions, suggesting that in recent years, studies have diversified and evaluated perioperative intervention methods other than CBT.

Wang et al.[65] used meta-analyses to summarize the results of 8 articles examining the effects of psychological interventions and 7 articles examining educational interventions on chronic pain and disability. Their results showed that educational interventions were not effective, whereas moderate quality evidence indicated that psychological interventions reduced CPSP and disability. Our updated and more extensive review confirms these early findings. Although, it should be noted that the definition of psychological intervention used by Wang et al.[65] was broader than ours and included relaxation as a standalone technique. Only 3 of the 8 articles included in their article met the inclusion criteria for our review; most were excluded based on insufficient psychological content or because they were delivered too long after surgery. The fact that we reached the same conclusion with a partially different set of studies point towards the generalizability of the findings.

4.3. Clinical implications and further research

Considering the high volume of surgical procedures performed, and the large individual and societal burden of chronic pain, interventions that effectively reduce the risk of CPSP are of paramount importance. Our meta-analyses show that perioperative psychological interventions can decrease pain and disability in the early postoperative period (ie, up to 3 months after surgery) and the late postoperative period (ie, more than 3 months after surgery) after different types of surgery. For pain outcomes, it should be mentioned that all studies assess this outcome through direct self-report measures. Future studies could benefit from assessing pain using other outcomes such as analgesic medication usage and length of hospital stay.

Within the current review, we identified only few moderating effects from the factors that we examined. It should be noted that the small number of studies in some categories may have contributed to the lack of moderating effects. Indeed, although moderator analyses did not reach significance, results indicated that CBT-based interventions showed a significant treatment effect for all outcomes, which was not the case for other types of interventions that only showed a significant effect on chronic disability outcomes. Moreover, other types of interventions had smaller effect sizes compared with those of CBT-based interventions for all outcomes (**Table 2 and 3**). Future research on this moderator variable is therefore warranted. Currently, CBT-based interventions remain the most studied form of perioperative psychological interventions, and proper comparison with specific types of psychological interventions other than CBT (eg, psychoeducation or mindfulness interventions) will only be possible when additional studies becomes available. Moreover, across CBT-based studies, there was significant variability in intensity, duration, and timing as well as the specific components included. Evaluating how these aspects contribute to and interact with factors that optimize the effects on postsurgical pain may be an important next step.

Moreover, there is a lack of studies investigating interventions delivered preoperatively, especially for outcomes within the early postoperative period. More studies are needed to assess the efficacy of psychological interventions on (sub)acute pain and disability outcomes. In addition, future work should examine which patients will benefit the most from psychological interventions. Because preoperative emotional and cognitive factors are known risk factors for unfavorable outcomes, we had expected that interventions directed at patients selected for the presence of these risk factors would be most effective. However, there was no evidence indicating that targeted interventions were more effective than nontargeted interventions. One reason may be the paucity of data on the appropriate selection criteria to decide whether a patient is at an increased risk for CPSP. Most of the selection instruments that have been used are dimensional in nature and use relatively arbitrary cutoff scores to identify at-risk patients.[63] Future studies should assess the sensitivity and specificity of these instruments to select patients at risk for detrimental acute or chronic postsurgical outcomes.

Our meta-analysis also provides insights into the quality of studies. Although we only included randomized controlled trials, none of the studies included in this meta-analysis had an overall low ROB judgement. Because double blinding is not possible in psychological intervention studies, most studies had concerns regarding bias in the measurement of the outcome. Including an active control group may reduce some of this bias. Only 6 of the studies in the current review did include such an active control condition. This illustrates the need for more studies to assess the efficacy of psychological interventions in comparison with active comparator groups, especially because our analyses only indicated a significant effect for chronic disability outcomes when compared with an active control group. Our ROB assessment has shown that the domain with the highest ROB was bias due to missing outcome data. The reason for missing data varied from withdrawal, dropout, declined follow-up, to medical complications, death, and moving abroad. Only 4 studies had less than 10% dropout at final follow-up (refer to **Table 1** for an overview). Furthermore, it should be noted that not all studies used appropriate techniques (eg, intention-to-treat analysis) to address these missing data. This is especially important as some studies had up to 50% dropout rates at final follow-up. However, as the reasons for missing data varied, we cannot be certain whether low retention and longer follow-up times were solely due to the intervention. Furthermore, for several studies, we were unable to determine bias due to selective reporting because there was no preregistration of the trial or the trial was registered after

the study was completed. Thus, we urge future studies to register their studies in advance and report all findings as planned to remain transparent.

4.4. Strengths and limitations

To the best of our knowledge, this is the first meta-analysis that evaluated the effects of psychological interventions on both (sub)acute postsurgical pain and CPSP and disability. We were able to include 21 studies, making this the largest meta-analysis on the topic so far. In addition to systematically searching the literature, we also contacted experts in the field to ascertain that no articles were missed. We also contacted authors to obtain data that could not be retrieved from their articles but were necessary to conduct the meta-analyses. Owing to the high response rate, we were able to include all eligible articles in the analyses. Compared with previous reviews, we could also evaluate the effects of a larger variety of psychological interventions. Finally, we conducted moderation analyses to identify factors that could potentially influence the effectiveness of perioperative psychological interventions.

There are also some limitations. First, our search strategy only included English search terms in English language databases. As such, the search performed in the current meta-analysis does not include potentially relevant articles that contained no English keywords or an English abstract. Indeed, there may be studies published in other languages that could be of importance for the current meta-analysis but were not included because they were not identified by our search terms. Second, we only included published studies. Inclusion of gray literature can reduce the risk of publication bias.[38] However, because not all gray literature is peer reviewed, assessment of the validity of the results can be problematic.[38] Third, our determination of what constitutes a psychological intervention was restricted to the descriptions listed in the study. In several cases, we had to contact study authors to determine whether an intervention contained enough psychological elements, but even so, our assessment remains subjective. Therefore, we also stress the importance for future studies to include study protocols and a proper theory to describe psychological interventions. Furthermore, despite various studies assessing the efficacy of interventions such as hypnosis, guided imagery, and relaxation, we decided to exclude these studies because these interventions do not target emotion and cognition directly or consciously. However, it should be noted that both hypnosis and guided imagery have been shown to have positive effects on pain reduction.[1,57] It may be beneficial to compare the efficacy of psychological interventions with other (psycho) therapeutic tools that were not assessed in the current meta-analysis in future studies. Finally, not all planned moderator analyses could be conducted because for some outcomes too few studies were available per moderator category. In addition, although a minimum of 3 studies was required before running a moderator analysis, the moderator analyses that were conducted may have had limited power to reliably detect meaningful effects.

5. Conclusion

The current review and meta-analyses of 21 studies shows that psychological interventions can be effective in reducing (sub) acute postsurgical pain and CPSP and disability. These results underscore the possible benefits of integrating psychological services into multidisciplinary acute and transitional pain teams.[27] Considering the large volume of surgeries occurring worldwide, implementing psychological interventions in the perioperative period may have the potential to reduce the humanitarian and economic burden of CPSP. Further research is required to determine which psychological intervention may be the most beneficial, as well as their cost-effectiveness.

Conflict of interest statement

The authors have no conflicts of interest to declare.

Appendix A. Supplemental digital content

Supplemental digital content associated with this article can be found online at http://links.lww.com/PAIN/B526.

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