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Effectiveness of perioperative psychological interventions for the reduction of postsurgical pain intensity, depression, anxiety, and pain catastrophising: A systematic review and meta-analysis

Short running title: Perioperative psychotherapy for postsurgical pain, depression, anxiety, and catastrophising

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Abstract

BACKGROUND. Evidence suggests that psychological interventions during the perioperative period can help reduce the development of chronic postsurgical pain (CPSP); however, there is no evidence of their effects on other important pain-related variables.

OBJECTIVES. This systematic review and meta-analysis evaluated the effectiveness of perioperative psychological interventions for the reduction of postsurgical pain intensity, depression, anxiety, stress, and pain catastrophising.

STUDY DESIGN. Systematic review of randomised controlled trials (RCTs) with meta-analyses (registration number: CRD42023403384). The search for studies was carried out in Web of Science, PsychINFO, MEDLINE, and CINAHL up to March 2023.

ELIGIBILITY CRITERIA. RCTs comparing perioperative psychological interventions with usual care or non-psychological control interventions in adult patients with any type of surgery. The main outcome was pain intensity reduction after surgery. Secondary outcomes included patient-reported depression, anxiety, stress, and pain catastrophising after surgery.

RESULTS. Twenty-seven RCTs (psychological intervention: 1,462 patients; control: 1,528 patients) were included in the systematic review and 17 studies for the meta-analysis. Random-effect models were used to combine the effect sizes of the studies. Compared with usual care or control interventions, psychological interventions reduced pain intensity (d = -0.45, 95%CI [-0.77 to -0.13]) and anxiety (d = -0.33, 95%CI [-0.54 to -0.11]) after surgery. Moderator analyses revealed that CBT seemed the most beneficial for surgical patients. The findings in other moderator analyses were heterogeneous.

CONCLUSIONS. Moderate-quality evidence exists that perioperative psychological interventions can significantly reduce pain intensity and anxiety post-surgery. However, results should be interpreted with caution because of the presence of a high risk of bias in many trials.

Keywords: Anxiety, Chronic Postsurgical Pain (CPSP), Depression, Meta-analysis, Pain, Pain Catastrophising, Perioperative, Psychological interventions, Surgery

Systematic review protocol: PROSPERO CRD42023403384

KEY POINTS

1. Perioperative psychological interventions are promising for reducing pain intensity and anxiety after surgery.
2. Cognitive-behavioral therapy (CBT) appears to be particularly effective for reducing post-operative pain intensity.
3. Psychological interventions delivered by psychologists may yield better outcomes compared to those delivered by other professionals.
4. This systematic review and meta-analysis provide moderate-quality evidence supporting the efficacy of perioperative psychological interventions in mitigating pain intensity and anxiety after surgery.

Introduction

Common clinical problems after surgery include insufficiently controlled pain in the acute postoperative phase and/or pain that persists beyond the expected healing period[1]. Acute pain is an inevitable experience after surgery; however, 10-80% of surgical patients develop persistent pain[2–5]. Unrelieved acute postsurgical pain increases the risk of its progression to chronic pain[6]. Chronic postsurgical pain (CPSP) is defined as chronic pain that develops or increases in intensity after a surgical procedure and persists beyond the normal and expected healing process, i.e., at least 3 months after the surgery[7]. CPSP is associated with reduced quality of life, physical and psychological impairment, and increased healthcare costs[8, 9].

Prospective studies have identified various risk factors (including psychological ones) for both early and late postsurgical pain[10, 11]. Patient data for evaluating risk factors are often collected in the perioperative period, which generally lasts from the time a patient enters the hospital for surgery to the time the patient is discharged. Evidence suggests that perioperative patient-reported symptoms of depression, anxiety, stress, and pain catastrophising are associated with persistent postsurgical pain[4, 9]. Therefore, a preliminary assessment of these factors could help to identify patients at risk for unfavourable surgical outcomes and could guide specific early interventions for preventing them[10]. Psychological approaches such as Cognitive-Behavioral Therapy (CBT), Acceptance and Commitment Therapy (ACT), and Mindfulness-Based Interventions (MBIs) are effective in the treatment of chronic pain and related cognitive and affective symptoms[12–23] and there is evidence that they can also be effective in reducing subacute and chronic postsurgical pain and disability[24–26]. Persistent postsurgical pain and associated disability could be reduced or prevented with specific psychological interventions in the perioperative period to address modifiable psychological variables associated with the prediction of postsurgical pain.

The objective of the present study was twofold. The first goal was to extend the review published by Nadinda and colleagues[26], who analysed the effects of perioperative psychological interventions on postsurgical pain intensity. We aimed to expand on that study by reviewing additional postsurgical patient-reported outcome measures of depression, anxiety, perceived stress, and pain catastrophising, which, altogether delimit the patient's experience and risk of chronification. This different and more comprehensive focus allows for exploring more ubiquitous effects of psychological interventions during the perioperative period. Postsurgical pain is often accompanied by psychopathological symptoms, so it is important to

know whether psychological interventions also alleviate these symptoms. The rationale for expanding Nadinda's review is to provide the most current and best available evidence to inform clinical decision-making for this highly relevant clinical problem. The second goal was to compute moderation analyses to identify factors influencing the efficacy of psychological interventions. As done by Nadinda and colleagues[26], we analysed the moderating role of the type of psychological intervention (CBT, MBIs + ACT, or multicomponent), the timing of the intervention (preoperative, postoperative, or pre- and post-operative), the intervention provider (psychologist or non-psychologist), the format of intervention (online or in-person), the intervention targeted at an at-risk population (targeted intervention or non-targeted intervention), the presurgical pain (yes or no), the risk of bias (low risk, some concerns, or high risk), the duration of intervention, and the rate of females.

Methods

Protocol and Registration

Our systematic review and meta-analysis were conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement[27] and registered in the Prospective Register of Systematic Reviews (PROSPERO) database on 12 March 2023 (registration number: CRD42023403384).

Data Sources and Searches

Following Nadinda et al.'s[26] methodology, the search for studies was carried out in the PubMed, PsycINFO, Web of Sciences Core Collection, and Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases up to March 2023. Following the "Population", "Intervention", "Comparison", "Outcomes", and "Study design" (PICOS) strategy, these main search terms were used: "psychological interventions", "surgery", "pain", "pain catastrophising", "anxiety", "depression", "stress", and "posttraumatic". Specific search terms were combined and adapted to each database and are detailed in Supplementary File 1. Additionally, the reference lists of included studies were searched to detect possible articles not included in the search strategies. Finally, in those cases in which data was missing or the reported information needed to be confirmed, an email was written to the authors (a reminder was sent if no response was received after two weeks).

Study Selection

Concerning the selection of articles, the following selection criteria were guided by the PICOS framework or strategy of evidence-based medicine[28]:

- Population: The participants of the studies included adult patients who were scheduled for or have had any type of surgery (even ambulatory surgery).
- Interventions and comparisons: The interventions included in this systematic review and meta-analyses were those constituted under the epigraph of "psychological therapies" according to the definition established by Norcross[29]. Among the different psychological interventions that met this condition were cognitive therapy, CBT, psychoeducation, ACT, MBIs, and compassion-focused therapy. Interventions could be individual or group-based and could be conducted either in person or online. Comparison groups, used for control interventions, were defined as either usual care or non-psychological interventions with or without minor psychological ingredients (i.e., education, physical exercise, relaxation, self-hypnosis, and nature-based therapies). Finally, for the study to be included, the time of administration of the psychological therapy had to be within the perioperative period, meaning that it was administered before surgery or immediately after surgery (starting no later than two weeks after surgery), or a combination (pre- and post-surgery).
- Outcomes: The study had to report pain intensity outcomes explicitly and quantitatively and optionally one of the following outcome variables: pain catastrophising, anxiety, depression, and/or stress. The inclusion criteria for studies in our meta-analysis required that the assessment of both primary (pain intensity) and secondary outcomes (anxiety, depression, pain catastrophizing, and stress) be conducted after the surgery. When multiple assessments of the main outcome were available using different instruments, we selected the most commonly used instrument, specifically the Numerical Rating Scale (NRS) or the Visual Analog Scale (VAS), when possible.
- Study design: Only RCTs with pre-post analysis and published in English or Spanish were included. Pilot studies were also included as long as they followed an RCT design. It is important to indicate that if the article compared two psychological interventions according to the definition of Norcross[29], it was not included.

Data Extraction

Once the results from the different databases were obtained, duplicates were eliminated using the Mendeley bibliographic tool. Then, four reviewers (J-RCA, ABS, ERC, and VG) independently screened all articles in pairs through Rayyan QCRI[30] based on their titles and abstracts. Potentially relevant articles were subsequently selected for detailed assessment of the full text, and disagreements between authors were resolved by consensus. After completing this procedure, the references of the included articles were reviewed to identify additional relevant studies that had not been identified by the initial search strategies. Furthermore, we screened all the articles that Nadinda et al.[26] had reviewed in case they had not appeared in our search. Some additional articles were subsequently included, but some were excluded. See Supplementary File 2 for a detailed description of Nadinda's studies, which we did not include.

After confirming the articles to be included in this study, data extraction from each article was conducted using a predefined data extraction sheet. Extracted data included: study characteristics (authors, year of publication, journal, and country), sample characteristics (sample sizes, mean age, gender, and surgery type), design characteristics (person delivering the intervention, intervention and control type, duration, intervention format, length of follow-up, and dropout percentage), and treatment outcomes (study measures, points of assessment, mean and standard deviation). The extraction of all data was carried out by three reviewers independently (JR-CA, VG, ABS, and ERC). Cases of disagreement were resolved by consensus among the same reviewers.

Risk of Bias Assessment

A quality assessment was undertaken for the included studies by three independent reviewers (J-RCA, ABS, and ERC) working in pairs; disagreements were solved by a senior reviewer (JVL). It was conducted using the Revised Cochrane risk-of-bias tool for randomised trials (RoB 2)[31]. This tool is made up of the following five domains: (1) bias arising from the randomisation process; (2) bias due to deviation from intended interventions; (3) bias due to missing outcome data; (4) bias in the measurement of the outcome; and (5) bias in the selection of the reported results. In turn, each domain is made up of a series of questions whose answers are categorised as “yes”, “probably yes”, “probably no”, “no”, and “no information”. Finally, according to the answers given to each of the questions, the tool uses an algorithm from which the final assessment result for each domain is derived, which can be “low risk”, “some concerns”, or “high risk”.

Data Synthesis and Analysis

Four meta-analyses were conducted (i.e., for pain intensity, pain catastrophising, depression, and anxiety) to explore the efficacy of perioperative psychological interventions versus a control group. Unlike Nadinda et al.[26], and to ensure a robust number of studies for the meta-analysis, RCTs addressing acute postsurgical pain and chronic postsurgical pain were aggregated without differentiation under the overarching term "postsurgical pain". As we did not find studies that assessed the variable "stress," we were unable to include that variable in our analysis. Moreover, we included the analysis of the following potential moderator variables: type of psychological intervention, timing and format of interventions, intervention provider, intervention targeted at an at-risk population (i.e., individuals who were selected because of an increased risk of developing CPSP), presurgical pain, risk of bias, duration of intervention, and rate of females. Effect sizes were calculated using Cohen's d[32]. Random-effect models were used to combine the effect sizes of the studies. To compute our analysis, we followed the approach outlined by Nadinda et al.[26] and used post-test data. In cases where there were multiple assessments over different time points, as done in Nadinda et al, posttests scores were averaged. For studies including more than one intervention or control group (e.g., treatment as usual and active control), the overall effect size was estimated using the available formula in the Cochrane Handbook[33] and assigned the pooled mean and SD in the meta-analysis.

The degree of heterogeneity in effect sizes was computed using Cochran's Q, to explore whether variations in effect sizes could be explained by the categorical moderators (i.e., type of intervention, timing and format of interventions, intervention provider, intervention targeted at an at-risk population, presurgical pain, and risk of bias). We also report I^2 to quantify the dispersion of effect sizes in our meta-analysis. I^2 values of 25%, 50%, and 75%, correspond to small, moderate, and large amounts of heterogeneity. Meta-regressions were employed for continuous moderators (i.e., the duration of intervention and the proportion of females) using the method of moments procedure with the Knapp–Hartung correction. These results served as indicators of the significance of these moderator variables in the linear changes in effect sizes. Effect sizes were interpreted according to Cohen[32]: 0.20 are considered small effects, 0.50 moderate, and 0.80 large effects. The analysis of publication bias was conducted using Egger's regression intercept.

Results

Selection of studies

Figure 1 shows the flowchart of the study selection process. The initial database search yielded a total of 2,556 potentially relevant studies. After removing duplicates and screening, 27 studies were included for the systematic review and 17 studies for the meta-analysis.

Insert Figure 1

Description of included studies

Characteristics of the 27 articles included in this systematic review are summarised in Table 1. These studies were published between 2004 and 2022:

Insert Table 1

Risk of bias assessment

Figure 2 displays the RoB of the 27 studies included in this systematic review. In total, 20 studies (74%) showed a low RoB with the randomisation procedure and 14 studies (52%) with the selection procedure. In addition, 20 studies (74%) presented some concerns or a high RoB with the measurement of outcomes, 15 studies (56%) with missing outcome data, and 15 studies (56%) with the selection of the reported results. Based on Cochrane Review criteria, 14 studies (52%) were identified with some concerns about their RoB, and 13 studies (48%) were identified as having a high RoB.

Insert Figure 2

Main analysis

Out of the 27 studies included in this systematic review, 10 were excluded from the meta-analyses due to a lack of sufficiently detailed data, including mean, standard deviation, and/or sample size. The studies were excluded after first contacting the authors to request this data and not receiving a response. Finally, 17 studies were eligible for meta-analysis. Meta-analyses of pain intensity were performed with 17 studies, pain catastrophising with 8 studies, depression with 7 studies, and anxiety with 9 studies. Stress as an outcome could not be meta-analysed due to the absence of studies focused on this construct. As shown in the Forest Plots in Figure 3, 4, 5, and 6, negative effect sizes favour the psychological intervention group and positive effect sizes favour the control group.

Insert Figures 3,4,5, and 6

Compared with the control interventions, psychological interventions showed a moderate beneficial effect on pain intensity (d = -0.45, p = 0.006) and a small to moderate beneficial effect on anxiety (d = -0.33, p = 0.004). However, statistically significant beneficial effects were not observed on pain catastrophising (d = -0.23, p = 0.097) and depression (d = -0.19, p = 0.405). Substantial heterogeneity was observed for pain intensity (I^2 = 88%, Q = 110.87, p < 0.001) and moderate for anxiety (I^2 = 40.6%, Q = 12.81, p = 0.119). Egger's test was not statistically significant for any of these four outcomes (p > 0.05), suggesting insufficient evidence of publication bias.

Following Nadinda et al's[26] methodology, when postsurgical pain intensity was divided into (sub)acute pain (i.e., within 3 months after surgery) and chronic pain (> 3 months after surgery). For (sub)acute pain (< 3 months), there were 12 studies, and for chronic pain (> 3 months), 12 studies; 7 studies were included in both categories. We found a stronger impact of perioperative psychological therapies for pain intensity on (sub)acute pain (d = -.53, p =0.017) than on chronic pain (d = -.31, p = 0.044). Moderator analyses were recomputed for (sub)acute pain and chronic pain, respectively, but there was an insufficient number of studies per moderator (i.e., type of intervention) to obtain robust conclusions. Results of the moderator analyses are not reported here but are available upon request.

Insert Table 2

Moderator analyses

Moderation analyses were only computed for pain intensity. The specific effect sizes for the moderators are reported in Table 2.

Type of psychological intervention

For the pain intensity outcome, 10 studies employed a CBT intervention, 2 ACT, 2 MBIs, and 3 delivered a multicomponent intervention. To ensure each category had three or more studies, ACT was combined with MBIs (both third-generation therapies based on acceptance). Our results showed a non-significant moderation effect (Q_I = 0.79, p = 0.672), indicating that the total variance between RCTs was not explained by the type of psychological intervention.

Timing of the intervention

Regarding the timing of the intervention, for the pain intensity outcome, 4 studies provided the intervention preoperatively, 5 postoperatively, and 8 studies delivered the intervention before

and after the surgery. The results indicated the absence of a moderating effect on the timing of the intervention ($Q_1 = 1.94$, $p = 0.379$).

Intervention provider

Interventions were delivered in 11 studies by psychologists, 3 by non-psychologists, and 3 self-administered. Overall, the impact of the psychological intervention did not vary significantly depending on the intervention provider ($Q_1 = 3.81$, $p = 0.149$).

Format of the intervention

Regarding pain intensity, 5 studies included an online intervention (1 via telephone) and 12 in-person. The study that delivered a telephone intervention was grouped with the online group to conduct the analyses. Overall, the impact of the psychological intervention did not vary significantly depending on the format of the intervention ($Q_1 = 0.44$, $p = 0.507$).

Targeted at risk

A total of 6 interventions were targeted and 11 were nontargeted. Overall, the impact of the psychological intervention did not vary significantly depending on targeting ($Q_1 = 2.26$, $p = 0.133$).

Presence of presurgical pain

Regarding the presence of presurgical pain, 11 studies included patients with presurgical pain (chronic or acute) and 6 studies included participants with no reported presurgical pain. Overall, the impact of the psychological intervention did not vary significantly depending on the inclusion of patients with or without presurgical pain ($Q_1 = 0.22$, $p = 0.642$).

Risk of bias

Regarding RoB, for the pain intensity outcome, 10 studies were categorised as having some concerns and 7 as having high RoB. No moderation effect was observed ($Q_1 = 0.07$, $p = 0.792$).

Duration of intervention

For the 17 studies included in the meta-analysis, the duration of the intervention ranged from 15 to 1740 minutes. The results of the meta-regression indicated that the duration of the intervention did not moderate the impact on pain intensity reduction ($F_{(1,15)} = 0.01$, $p = 0.985$).

Proportion of females

For the 17 studies included in the meta-analysis, the proportion of females in the intervention group ranged from 7 to 100%. A meta-regression was computed to investigate the impact of the gender composition of the sample on pain intensity. The results indicated that the rate of females did not moderate the efficacy of the psychological interventions ($F_{(1,15)} = 0.01$, $p = 0.940$).

Discussion

The present findings extend previous systematic reviews and meta-analyses that have examined the effects of psychological interventions during the perioperative period for the reduction of postsurgical pain[24–26, 34]. The most direct comparison can be made with Nadinda's et al.[26], who synthesised data from RCTs and pointed out that psychological interventions, such as CBT, have a significant beneficial effect in managing postoperative pain. Unlike these authors, who centred the analysis on (sub)acute postsurgical pain, chronic postsurgical pain, and disability, we focused the review not only on postsurgical pain but also on psychological variables, including depression, anxiety, stress, and pain catastrophising. Compared with usual care or control arms with minimal psychological ingredients, psychological interventions were associated with significant reductions in postsurgical pain intensity and anxiety. However, no significant improvements were identified in measures of depression or pain catastrophising. According to Pinskiy et al.[35], postsurgical pain and postsurgical anxiety are significantly correlated, thereby suggesting that both can be simultaneously improved with perioperative psychological interventions.

Interventions delivered by psychologists were significantly more effective for reducing postsurgical pain intensity than those delivered by other healthcare professionals (physiotherapists and nurses, among others). This result is in line with those reported by Bostick[36]. In his review, psychological interventions delivered by non-psychologists only showed modest effects on low back pain and disability. Similarly, Nadinda et al.[26] found that psychological interventions delivered by a psychologist tended to be more effective for postsurgical pain management. Additionally, it's worth noting that certain newer forms of CBT, such as ACT, have consistently demonstrated significant effects in reducing pain intensity and negative affective symptoms[37]. However, achieving symptom reduction is considered a welcomed by-product in interventions such as ACT, stemming from the cultivation of six core psychological processes: acceptance, cognitive defusion, being present, self as context, values,

and committed action. Future reviews could explore which specific types of interventions administered during the perioperative period (i.e., CBT, ACT, and MBIs, among others) are more effective for producing positive changes in underlying psychological mechanisms. In other words, the analysis should not solely focus on the endpoint (i.e., postoperative pain reduction), but also on the process (i.e., enhancement of psychological flexibility towards pain)[38].

We must acknowledge the following limitations in the present study. In many of the included RCTs, some threats to both internal and external validity were detected. Reports of trials did not always include a sample size calculation. A high risk of bias was identified in almost half of the included studies. A high number of RCTs presented some concerns or high concerns regarding the following: the measurement of the outcome; missing data were not managed properly; and results were not reported with equipoise by highlighting the positive outcomes. In addition, the relatively small sample sizes of the included studies may limit the generalizability of our results. Smaller studies can introduce variability and reduce the statistical power, potentially affecting the reliability of the effect sizes observed. Future research should aim for larger, more robustly powered trials to confirm these findings.

As in previous reviews with a similar focus[39], there was some heterogeneity in the definition of postsurgical pain and the types of psychological interventions. The relatively small sample sizes in some of the RCTs that met the selection criteria could have had an impact on the reliability and generalizability of the findings. As Morley et al. pointed out some years ago, no additional low-quality trials of psychological therapies for the management of pain are needed[40]. Additionally, our systematic review was limited to pain intensity and some secondary outcomes, but other outcomes might be of interest in trials assessing the benefits of psychological interventions for postsurgical pain. For example, it is widely accepted that acute pain after surgery is associated with increased kinesiophobia, which in turn is a predictor of postsurgical pain[10, 41], so this construct might be a target of psychological interventions delivered during the perioperative period.

A logical step forward in this research field is the inclusion of economic evaluations embedded within trials examining the efficacy of psychological therapies for the management of postsurgical pain and affective symptoms. To the best of our knowledge, there is limited evidence about the cost-effectiveness of these therapies for the management of postsurgical pain[42]. More evidence about cost-effectiveness seems indispensable to ensure the inclusion of

evidence-based psychological treatments in resource allocation deliberations[43, 44]. Regarding the implications for future research, aggregating data at group levels has limited usefulness for identifying which psychological processes of each individual merit therapeutic attention. In addition to conducting classical full trials, future studies might test the efficacy of psychological interventions at the perioperative period using n-of-1 trials[45] combined with ecological momentary assessment[46]. Intensive longitudinal data collection of individuals subjected to surgery might reveal not only whether the tested psychological interventions work, but also how they work at the individual level, helping to develop personalised treatment plans in cases of non-response to psychological treatment.

In conclusion, the results from the present systematic review and meta-analysis suggest that the inclusion of evidence-based psychological interventions in the context of surgical management might have a positive impact on postsurgical pain and anxiety.

Details of authors' contributions

JRCA: Study design, data collection, literature review, and writing up of the first draft of the paper.
ABS: Study design, data collection, and writing up of the first draft of the paper.
ERC: Study design, data collection, statistical analysis, and writing up of the first draft of the paper.
JPSM: Study design, statistical analysis, and writing up of the first draft of the paper.
VG: Data collection, literature review.
RN: Revision of the final draft of the paper.
AB: Revision of the final draft of the paper.
VPS: Revision of the final draft of the paper.
AMG: Revision of the final draft of the paper.
GU: Revision of the final draft of the paper.
AFS: Revision of the final draft of the paper.
JVL: Study design, writing up the first draft of the paper, and supervision of the study.

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Data availability

Data is available upon request.

Declaration of interests

All authors declare no conflict of interest.

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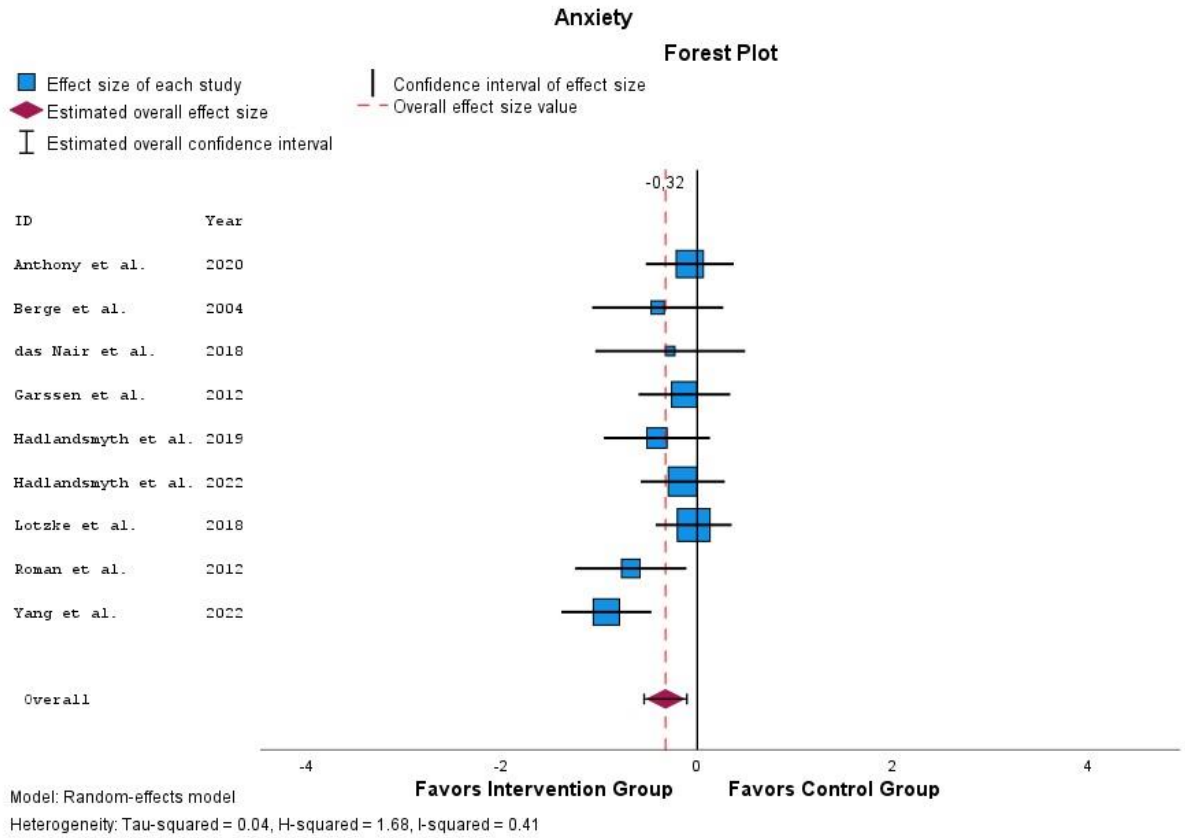
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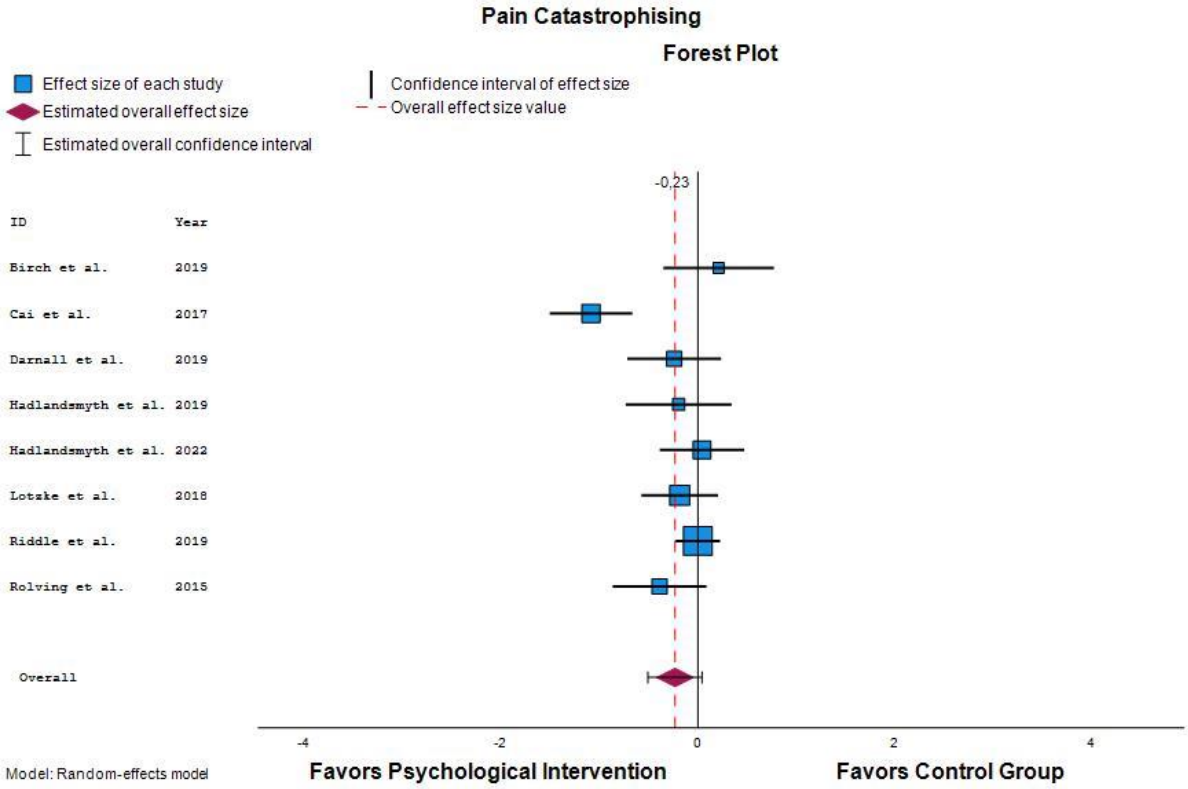
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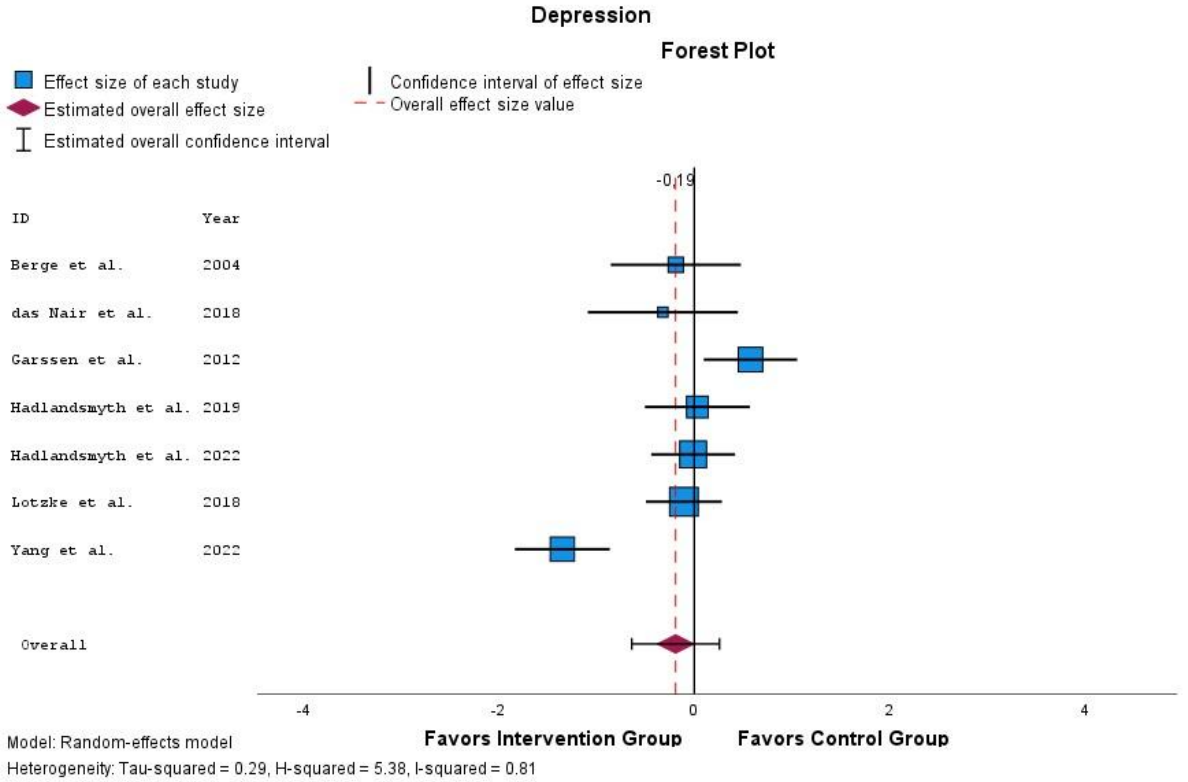
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Figure and Table Legends

Figure 1. Flowchart of the included studies in the systematic review and meta-analysis
Figure 2. Risk of bias of the included studies
Figure 3. Forest Plot
Table 1. Characteristics of Studies
Table 2. Effect sizes of Individual Moderator Groups and Subgroups for Pain Intensity
Supplementary File 1. Search Terms Used to Identify Studies in Databases
Supplementary File 2. Studies included by Nadinda that were not included in this study and reasons




Pain Catastrophising
Forest Plot
Effect size of each study
Estimated overall effect size
Estimated overall confidence interval
Confidence interval of effect size
Overall effect size value
-0.23
ID
Year
Birch et al. 2019
Cai et al. 2017
Darnall et al. 2019
Hadlandsmyth et al. 2019
Hadlandsmyth et al. 2022
Lotzke et al. 2018
Riddle et al. 2019
Rolving et al. 2015
Overall
-4
-2
0
2
4
Favors Psychological Intervention
Favors Control Group
Model: Random-effects model
Heterogeneity: Tau-squared = 0.11, H-squared = 3.49, I-squared = 0.71


Depression
Forest Plot
Effect size of each study
Estimated overall effect size
Estimated overall confidence interval
Confidence interval of effect size
Overall effect size value
-0.19
ID
Year
Berge et al. 2004
das Nair et al. 2018
Garssen et al. 2012
Hadlandsmyth et al. 2019
Hadlandsmyth et al. 2022
Lotzke et al. 2018
Yang et al. 2022
Overall
-4
-2
0
2
4
Favors Intervention Group
Favors Control Group
Model: Random-effects model
Heterogeneity: Tau-squared = 0.29, H-squared = 5.38, I-squared = 0.81

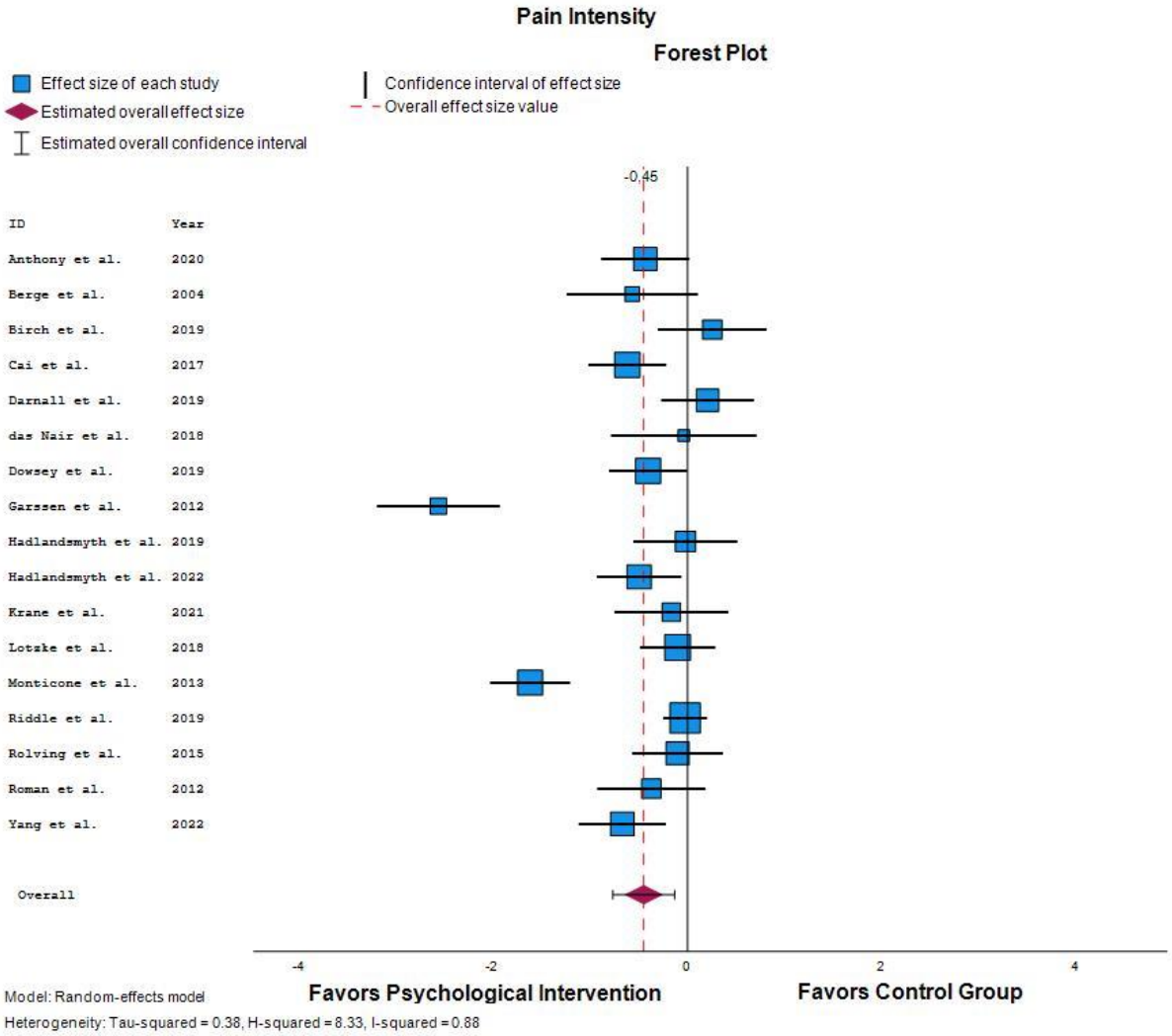

Pain Intensity
Forest Plot
Effect size of each study
Estimated overall effect size
Estimated overall confidence interval
Confidence interval of effect size
Overall effect size value
-0.45
ID
Year
Anthony et al. 2020
Berge et al. 2004
Birch et al. 2019
Cai et al. 2017
Darnall et al. 2019
das Nair et al. 2018
Dowsey et al. 2019
Garssen et al. 2012
Hadlandsmyth et al. 2019
Hadlandsmyth et al. 2022
Krane et al. 2021
Lotzke et al. 2018
Monticone et al. 2013
Riddle et al. 2019
Rolving et al. 2015
Roman et al. 2012
Yang et al. 2022
Overall
-4
-2
0
2
4
Favors Psychological Intervention
Favors Control Group
Model: Random-effects model
Heterogeneity: Tau-squared = 0.38, H-squared = 8.33, I-squared = 0.88

Table 1. Characteristics of Studies

Study	Participants								Type of surgery	Psychological intervention	Comparison	Timing of follow-up (dropout %)	Outcome measures			
	Control				Intervention											
	N Initial	N final	Age (mean)	Gender (%fem)	N Initial	N final	Age (mean)	Gender (%fem)					Pain	Depre	Anxiety	Catast
***Anthony et al. (2020)**	40	38	48.7	48%	42	38	45.5	52%	Fractures in upper or lower limbs	**Intervention**: ACT **Timing**: postoperative **Delivered by**: psychologist **Total duration**: 28 min	TAU: treatment as usual	FW1: 2 wk after surgery (7%)	PROMIS (Pain Intensity 1A and 3A)	X	PROMIS (Emotional Distress-Anxiety 8A Short form)	X
Balck et al. (2019)	49	28	52.6	36.7%	46	21	52.3	39.1%	Transplant	**Intervention:** PST **Timing**: pre and postoperative **Delivered by:** psychologist **Total duration:** 300 min	TAU: treatment as usual	FW1: 10-12 d FW2: 20-22 d after surgery (20.5%; 48.4%)	Questions of Pain	HADS-D	HADS-A	X
***Berge et al. (2004)**	21	15	71	TAU: 79%	19	18	71.6	63%	Hip surgery	**Intervention:** Pain management program (multicomponent) **Timing:** Preoperative **Delivered by**: clinical psychologist, occupational therapist, and physiotherapist **Total duration:** 1,290 min	TAU: waiting list without treatment	FW1: 3 mo after psychological intervention FW2: 1 y after surgery (5.9%; 25%)	NRS	AIMS Subscale Depression	AIMS Subscale Anxiety	X
***Birch et al. (2019)**	32	29	66	62%	35	31	66	71%	Total knee arthroplasty	**Intervention:** CBT **Timing**: pre and postoperative **Delivered by:**	TAU: usual care	FW1: 3 mo FW2:12 mo after surgery	VAS (0-100) and KOOS	X	X	PCS

									Physiotherapist **Total duration:** 315 min		(20%, 20%)					
Buvanendran et al. (2021)	37	37	62	68%	40	40	66	65%	Total knee arthroplasty	**Intervention**: CBT **Timing**: pre and postoperative **Delivered by**: not specified **Total duration**: not specified	TAU: treatment as usual	FW1: 1 wk FW1: 3 mo after surgery (15%)	NRS (0-10) and WOMAC Pain	PHQ-9	GAD-7	PCS
***Cai et al. (2017)**	56	50	66.2	60%	55	50	65.3	64%	Total knee arthroplasty	**Intervention:** CBT **Timing**: Postoperative **Delivered by:** Physiotherapist and a psychologist **Total duration:** 120 min	TAU: standard care	FW1: 4 wk FW2: 6 mo after intervention (9.9%)	NRS	X	X	PCS
Carender et al. (2022)	TAU: 85 AC: 67	TAU: 63 AC: 55	TAU: 59% AC: 59%	TAU: 62 AC: 58	78	65	58	62%	Primary total joint arthroplasty	**Intervention:** ACT **Timing**: pre and postoperative **Delivered by:** Surgeons (video) and robot (messages) **Total duration:** 3 min	TAU: standard care AC: Video	FW1: 6 wk after surgery (20.43%)	PROMIS	X	X	X
Chen et al. (2021)	45	41	NI	68.3%	45	42	NI	73.8%	Total knee arthroplasty	**Intervention:** CBT **Timing**: pre and postoperative **Delivered by:** psychologist **Total duration:** 150 min	TAU: standard care	FW1: 1 wk FW2: 2 wk FW3: 3 mo after surgery (7.8%)	VAS	SDS	SAS	X
***Darnall et al. (2019)**	50	32	51.2	100%	77	36	51.3	100%	Lumpectomy or mastectomy	**Intervention:** Psychoeducation and relaxation (multicomponent) **Timing**: preoperative **Delivered by:** self-	AC: Online health education	FW1: 2 wk FW2: 4 wk FW3: 8 wk FW4: 12 wk after surgery (46.5%)	PROMIS	PROMIS	PROMIS	PCS

									administered **Total duration:** 90 min							
***das Nair et al. (2018)**	25	12	65.1	66.1%	25	13	65.8	78.5%	Total knee arthroplasty	**Intervention:** CBT **Timing:** Preoperative **Delivered by:** Psychologist **Total duration:** 330 min	TAU: Standard care	FW1: 4 mo FW2: 6 mo after surgery (40%; 50%)	WOMAC and ICOAP	BDI	BAI	X
Dindo et al. (2019)	44	31	63	0%	44	35	62.2	12%	Orthopedic surgery	**Intervention**: ACT **Timing**: pre and postoperative **Delivered by**: psychologist **Total duration**: 300 min	TAU: treatment as usual	FW1: 2 d (everyday for 15 d) FW2: 3 mo after surgery (25%)	BPI	X	X	X
***Dowsey et al. (2019)**	62	56	65.1	66.1%	65	44	65.8	78.5%	Total knee or hip arthroplasty	**Intervention**: Mindfulness based stress reduction **Timing**: pre and postoperative **Delivered by**: Psychiatrist Orthopedic Surgeon/Nursing **Total duration**: 1,740 min	TAU: treatment as usual	FW1: 3 mo FW2: 12 mo after surgery (25%)	WOMAC Pain	X	X	X
***Garssen et al. (2012)**	36	36	54	100%	34	34	52	100%	Breast cancer surgery	**Intervention**: stress management training (multicomponent) **Timing**: pre and postoperative **Delivered by**: psychologist **Total duration**: 240 min	TAU: treatment as usual	FW1: 2 d FW2: 5 d FW3: 1 mo FW4: 3 mo after surgery	NRS	PHQ-8 (Depression Scale)	STAI	X
***Hadlands myth et al. (2019)**	31	30	50.7	100%	31	24	55.7	100%	Mastectomy or lumpectomy	**Intervention**: ACT **Timing**: postoperative **Delivered by**:	TAU: treatment as usual/	FW1: 1 wk FW2: 3 mo post-surgery	BPI and NRS	PHQ-8	GAD-7	PCS

									psychologist **Total duration**: 120 min		(12.9%)					
***Hadlandsmyth et al. (2022)**	52	39	TAU: 66.22	4%	58	45	64.18	7%	Various surgeries (hernia repair, breast surgery, amputation, thoracotomy,cholecystectomy, unilateral total joint replacement, or select urologic surgeries)	**Intervention:** Pain self-management (CBT-based) **Timing**: pre and postoperative **Delivered by**: psychologist **Total duration:** 130 min	TAU: Standard care	FW1: 3 mo after surgery (24%)	NRS and BPI	PHQ-8	GAD-7	PCS
Haisley et al. (2020)	26	26	61.5	65%	26	26	65.4	81%	Fundoplication, paraesophage hernia, esophageal myotomy or pyloroplasty	**Intervention:** Mindfulness **Timing**: pre and postoperative **Delivered by:** self-administered **Total duration:** 28 min	TAU: standard care	FW1: 1 day after surgery	An ad hoc question (0-10)	X	An ad hoc question (0-10)	X
Hanley et al. (2021)	89	69	63.2	67.4%	E1: 106 E2: 90	E1: 85 E2: 72	E1: 65.5 E2: 67.6	E1: 59.4% E2: 64.4%	Total knee or hip arthroplasty	**Intervention**: (E1) Mindfulness (E2) Cognitive Behavioral Pain Psychoeducation **Timing**: preoperative **Delivered by**: psychologist **Total duration**: 15 min	AC: Hypnotic Suggestion	FW1: just after the surgery (26%)	VAS (0-10)	X	VAS Anxiety (0-10)	X
***Krane et al. (2021)**	27	24	33	83.3%	24	21	32.4	95.2%	Septorhinoplasty	**Intervention:** Mindfulness **Timing**: postoperative **Delivered by:** self-administered **Total duration:** 16 min	TAU: standard care	FW1: 3 d after surgery (11.8%)	VAS (0-10)	X	X	X
***Lotzke et al.**	59	51	46.7	50.9%	59	50	44.8	55.9%	Lumbar fusion surgery	**Intervention:** CBT **Timing**: pre and	TAU: Conventional	FW1: 3 wk FW2: 8 wk	VAS	HADS-D	HADS-A	PCS

(2018)										postoperative **Delivered by:** physiotherapist trained in CBT **Total duration:** 300 min	care	FW 3: 3 mo FW 4: 6 mo after surgery (15.3%; 13.6; 11.9%;14.4%)				
***Monticone et al. (2013)**	65	58	55.9	67.6%	65	59	58.8	53.8%	Lumbar fusion surgery	**Intervention:** CBT **Timing**: postoperative **Delivered by:** 2 psychiatrist and 1 psychologist **Total duration:** 480 min	AC: Physiotherapy	FW1: 4 wk FW2: 12 mo after surgery (5.4%:10%)	NRS (0-10)	X	X	PCS
***Riddle et al. (2019)**	AC: 135 TAU: 137	AC: 113 TAU: 122	AC: 64.2 TAU: 62.7	AC: 63% TAU: 64%	130	111	62.6	72%	Total knee arthroplasty	**Intervention:** Pain coping skills training (based on CBT) **Timing**: pre and postoperative **Delivered by:** Physiotherapist **Total duration:** 400 min	AC: Education about the disease TAU: usual care	FW1: 2 mo FW2: 6 mo FW3: 12 mo after surgery (14.9%; 16.7; 13.9%)	NRS (0-10) and WOMAC	PHQ-8	GAD-7	PCS
***Rolving et al. (2015)**	33	31	47.7	48%	63	59	51.4	61%	Lumbar spinal fusion surgery	**Intervention:** CBT **Timing**: pre and postoperative **Delivered by:** Psychologist, occupational therapist, physiotherapist, social worker, spine surgeon, and previously operated patient **Total duration:** 1,080 min	TAU: treatment as usual	FW1: 3 mo FW2: 6 mo FW3: 12 mo after surgery (10%;10%; 14%)	LBPRS	X	X	CSQ-CAT
***Roman et al. (2012)**	31	27	38.9	74.2%	21	16	33.6	61.9%	Periodontal surgery	**Intervention:** CBT **Timing**: Preoperative	TAU: surgical intervention alone	FW1: Just after surgery	VAS	X	VAS Anxiety	X

									Delivered by: Clinical psychologist **Total duration:** 15 min		(17.31%)					
Strøm et al. (2018)	57	49	55	75%	57	45	53	54%	Spondylolisthesis	**Intervention**: CBT and Psychoeducation **Timing**: pre and postoperative **Delivered by**: (Web platform) self-administered **Total duration**: unlimited 18 days	TAU: treatment as usual	FW1: 2 d FW2: 3 mo FW3: 6 mo after surgery (5.1%)	LBPRS	HADS-D	HADS-A	X
Sun et al. (2020)	50	38	60.2	55.3%	50	42	57.8	45.2%	Total knee arthroplasty	**Intervention:** CBT **Timing**: pre and postoperative **Delivered by:** Physiotherapist **Total duration:** 180 min	TAU: usual care	FW1: 2 wk pain/1mo cat. FW2: 3 mo FW3: 12 mo after surgery (25%)	VAS	X	X	PCS
***Yang et al. (2022)**	40	40	51	20%	40	40	51	15%	Total laryngectomy and partial laryngectomy	**Intervention**: Computer Assisted CBT **Timing**: pre and postoperative **Delivered by:** Remote computer program developed by the authors of the study **Total duration:** 100 min	TAU	FW1: 3 d FW2: 7 d FW3:10 d after surgery	VAS	PHQ-9	STAI	X
Ziadni et al. (2022)	47	43	47.8%	36.2	37	35	51.6	40.5%	Orthopedic trauma surgery	**Intervention:** Psychoeducation and relaxation **Timing**: postoperative **Delivered by:** self-administered **Total duration:** 45 min	AC: Online health education	FW1:1 mo FW2: 2 mo FW3: 3 mo post treatment (7.1%)	NPRS (0-10)	PROMIS	PROMIS	PCS

Note. AC = Active Control Condition; ACT = Acceptance and Commitment Therapy; AIMS = Arthritis Impact Measurement Scale; BAI = Beck Anxiety Inventory; BDI = Beck Depression Inventory ; BPI = Brief Pain Inventory CBT= Cognitive Behavioural Therapy; CSQ-CAT = coping strategies questionnaire-catastrophizing subscale ; GAD = Generalized Anxiety Disorder Scale; HADS: Hospital Anxiety and Depression Scale; ICOAP = Measure of intermittent and constant osteoarthritis pain; KOOS = Knee Osteoarthritis Outcome Scale; LBPRS = Low Back Pain Rating Scale ; NI = No information available ; NRS = Numeric Rating Scale ; PCS = Pain Catstrophizing Scale; PHQ = Patient Health Questionaire; PST = Problem Solving Training; SAS = Self-Rating Anxiety Scale; SDS = Self-Rating Depression Scale; STAI = State-Trait Anxiety Scale; TAU = Treatment as Usual; VAS = Visual Analogue Scale; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index ***Included at least in one of the meta-analyses.**

Table 2. Effect sizes of Individual Moderator Groups and Subgroups for Depression and Anxiety Outcomes

Moderator Group	Depression							Anxiety						
	Sample	Effect size			Heterogeneity			Sample	Effect size			Heterogeneity		
	k	*d*	*P*	95% CI	I^2	Q-value	*P*	k	*d*	*P*	95% CI	I^2	Q-value	*P*
Overall	7	-.19	.405	-.64 to .26	81.4	33.32	**<.001**	9	-.33	**.004**	-.54 to -.11	40.6	12.81	.119
Type of Intervention														
CBT	4	-.44	.164	-1.07 to 0.18	84.6	20.07	**<.001**	5	-.41	**.028**	-0.77 to -0.04	61.8	10.7	**.030**
ACT	1	.03	.906	-0.51 to 0.57	-	-	-	2	-.21	.227	-0.56 to 0.13	0	0.88	.349
Mindfulness	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Multicomponent	2	.23	.546	-0.52 to 0.98	70.1	3.34	.068	2	-.22	.259	-0.61 to 0.16	0	0.427	.51
Timing of Intervention														
Preoperative	2	-.25	.338	-0.75 to 0.26	0	0.07	.798	3	-.5	**.010**	-0.87 to -0.12	0	0.79	.675
Postoperative	1	.03	.906	-0.51 to 0.57	-	-	-	3	-.21	.227	-0.56 to 0.13	0	0.88	.349
Pre- and post-operative	4	-.22	.581	-1 to 0.56	92	32.58	**<.001**	4	-.3	.137	-0.7 to 0.1	40.6	9.87	**.020**

Intervention Provider													
Psychologist	6	.03	.787	-0.21 to 0.28	27.6	6.72	.243	8	-.22	**.017**	-0.4 to -0.04	0	4.79	.685
Other	1	-1.35	**<.001**	-1.83 to 0.86	-	-	-	1	-.93	**<.001**	-1.39 to -0.47	-	-	-
Format of Intervention													
Online	1	-1.35	**<.001**	-1.84 to -0.86	-	-	-	2	-.5	.240	-1.34 to 0.34	85.2	6.74	**.009**
In-person	5	.04	.803	-0.28 to 0.36	41.4	6.65	-156	6	-.27	**.017**	-0.49 to -0.05	2.2	4.13	.531
Other[1]	1	-.01	.958	-0.44 to 0.42	-	-	-	1	-.15	.498	-0.58 to 0.28	-	-	-
Riks of Bias													
Some Concerns	4	-0.36	.278	-1 to 0.29	87.4	22.07	**<.001**	5	-.42	**.015**	-0.76 to -0.08	61.7	10.65	**.031**
High Risk	3	.08	.793	-0.51 to 0.67	61.8	5.45	.066	4	-.18	.209	-0.45 to 0.1	0	0.74	.865

ACT = Acceptance and Commitment Therapy
CBT = Cognitive Behavioural Therapy
[1]Telephone based

Supplementary Material

Below is the list of articles included in the systematic review and meta-analysis. Articles marked with an asterisk (*) were included in the meta-analysis.

1. *Anthony et al. (2020)[1]
2. Balck et al. (2019)[2]
3. *Berge et al. (2004)[3]
4. *Birch et al. (2019)[4]
5. Buvanendran et al. (2021)[5]
6. *Cai et al. (2017)[6]
7. Carender et al. (2022)[7]
8. Chen et al. (2021)[8]
9. *Darnall et al. (2019)[9]
10. *das Nair et al. (2018)[10]
11. Dindo et al. (2019)[11]
12. *Dowsey et al. (2019)[12]
13. *Garssen et al. (2012)[13]
14. *Hadlandsmyth et al. (2019)[14]
15. *Hadlandsmyth et al. (2022)[15]
16. Haisley et al. (2020)[16]
17. Hanley et al. (2021)[17]
18. *Krane et al. (2021)[18]
19. *Lotzke et al. (2018)[19]
20. *Monticone et al. (2013)[20]
21. *Riddle et al. (2019)[21]
22. *Rolving et al. (2015)[22]
23. *Roman et al. (2012)[23]
24. Strøm et al. (2018)[24]
25. Sun et al. (2020)[25]
26. *Yang et al. (2022)[26]
27. Ziadni et al. (2022)[27]

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1. Anthony CA, Rojas EO, Keffala V, et al. Acceptance and Commitment Therapy Delivered via a Mobile Phone Messaging Robot to Decrease Postoperative Opioid Use in Patients With Orthopedic Trauma: Randomized Controlled Trial. *J Med Internet Res* 2020; 22: e17750

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