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Psychological therapies delivered remotely for the management of chronic pain (excluding headache) in adults (Review)

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[Intervention Review]

Psychological therapies delivered remotely for the management of chronic pain (excluding headache) in adults

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ABSTRACT

Background

Chronic pain (pain lasting three months or more) is an unpleasant sensory and emotional experience associated with actual or potential tissue damage. Common types (excluding headache) include back pain, fibromyalgia, and neuropathic pain. Access to traditional face-to-face therapies can be restricted by healthcare resources, geography, and cost. Remote technology-based delivery of psychological therapies has the potential to overcome treatment barriers. However, their therapeutic effectiveness compared to traditional delivery methods requires further investigation.

Objectives

To determine the benefits and harms of remotely-delivered psychological therapies compared to active control, waiting list, or treatment as usual for the management of chronic pain in adults.

Search methods

We searched for randomised controlled trials (RCTs) in CENTRAL, MEDLINE, Embase, and PsycINFO to 29 June 2022. We also searched clinical trials registers and reference lists. We conducted a citation search of included trials to identify any further eligible trials.

Selection criteria

We included RCTs in adults (≥ 18 years old) with chronic pain. Interventions included psychological therapies with recognisable psychotherapeutic content or based on psychological theory. Trials had to have delivered therapy remote from the therapist (e.g. Internet, smartphone application) and involve no more than 30% contact time with a clinician. Comparators included treatment as usual (including waiting-list controls) and active controls (e.g. education).

Data collection and analysis

We used standard Cochrane methodological procedures.

Main results

We included 32 trials (4924 participants) in the analyses. Twenty-five studies delivered cognitive behavioural therapy (CBT) to participants, and seven delivered acceptance and commitment therapy (ACT). Participants had back pain, musculoskeletal pain, opioid-treated chronic pain, mixed chronic pain, hip or knee osteoarthritis, spinal cord injury, fibromyalgia, provoked vestibulodynia, or rheumatoid arthritis.

We assessed 25 studies as having an unclear or high risk of bias for selective reporting. However, across studies overall, risk of bias was generally low. We downgraded evidence certainty for primary outcomes for inconsistency, imprecision, and study limitations. Certainty of evidence ranged from moderate to very low. Adverse events were inadequately reported or recorded across studies. We report results only for studies in CBT here.

Cognitive behavioural therapy (CBT) versus treatment as usual (TAU)

Pain intensity

Immediately after treatment, CBT likely demonstrates a small beneficial effect compared to TAU (standardised mean difference (SMD) -0.28, 95% confidence interval (CI) -0.39 to -0.16; 20 studies, 3206 participants; moderate-certainty evidence). Participants receiving CBT are probably more likely to achieve a 30% improvement in pain intensity compared to TAU (23% versus 11%; risk ratio (RR) 2.15, 95% CI 1.62 to 2.85; 5 studies, 1347 participants; moderate-certainty evidence). They may also be more likely to achieve a 50% improvement in pain intensity (6% versus 2%; RR 2.31, 95% CI 1.14 to 4.66; 4 studies, 1229 participants), but the evidence is of low certainty.

At follow-up, there is likely little to no difference in pain intensity between CBT and TAU (SMD -0.04, 95% CI -0.17 to 0.09; 8 studies, 959 participants; moderate-certainty evidence). The evidence comparing CBT to TAU on achieving a 30% improvement in pain is very uncertain (40% versus 24%; RR 1.70, 95% CI 0.82 to 3.53; 1 study, 69 participants). No evidence was available regarding a 50% improvement in pain.

Functional disability

Immediately after treatment, CBT may demonstrate a small beneficial improvement compared to TAU (SMD -0.38, 95% CI -0.53 to -0.22; 14 studies, 2672 participants; low-certainty evidence). At follow-up, there is likely little to no difference between treatments (SMD -0.05, 95% CI -0.23 to 0.14; 3 studies, 461 participants; moderate-certainty evidence).

Quality of life

Immediately after treatment, CBT may not have resulted in a beneficial effect on quality of life compared to TAU, but the evidence is very uncertain (SMD -0.16, 95% CI -0.43 to 0.11; 7 studies, 1423 participants). There is likely little to no difference between CBT and TAU on quality of life at follow-up (SMD -0.16, 95% CI -0.37 to 0.05; 3 studies, 352 participants; moderate-certainty evidence).

Adverse events

Immediately after treatment, evidence about the number of people experiencing adverse events is very uncertain (34% in TAU versus 6% in CBT; RR 6.00, 95% CI 2.2 to 16.40; 1 study, 140 participants). No evidence was available at follow-up.

Cognitive behavioural therapy (CBT) versus active control

Pain intensity

Immediately after treatment, CBT likely demonstrates a small beneficial effect compared to active control (SMD -0.28, 95% CI -0.52 to -0.04; 3 studies, 261 participants; moderate-certainty evidence). The evidence at follow-up is very uncertain (mean difference (MD) 0.50, 95% CI -0.30 to 1.30; 1 study, 127 participants). No evidence was available for a 30% or 50% pain intensity improvement.

Functional disability

Immediately after treatment, there may be little to no difference between CBT and active control on functional disability (SMD -0.26, 95% CI -0.55 to 0.02; 2 studies, 189 participants; low-certainty evidence). The evidence at follow-up is very uncertain (MD 3.40, 95% CI -1.15 to 7.95; 1 study, 127 participants).

Quality of life

Immediately after treatment, there is likely little to no difference in CBT and active control (SMD -0.22, 95% CI -1.11 to 0.66; 3 studies, 261 participants; moderate-certainty evidence). The evidence at follow-up is very uncertain (MD 0.00, 95% CI -0.06 to 0.06; 1 study, 127 participants).

Adverse events

Immediately after treatment, the evidence comparing CBT to active control is very uncertain (2% versus 0%; RR 3.23, 95% CI 0.13 to 77.84; 1 study, 135 participants). No evidence was available at follow-up.

Authors' conclusions

Currently, evidence about remotely-delivered psychological therapies is largely limited to Internet-based delivery of CBT. We found evidence that remotely-delivered CBT has small benefits for pain intensity (moderate certainty) and functional disability (moderate to low certainty) in adults experiencing chronic pain. Benefits were not maintained at follow-up. Our appraisal of quality of life and adverse events

outcomes post-treatment were limited by study numbers, evidence certainty, or both. We found limited research (mostly low to very low certainty) exploring other psychological therapies (i.e. ACT). More high-quality studies are needed to assess the broad translatability of psychological therapies to remote delivery, the different delivery technologies, treatment longevity, comparison with active control, and adverse events.

PLAIN LANGUAGE SUMMARY

Which remotely-delivered psychological approaches help people with long-term chronic pain to improve symptoms?

Key messages

• Online cognitive behavioural therapy represents the most common remotely-delivered psychological therapy. It may improve pain and disability in individuals experiencing chronic pain.

• It is largely unclear whether remotely-delivered psychological therapies improve quality of life or cause harmful effects due to limited evidence, of often limited quality.

• We need more and better studies to investigate remotely-delivered psychological therapies. Future studies should explore a broader range of technologies and therapies, and focus on possible unwanted effects.

Why consider remotely-delivered psychological therapies for chronic pain?

Chronic pain is pain that lasts three months or longer. It is a common experience that can significantly impact on a person's everyday life and well-being. Psychological therapies have been found to improve mood and pain-related disability. The most common psychological approach for chronic pain is cognitive behavioural therapy (CBT), which focuses on the interrelationship between thoughts, feelings, and actions, to support symptom management.

Unfortunately, gaining access to psychological therapies may be difficult. There are limited numbers of qualified healthcare professionals providing these services, and some people may find it physically difficult to attend clinics. Technologies (such as mobile phones, computers, and the Internet) may offer new ways of delivering psychological therapies directly to people within their everyday environment and without a healthcare professional being present. This approach (known as remote delivery) has the potential to help more people access therapy.

What did we want to find out?

We wanted to find out if remotely-delivered psychological therapies:

• improve pain, disability, and quality of life (i.e. well-being across life as a whole);

• cause any unintended harmful effects.

What did we do?

We searched for studies that compared remotely-delivered psychological therapies with usual care or non-psychological treatments (such as education about pain). We looked at study results at the end of treatment and up to one year after.

We compared and summarised the results of the studies and rated our confidence in the evidence, based on factors such as study methods and sizes.

What did we find?

We found 32 studies that included 4924 people with a range of chronic pain conditions, such as back pain, osteoarthritis, fibromyalgia, and rheumatoid arthritis. Average ages ranged from 24 to 67 years. Where those taking part were followed up after treatment ended, this follow-up was between 3 and 12 months later; we did not include results collected after 12 months. Studies included in the review were carried out across 11 countries, with over half attributable to Sweden (9), the USA (6), and Australia (5). All studies were funded by government grants or charities, bar one study that did not state its funding source.

Studies investigated treatments based on the psychological therapies of CBT (25 studies) and acceptance and commitment therapy (ACT; 7 studies). One of the CBT studies included an additional group who received a positive psychology intervention. All therapies were delivered online, except one study using a smartphone app.

Main results

Our results only speak to therapy delivered by the Internet due to the lack of alternative forms of remote delivery in the studies.

• Compared to usual treatment (i.e. the standard support typically available), online CBT probably reduces pain and may reduce disability slightly. It is unclear whether online CBT improves quality of life or has unintended harmful effects.

• Compared to non-psychological treatments for pain (e.g. education, online discussion boards), online CBT also probably reduces pain slightly. However, it probably makes little to no difference to quality of life, may make little or no difference to disability, and it is unclear whether it has unintended harmful effects.

• The benefits of online CBT compared to usual treatment are probably no longer present at 3 to 12 months after treatment ends. We do not know if this finding is also the case when compared to a non-psychological treatment because the effects are unclear.

It is unclear whether other psychological therapies (such as ACT) lead to improvements because, overall, we are very uncertain of the available results.

What are the limitations of the evidence?

We have moderate confidence that pain is reduced by online CBT by the end of treatment, but this improvement is not present 3 to 12 months later. In addition, we have moderate confidence in our finding of no benefits of online CBT for disability and quality of life at follow-up. However, we have little to very little confidence in our findings for ACT.

Three main factors reduced our confidence in the evidence. First, some of the studies were very small or there were not enough studies to be certain about their results. Second, where there were small numbers of studies for an outcome, the evidence did not cover a range of pain conditions, so we cannot assume that those findings would be the same across all types of chronic pain. Finally, the results were sometimes inconsistent across studies.

How up to date is this evidence?

The evidence is up to date to 29 June 2022.

SUMMARY OF FINDINGS

Summary of findings 1. CBT compared to TAU (post-treatment) for the management of chronic pain (excluding headache) in adults

CBT compared to TAU (post-treatment) for the management of chronic pain (excluding headache) in adults

Patient or population: chronic pain (excluding headache) in adults
Setting: remote delivery
Intervention: cognitive behavioural therapy (CBT)
Comparison: treatment as usual (TAU)

Outcomes	Probable outcome with TAU	Probable outcome with CBT	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
Pain intensity (Higher scores indicate higher pain intensity) Assessed with: AIMS-2, BPI, FIQ, IRDGHL, MPI, NRS, PCP-S, WBPQ Interventions ranged in duration from 8 to 24 weeks	See comments	The SMD for pain intensity in the CBT group was 0.28 lower compared to control (0.39 lower to 0.16 lower)	-	3206 (20 RCTs)	⊕⊕⊕⊖ **Moderate**[a]	A SMD of 0.2 represents a small difference between groups.
Pain intensity (number of people with ≥ 30% improvement) (Higher scores indicate improvement) Assessed with: BPI, mean pain score, WBPQ Interventions ranged in duration from 8 to 24 weeks	Study population 114 per 1000	 245 people per 1000 (184 to 324)	RR 2.15 (1.62 to 2.85)	1347 (5 RCTs)	⊕⊕⊕⊖ **Moderate**[b]	NNTB = 8
Pain intensity (number of people with ≥ 50% improvement) (Higher scores indicate improvement) Assessed with: BPI, WBPQ Interventions lasted 8 weeks	Study population 22 per 1000	 51 people per 1000 (25 to 103)	RR 2.31 (1.14 to 4.66)	1229 (4 RCTs)	⊕⊕⊖⊖ **Low**[b,c]	NNTB = 35
Functional disability (Higher scores indicate higher levels of disability) Assessed with: AIMS-2, FIQ, ODI, PCP, PDI, RMDQ, SF-36 physical functioning scale	See comments	The SMD for functional disability in the CBT group was 0.38 lower compared to control (0.53 lower to 0.22 lower)	-	2672 (14 RCTs)	⊕⊕⊖⊖ **Low**[d]	A SMD of 0.2 represents a small difference between groups; an SMD of 0.5 represents a moderate dif-

Interventions ranged in duration from 3 to 24 weeks						ference between groups.
Quality of life (Higher scores indicate improvement) Assessed with: AQOL, BBQL, EQ-5D-5L, IRDGHL and RAND-36, QOLI Interventions ranged in duration from 8 to 24 weeks	See comments	The SMD for quality of life in the CBT group was 0.16 lower compared to control (0.43 lower to 0.11 higher)	-	1423 (7 RCTs)	⊕⊖⊖⊖ **Very low**[b,e]	A SMD of 0.2 represents a small difference between groups. Confidence intervals including 0 indicate the possibility of little or no difference between groups.
Adverse events (number of people with adverse events) (Lower events indicate fewer adverse events) Interventions lasted 10 weeks	Study population 57 per 1000	343 people per 1000 (126 to 937)	RR 6.0 (2.2 to 16.4)	140 (1 RCT)	⊕⊖⊖⊖ **Very low**[f,g,h]	NNTH = 4

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

AE: adverse event; **AIMS-2:** Arthritis Impact Scale 2;**AQOL:** Assessment of Quality of Life;**BBQL:** Brunnsviken Brief Quality of Life;**BPI:** Brief Pain Inventory;**CBT:** cognitive behavioural therapy; **CI:** confidence interval;**EQ-5D-5L:** EuroQoL 5-Dimension 5-Level questionnaire; **FIQ:** Fibromyalgia Impact Questionnaire;**IRDGHL:** Impact of Rheumatic Diseases on General Health and Lifestyle; **MPI:** Multidimensional Pain Inventory; **NNTB/H:** number needed to treat for an additional beneficial/harmful outcome; **NRS:** numerical rating scale; **ODI:** Oswestry Disability Index; **OR:** odds ratio; **PCP:** Profile of Chronic Pain; **PDI:** Pain Disability Index; **QOLI:** Quality of Life Inventory; **RAND-36:** Research and Development Corporation 36-item health survey; **RCT:** randomised controlled trial; **RR:** risk ratio; **RMDQ:** Roland-Morris Disability Questionnaire; **SF-36:** Short Form-36; **SMD:** standardised mean difference; **TAU:** treatment as usual; **WBPQ:** Wisconsin Brief Pain Questionnaire

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[a]Downgraded 1 level for inconsistency due to moderate heterogeneity (I^2 was 53%)
[b]Downgraded 1 level for publication bias due to asymmetrical funnel plot
[c]Downgraded 1 level for imprecision due to 50% of studies with < 50 participants per arm
[d]Downgraded 2 levels for inconsistency due to substantial heterogeneity (I^2 was 69%)
[e]Downgraded 2 levels for inconsistency due to substantial heterogeneity (I^2 was 81%)
[f]Downgraded 1 level for imprecision due to small sample size (< 200 participants)
[g]Downgraded 1 level for imprecision due to wide confidence intervals
[h]Downgraded 2 levels for indirectness due to insufficient information about population (fibromyalgia only) and CBT interventions

Summary of findings 2. CBT compared to TAU (at follow-up) for the management of chronic pain (excluding headache) in adults

CBT compared to TAU (at follow-up) for the management of chronic pain (excluding headache) in adults

Patient or population: chronic pain (excluding headache) in adults
Setting: remote delivery
Intervention: cognitive behavioural therapy (CBT)
Comparison: treatment as usual (TAU)

Outcomes	Probable outcome with TAU	Probable outcome with CBT	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
Pain intensity (Higher scores indicate greater pain intensity) Assessed with: BPI, IRDGHL, MPI, NRS, PCP Interventions ranged in duration from 12 to 52 weeks	See comments	The SMD for pain intensity in the CBT group was 0.04 lower compared to control (0.17 lower to 0.09 higher)	-	959 (8 RCTs)	⊕⊕⊕⊖ **Moderate**[a]	A SMD of 0 represents no difference between groups.
Pain intensity (number of people with ≥ 30 % improvement) Interventions lasted 13 weeks	Study population		RR 1.70 (0.82 to 3.53)	69 (1 RCT)	⊕⊖⊖⊖ **Very low**[b,c]	NNTB = 6.07
	235 per 1000	400 people per 1000 (193 to 831)				
Pain intensity (number of people with ≥ 50 % improvement)	Study population		-	0 (0 RCTs)	-	No data available
	-	-				
Functional disability (Higher scores indicate increased disability) Assessed with: ODI, PDI, PCP Intervention duration ranged from 12 to 24 weeks	See comments	The SMD for functional disability in the CBT group was 0.05 lower compared to control (0.23 lower to 0.14 higher)	-	461 (3 RCTs)	⊕⊕⊕⊖ **Moderate**[a]	A SMD of 0 represents no difference between groups.
Quality of life (Higher scores indicate improvement) Assessed with: AQOL, EQ-5D, IRDGH, and RAND-36	See comments	The SMD for quality of life in the CBT group was 0.16 lower compared to control (0.37 lower to 0.05 higher)	-	352 (3 RCTs)	⊕⊕⊕⊖ **Moderate**[a]	A SMD of 2 represents a small difference between groups. Confidence intervals including

Intervention duration ranged from 24 to 52 weeks					0 indicate the possibility of little or no difference between groups.
Adverse events (number of people with adverse events)	Study population - -	-	0 (0 RCTs)	-	No data available

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

AE: adverse event; **AQOL:** Assessment of Quality of Life; **BPI:** Brief Pain Inventory; **CBT:** cognitive behavioural therapy; **CI:** confidence interval; **EQ-5D:** EuroQoL 5-dimension questionnaire; **EQ-5D-5L:** EuroQoL 5-dimension 5-level questionnaire; **IRDGHL:** Impact of Rheumatic Diseases on General Health and Lifestyle; **MPI:** Multidimensional Pain Inventory; **NNTB:** number needed to treat for an additional beneficial outcome; **NRS:** numerical rating scale; **ODI:** Oswestry Disability Index; **OR:** odds ratio; **PCP:** Profile of Chronic Pain; **PDI:** Pain Disability Index; **RAND-36:** Research and Development Corporation 36-item health survey; **RCT:** randomised controlled trial; **RR:** risk ratio;**SMD:** standardised mean difference; **TAU:** treatment as usual

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[a]Downgraded 1 level for imprecision due to 50% or more studies with < 50 participants per arm
[b]Downgraded 1 level for imprecision due to small sample size (< 200 participants)
[c]Downgraded 2 levels for indirectness due to insufficient evidence about other chronic pain populations (spinal cord injury only) and CBT interventions

Summary of findings 3. CBT compared to active control (post-treatment) for the management of chronic pain (excluding headache) in adults

CBT compared to active control (post-treatment) for the management of chronic pain (excluding headache) in adults

Patient or population: chronic pain (excluding headache) in adults
Setting: remote delivery
Intervention: cognitive behavioural therapy (CBT)
Comparison: active control

Outcomes	Probable outcome with active control	Probable outcome with CBT	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments

Pain intensity (Higher scores indicate increased pain intensity) Assessed with: MPI, NRS Interventions lasted 8 weeks	See comments	The SMD for pain intensity in the CBT group was 0.28 lower compared to control (0.52 lower to 0.04 lower)	-	261 (3 RCTs)	⊕⊕⊕⊖ **Moderate**[a]	A SMD of 0.2 represents a small difference between groups. Confidence intervals including 0 indicate the possibility of little or no difference between groups.
Pain intensity (number of people with ≥ 30% improvement)	Study population -	 -	-	0 (0 RCTs)	-	No data available
Pain intensity (number of people with ≥ 50% improvement)	Study population -	 -	-	0 (0 RCTs)	-	No data available
Functional disability (Higher scores indicate greater disability) Assessed with: PDI, WOMAC Interventions lasted 8 weeks	See comments	The SMD for functional disability in the CBT group was 0.26 lower compared to control (0.55 lower to 0.02 higher)	-	189 (2 RCTs)	⊕⊕⊖⊖ **Low**[a,b]	A SMD of 0.2 represents a small difference between groups. Confidence intervals including 0 indicate the possibility of little or no difference between groups.
Quality of life (Higher scores indicate improvement) Assessed with: AQOL, QOLI Interventions lasted 8 weeks	See comments	The SMD for quality of life in the CBT group was 0.22 lower compared to control (1.11 lower to 0.66 higher)	-	261 (3 RCTs)	⊕⊕⊕⊖ **Moderate**[a]	A SMD of 0.2 represents a small difference between groups. Confidence intervals including 0 indicate the possibility of little or no difference between groups.
Adverse events (Number of people experiencing adverse events) Interventions lasted 8 weeks	0/70	1/65		135 participants (1 RCT)	⊕⊖⊖⊖ **Very low**[b,c,d]	One study reported 1 participant in the CBT group experienced an AE compared to no participants in the control group.

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

AE: adverse event; **AQOL:** Assessment of Quality of Life; **CBT:** cognitive behavioural therapy; **CI:** confidence interval; **MPI:** Multidimensional Pain Inventory ; **NRS:** numerical rating scale; **OR:** odds ratio; **PDI:** Pain Disability Index; **QOLI:** Quality of Life Inventory; **RCT:** randomised controlled trial; **RR:** risk ratio; **SMD:** standardised mean difference; **WOMAC:** Western Ontario and McMaster Universities Osteoarthritis Index

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.

Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[a]Downgraded 1 level for imprecision due to < 50 participants per arm in 50% of studies
[b]Downgraded 1 level for imprecision due to small sample size (< 200 participants)
[c]Downgraded 2 levels for imprecision due to very wide confidence intervals
[d]Downgraded 2 levels for indirectness due to insufficient information about other chronic pain populations (hip osteoarthritis only) and CBT interventions

Summary of findings 4. CBT compared to active control (at follow-up) for the management of chronic pain (excluding headache) in adults

Patient or population: chronic pain (excluding headache) in adults
Setting: remote delivery
Intervention: cognitive behavioural therapy
Comparison: active control

Outcomes	Probable outcome with active control	Probable outcome with CBT	Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
Pain intensity (Higher scores indicate greater pain intensity) Assessed with: NRS Interventions lasted 52 weeks	-	The MD for pain intensity in the CBT group was 0.50 higher compared to control (0.30 lower to 1.30 higher)	-	127 (1 RCT)	⊕⊖⊖⊖ **Very low**[a-d]	
Pain intensity (number of people with ≥ 30% improvement)	Study population		-	0 (0 RCTs)	-	No data available
	-	-				
Pain intensity (number of people with ≥ 50% improvement)	Study population		-	0 (0 RCTs)	-	No data available
	-	-				
Functional disability (Higher scores indicate greater levels of disability) Assessed with: WOMAC Interventions lasted 52 weeks	-	The MD for functional disability in the CBT group was 3.40 higher compared to control (1.15 lower to 7.95 higher)	-	127 (1 RCT)	⊕⊖⊖⊖ **Very low**[a-d]	
Quality of life (Higher scores indicate improvement)	-	The MD for quality of life in the CBT group was 0 compared to control	-	127 (1 RCT)	⊕⊖⊖⊖ **Very low**[a-d]	

Assessed with: AQOL Interventions lasted 52 weeks		(0.06 lower to 0.06 higher)			
Adverse events	Study population	-	0 (0 RCTs)	-	No data available
	-	-			

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

AQOL: Assessment of Quality of Life;**CBT:** cognitive behavioural therapy; **CI:** confidence interval; **MD:** mean difference; **NRS:** numerical rating scale; **OR:** odds ratio; **RCT:** randomised controlled trial; **RR:** risk ratio; **WOMAC:** Western Ontario and McMaster Universities Osteoarthritis Index

GRADE Working Group grades of evidence
High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
Moderate certainty: we are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.
Low certainty: our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of the effect.
Very low certainty: we have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

[a]Downgraded 1 level for imprecision due to small sample size (< 200 participants)
[b]Downgraded 1 level for imprecision due to wide confidence intervals
[c]Downgraded 1 level for imprecision due to not meeting the optimal information size
[d]Downgraded 2 levels for indirectness due to insufficient evidence for other chronic pain populations (hip osteoarthritis only) and CBT interventions

BACKGROUND

Description of the condition

Chronic pain (defined as pain lasting three months or more) is a global public health challenge. The International Association for the Study of Pain defines pain as “an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage" (Raja 2020). The prevalence of chronic pain is estimated to be between 20% and 43% globally (Eccleston 2017; Fayaz 2016; Mansfield 2016; Tsang 2008), with annual societal costs per patient estimated at EUR 10,191 (Mayer 2019). Further, the challenge is increasing as the incidence of chronic pain rises in older age (Fayaz 2016; Tsang 2008). The most common types of chronic pain in adults include chronic back pain, fibromyalgia, neuropathic pain, and headache. Chronic pain can be categorised as the disease itself (e.g. fibromyalgia) and is defined as chronic primary pain, or can be associated with or a consequence of an underlying disease (e.g. chronic cancer-related pain; Treede 2019). The personal consequences of chronic pain may be widespread, disrupting an individual’s ability to engage in everyday life and occupation, affecting social relationships, and deleteriously influencing quality of life (Dueñas 2016; Reid 2011). High levels of depression and anxiety associated with chronic pain may further complicate the emotional impact (Scott 2007). Consequently, chronic pain presents a psychological, as well as physical, challenge.

Description of the intervention

Psychological therapies can address the cognitive, behavioural, and emotional factors associated with the experience of chronic pain to support self-management and the pursuit of personally meaningful goals. These interventions contribute to improvements in mood and pain-related disability (Williams 2020), and are recognised as an important component of effective pain management treatment (Eccleston 2013; Kerns 2011). However, patients and providers report that access to ‘non-pharmacological’, often psychological, pain treatments is constrained by multiple barriers, including geographic and economic restrictions (Becker 2017). Consequently, provision of effective and scalable support for chronic pain remains a substantial challenge.

Technological advances provide new opportunities for treatment delivery that may overcome traditional barriers and provide support remote from clinician involvement. Technology-based delivery offers the potential to liberate healthcare expertise from its temporal, geographic, and economic restrictions through partial or complete automation of treatment (Griffiths 2006; McGeary 2012; Rini 2012). Consequently, such delivery methods may increase access to psychological therapeutic support for health conditions such as chronic pain (McGuire 2017).

Relevant technologies are multiform and multiplying. Examples include the Internet, interactive voice response, smartphone apps, videoconferencing, and virtual reality. Correspondingly, recent reviews emphasise the need to evaluate technology-based delivery across multiple modalities (Heapy 2015; Slattery 2019a). The encouraging support for technology-based intervention delivery for chronic pain is often tempered by the disproportionate representation of specific modalities (e.g. Internet-based interventions) within the evidence-base. However, increasing investigation of technologies such as smartphones is anticipated (McGuire 2017). Consequently, rigorous verification of intervention effectiveness must match rapidly evolving technology.

This review is concerned with any technology-based delivery of psychological therapy for chronic pain that is remote from both the physical presence of the healthcare professional and their active involvement. We employ the term ‘remote delivery’ for its superior descriptive capacity to other terms (such as e-health, telehealth, telemedicine, and digital therapeutics). Fisher and colleagues also employed ‘remote delivery’ in their related review within child and adolescent populations (Fisher 2019), so this enables cross-review comparison. Eligible interventions will utilise technology as the primary agent of delivering psychological therapy. Technology solely facilitating distance contact between client and clinician (such as videoconferencing) does not fulfil our definition of remote delivery because the intervention, whilst remote from the healthcare professional’s physical presence, remains dependent on their active involvement and direction. We place no restrictions on technology type.

How the intervention might work

Psychological therapies comprise multiple modalities with variable intervention targets and therapeutic processes. Existing reviews suggest that psychological therapies have beneficial effects for both adults and children (Fisher 2018; Williams 2020). Mainstream psychological approaches supporting individuals experiencing chronic pain typically derive from cognitive and behavioural models of human experience and difficulty (Eccleston 2013; Williams 2020). Traditional cognitive behavioural interventions comprise varying content including psychoeducation, identification and modification of unhelpful patterns of thought and behaviour, and the development and application of coping strategies (Kerns 2011). Whilst content varies, these interventions share an underlying aim to target the interactive relationship between internal experience and external behaviour in order to support personally meaningful engagement with life. Whilst cognitive and behavioural therapies dominate the literature, this review is not limited to any specific therapy modality.

Remote delivery of psychological therapy divorces intervention content from face-to-face clinician delivery. Technology offers increasingly varied media to achieve this end and facilitate new ways to access psychological interventions for chronic pain (including the Internet, smartphone applications, and virtual reality). The potential impact of delivery method should not be underestimated, particularly given the emphasis within psychological interventions on the therapeutic role of client-clinician relationships (Horvath 2011; Zilcha-Mano 2017). However, as related reviews suggest, remote delivery also offers additional features beyond those of traditional therapy, which may contribute to the impact of interventions, such as immediate 24-hour access to support (Fisher 2019), and exact treatment fidelity (Heapy 2015). Consequently, whilst the intervention content and underlying psychological frameworks may appear comparable between traditional and technology-based delivery, the delivery method has the potential to influence both message and outcome. We have chosen to use the term 'remote delivery' to describe geographical distance from the healthcare clinic and professional distance from the healthcare professional.

Why it is important to do this review

Traditional face-to-face psychological therapies for chronic pain appear useful (Williams 2020). However, access to treatment is restricted by healthcare resources, geography, and cost. Remote technology-based delivery holds the potential to overcome these traditional treatment barriers. However, therapeutic equivalence between traditional and technology-based delivery requires substantiation. Further, communication technology provides opportunities for content and delivery that outstrip what is possible face to face, and may facilitate novel interventions (Eccleston 2018). Whilst previous reviews of Internet-based psychological interventions for chronic pain are encouraging (Bender 2011; Buhrman 2016; Eccleston 2014), evolving technologies necessitate the need to consider a broader spectrum of technologies capable of remote delivery. Concern remains that technological innovation, such as smartphone applications, is outpacing regulation and evidential support, despite repeat criticism (Lalloo 2015; Portelli 2016; Rosser 2011). Consequently, a review enabling aggregation and evaluation of remote delivery – via multiple technologies – of psychological therapy for chronic pain is warranted. Fisher 2019 provides such a review of remotely-delivered psychological interventions for chronic pain in children and adolescents. Williams 2020 provides a review of face-to-face psychological interventions in adults with chronic pain. We aim to complement both reviews by conducting a review of psychological interventions delivered remote from the therapist for adults with chronic pain. Here we exclude headache conditions; Sharpe 2019 provides a review of interventions (delivered by any mode) for adults with migraine. Other headache conditions include outcomes that are different to those assessed in other chronic pain conditions, which is the focus here. This review will expand and supersede our previous review focused on Internet-delivered psychological therapies (Eccleston 2014).

OBJECTIVES

To determine the benefits and harms of remotely-delivered psychological therapies compared to active control, waiting list, or treatment as usual for the management of chronic pain in adults.

METHODS

Criteria for considering studies for this review

Types of studies

We included peer-reviewed randomised controlled trials (RCTs). RCTs are the best design to minimise bias when evaluating interventions. We excluded equivalence studies, conference abstracts, dissertations, quasi-randomised studies, and non-randomised studies as a quality threshold and to support confidence in the reliability of included data. We searched databases without language or date restrictions, and we have reported ongoing trials and trials with data.

Types of participants

We included adults (≥ 18 years of age) with chronic pain. Typically, these conditions include musculoskeletal and neuropathic pain. We included participants experiencing chronic pain as a primary symptom of a condition or disease, such as diabetic neuropathy, sickle cell disease, or primary chronic pain conditions. For consistency with Williams 2020, we excluded from the review life-limiting conditions such as cancer, and participants with headache or migraine. Outcomes in trials of participants with headache and migraine are different from trials in other chronic pain conditions. We included studies where only a subset of participants was eligible, if we could extract the characteristics and outcomes of those participants separately. Studies must have included a minimum of 20 participants in each trial arm post-treatment to be considered for inclusion, for consistency with Williams 2020 and in recognition of the increased risk of bias associated with small sample sizes even when pooled in meta-analyses (Lin 2018).

Types of interventions

We included psychological therapies that had recognisable psychotherapeutic content or were based on a psychological theory. In a refinement of our protocol (Rosser 2021), we elected to exclude solely mindfulness interventions. We acknowledge that mindfulness may be a useful intervention technique for individuals experiencing chronic pain (Hilton 2017), and that it can form part of psychological therapy (e.g. acceptance and commitment therapy). However, in order to maintain a clear distinction between psychological therapies and other mind-body approaches that originate from practises outside of psychology, we excluded interventions utilising only mindfulness. This approach is consistent with Williams 2020. We included interventions which included mindfulness as a component of a broader psychological intervention.

Psychological therapy delivery had to be predominantly remote from the therapist. We defined 'remote delivery' as the transfer of intervention content remote from both therapist location and their active guidance. We excluded trials that involved more than 30% contact time with a clinician, either in-person or via technology-mediated communication (e.g. email, phone, teleconference, online chat).

Eligible trials using remotely-delivered psychological therapies could utilise various technologies, such as the Internet or smartphone applications. The intervention had to include content that required the participant to engage in one or more psychologically-informed therapeutic activity. We excluded interventions that only provided education or passively-consumed content (e.g. description of psychological theory rather than its application). Eligible interventions had to have been developed by (or under the supervision of) a qualified psychologist and based on existing psychological theory, echoing the Cochrane Review of face-to-face delivery of psychological therapies (Williams 2020). In an extension of our protocol, we distinguished between academic and clinically-trained psychologists, and only included the latter. In addition, we included studies where authors reported that a qualified psychiatrist was involved in intervention development as they were considered to have the requisite knowledge of psychological interventions. Importantly, the intervention had to be potentially scalable to reach numerous people, rather than relying on intensive one-to-one interactions, such as delivering interventions via Skype or videoconferencing software. All review authors agreed on the included studies.

This is a rapidly evolving field, with new technologies and delivery modes emerging. Therefore, in future updates we may need to expand our inclusion criteria to include new forms of intervention modes as technology evolves.

We compared intervention arms to control arms. We included active controls (e.g. education), treatment as usual, or waiting-list controls. We combined treatment as usual and waiting-list controls in the analyses. As described, we excluded equivalence trials, and therefore we excluded studies in which psychotherapeutic content was delivered to control groups.

Types of outcome measures

We compared psychological interventions to control groups at two time points: 1) immediately after treatment ended; and 2) follow-up. We determined an eligible time frame for follow-up as between three and 12 months after treatment ended. We extracted outcomes assessed by validated measures. In the event of multiple follow-up assessments, we extracted the time point closest to 12 months. Where studies provided additional assessment beyond 12 months, we intended to extract this as a secondary follow-up time point providing the control group remained consistent and, therefore, comparable across time points. However, we found no studies with these data. Where studies included multiple measures for the same outcome, we used the most reliable and frequently-employed measure across the studies included in the analysis.

Primary outcomes

We extracted the following primary outcomes:

- pain intensity (continuous data: e.g. numerical rating scale, visual analogue scale). Where possible, we extracted 30% reduction in pain, 50% reduction in pain, or both, separately;
- functional disability (e.g. Functional Disability Inventory);
- quality of life (e.g. Short Form-36);
- adverse events.

Secondary outcomes

We extracted the following secondary outcomes:

- anxiety (e.g. Hamilton Anxiety Rating Scale);
- depression (e.g. Beck Depression Inventory);
- intervention satisfaction (e.g. numerical rating scale);
- intervention engagement (i.e. measurement of intervention use, technology usage, and/or activity completion);
- attrition (from baseline to post-intervention).

Search methods for identification of studies

Electronic searches

We searched the following electronic databases without date or language restriction up to 29 June 2022.

- CENTRAL (Cochrane Library) all issues up to 29 June 2022.
- MEDLINE (OVID) 1946 to 29 June 2022.
- Embase (OVID) 1974 to 29 June 2022.
- PsycINFO (EBSCO) 1806 to 29 June 2022.

We employed a comparable search strategy across databases (see Appendix 1 for the CENTRAL, MEDLINE (OVID), Embase (OVID) and PsycINFO (EBSCO) strategies).

Searching other resources

We searched clinicaltrials.gov and the World Health Organization (WHO) International Clinical Trials Registry Platform (ICTRP) (apps.who.int/trialsearch/) for any ongoing trials or completed trials not yet published in a peer-reviewed journal. We entered these into the Characteristics of ongoing studies section. We searched the reference lists and conducted a citation search of included trials to identify any further trials that met our eligibility criteria.

Data collection and analysis

Selection of studies

The search results were screened by review authors (BR, EF, and SJ) in pairs. In each pair, the two review authors (e.g. BR and EF) independently determined eligibility by screening the title and abstract of studies identified by the search. We excluded studies that did not clearly satisfy inclusion criteria, and obtained full copies of the remaining studies. Any disagreements that could not be resolved by discussion between the two authors doing the initial screening were subject to arbitration by a third author.

In pairs, the review authors (BR, EF, and SJ) independently read the full texts of the retrieved studies to identify eligible studies. Where authors disagreed on inclusion, a third author read the full text and resolved the discrepancy. We contacted study authors to confirm that the intervention involved less than 30% contact time with clinician and that a qualified psychologist was involved in intervention development. We considered studies to remain eligible in instances where the authors responded that a psychiatrist was involved in intervention development. All review authors agreed on all included studies.

Eligible studies met the following criteria:

- a randomised controlled trial;
- published in peer-reviewed scientific journals;
- included 20 or more participants in each trial arm post-treatment, for consistency with Williams 2020. Small studies are known to produce larger effect sizes (Dechartres 2013);
- therapy was primarily psychological in at least one trial arm;
- psychological therapy aimed to facilitate adults in managing or coping with chronic pain;
- the intervention included content that required the participant to engage in one or more psychologically-informed therapeutic activities;
- a qualified psychologist with clinically relevant training or a psychiatrist developed or supervised the development of the psychological component of the intervention;
- technology was the primary delivery mechanism for the psychological therapy;
- technology-based delivery of psychological therapy was remote from clinician contact and their active guidance;
- participants received the intervention in their everyday setting, rather than in a clinic or laboratory.

Data extraction and management

In a refinement of our protocol, we elected to have two authors (BR, EF, SJ, and GF working in pairs), rather than one, extract data from each included study independently to increase the reliability of the review. A third author read the full text, arbitrated, and resolved any disagreements. We extracted the following data:

- article details (e.g. authorship, title, year, study funding sources, study author declarations of interest);
- participant characteristics (e.g. sample size, age, sex, pain condition or characteristics and duration, dropout);
- intervention characteristics (e.g. psychological theory and content, duration, delivery mode, therapeutic activity requiring participant interaction or involvement);
- comparison characteristics (e.g. type of comparison and content);
- methodological characteristics (e.g. study design, randomisation method, assessment points);
- outcomes (e.g. primary and secondary outcomes).

Where there were multiple reports of the same study, we amalgamated them into a single study summary.

Assessment of risk of bias in included studies

We assessed risk of bias using the Cochrane risk of bias (RoB) version 1 tool for randomised trials (Higgins 2011). The tool assesses bias arising from multiple domains, including selection bias, performance and detection bias, attrition bias, and reporting bias. We categorised risk for each domain as low, high, or unclear. Two authors independently assessed included articles for risk of bias. A third author reviewed and resolved any discrepancies between the extractions in discussion with the extracting authors.

Selection bias

- Random sequence generation (checking for possible selection bias). We assessed the method used to generate the allocation sequence as: low risk of bias (any truly random process, e.g. random number table, computer random number generator); or unclear risk of bias (method used to generate sequence not clearly stated). Studies using a non-random process (e.g. odd or even date of birth, hospital or clinic record number) did not meet eligibility criteria and were not included.
- Allocation concealment (checking for possible selection bias). The method used to conceal allocation to interventions prior to assignment determines whether intervention allocation could have been foreseen in advance of, or during recruitment, or changed after assignment. We assessed the methods as: low risk of bias (e.g. telephone or central randomisation; consecutively numbered, sealed, opaque envelopes); or unclear risk of bias (method not clearly stated). Studies that did not conceal allocation (e.g. open list) were rated as high risk of bias.

Performance and detection bias

- Blinding of participants and personnel (checking for possible performance bias). In line with other Cochrane Reviews of psychological interventions (Fisher 2018; Fisher 2019; Williams 2020), we did not assess blinding of participants and personnel as it is not possible to blind fully delivery of psychological therapies. We considered the possible influence of performance bias in the interpretation of the findings.
- Blinding of outcome assessment (checking for possible detection bias). We assessed the methods used to blind study participants and outcome assessors from knowledge of which intervention a participant received. We assessed the methods as: low risk of bias (assessments were completed online or directly into a database and could not be influenced by an outcome assessor); unclear risk of bias (it was not clear how assessments were taken, or whether the outcome assessor knew of treatment allocation); or high risk of bias (outcome assessors were aware of treatment allocation). As outcome assessment was expected often to involve self-report, we acknowledged the possible influence of bias arising from the difficulties of fully blinding participants when delivering psychological therapies. We considered this potential influence in interpretation of the findings.

Attrition bias

- Incomplete outcome data (checking for possible attrition bias due to the amount, nature, and handling of incomplete outcome data). We assessed the methods used to deal with incomplete data as: low risk (< 10% of participants did not complete the study, or study used ‘baseline observation carried forward’ analysis, a method of data imputation (e.g. maximum likelihood estimation)); unclear risk of bias (used 'last observation carried forward' analysis); or high risk of bias (used 'completer' analysis).

Reporting bias

- Selective reporting (checking for reporting bias). We assessed whether primary and secondary outcome measures were pre-specified and whether these were consistent with those reported: low risk of bias (all pre-specified outcomes were reported in the manuscript and no additional outcomes were included); unclear risk of bias (a trial registration or protocol was not available, or trial was post-registered); or high risk of bias (pre-specified outcomes were missing from the trial manuscript, additional outcomes were included in the manuscript but not listed in the pre-registered database, or primary and secondary outcomes were changed between pre-registration and manuscript). In a refinement of our protocol, we considered a judgement of high risk of bias was only appropriate where there was notable deviation from the protocol/trial registration outcomes, such as numerous and/or impactful outcome alteration or omissions (e.g. outcomes relevant to the review).

Measures of treatment effect

We extracted and analysed continuous outcome data where reported. We employed standardised mean differences (SMDs) with 95% confidence intervals (CIs) to evaluate treatment effects for continuous data. We interpreted SMD as small (0.2), moderate (0.5), and large (0.8), in accordance with Cohen 1988.

We extracted and analysed dichotomous data for pain intensity (30% or 50% improvement) and adverse events, where reported. We employed risk ratios (RRs) with 95% confidence interventions (CIs) to evaluate treatment effects for dichotomous data.

Unit of analysis issues

We expected that studies would randomise at the individual level. For cluster-randomised trials, we intended to follow guidance in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2020b), but we did not find any cluster-randomised trials. In such instances, the clusters would be considered as the unit of analysis, rather than participants. We collapsed arms into intervention and control groups, respectively, where a study employed multiple intervention or control arms, or both. We split the control group equally across intervention arms to enable comparisons where a

notable discrepancy in the underpinning psychological approach or theory prohibited meaningful amalgamation. For crossover trials, we included the first step comparison of treatment and control. We did not include data from the second step where the arms are crossed over, to avoid carryover effects of the intervention in the first step.

Dealing with missing data

We contacted authors if outcome data were missing from published studies. We contacted one author to determine participant numbers at randomisation (Buhrman 2004); these data were provided and included to determine attrition. We also contacted two authors to confirm our interpretation of participant numbers (Dear 2021; Hess Engström 2022), and confidence intervals for one measure of quality of life (Hess Engström 2022). We used available statistical information from the published study to calculate the necessary data (e.g. standard deviations) where possible, in accordance with *Cochrane Handbook* guidance (Higgins 2020a), in the event that these data were not available from the authors. We did not impute missing variables in analyses where outcome data were not available or calculable. We preferentially extracted intention-to-treat data when presented alongside per-protocol data.

Assessment of heterogeneity

We interpreted heterogeneity by visually inspecting forest plots alongside calculating Chi^2 and I^2. We interpreted I^2 with reference to *Cochrane Handbook* guidelines (Deeks 2020):

- 0% to 40%: might not be important;
- 30% to 60%: may represent moderate heterogeneity;
- 50% to 90%: may represent substantial heterogeneity;
- 75% to 100%: considerable heterogeneity.

Where heterogeneity was substantial or considerable, we conducted sensitivity analyses if appropriate (i.e. enough studies included in the analysis). As heterogeneity categories are overlapping, we also considered heterogeneity between studies included in the analysis when making our category judgement.

Assessment of reporting biases

We assessed reporting biases as part of the risk of bias assessment in this review. We also assessed funnel plots, in accordance with *Cochrane Handbook* guidance (Page 2020), where there were at least 10 studies included in each analysis.

Data synthesis

We analysed data using Review Manager (Review Manager 2020). We analysed outcome data using random-effects models. Where it was not possible to combine data, we described the findings across studies.

We conducted the comparisons listed below for two individual therapy types: cognitive behavioural therapy (CBT), and acceptance and commitment therapy (ACT). We separated comparisons by control group type (e.g. waiting-list control or treatment as usual; active control). In a refinement of and alteration to our protocol, we elected to follow the same analysis strategy as Williams 2020. That is, we employed the same classifications of active control, waiting-list control, and treatment as usual (TAU), and we collapsed the latter two into a single comparison group labelled 'TAU control'. We conducted comparisons on data immediately post-treatment and at follow-up.

- CBT versus TAU control, post-treatment.
- CBT versus TAU control, follow-up.
- CBT versus active control, post-treatment.
- CBT versus active control, follow-up.
- ACT versus TAU control, post-treatment.
- ACT versus TAU control, follow-up.
- ACT versus active control, post-treatment.
- ACT versus active control, follow-up.

We intended to add further comparisons where separate categories of psychological therapies were identified within included studies. We reported therapies that were not CBT or ACT narratively, as there were insufficient trials to enable a meta-analysis.

Subgroup analysis and investigation of heterogeneity

We conducted subgroup analyses where at least 10 eligible studies were available, evaluating the following:

- delivery method (e.g. computer versus smartphone application);
- delivery automation (i.e. no therapist versus therapist interaction).

We were unable to conduct assessment of delivery method as there were insufficient non-Internet-based interventions to permit these analyses.

We did not conduct subgroup analyses based on pain type; this approach was consistent with Williams 2020.

Sensitivity analysis

We conducted sensitivity analyses by considering:

- trials with more than 50 participants versus less than 50 participants per arm; and
- trials assessed as low risk of bias across all bias domains.

We also conducted sensitivity analyses excluding trials where we identified substantial or considerable heterogeneity. In future updates, we will consider other sensitivity analyses as the literature evolves and new technologies emerge. We only conducted sensitivity analyses when there were at least 10 eligible studies to enter into the meta-analysis in either subgroup.

Summary of findings and assessment of the certainty of the evidence

We used the GRADE system to rank the certainty of the evidence using the GRADEprofiler Guideline Development Tool software (GRADEpro GDT), and the guidelines provided in the *CochraneHandbook* (Chapter 14, Higgins 2020c) and GRADEpro Handbook (Schünemann 2013). In a clarification of our protocol, one review author (SJ) independently rated the certainty of the body of evidence for the outcomes and a second review author (EF) independently reviewed these ratings. We resolved any discrepancies through discussion.

The GRADE approach uses five considerations (study limitations (risk of bias); unexplained heterogeneity and inconsistency of effect; imprecision; indirectness; and publication bias) to assess the certainty of the body of evidence for each outcome. The GRADE system uses the following criteria to assign evidence grades.

- High certainty: we are very confident that the true effect lies close to that of the estimate of the effect.
- Moderate certainty: we are moderately confident in the effect estimate; the true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different.
- Low certainty: our confidence in the effect estimate is limited; the true effect may be substantially different from the estimate of the effect.
- Very low certainty: we have very little confidence in the effect estimate; the true effect is likely to be substantially different from the estimate of effect.

The GRADE system considers study design as a marker of quality. Randomised controlled trials are considered to yield high-certainty evidence, but they can be downgraded for important limitations. Factors that may decrease the certainty level of a body of evidence are as follows:

- serious or very serious study limitations (risk of bias);
- important or serious inconsistency of results;
- some or major indirectness of evidence;
- serious or very serious imprecision; and
- probability of publication bias.

We included four summary of findings tables to present the main findings for the most common therapy (i.e. CBT) versus each control comparison (e.g. TAU, active) at post-treatment and follow-up. In a refinement of our protocol, for clarity and readability, we restricted the summary of findings tables to studies providing CBT, as it is the most commonly available and utilised therapy type within the field, and thus represents the psychological intervention most likely to be accessible to decision-makers and individuals experiencing chronic pain. Within the tables, we included key information concerning the certainty of evidence, the magnitude of effect of the interventions examined, and the sum of available data on the primary outcomes: pain intensity, functional disability, quality of life, and adverse events.

RESULTS

Description of studies

See Characteristics of included studies; Characteristics of excluded studies.

Results of the search

We conducted database searches up to 29 June 2022. We also handsearched for relevant references (Figure 1, study flow diagram (Moher 2009)). We found 1394 records from databases and 17 records from other sources. After deduplication, we retrieved 1411 records, of which we excluded 1188 at the first screening stage (titles and abstracts). We then screened 223 articles in full text. Of these, we identified 159 articles that were ineligible for inclusion in the review. Rather than presenting an exhaustive list of all excluded articles in the review, we discarded 128 articles and selected a representative sample of 26 excluded studies (published across 31 articles), in accordance with *Cochrane Handbook* guidance (Lefebvre 2022). We describe these studies and the reasons for exclusion in the Excluded studies section and the Characteristics of excluded studies table. Of the 64 references included, 32 were primary publications of trials (Included studies), with 8 secondary references, and 17 ongoing trials with 7 secondary references (Ongoing studies). We included 32 primary trials in the analyses.

Figure 1. Study flow diagram

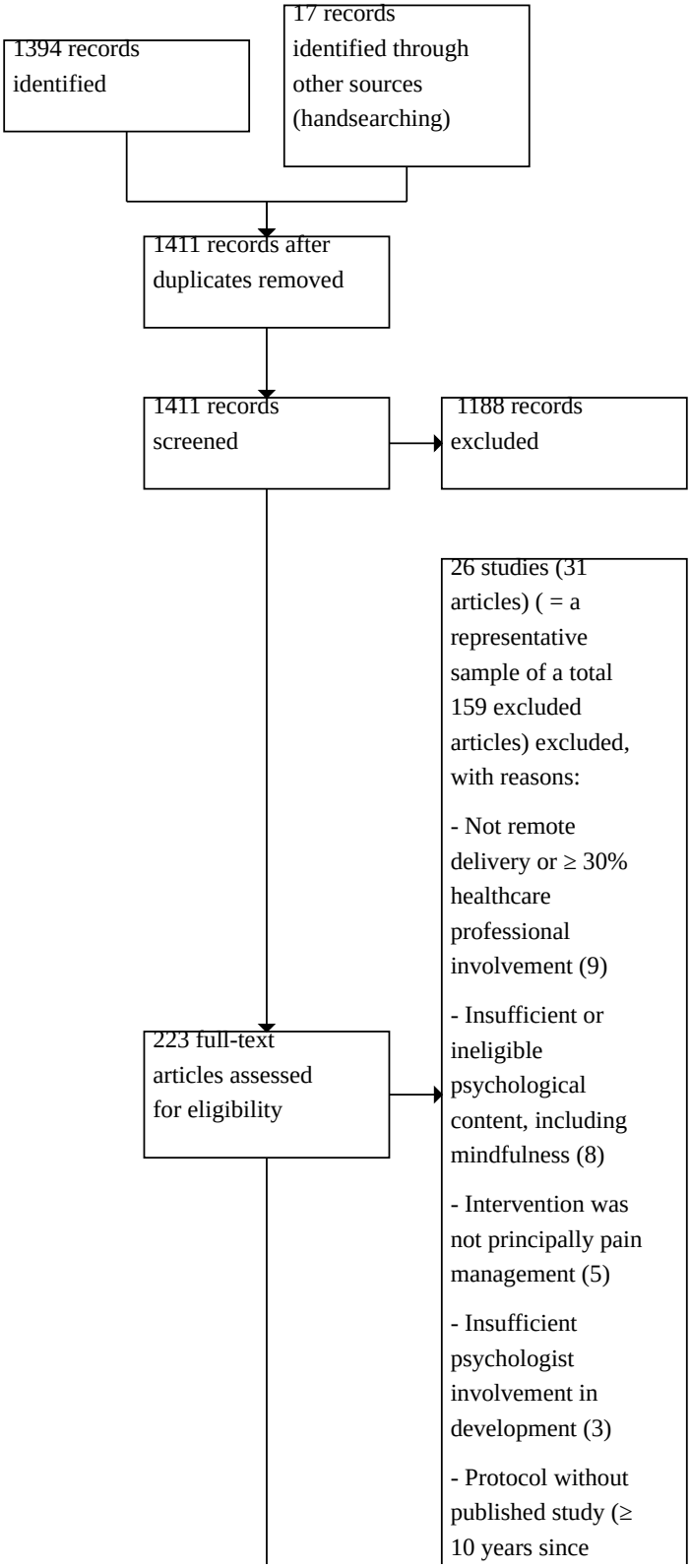
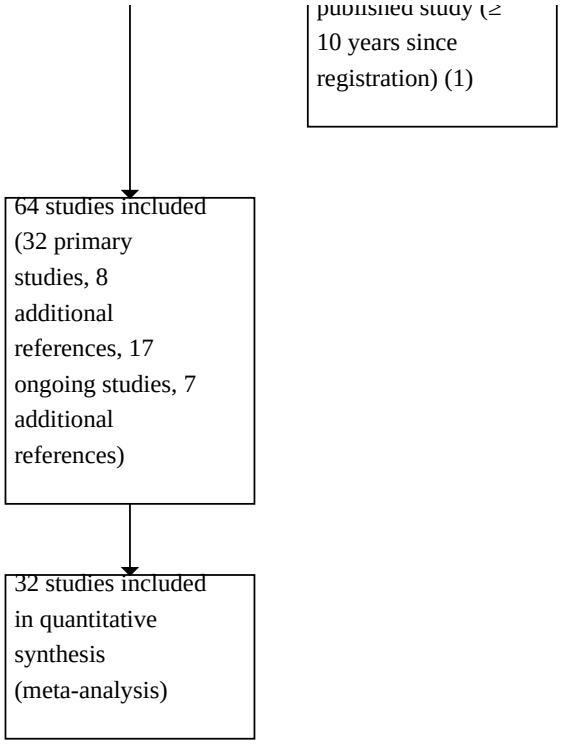


Figure 1. (Continued)



Included studies

We found 32 completed trials with results, evaluating the efficacy and safety of remotely-delivered interventions for adults with chronic pain (Baumeister 2021; Bennell 2018; Buhrman 2004; Buhrman 2011; Buhrman 2013a; Buhrman 2013b; Buhrman 2015; Burke 2019; Carpenter 2012; Dear 2013; Dear 2015; Dear 2021; Hess Engström 2022; Ferwerda 2017; Friesen 2017; Gasslander 2022; Guarino 2018; Hedman-Lagerlöf 2018; Lin 2017; Morcillo-Muñoz 2022; Peters 2017; Rickardsson 2021; Rini 2015; Ruehlman 2012; Schlicker 2020; Scott 2018; Serrat 2021; Simister 2018; Smith 2019; Vallejo 2015; Williams 2010; Wilson 2015).

Nine studies were conducted in Sweden, six in the USA, five in Australia, three each in Germany and Spain, two in Canada, and one each in Belgium, Ireland, the Netherlands, and the UK, respectively.

Thirty-one studies reported funding sources which were exclusively from government grants or charity funding. One study did not report funding information (Buhrman 2015).

There were 3725 females and 1048 males included in the studies. All studies reported participant average age; participants were an average of 48.00 years of age (SD = 10.77).

Most studies (N = 28) included two arms, three studies included three arms, and one study included four arms. We did not find any crossover or cluster-randomised studies.

Amongst the included studies, participants had a range of chronic pain conditions. Fifteen studies included participants with a mix of chronic pain conditions or chronic pain with no further definition (Buhrman 2013b; Buhrman 2015; Dear 2013; Dear 2015; Dear 2021; Gasslander 2022; Guarino 2018; Lin 2017; Morcillo-Muñoz 2022; Peters 2017; Rickardsson 2021; Ruehlman 2012; Scott 2018; Smith 2019; Wilson 2015); six studies were in people with chronic back pain (Baumeister 2021; Buhrman 2004; Buhrman 2011; Buhrman 2013a; Carpenter 2012; Schlicker 2020); six studies exclusively included participants with fibromyalgia (Friesen 2017; Hedman-Lagerlöf 2018; Serrat 2021; Simister 2018; Vallejo 2015; Williams 2010); two studies were in people with hip (Bennell 2018) and/or knee osteoarthritis (Rini 2015); and there was one study each in rheumatoid arthritis (Ferwerda 2017), spinal cord injury (Burke 2019), and provoked vestibulodynia (Hess Engström 2022).

We provide details of the CBT and ACT interventions in the included studies in Table 1. Interventions ranged in duration from three to 24 weeks, except for Ferwerda 2017 who reported a variable intervention duration, ranging from nine to 65 weeks, with an average duration of 26 weeks. Due to the wide variability in treatment duration, we do not include this study in the subsequent text summary of treatment durations (Effects of interventions); however, the study outcomes are included in the analyses. We converted all intervention lengths to weeks (one month = four weeks). Most of the interventions were delivered online. One study employed a smartphone application (Morcillo-Muñoz 2022), and another study included an online video only (Serrat 2021).

We classified interventions on the basis of their content, as well as the label given by the authors, as CBT or ACT. Interventions were developed or delivered by a psychologist or therapist (trained, in training, or supervised) and involved less than 30% interaction with participants during treatment. Upon contact with all principle

study authors, 29 confirmed this information (Baumeister 2021; Bennell 2018; Buhrman 2004; Buhrman 2011; Buhrman 2013a; Buhrman 2013b; Burke 2019; Carpenter 2012; Dear 2013; Dear 2015; Dear 2021; Hess Engström 2022; Ferwerda 2017; Friesen 2017; Hedman-Lagerlöf 2018; Lin 2017; Morcillo-Muñoz 2022; Peters 2017; Rickardsson 2021; Rini 2015; Ruehlman 2012; Schlicker 2020; Scott 2018; Serrat 2021; Simister 2018; Smith 2019; Vallejo 2015; Williams 2010; Wilson 2015). We did not receive a response in three instances (Buhrman 2015; Gasslander 2022; Guarino 2018). We included the Buhrman 2015 and Gasslander 2022 studies (which used the same intervention), based on the principle study authors' responses about their other included studies (Buhrman 2004; Buhrman 2011; Buhrman 2013a; Buhrman 2013b), as well as on information contained in the study articles, making a judgement that these studies likely met the intervention criteria. We included Guarino 2018, as a previous paper describing the intervention development included mention of psychologist involvement (Moore 2013). We classified control groups as TAU (i.e. treatment as usual or waiting-list) or active control (e.g. educational programme). We combined treatment as usual groups with waiting-list groups when there was no available information to classify the control group as active control. We acknowledge that treatment as usual may include some elements of active treatment (e.g. physiotherapy, pharmacotherapy, education). Similarly, it is possible that TAU could include some form of psychotherapy; however, this was not possible to determine. Finally, we contacted the Buhrman 2004 study authors to request additional detail regarding baseline participant numbers per group to determine attrition and received these data.

We found 25 studies that delivered CBT and seven studies that delivered ACT remotely. One study included a positive psychology intervention (PPI) which we did not include in analyses but described separately in comparison 5 of the Effects of interventions section (Peters 2017). Most CBT studies (N = 22) compared CBT with TAU and the remaining three studies compared CBT with active controls. Five studies compared ACT with TAU, and two studies compared ACT with active controls.

Excluded studies

See Figure 1 for a summary of reasons for exclusion.

As noted above, from 159 ineligible articles, we selected a representative sample of 26 excluded studies (Lefebvre 2022). These studies are listed in the Characteristics of excluded studies table with reasons for exclusions.

The most common reasons for excluding studies from the review were due to the intervention not being remotely delivered or the healthcare professional's involvement exceeding our eligibility threshold. Non-remote therapy delivery in an individual's everyday life was typically clearly identifiable (e.g. Garcia-Palacios 2015). Therapy delivery that exceeded our maximum 30% contact time criterion was clearly evident in some study interventions, such as telephone-delivered CBT (e.g. Fraenkel 2020; Rutledge 2018). In other studies, fundamental intervention components involved clinician contact that exceeded the maximum clinician contact time we pre-specified (e.g. Martin 2021; Molinari 2018). We excluded studies in which technology was adjunctive rather than the primary intervention (e.g. Domenech 2013). We also excluded articles that involved regular non-psychologist healthcare professional contact, such as with a physiotherapist (e.g. Dobson 2014). Finally, we excluded two articles due to the remote intervention immediately following a clinician-led pain management programme (e.g. Kristjánsdóttir 2013; Nes 2017).

We excluded studies with interventions that either did not incorporate sufficient eligible psychological content to meet our criteria (and were often instead more educational) (e.g. Riva 2014; Suman 2019), or were focused on physical interventions (e.g. Sandal 2021), relaxation (e.g. Pach 2022) or mindfulness (e.g. Forbes 2020). On occasion, the study's intervention description initially appeared to meet eligibility criteria, but review of the online intervention (where available) suggested the content was predominantly educational, insufficiently interactive (e.g. Chiauzzi 2010), or both. Additionally, we excluded attentional bias modification interventions (Carleton 2020) and text-message social support (Guillory 2015), as we did not consider either to constitute psychological therapy as isolated techniques.

We excluded studies in which pain was a consideration but not the principal focus of the intervention, such as for irritable bowel syndrome (Everitt 2019) or inflammatory bowel disease (Norton 2021). In other instances, excluded studies involved interventions developed for individuals with chronic pain but were not focused specifically on pain management, such as interventions targeting depression (Sander 2020), analgesic misuse (Dhokia 2020), or the acceptability of remote therapy use (Lin 2018).

Trained psychologist or psychiatrist involvement in the development of the intervention was not always reported or obvious, based on the research team (e.g. Geraghty 2018). We excluded studies where we could not verify that they met this criterion, including through attempting to contact the author (e.g. Lorig 2008). This approach led to the exclusion of Trompetter 2015 as we were unable to confirm with the authors the qualifications and training of those involved in the intervention development.

Finally, we encountered two dated protocols of completed trials that had not published the study outcomes. We excluded one protocol as it was over 10 years since registration, and we did not receive a response from the author (NTR3775). We retained the second one as an 'ongoing study', based on the author response (Hayes 2014).

Risk of bias in included studies

Judgements for risk of bias and reasons can be found in the Characteristics of included studies table and an overview of judgements for risk of bias can be found in Figure 2.

Figure 2. Risk of bias for included studies: review authors' judgements about each risk of bias item for each included trial

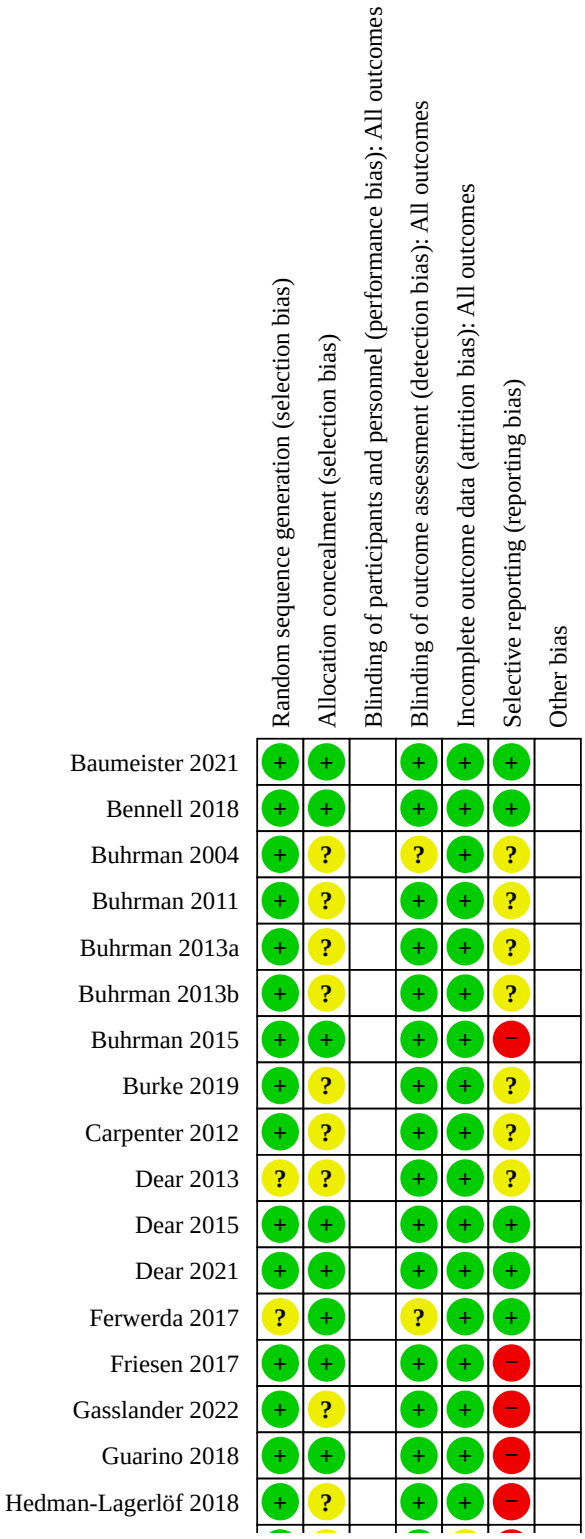
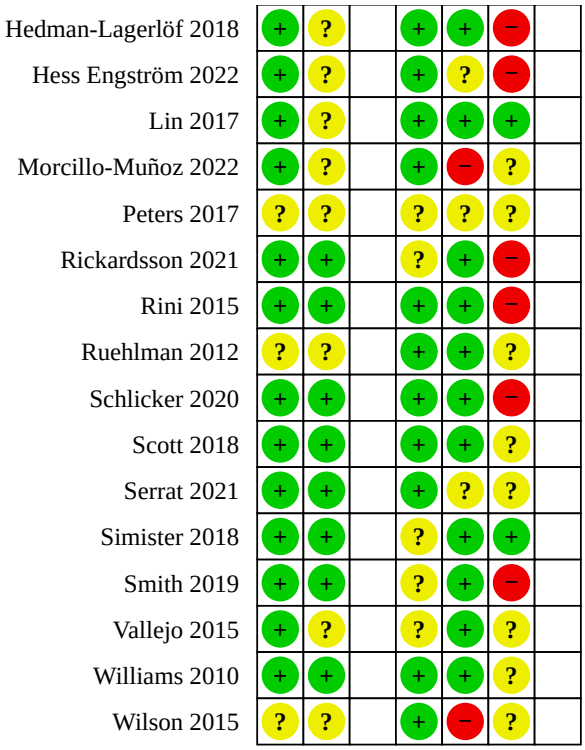


Figure 2. (Continued)



Allocation

We assessed each study's randomisation procedure and found five studies were at unclear risk and did not provide an explicit method of randomisation; the remaining studies were at low risk of bias. For allocation concealment, we judged 16 studies to be at low risk of bias, providing an adequate method of concealing the randomisation procedure from participants. We judged the remaining studies to have an unclear risk of bias.

Blinding

We judged seven studies as having an unclear risk of bias for blinding of outcome assessors. These studies did not explicitly state that outcome assessors were blind, or that measures were completed online. We judged the remaining studies as having a low risk of bias, most of which had participants complete measures online.

Incomplete outcome data

We judged two studies to have a high risk of bias for incomplete outcome data, three as unclear risk of bias, and the remaining studies as having a low risk of bias. Most studies used an appropriate method of imputation where attrition was higher than 10%.

Selective reporting

We judged 10 studies as having a high risk of selective reporting bias, as they changed their outcomes from registration to publication. We judged 15 studies as unclear, as they either did not have a prospective trial registration (or similar) or retrospectively registered their protocol, and therefore we were unable to determine if the outcomes had changed after the results were analysed. We judged the remaining studies as having a low risk of bias: studies reported outcomes as stated in their protocol.

Other potential sources of bias

We did not judge any other sources of bias across the included studies.

Effects of interventions

See: **Summary of findings 1** CBT compared to TAU (post-treatment) for the management of chronic pain (excluding headache) in adults; **Summary of findings 2** CBT compared to TAU (at follow-up) for the management of chronic pain (excluding headache) in adults; **Summary of findings 3** CBT compared to active control (post-treatment) for the management of chronic pain (excluding headache) in adults; **Summary of findings 4** CBT compared to active control (at follow-up) for the management of chronic pain (excluding headache) in adults

Most of the evidence that we identified was for cognitive behavioural therapy (CBT). Thus, we created summary of findings tables only for comparisons of CBT with treatment as usual (TAU) or active control. See summary of findings tables, including certainty ratings and reasons for downgrading outcome evidence, for CBT versus TAU at post-treatment (Summary of findings 1), CBT versus TAU at follow-up (Summary of findings 2), CBT versus active control at post-treatment (Summary of findings 3), and CBT versus active control at follow-up (Summary of findings 4). For continuous outcomes, we were unable to translate effects into meaningful minimum important differences due to the lack of natural units and a variety of scales used for outcomes. Studies that used

therapies that we could not categorise as CBT or ACT are narratively described.

We outline the effects for psychological therapies (CBT, ACT, and positive psychology intervention) versus control type (TAU or active control) at post-treatment (end of treatment) and follow-up for primary outcomes pain intensity, functional disability, quality of life, and adverse events. Secondary outcomes included anxiety, depression, intervention satisfaction, intervention engagement, and attrition at follow-up. We have interpreted the size of standardised mean differences (SMDs) for continuous outcomes based on Cohen 1988: 0.2 represents a small effect, 0.5 represents a moderate effect, and 0.8 represents a large effect. Analyses where only one study could be included are not described in the text below, but data are included in the analysis section for the interested reader. However, for adverse events, intervention satisfaction, and intervention engagement outcomes, we have narratively described results where we are able to, as data for these outcomes are often described for only one group. We have included the certainty of the evidence for treatment effects below.

1. Cognitive behavioural therapy (CBT) versus treatment as usual (TAU)

Primary outcomes

Pain intensity

We included 20 randomised controlled trials (RCTs) measuring effects of treatment on pain intensity immediately after treatment. Treatments ranged in duration from three to 24 weeks. The evidence showed that CBT probably resulted in a small beneficial effect on reducing pain intensity compared with TAU (SMD -0.28, 95% CI -0.39 to -0.16; I^2 = 53%; 20 studies, 3206 participants; moderate-certainty evidence; Analysis 1.1).

At follow-up, ranging from 12 to 52 weeks, the evidence showed CBT likely had no difference of effect on pain intensity compared with TAU (SMD -0.04, 95% CI -0.17 to 0.09; I^2 = 0%; 8 studies, 959 participants; moderate-certainty evidence; Analysis 2.1).

Pain intensity (≥ 30% improvement)

We investigated the number of people achieving at least a 30% improvement in pain on the Brief Pain Inventory (BPI), the Wisconsin Brief Pain Questionnaire (WBPQ) average pain scales, or in mean pain score. Treatments ranged in duration from eight to24 weeks. The evidence showed that CBT likely resulted in a beneficial effect on the number of people achieving an improvement in pain intensity by 30% or more compared to TAU (absolute effect: 245 per 1000 (184 to 324) people in the CBT arm compared to 114 per 1000 people in the TAU arm; risk ratio (RR) 2.15, 95% CI 1.62 to 2.85; I^2 = 0%; 5 studies, 1347 participants; moderate-certainty evidence; Analysis 1.2; number needed to treat for an additional beneficial outcome (NNTB) = 8).

At follow-up, only one study with 69 participants could be included in the analysis, comparing CBT and TAU (RR 1.70, 95% CI 0.82 to 3.53; very low-certainty evidence; Analysis 2.2).

Pain intensity (≥ 50% improvement)

Based on four studies with treatments lasting eight weeks, the evidence showed that CBT may have resulted in a beneficial effect on the number of people achieving an improvement in pain intensity of 50% or more compared to TAU (absolute effect: 51 per 1000 (25 to 103) people in the CBT arm versus 22 per 1000 people in the TAU arm; RR 2.31, 95% CI 1.14 to 4.66; I^2 = 0%; 4 studies, 1229 participants; low-certainty evidence; Analysis 1.3; NNTB = 35).

We identified no evidence for this outcome at follow-up.

Functional disability

Evidence taken at the end of studies' treatment periods, which ranged in duration from three to 24 weeks, showed that CBT may have resulted in a small beneficial effect on reducing functional disability slightly compared to TAU (SMD -0.38, 95% CI -0.53 to -0.22; I^2 = 69%; 14 studies, 2672 participants; low-certainty evidence; Analysis 1.4).

At follow-up, ranging from 12 to 24 weeks, the evidence showed that CBT likely had no difference of effect on functional disability compared to TAU (SMD -0.05, 95% CI -0.23 to 0.14; I^2 = 0%; 3 studies, 461 participants; moderate-certainty evidence; Analysis 2.3).

Quality of life

At post-treatment, CBT delivered for the duration of eight to 12 weeks, may not have resulted in a beneficial effect on quality of life compared to TAU, but the evidence was very uncertain (SMD -0.16, 95% CI -0.43 to 0.11; I^2 = 81%; 7 studies, 1423 participants; very low-certainty evidence; Analysis 1.5).

Similarly, at follow-up, ranging from 24 to 52 weeks, the evidence showed that CBT likely resulted in little to no difference of effect on quality of life compared to TAU (SMD -0.16, 95% CI -0.37 to 0.05; I^2 = 0%; 3 studies, 352 participants; moderate-certainty evidence; Analysis 2.4).

Adverse events

At post-treatment, one study (140 participants) compared CBT with TAU, measuring the number of people experiencing adverse events (e.g. increased pain; RR 6.00, 95% CI 2.2 to 16.40; Analysis 1.6). The evidence was of very low certainty. More people in the CBT group reported experiencing adverse events compared to the TAU group.

No data were available for meta-analysis at follow-up.

Narrative description of adverse events in studies

At post-treatment, one study reported an overall assessment of negative effects of psychotherapy delivered over nine weeks (Baumeister 2021). In the CBT arm, there were 49 negative effects (104 participants) compared to 44 effects (105 participants) in the control arm. Burke 2019 reported two people who experienced minor adverse events; however, it was unclear which arm(s) the participants were in. In another study, participants in the CBT arm reported at least one negative event not related to training, and three participants suffered more from events since the start of the intervention (Schlicker 2020).

At the follow-up time point of 26 weeks, one study reported the number of adverse events per treatment arm. CBT resulted in relatively comparable numbers of adverse events to TAU (48 events in 104 participants versus 44 events in 105 participants, respectively) (Baumeister 2021).

Secondary outcomes

Anxiety

At post-treatment, the evidence showed that CBT probably resulted in a slight beneficial effect in reducing anxiety during treatments that lasted between six and 24 weeks compared to TAU (SMD -0.29, 95% CI -0.40 to -0.17; I^2 = 42%; 16 studies, 2686 participants; moderate-certainty evidence; Analysis 1.7).

At follow-up, ranging from 12 to 52 weeks, the evidence showed that CBT likely resulted in little to no difference of effect in reducing anxiety compared to TAU (SMD -0.16, 95% CI -0.33 to 0.00; I^2 = 0%; 5 studies, 565 participants; moderate-certainty evidence; Analysis 2.5).

Depression

At post-treatment, CBT, delivered for between six and 24 weeks, may have resulted in a small beneficial effect on reducing depression compared to TAU, but the evidence was very uncertain (SMD -0.42, 95% CI -0.58 to -0.26; I^2 = 75%; 19 studies, 3046 participants; very low-certainty evidence; Analysis 1.8).

At follow-up, ranging from 12 to 52 weeks, CBT may have resulted in little to no effect on reducing depression compared to TAU (SMD -0.16, 95% CI -0.35 to 0.04; I^2 = 44%; 7 studies, 853 participants; low-certainty evidence; Analysis 2.6).

Intervention satisfaction

One study reported intervention satisfaction post-treatment (Analysis 1.9). Participants in the CBT group were more satisfied than people in the control group (RR 1.25, 95% CI 1.04 to 1.51; very low-certainty evidence).

Narrative description of intervention satisfaction in studies

At post-treatment, nine studies reported the outcome for CBT (Dear 2013; Dear 2015; Dear 2021; Ferwerda 2017; Friesen 2017; Gasslander 2022; Guarino 2018; Schlicker 2020; Wilson 2015). After eight weeks of treatment, one study reported that the number of people who had a high level of satisfaction with the overall programme was 25/27 (92%) participants (Dear 2013). Three studies reported the number of people satisfied or very satisfied with the intervention (299/340 (88%) participants (Dear 2015); 55% very satisfied, 33% satisfied (of 290 participants) (Dear 2021); 19/22 (86%) participants (Friesen 2017)).

Five studies reported mean satisfaction using various scales (e.g. Client Satisfaction Scale (CSQ-8), IBM Computer Usability and Satisfaction Questionnaire, numerical rating scale (NRS), visual analogue scale (VAS)). For all scales, higher scores indicated better outcomes. Schlicker 2020 reported a mean satisfaction score of 24.53 (standard deviation (SD) 5.2) (CSQ-8; range 8 to 32 (minimum = 10, maximum = 32); post-treatment (nine-week treatment, 40 participants)). Wilson 2015 reported a mean satisfaction score of 5.17 (SD 1.22) on the IBM computer usability and satisfaction questionnaire based on overall satisfaction with how easy it was to use the programme, the amount of time it took to complete the programme, and the amount of support available to complete the programme (scale 1 = strongly disagree to 7 = strongly agree); eight-week treatment duration; CBT arm (65 participants). Both Ferwerda 2017 and Gasslander 2022 measured overall satisfaction using a numerical rating scale. The mean NRS score was 2.45 (SD 1.05) at post-treatment (NRS scale 0 to 4, where 0 = not helpful at all and 4 = very helpful; 40 participants; 12-week treatment; Gasslander 2022) and mean 7.44 (SD 1.71) at follow-up (assessed at 24 weeks; NRS scale 1 to 10; 44 participants; Ferwerda 2017). Guarino 2018 reported a mean overall satisfaction of 8 (VAS score range 0 to 10; 55 participants) after a 12-week intervention.

At follow-up, one study reported intervention satisfaction (Schlicker 2020), with 26/29 (89%) participants satisfied with the CBT intervention.

Intervention engagement

At post-treatment, 11 studies reported intervention engagement. We could not conduct a meta-analysis due to insufficient data, so we have described the information narratively. Of the 11 studies, two reported the number of people logging on to the intervention website or number of times logging on (Carpenter 2012; Friesen 2017). In Carpenter 2012, 81% completed all chapters of the three-week CBT intervention (114/141). The mean number of times logging on over eight weeks was 23.43 (SD 13.65) amongst 30 participants (Friesen 2017). Seven studies reported CBT module or lesson completion over eight to 17 weeks (Dear 2013; Dear 2015; Dear 2021; Gasslander 2022; Guarino 2018; Schlicker 2020; Smith 2019). The percentage of people completing all lessons in the CBT arm ranged from 50% to 90% (Dear 2013; Dear 2021; Gasslander 2022; Guarino 2018; Schlicker 2020; Smith 2019). Wilson 2015 reported that 12/45 (26%) participants in the CBT arm were engaged in all four learning modules after the eight weeks of treatment. In one study (Williams 2010), the mean number of skills used per month as a result of engagement was reported as 4.2 across all modules, with the first module being used each month by 89% to 94% of participants at the 24-week assessment point (Williams 2010).

Attrition

For this comparison, 22 studies reported attrition in both CBT and control arms (Baumeister 2021; Buhrman 2004; Buhrman 2011; Burke 2019; Carpenter 2012; Dear 2013; Dear 2015; Dear 2021; Ferwerda 2017; Friesen 2017; Gasslander 2022; Guarino 2018; Hedman-Lagerlöf 2018; Peters 2017; Rini 2015; Ruehlman 2012; Schlicker 2020; Serrat 2021; Smith 2019; Vallejo 2015; Williams 2010; Wilson 2015). Attrition from randomisation to post-treatment in the CBT arm ranged from 0% (Hedman-Lagerlöf 2018; Vallejo 2015) to 45% (Serrat 2021). Thirteen studies reported less than 20% attrition in the CBT arm (Buhrman 2004; Buhrman 2011; Burke 2019; Carpenter 2012; Dear 2013; Dear 2015; Dear 2021; Friesen 2017; Guarino 2018; Hedman-Lagerlöf 2018; Rini 2015; Vallejo 2015; Williams 2010), and nine studies reported more than 20% attrition (Baumeister 2021; Ferwerda 2017; Gasslander 2022; Peters 2017; Ruehlman 2012; Schlicker 2020; Serrat 2021; Smith 2019; Wilson 2015).

In the control arm (TAU, waiting-list (WL), or TAU+WL), attrition from randomisation to post-treatment ranged from 0% (Buhrman 2004; Hedman-Lagerlöf 2018; Vallejo 2015) to 30% (Gasslander 2022). Eighteen studies reported less than 20% attrition in the control arm (Buhrman 2004; Buhrman 2011; Burke 2019; Carpenter 2012; Dear 2013; Dear 2015; Dear 2021; Ferwerda 2017; Friesen 2017; Guarino 2018; Hedman-Lagerlöf 2018; Peters 2017; Rini 2015; Schlicker 2020; Serrat 2021; Vallejo 2015; Williams 2010; Wilson 2015), with four studies reporting more than 20% attrition (Baumeister 2021; Gasslander 2022; Ruehlman 2012; Smith 2019).

2. CBT versus active control

All analyses below relate to studies delivering interventions over eight weeks unless otherwise specified.

Primary outcomes

Pain intensity

At post-treatment, the evidence showed that CBT likely resulted in a slightly beneficial effect on reducing pain intensity at compared to active control (SMD -0.28, 95% CI -0.52 to -0.04; I^2 = 0%; 3 studies, 261 participants; moderate-certainty evidence; Analysis 3.1).

At follow-up, we found only one study with 127 participants, which provided very low-certainty evidence (MD 0.50, 95% CI -0.30 to 1.30; very low-certainty evidence; Analysis 4.1).

No evidence was available for 30% or 50% pain intensity improvement.

Functional disability

At post-treatment, CBT may have resulted in little to no difference of effect on functional disability compared to active control (SMD -0.26, 95% CI -0.55 to 0.02; I^2 = 0%; 2 studies, 189 participants; low-certainty evidence; Analysis 3.2).

At follow-up, only one study with 127 participants could be included; the evidence was of very low certainty (MD 3.40, 95% CI -1.15 to 7.95; very low-certainty evidence; Analysis 4.2).

Quality of life

At post-treatment, the evidence showed that CBT likely resulted in little to no difference of effect on quality of life compared to active control (SMD -0.22, 95% CI -1.11 to 0.66; I^2 = 91%; 3 studies, 261 participants; moderate-certainty evidence; Analysis 3.3).

At follow-up, only one study with 127 participants could be included; the evidence was of very low certainty (MD 0.00, 95% CI -0.60 to 0.60; very low-certainty evidence; Analysis 4.3).

Adverse events

At post-treatment, one study with 135 participants showed one person in the CBT group reported an adverse event compared to no one in the active control group (RR 3.23, 95% CI 0.13 to 77.84; very-low certainty evidence; Analysis 3.4).

We identified no evidence at follow-up for this outcome.

Secondary outcomes

Anxiety

At post-treatment, CBT may have had little to no difference of effect on anxiety compared to active control, but the evidence was very uncertain (SMD -0.20, 95% CI -0.53 to 0.14; I^2 = 43%; 3 studies, 261 participants; very-low-certainty evidence; Analysis 3.5).

At follow-up, only one study with 127 participants could be included; the evidence was of very low certainty (MD -0.30, 95% CI -1.38 to 0.78; very low-certainty evidence; Analysis 4.4).

Depression

At post-treatment, the evidence showed that CBT may have resulted in little to no difference of effect on depression compared to active control (SMD -0.12, 95% CI -0.38 to 0.14; I^2 = 9%; 3 studies, 261 participants; low-certainty evidence; Analysis 3.6).

At follow-up, only one study with 127 participants could be included; the evidence was of very low certainty (MD 0.10, 95% CI -1.31 to 1.51; very low-certainty evidence; Analysis 4.5).

Intervention satisfaction

We identified no evidence at post-treatment or follow-up for this outcome.

Intervention engagement

One study reported that 28 participants completed a mean number of six treatment sections of CBT (SD 2.86) during an eight-week intervention (Buhrman 2015).

We identified no evidence at follow-up for this outcome.

Attrition

For this comparison, three studies reported attrition for both CBT and active control arms (Bennell 2018; Buhrman 2013a; Buhrman 2015). In the CBT arm, attrition rates were 8% (Bennell 2018), 18% (Buhrman 2015), and 27% (Buhrman 2013a). In the control arm, attrition ranged from 1% (Bennell 2018) to 16% (Buhrman 2013a; Buhrman 2015).

3. Acceptance and commitment therapy (ACT) versus treatment as usual (TAU)

Primary outcomes

Pain intensity

At post-treatment, ACT may not have resulted in a beneficial effect on reducing pain intensity during treatment lasting six to 12 weeks compared to TAU, but the evidence was very uncertain (SMD -0.38, 95% CI -0.82 to 0.05; I^2 = 78%; 4 studies, 524 participants; Analysis 5.1).

At follow-up, ranging from 20 to 36 weeks, the evidence showed that ACT may have resulted in little to no difference of effect on pain intensity compared to TAU (SMD -0.18, 95% CI -0.38 to 0.02; I^2 = 0%; 3 studies, 412 participants; low-certainty evidence; Analysis 6.1).

One additional study assessed pain during intercourse in participants with vestibulodynia and found beneficial effects at reducing pain in favour of ACT compared to TAU. We did not include this study in Analysis 5.1 and Analysis 6.1 due to the specific nature of assessing pain during one activity.

Pain intensity (≥ 30% improvement)

At post-treatment, only one study with 113 participants could be included; the evidence was of very low certainty (RR 2.05, 95% CI 1.14 to 3.66; very low-certainty evidence; Analysis 5.2).

We identified no evidence for this outcome at follow-up.

Pain intensity (≥ 50% improvement)

At post-treatment, only one study with 113 participants could be included; the evidence was of very low certainty (RR 2.07, 95% CI 1.03 to 4.19; very low-certainty evidence; Analysis 5.3).

We identified no evidence for this outcome at follow-up.

Functional disability

At post-treatment, ACT may have had little to no effect on functional disability during treatments lasting nine to 12 weeks compared to TAU, but the evidence was very uncertain (SMD -0.16, 95% CI -0.52 to 0.21; I^2 = 40%; 2 studies, 350 participants; very-low-certainty evidence; Analysis 5.4).

At follow-up, ranging from 24 to 36 weeks, ACT may have resulted in little to no difference of effect on functional capacity compared to TAU, but the evidence was very uncertain (SMD -0.25, 95% CI -0.55 to 0.05; I^2 = 23%; 2 studies, 351 participants; very-low-certainty evidence; Analysis 6.2).

Quality of life

At post-treatment, only one study with 113 participants could be included; the evidence was of very low certainty (MD 0.12, 95% CI 0.00 to 0.23; very low-certainty evidence; Analysis 5.5).

Narrative description of quality of life in studies

At post-treatment, one study reported the numbers needed to treat (NNT) for 30% and 50% improvement in quality of life on the EuroQoL 5-dimension (EQ-5D) questionnaire after an eight-week treatment duration. At eight weeks, the NNT for 30% improvement was 30.1, and 63.8 for 50% improvement (Rickardsson 2021).

At follow-up, evidence from one study (302 participants) showed that ACT may have little to no difference of effect on quality of life compared to TAU. The evidence is very uncertain (Analysis 6.3).

Adverse events

At post-treatment, evidence from one study (113 participants) showed no serious adverse events (e.g. suicide) were reported in the ACT or TAU arms after an eight-week treatment duration (meta-analysis could not estimate risk ratio; very low-certainty evidence; Analysis 5.6).

Narrative description of adverse events in studies

After a 12-week treatment duration, one study reported no adverse events in the ACT or TAU arms to a therapist (Scott 2018).

We identified no evidence at follow-up for this outcome.

Secondary outcomes

Anxiety

At post-treatment, the evidence showed that ACT delivered for eight or nine weeks, may have resulted in a slight beneficial effect on reducing anxiety compared to TAU (SMD -0.44, 95% -0.65 to -0.24; I^2 = 0%; 2 studies, 415 participants; low-certainty evidence; Analysis 5.7).

Narrative description of anxiety in studies

At post-treatment, one study reported NNT for 30% improvement in anxiety on the Generalised Anxiety Disorder (GAD-7) scale. The NNT at eight weeks was 20.6 (Rickardsson 2021).

At follow-up, only one study with 302 participants could be included; the evidence was of very low certainty (MD -1.47, 95% CI -2.57 to -0.37; very low-certainty evidence; Analysis 6.4).

Depression

At post-treatment, the evidence showed that ACT likely resulted in a slight beneficial effect on reducing depression after treatment lasting eight to 12 weeks compared to TAU (SMD -0.48, 95% CI -0.68 to -0.28; I^2 = 10%; 4 studies, 524 participants; moderate-certainty evidence; Analysis 5.8).

Narrative description of depression in studies

At post-treatment, one study reported NNT for 30% and 50% improvement in depression on the Patient Health Questionnaire (PHQ-9) scale. The NNT after treatment lasting eight weeks was 7.3 and 11.6 for 30% and 50% improvement in depression, respectively (Rickardsson 2021).

At follow-up, ranging from 21 to 36 weeks, the evidence from three studies (412 participants) showed that ACT likely resulted in a slight beneficial effect on reducing depression (SMD -0.42, 95% CI -0.62 to -0.21; I^2 = 0%; 3 studies, 412 participants; moderate-certainty evidence; Analysis 6.5).

Intervention satisfaction

One study reported this outcome for both ACT and TAU arms on a validated measure of treatment credibility (Scott 2018). After 12 weeks' treatment duration, the median satisfaction was 38 (range 10 to 47) in the ACT arm (23 participants) compared to median 31 (range 0 to 46) in the control arm (25 participants). Moreover, 65.2% to 91% in the ACT arm scored 5 and above on all 15 treatment satisfaction items compared to 40% to 76% in the TAU arm (Scott 2018).

We identified no evidence at follow-up for this outcome.

Intervention engagement

Two studies reported this outcome (Scott 2018; Simister 2018). Scott 2018 reported a mean number of 6.9 (SD 3.49) sessions completed (by 23 participants completing at least seven of 10 sessions) after a 12-week treatment period. Simister 2018 reported the percentage of participants submitting optional unit assignments, with 100% participants logging onto the online ACT programme during the treatment period. More than 60% practised treatment components regularly (> 60% practised ACT components once daily, more than 80% practised more than once a week). In the control group, 35% logged on to access the treatment materials (Simister 2018).

We identified no evidence at follow-up for this outcome.

Attrition

For this comparison, three studies reported attrition in both ACT and TAU arms (Hess Engström 2022; Scott 2018; Simister 2018). In the ACT arm, attrition rates were 18% (Simister 2018), 26% (Scott 2018), and 38% (Hess Engström 2022). In the TAU arm, attrition rates were 9% (Simister 2018), 21% (Hess Engström 2022), and 22% (Scott 2018).

4. ACT versus active control

Primary outcomes

Pain intensity

One study with 74 participants had post-treatment evidence available; the evidence was of very low certainty (MD 0.01, 95% CI -0.45 to 0.47; very low-certainty evidence; Analysis 7.1).

No data were available at follow-up, and therefore we are uncertain of the effects of ACT versus active control for pain intensity.

Functional disability

We identified no evidence at post-treatment or follow-up time points for this outcome.

Quality of life

At post-treatment, ACT may have had little to no effect on quality of life after treatment lasting six to seven weeks compared to active control, but the evidence was very uncertain (SMD 0.36, 95% CI -0.23 to 0.95; $I^2 = 62\%$; 2 studies, 126 participants; very low-certainty evidence; Analysis 7.2).

At follow-up, only one study with 50 participants could be included; the evidence was of very low certainty (MD 0.04, 95% CI -0.07 to 0.15; very low-certainty evidence; Analysis 8.1).

Adverse events

We identified no evidence at post-treatment or follow-up time points for this outcome.

Secondary outcomes

Anxiety

One study with 74 participants had post-treatment evidence available; the evidence was of very low certainty (MD -0.70, 95% CI -2.47 to 1.07; very low-certainty evidence; Analysis 7.3).

No data were available at follow-up. Overall, we are uncertain of the effects of ACT versus active control for anxiety.

Depression

One study with 74 participants had post-treatment evidence available; the evidence was of very low certainty (MD 1.67, 95% CI -3.51 to 0.17; very low-certainty evidence; Analysis 7.4)

No data were available at follow-up. Overall, we are uncertain of the effects of ACT versus active control for depression.

Intervention satisfaction

We identified no evidence at post-treatment or follow-up time points for this outcome.

Intervention engagement

We identified no evidence at post-treatment or follow-up time points for this outcome.

Attrition

For this comparison, two studies reported attrition in both ACT and active control arms (Buhrman 2013b; Morcillo-Muñoz 2022). Buhrman 2013b reported 24% attrition and Morcillo-Muñoz 2022 reported 28% in the ACT arm. In the active control arm, Buhrman 2013b reported 16% attrition whereas Morcillo-Muñoz 2022 reported 8% attrition.

5. Other comparisons: positive psychology intervention versus TAU

At post-treatment, one study (126 participants) reported results for pain intensity, functional disability, anxiety, and depression after an eight-week positive psychology intervention (PPI) compared to TAU (Peters 2017). On all measures, lower scores indicated improvement of outcomes.

At post-treatment, the mean pain intensity score (as measured by a numerical rating scale (NRS)) was 6.12 (SD 2.04) in the PPI arm compared to 6.2 (SD 1.99) for participants in the TAU arm.

At post-treatment, the mean functional disability score (as measured by the Fibromyalgia Impact Scale-physical impairment) in the PPI arm was 18.76 (SD 5.96) compared to a mean score of 20.63 (SD 5.86) in the TAU arm (Peters 2017).

At post-treatment, the mean anxiety score (Hospital Anxiety and Depression Scale-Anxiety (HADS-A)) was lower in the PPI arm (5.93 (SD 4.42)) compared to the TAU arm (7.27 (SD 3.58)) (Peters 2017). Similarly, results for depression (HADS-Depression scale) indicated a lower mean score for the PPI arm (5.25 (SD 3.77)) compared to the TAU arm (7.73 (SD 3.27)) (Peters 2017).

The study did not include comparison of the intervention versus TAU at follow-up.

6. Subgroup analyses and sensitivity analyses: CBT versus TAU, post-treatment

We conducted subgroup analyses and sensitivity analyses for pain intensity and functional disability at post-treatment for the CBT versus TAU comparison as there were sufficient studies for both outcomes. For the follow-up time point, we did not conduct subgroup analyses due to insufficient studies, nor did we conduct sensitivity analyses due to 0% heterogeneity in the primary analyses.

Subgroup analysis: computer versus smartphone application

For both pain intensity and functional disability, we did not conduct a subgroup analysis because the majority of the CBT interventions were delivered via computer.

Subgroup analysis: no therapist versus therapist involvement

Pain intensity

At post-treatment, we conducted subgroup analyses to investigate heterogeneity, firstly by exploring differences between CBT interventions with no therapist or therapist involvement, where 'therapist' refers to any professional providing therapeutic contact (Analysis 9.1). The subgroup analysis showed 0% heterogeneity amongst CBT interventions without therapist involvement, whereas considerable heterogeneity remained in CBT interventions delivered with less than 30% therapist involvement.

No significant subgroup effect was detected (test for subgroup differences: $Chi^2 = 0.43$, degrees of freedom (df) = 1 (P = 0.51); Analysis 9.1). This means that involvement or no involvement of a therapist did not modify treatment effect, and could have resulted for a number of reasons. The effect estimate of both subgroups

favoured the CBT intervention (No therapist: SMD -0.20, 95% CI -0.33 to -0.07; 6 studies, 898 participants; therapist involvement: SMD -0.27, 95% CI -0.44 to -0.11; 14 studies, 1985 participants). The number of participants in each subgroup was disproportionate, with 898 participants in the 'no therapist involvement' subgroup, and 1985 in the 'therapist involvement' subgroup. There were also unequal numbers of studies in each of the subgroups (six 'no therapist involvement' studies versus 14 'therapist involvement' studies). The considerable unexplained heterogeneity observed in the therapist involvement subgroup requires further exploration. It is possible that variation in involvement of therapist contributed to heterogeneity, but we cannot be certain (Table 1). It is also possible that other factors may have contributed, such as the control group type (e.g. waiting list but also receiving TAU), which could have included some psychotherapeutic content that was not reported in studies. We did not seek this information; therefore, we cannot be certain that it is a contributing factor in this subgroup. Confounding factors, such as type of chronic pain amongst studies, could result in differences of effect estimates amongst the studies as some studies included participant with chronic back pain, mixed chronic pain, or rheumatoid arthritis. However, we did not investigate this possibility further. The validity of the treatment effect estimate for this subgroup is uncertain, as individual trial results are inconsistent.

Functional disability

At post-treatment, we conducted subgroup analyses to investigate heterogeneity due to no therapist or therapist involvement. No subgroup effect was detected (test for subgroup differences: Chi^2 = 0.03, df = 1 (P = 0.86); Analysis 9.2), and involvement or no involvement of a therapist in the subgroup analysis did not modify treatment effect. There was substantial heterogeneity within each subgroup, indicating an I^2 of 72% heterogeneity amongst CBT interventions with no therapist involvement, and 67% heterogeneity amongst CBT interventions with therapist involvement, respectively (Analysis 9.2). The effect estimate of both subgroups favoured the CBT intervention compared to TAU (no therapist: SMD -0.35, 95% CI -0.60 to -0.10; 5 studies, 788 participants; therapist involvement: SMD -0.38, 95% CI -0.60 to -0.16; 9 studies, 1561 participants), but there were discrepancies in the number of participants and studies in each subgroup. The 'no therapist involvement' subgroup included 788 participants from five studies, whereas the 'therapist involvement' subgroup included 1561 participants from nine studies. The validity of the treatment effect estimate for each subgroup is uncertain, as individual trial results are inconsistent.

Sensitivity analysis: trials with fewer than 50 versus more than 50 participants per arm

Pain intensity

At post-treatment, there was heterogeneity in the mean effects in the groups including trials with fewer than 50 participants (I^2 = 69%) and those with more than 50 participants (I^2 = 43%) per arm (Analysis 9.3). The effect estimate for the subgroup with fewer than 50 participants per arm did not favour CBT compared to TAU (SMD -0.30, 95% CI -0.64 to 0.04; 7 studies, 448 participants); however, the effect estimate for the subgroup with more than 50 participants per arm did favour CBT compared to TAU (SMD -0.27, 95% CI -0.38 to -0.16; 13 studies, 2758 participants). Differences amongst the two groups may be due to a number of reasons, including variation of the contents of the CBT interventions and TAU, duration of CBT and the scales used to measure pain intensity, or narrower confidence intervals due to the larger sample size in the 'more than 50 participants per arm' group. Larger samples have been shown to provide more reliable effects in systematic reviews (Dechartres 2013).

Functional disability

At post-treatment, we conducted a sensitivity analysis to investigate whether heterogeneity was related to the number of participants. We separated studies with fewer than 50 participants per arm from those with more than 50 per arm (Analysis 9.4), which resulted in I^2 values of 66% and 74% in the 'fewer than 50 participants' group and the 'more than 50 participants' group, respectively. The effect estimate for the subgroup with fewer than 50 participants per arm favoured CBT compared to TAU (SMD -0.36, 95% CI -0.70 to -0.02; 5 studies, 429 participants) and the effect estimate for the subgroup with more than 50 participants per arm favoured CBT compared to TAU (SMD -0.39, 95% CI -0.57 to -0.20; 9 studies, 2243 participants). The variation observed was not driven by the number of participants in each arm of the studies included in the analysis (Analysis 9.4).

Sensitivity analysis: studies at low risk of bias across all domains

Pain intensity

At post-treatment, we conducted a sensitivity analysis in which we removed studies that were at high or unclear risk of bias, leaving three studies that were at low risk across all domains (Analysis 9.5). The I^2 statistic for heterogeneity was reduced from 53% in the overall analysis to 0% with only the 'low risk of bias' studies remaining. Risk of bias assessments showed that most of the studies at unclear risk of bias had unclear randomisation methods (including allocation concealment) and outcome assessment. Domains at high risk of bias were due to outcome assessment, and issues with selective reporting. The effect estimate for both subgroups favoured CBT compared to TAU (low risk of bias: SMD -0.30, 95% CI -0.42 to -0.19; 3 studies, 1339 participants; high or unclear risk of bias: SMD -0.27, 95% CI -0.42 to -0.12; 17 studies, 1867 participants).

Functional disability

At post-treatment, we investigated whether risk of bias had any impact on the variation observed (Analysis 9.6). Only two studies were at low risk of bias across all domains (Dear 2015; Dear 2021), with minimal heterogeneity (I^2 = 23%) whereas the remaining studies were judged as having an unclear or high risk of bias across all domains, resulting in considerable variation in effects (I^2 = 72%). The effect estimates for both subgroups favoured CBT compared to TAU (low risk of bias: SMD -0.40, 95% CI -0.56 to -0.24; 2 studies, 1130 participants; high or unclear risk of bias: SMD -0.37, 95% CI -0.57 to -0.17; 12 studies, 1542 participants). We investigated the high heterogeneity amongst studies with high or unclear risk of bias further by eliminating studies that showed no difference in effect between CBT and TAU (Friesen 2017; Gasslander 2022; Ruehlman 2012; Schlicker 2020; Serrat 2021; Williams 2010), which reduced the I^2 value to 0% (Analysis 9.7). The six studies eliminated were at a high or unclear risk of bias for selective reporting (e.g. retrospective registration, outcomes reported in registries but not in publications, missing outcome measures, or lack of trial registry information and published protocols) which could have

contributed to the variation observed in the analysis. However, the effect estimate for the analysis favoured CBT compared to TAU (SMD -0.66, 95% CI -0.82 to -0.50; 6 studies, 647 participants).

DISCUSSION

Summary of main results

We identified 32 studies, involving 4924 participants, that evaluated remotely-delivered psychological interventions for adults with chronic pain. Participant samples had a range of pain conditions (often mixed), such as fibromyalgia, musculoskeletal pain, back pain, osteoarthritis, rheumatoid arthritis, vestibulodynia, and spinal cord injury. There were substantially more female (n = 3725) than male (n = 1048) participants. CBT was the most frequently delivered therapeutic approach, with 27 trials. Additionally, we found seven ACT interventions and one positive psychology intervention.

We found evidence that, compared to TAU, remotely-delivered CBT likely results in a slight reduction in pain intensity and functional disability. These effects were not maintained at follow-up. We did not find evidence of benefit of CBT over TAU in terms of quality of life; however, there were fewer studies from which to draw conclusions, and post-treatment evidence was of very low certainty. We found evidence that CBT over active control likely slightly reduces pain intensity at post-treatment, but there was insufficient evidence to conduct a meta-analysis at follow-up. We found no benefit of CBT over active control for any of the other primary outcomes. However, we are cautious in our conclusions, given that only three studies included an active control. Overall, when measured as a continuous variable, we judged the pain intensity evidence to be of moderate certainty when compared with both TAU and active control at post-treatment and follow-up (except for active control follow-up, which was of very low certainty). We judged the other primary outcome evidence as mostly low or very low certainty at post-treatment; and a mix of moderate and very low certainty at follow-up, with a TAU or active control comparison, respectively.

We found no benefits of ACT over TAU or active control for any primary outcomes. We judged this evidence to be of low and very low certainty.

The evidence pertaining to adverse events was of very low certainty. This evidence could not be statistically synthesised, and we are cautious about interpreting the related statistics, which present a mixed picture. Through narrative synthesis, we did not find a compelling demonstration of increased risk of adverse events in intervention compared to control groups. However, overall, it is not possible to conclude from these limited data whether remotely-delivered therapies may inadvertently result in unintended harm. These findings demonstrate the need for studies to assess adverse events more routinely.

For secondary outcomes, remotely-delivered CBT and ACT may have beneficial effects for anxiety and depression levels over TAU but not active control. Our narrative synthesis suggested that remote therapies appeared satisfactory to participants. Intervention engagement was difficult to judge due to a lack of standardised conception and assessment approaches. Attrition varied across the trials. Whilst there were some instances of moderate-certainty evidence, most secondary outcome evidence was of low to very low certainty.

We identified only one trial investigating an intervention that was not based on cognitive behavioural principles (Peters 2017). Consequently, there was insufficient evidence to analyse the effects of remote delivery of other therapeutic approaches.

Due to the number of available trials, we were only able to conduct subgroup and sensitivity analyses for remotely-delivered CBT versus TAU at post-treatment for the primary outcomes of pain intensity and functional disability. Subgroup analysis demonstrated that small beneficial intervention effects for pain and functional disability were maintained irrespective of therapist involvement. Technology delivery modality was near-exclusively Internet-based, which prohibited our intended subgroup analysis of delivery method. Sensitivity analyses demonstrated consistent small beneficial effect for remotely-delivered CBT: 1) when accounting for risk of bias; and 2) when accounting for sample size across trial arms (with narrower confidence intervals for > 50 participants per arm).

Overall, we judged few trials to have a consistently low risk of bias across all assessed domains (n = 4). However, trials typically included several domains we judged to be at low risk of bias, and only thirteen trials included any domain we judged to be at high risk. We identified selective reporting as the most commonly problematic domain; prospective trial registration without outcome amendment by the time of publication was uncommon (n = 7).

Overall completeness and applicability of evidence

Participants had a range of pain conditions and samples often included mixed difficulties. Trials included adults with an average age and standard deviation (mean = 48.00; SD = 10.77) comparable to those in face-to-face therapy trials (Williams 2020). Interventions were remotely delivered in everyday settings; we confirmed with study authors that trials involved 30% or less of clinician contact time. We encountered similar limitations to the completeness of evidence as Williams 2020, including limited evidence for psychological therapies other than CBT, fewer data at follow-up, and limited data of adverse events.

The available trials did not comprise a broad range of delivery technologies. Internet-based interventions dominated. Whilst this is a narrow representation of delivery modalities, it is consistent with the pervasiveness of the Internet (International Telecommunication Union 2021), and thus relevant to our focus on scalable interventions.

As found in related reviews (Fisher 2019; Williams 2020), interventions were predominantly CBT-based. We found only seven trials for ACT interventions, despite this approach featuring alongside CBT in clinician guidelines on psychological therapies for chronic pain (NICE 2021). Non-cognitive and behavioural therapies were limited to one positive psychology intervention. Consequently, it is not possible to draw conclusions about whether all psychological therapies can be successfully delivered remotely. Additionally, the included trials primarily compared interventions with TAU. Consequently, we know less about intervention effects relative to active control.

Our evaluation of long-term outcomes was limited by follow-up data being less frequently assessed than post-treatment data. Furthermore, adverse events were not routinely assessed and there was no standardised metric for this outcome. These issues limited our capacity to appraise the longevity of effects and potential harm associated with remotely-delivered psychological therapies. We encountered similar issues for the secondary outcomes of intervention satisfaction and engagement.

Finally, we systematically evaluated studies that were published in peer-reviewed scientific journals. This approach is consistent with the Cochrane Review investigating face-to-face therapies (Williams 2020), and allows for direct comparisons between the reviews. However, we acknowledge the restriction as a limitation.

Certainty of the evidence

The certainty of the evidence ranged from moderate to very low, and indicated limitations due to study quality, inconsistency, or imprecision. For all CBT comparisons (i.e. with TAU or active control) at post-treatment and follow-up, we judged pain intensity evidence as moderate certainty, except for CBT versus active control at follow-up, which we rated as very low-certainty evidence. Functional disability judgements ranged from moderate to very low certainty for both CBT versus TAU and active control comparisons (post-treatment and follow-up). We judged quality of life evidence as moderate to very low certainty for CBT versus TAU, and moderate to very low for comparison with active control at post-treatment and follow-up time points, respectively. We rated adverse events as very low certainty overall.

For ACT comparisons with TAU, we rated pain intensity evidence as low to very low certainty at post-treatment and follow-up. For ACT versus active control, we rated evidence as very low certainty at post-treatment for pain intensity. There was no available evidence at follow-up for pain intensity. Evidence for functional disability was only available for ACT versus TAU, and we rated it as very low certainty at both post-treatment and follow-up time points. We rated evidence for quality of life as very low certainty at post-treatment and follow-up time points, for both ACT versus TAU and ACT versus active control. We found very low-certainty evidence for adverse events from ACT versus TAU at post-treatment. As there were fewer heterogeneous studies that contributed to the certainty of outcomes for ACT comparisons, further research is likely to impact on the very uncertain ratings about clinical effectiveness of outcomes for chronic pain.

Potential biases in the review process

To minimise bias, two review authors worked independently at screening and extraction stages of the review. A third author reviewed and resolved all discrepancies to further reduce the risk of individual author bias. None of these review authors were directly involved in any of the included trials.

To mitigate the possibility of trial omissions, we searched multiple databases, trial registries, reference lists, and citations. We excluded conference abstracts because they include insufficient information to assess risk of bias and extract data, and grey literature because it is of lower quality. We implemented these methodological choices to help maintain a minimum level of quality in the included trials; however, we acknowledge that the potential omission of trials as a result may be considered a source of bias. Discrepancies between the trials included in our review and in a recent associated meta-analysis by Gandy and colleagues relate to differences in eligibility criteria (Gandy 2022). To enhance accuracy, we identified two eligibility criteria (i.e. clinician contact time; qualified psychologist involvement) as most vulnerable to subjective interpretation from our team. Consequently, we contacted authors of all included trials to confirm these criteria were met. We acknowledge that this methodology relies on the accuracy and veracity of study authors' evaluations with regard to these criteria. However, we considered the criteria to be concretely defined and these authors to be the most informed party to comment on their fulfilment. We also only included studies involving 20 or more participants in each arm, similar to Williams 2020. Smaller trials are published in the literature, but not included here. The exclusion of these trials can be considered a limitation of the review. However, we took this approach in recognition of the increased risk of bias associated with small sample sizes even when pooled in meta-analyses (Lin 2018).

We did not encounter missing data; however, we did correspond with authors from two trials to clarify that our interpretation of their published data was correct.

To avoid duplication of effects within our results, we only included measures of functional disability that were discrete from assessment of psychological and emotional difficulties. We excluded data that did not permit such distinction. We chose to exclude these data to improve the homogeneity of the pooled data types and the reliability of the analyses.

We chose to exclude mindfulness-only interventions. Whilst we acknowledge the potential therapeutic utility of mindfulness (Hilton 2017), we considered its inclusion as sole psychological intervention as problematic, given that the practise originates outside the field of psychology. Consequently, this exclusion improved homogeneity and confidence in the grouping of interventions under the label of 'psychological therapies'.

We elected to define therapist versus no therapist involvement stringently for the purposes of our subgroup analyses. Consequently, we classified two studies where there was potential therapist contact as part of safeguarding measures in the intervention arms as 'therapist involvement' studies, despite such involvement being minimal (Dear 2015; Smith 2019). We made this choice because the primary purpose of the subgroup analysis was to determine the effect associated with an intervention whose delivery was entirely independent of therapist involvement and thus has the greatest potential for scalability.

We did not assess performance risk of bias for the category 'blinding of participants and personnel' for this review. Performance bias assessment usually provides meaningful insight under many circumstances; however, the nature of psychological therapies entails that it is largely infeasible for those delivering and receiving therapy to be completely blind to the therapy. Consequently, the risk of bias rating for this domain would relate more to the use of psychological interventions than assessment of methodological rigour. Therefore, we omitted this criterion. This choice is consistent with related reviews in this field (e.g. Fisher 2018; Fisher 2019; Williams 2020).

We have comprehensively detailed and explained all alterations to our protocol for transparency (see Differences between protocol

and review). These alterations were superficial and predominantly made to increase the specificity of review procedures (e.g. exclusion of mindfulness-only interventions) and to reduce potential bias (e.g. increased involvement of third review author during screening and extraction).

Agreements and disagreements with other studies or reviews

Our review findings appear aligned with a number of related Cochrane Reviews. First, the post-treatment effects for remotely-delivered psychological therapies appear largely comparable to those found in face-to-face delivery (Williams 2020). Post-treatment, we similarly found small benefits of CBT compared to TAU for pain intensity (moderate-certainty evidence) and disability (low-certainty evidence), as well as very low-certainty evidence regarding adverse events. Regarding CBT versus active control, we also similarly found moderate-certainty evidence of small benefits of CBT for pain intensity post-treatment (although we note that these benefits were smaller, and the number of studies contributing to the analysis larger, in Williams 2020) and very low-certainty evidence for adverse effects. We did not replicate their finding of benefits for functional disability post-treatment but note that the evidence for this outcome was of very low certainty in our review compared to moderate-certainty evidence in Williams 2020. Finally, in contrast to Williams 2020, we did not find evidence that the benefits of CBT over TAU for pain intensity and functional disability were maintained at follow-up; however, we included notably fewer trials in our review. Second, the results pertaining to pain, disability, anxiety, and depression are consistent with our previous review of Internet-delivered interventions (Eccleston 2014). The proliferation of research on Internet-based psychological interventions is illustrated in the previous review's identification of 11 studies focused on non-headache conditions compared to the 31 online interventions identified in this review. Finally, although the beneficial effects of remotely-delivered psychological therapies found here in adults with chronic pain (excluding headache) have not been observed in children and adolescents (Fisher 2019), this discrepancy may reflect the limited quantity and quality of evidence currently available within younger populations.

Previous non-Cochrane reviews have favourably appraised the benefits of Internet-based psychological interventions, both narratively (Bender 2011) and analytically (Buhrman 2016). The positive evaluation and evidence of small beneficial effects appears to have persisted as the available evidence has grown. Most recently, meta-analysis of the efficacy of Internet-delivered cognitive and behavioural interventions for chronic pain (including Cochrane risk of bias assessment) demonstrated consistency both with the conclusions of previous reviews and our findings (Gandy 2022). Gandy and colleagues found 36 studies (all of which were either included or screened for inclusion in our review) and report comparable effects to the present review, despite amalgamating different types of cognitive and behavioural interventions (e.g. CBT and ACT) for their primary analyses. They found no moderation effect of treatment type; CBT and ACT demonstrated similar effects. Whilst our findings also suggest potential similarity between these therapies in terms of successful conversion to remote delivery, the reduced quantity and quality of available ACT trials emphasises the need for further investigation. Similar to our review findings, Gandy and colleagues found small effects for both pain intensity and functional disability in both therapist-guided and unguided interventions. Additionally, they reported significantly larger effects for interventions with therapist involvement. Whilst we replicated the direction of such differences, we did not replicate their magnitude. Differences between our reviews, as well as the complexity of accounting for human involvement in interventions, may account for this discrepancy. Additionally, we only included interventions with less than 30% healthcare professional contact time. Furthermore, our analyses did not amalgamate psychological approaches. Although our definitions of therapist involvement appeared comparable, we chose to also exclude safeguarding therapist involvement. The role of even minimal human involvement (e.g. researcher rather than therapist) in intervention delivery remains unclear. Few studies have directly explored this fundamental question.

Finally, previous reviews have aimed to synthesise evidence relating to a broad conception of remote delivery, encompassing multiple modalities of technology (e.g. Heapy 2015; Slattery 2019a). Although these reviews found evidence relating to telephone, interactive voice response, smartphone apps, videoconferencing, and virtual reality delivery, the evidence was dominated by Internet-based delivery. This finding is consistent with our review. Consequently, previous efforts to evaluate the relative efficacy of remote technologies have been compromised by insufficient trials in modalities outside the Internet (e.g. Slattery 2019a). Our review employed stringent eligibility criteria; consequently, the lack of variation in delivery technologies found in our review suggests available trials are likely limited by quality as well as quantity. We were unable to evaluate the impact of type of technology utilised for delivery for these reasons. However, we did identify registered trial protocols suggesting evaluation of innovative technologies, such as virtual reality, may be in progress (e.g. Birckhead 2021).

AUTHORS' CONCLUSIONS

Implications for practice

For adults with chronic pain (excluding headache and migraine)

We are moderately certain that remotely-delivered cognitive behavioural therapy (CBT) provides small beneficial effects over treatment as usual (TAU) and active control for pain intensity. We found small beneficial effects of CBT over TAU in terms of functional disability, with low-certainty evidence. We are moderately certain that remote CBT has little to no difference on quality of life compared to active control. Although findings were similar for CBT versus TAU, the evidence was of very low certainty. Overall, all beneficial effects were small, immediately post-treatment, and were not maintained at follow-up.

Few trials have evaluated remote delivery of other therapeutic approaches. These trials are predominantly limited to acceptance and commitment therapy (ACT), and the trials typically provide low- to very low-certainty evidence. Consequently, we remain uncertain about the effectiveness of remote delivery of psychological therapies beyond CBT.

The available evidence pertaining to remote delivery of psychological therapies is nearly exclusively limited to Internet-based interventions. Furthermore, we cannot reliably draw conclusions about potential harm associated with remote delivery

of psychological therapies as we found very limited evidence on adverse events.

For clinicians

Remotely-delivered CBT for adults experiencing chronic pain (excluding headache and migraine) may provide small, short-term, beneficial effects for pain intensity, functional disability, anxiety, and depression compared to TAU. However, remote delivery evidence is currently predominantly limited to Internet-based intervention. Current evidence for ACT is limited and of very low certainty. It is unclear whether other psychological therapies can also be successfully translated to remote delivery, given the evidence available.

For policy-makers

Policy-makers may consider remote delivery options for provision of psychological therapies for adults experiencing chronic pain as they may provide opportunities to improve treatment access. We find that evidence currently speaks primarily to CBT and Internet-based delivery; other therapeutic approaches and technologies remain potentially useful but insufficiently researched. The beneficial effects of remotely delivered CBT appear small and short-term, whereas face-to-face delivery may extend treatment effects (Williams 2020). Consequently, remotely-delivered CBT may be considered alongside, rather than in replacement of, other evidentially-established support, such as part of a stepped care approach.

For funders of interventions

The evidence supports the potential usefulness of remotely-delivered psychological therapies for adults experiencing chronic pain, which may increase access to interventions providing short-term, small benefits. The greatest evidence lies with translation of CBT to Internet-based delivery. Notably, for those commissioning remotely-delivered psychological therapies, we limited our review to interventions developed with the involvement of professionals with qualified expertise in psychological therapy. Whilst regulation exists for certain professional titles in psychology (e.g. Clinical Psychologist) and accreditation in particular therapeutic approaches (e.g. BABCP 2022), psychological interventions themselves are not regulated. Therefore, it remains possible for anyone to claim creation of CBT-based interventions, irrespective of their knowledge or capability. Consequently, policy-makers should look to the involvement of suitably-trained healthcare professionals to determine the likely fidelity of the intervention to the psychological approach utilised.

Implications for research

General

Although we have found moderate evidence for beneficial effects of remotely-delivered CBT, we do not consider the body of evidence to have yet reached the saturation point found for face-to-face therapies. Questions remain as to how remotely-delivered interventions perform compared to active controls, the longevity of intervention effects, and their potential for harm. Beyond CBT, research should explore translation of a wider range of psychological therapeutic approaches for the management of chronic pain in adults. Whilst we identified ongoing trials focusing on approaches such as ACT (e.g. Slattery 2019b; Terhorst 2020), and emotional awareness and expression therapy (NCT04751825), overall CBT is still the dominant underpinning therapeutic approach in ongoing trials.

Whilst a broad range of delivery technologies were eligible for inclusion in our review, we found the evidence-base to be near-exclusively Internet-based. Despite expectations of an increasing volume of research utilising smartphone applications (McGuire 2017), we found only one completed trial (Morcillo-Muñoz 2022) and one ongoing trial (NCT05090683) using this technology. Review of the ongoing trials suggests that planned research of other novel technologies, such as virtual reality (Birckhead 2021; NCT04042090), is limited currently. Consequently, the individual and relative efficacy of different delivery technologies remains insufficiently explored at present.

Given the proposed importance of therapeutic alliance within psychological interventions (Horvath 2011; Zilcha-Mano 2017), we recommend more direct research exploring relative levels of human involvement and type of involvement in remote delivery of psychological therapies. We identified few studies that did not involve some form of human contact. Even in interventions where that contact was not considered intentionally therapeutic, it remains possible that any human involvement may alter how intervention content is received and experienced. Currently, empirical comparison of different levels and type of involvement remains uncommon (e.g. Dear 2015; Lin 2017), and therefore, inconclusive. Finally, developments in artificial intelligence provide new potential avenues for enhanced emulation of interpersonal therapy components, alongside ethical issues, that warrant consideration (Fiske 2019).

Design

We recommend further randomised controlled trials within this field. Good-quality designs should be sufficiently powered in all trial arms and routinely include follow-up as well as post-treatment assessment. We encourage inclusion of active control comparisons as well as TAU and waiting-list controls to facilitate determination of effects attributable to the psychological intervention. Consistent with the recommendations of Fisher 2019, researchers should seek to control for the influence of delivery technology in their selection of a suitable control comparison (e.g. Internet-delivered psychoeducation). Research should provide clear and detailed overviews of intervention content and proposed mechanisms of actions. We recommend routine incorporation of proof of intervention fidelity to psychological therapeutic approach in trial reports. To support generation of efficient and targeted interventions, we also encourage consideration of designs enabling component analysis. The role and type of human involvement incorporated into intervention delivery may comprise one element of such a design and support better prediction of resources required and scalability of interventions. Correspondingly, fully automated interventions involving zero human contact are presently scarce. Finally, an area of common concern identified in GRADE assessment of the current evidence was retrospective trial registration and deviation of outcomes from those specified in the registered protocol. We emphasise the importance of prospective trial registration and consistency in specified outcomes between protocol and final report.

Measurement

We make the following recommendations in terms of measurement.

- Trials should assess key outcomes associated with chronic pain using validated, standardised measures, as specified by the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT) (Dworkin 2005). To facilitate standardisation and comparison, we recommend selection of measures that are most utilised with the field and have the greatest reliability and validity.
- In terms of choice of outcomes, priority should be given to measures capturing meaningful change in the participant's life over the use of symptoms as proxies for such change. Additionally, we encourage more frequent inclusion of behavioural assessment alongside self-report measures.
- Trials investigating remotely-delivered therapies should routinely include assessment of engagement and adverse outcomes. Additionally, we encourage collaboration within the research community to develop more standardised methods for capturing these data and improving cross-study comparison.
- Trials should routinely include a follow-up assessment at least three months' post-intervention to support evaluation of the longevity of intervention effects.

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- Managing Editor (selected peer reviewers, collated peer-reviewer comments, provided editorial guidance to authors, edited the article): Sam Hinsley, Central Editorial Service;
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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Baumeister 2021

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment, post-treatment (9 weeks), and 6 months FU
Participants	Start of treatment: N = 209 Post-treatment: N = 165 Sex: 125 F, 84 M Mean age: 49.9 years (SD 9.36) Diagnosis: chronic back pain Mean years of pain: at least 6 months
Interventions	Intervention name: eSano Backcare-D plus TAU Psychological approach: CBT Duration: 6 weeks plus 3 optional modules Control type: TAU
Outcomes	Primary pain outcome: pain intensity (NRS) Primary disability outcome: ODI Primary quality-of-life outcome: AQOL-6D Adverse events: number of people experiencing adverse events Primary anxiety outcome: none Primary depression outcome: HDS Intervention satisfaction: CSQ-8 Intervention engagement: intervention adherence (average number of completed sessions, overall attrition rate) Other outcome measures: work capacity (SPE), healthcare utilisation (Trimbos Institute and Institute of Medical Technology Questionnaire for Costs Associated with Psychiatric Illness (TiC-P)), pain self-efficacy (PSEQ), INEP, deterioration based on HDS (calculated to assess possible negative changes in symptom severity), depressive symptomatology (QIDS), depression severity (PHQ-9)
Notes	**Funding**: German Federal Ministry of Education and Research

Baumeister 2021 *(Continued)*

Conflicts of interest: authors were partly involved in developing intervention or its previous versions. LBS and SS received payments for workshops on e-mental health. HB received consultancy fees, reimbursement of congress attendance and travel costs, cost for Psychotherapy and Psychiatry Association lectures, training in e-mental health, and third-party funding from several public funding organisations. DDE and DI own shares in GET.ON Institut GmbH. DDE received payment for advice on use of internet-based interventions and lectures for Psychotherapy and Psychiatry Association and was beneficiary of third-party funding from health insurance providers. JB is a member of the committee on e-mental health in the Association of Psychotherapists.

Country: Germany

Trial registration: DRKS00009272

Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	An automated web-based randomisation programme was used by an independent researcher not involved in the trial to generate the permuted block randomisation sequence.
Allocation concealment (selection bias)	Low risk	An independent researcher used an automated web-based programme, www.sealedenvelope.com. There was no description of allocation concealment, but it was assumed that the 'sealed envelope' was sent to participants online through the programme.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	The researchers who recruited and screened participants for eligibility and conducted the baseline assessments via telephone were kept blinded to the randomisation status. Telephone interviews with participants at T1 and T2 were conducted by independent interviewers to keep outcome assessors blinded to the randomisation status.
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition. Missing data were assumed to be missing at random. Multivariate imputation by chained equations using predictive mean matching was performed to create 20 complete datasets. Imputation models were defined following recommendations by van Buuren and colleagues with imputation models including outcome and auxiliary variables. Analyses were conducted for each imputed dataset and pooled using Rubin's rules.
Selective reporting (reporting bias)	Low risk	All outcomes were reported as planned in the trial registry and the publication. Authors of the trial changed the quality-of-life outcome measure from EQ-5D to AQOL-6D.

Bennell 2018

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, post-treatment, and 12 months FU. Only post-treatment data were extracted as there was > 30% interaction (face to face) with the health professional and participants and physiotherapy input from post-treatment to 52 weeks.
Participants	Start of treatment: N = 144 Post-treatment: N = 137

Bennell 2018 *(Continued)*

	Sex: 82 F, 62 M Mean age: 61.25 years (SD 7.15) Diagnosis: hip osteoarthritis Mean years of pain: reported as the number and percentage of participants falling into three symptom duration categories: < 2 years (n = 64), 2 to 10 years (n = 66), > 10 years (n = 18). We note that there is discrepancy within the article report between the overall sample size and this breakdown of symptom duration (with the latter, apparently erroneously, equalling 148).
Interventions	Intervention name: pain coping skills training Psychological approach: CBT Duration: 8 weeks, 1 module per week, 35- to 45-minute module, then 16-week exercise programme Control type: active
Outcomes	Primary pain outcome: pain intensity (NRS) Primary disability outcome: WOMAC – Physical Function subscale Primary quality-of-life outcome: AQOL Adverse events: number of people experiencing adverse events Primary anxiety outcome: DASS – Anxiety subscale Primary depression outcome: DASS – Depression subscale Intervention satisfaction: none Intervention engagement: adherence, number of education information sheets accessed, number of physiotherapy sessions attended, and home exercise adherence Other outcome measures: self-efficacy for pain and function (Arthritis Self-Efficacy Scale), coping skills (Coping Attempts Scale of the Coping Strategies Questionnaire), Pain Catastrophizing Scale, and physical activity (Physical Activity Scale for the Elderly), WOMAC Pain subscale
Notes	**Funding:** National Health and Medical Research Council Programme Grant **Conflicts of interest:** KLB received grants from National Health and Medical Research Council during the conduct of the study; personal fees from Physitrack, ASICS Oceania, Peking University, and Brigham and Women's Hospital outside submitted work; and other support from ASICS Oceania outside the submitted work. RKN received grants from National Health and Medical Research Council during conduct of study. FD received grants from National Health and Medical Research Council during conduct of study and personal fees from Elsevier Oracle outside submitted work. PWH received grants from the National Health and Medical Research Council during the conduct of the study. RSH received grants from National Health and Medical Research Council and Australian Research Council Future Fellowship during conduct of study; grant from Medibank Better Health Foundation; and other support from ASICS Oceania outside submitted work. Remaining authors have no conflicts of interest. **Country:** Germany **Trial registration:** Australian and New Zealand Clinical Trials Registry 12614000230651 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement

Bennell 2018 *(Continued)*

Random sequence generation (selection bias)	Low risk	An independent researcher prepared a computer-generated randomisation schedule (randomised permuted blocks of varying sizes) stratified by physiotherapist and sex.
Allocation concealment (selection bias)	Low risk	The schedule was concealed using opaque, sealed envelopes.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Participants, who were themselves blinded, self-reported outcome assessments. The statistician was blinded to group allocation.
Incomplete outcome data (attrition bias) All outcomes	Low risk	< 10% of participants dropped out during the whole study.
Selective reporting (reporting bias)	Low risk	Registry details are available; all outcomes were reported as planned.

Buhrman 2004

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment, post-treatment (8 weeks), and 3 months FU
Participants	Start of treatment: N = 56 Post-treatment: N = 51 Sex: 35 F, 21 M Mean age: 44.6 years (SD 10.4) Diagnosis: chronic back pain Mean years of pain: 10.1 (SD 9.2)
Interventions	Intervention name: self-help programme Psychological approach: CBT Duration: 7 weeks Control type: WL
Outcomes	Primary pain outcome: Multidimensional Pain Inventory, pain intensity Primary disability outcome: none Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: HADS Primary depression outcome: HADS Intervention satisfaction: treatment credibility, satisfaction with treatment format Intervention engagement: none

Buhrman 2004 *(Continued)*

	Other outcome measures: cognitive and behavioural coping strategies (Coping Strategies Questionnaire), Pain and Impairment Relationship Scale
Notes	**Funding**: Swedish Council for Social Research **Conflicts of interest**: not reported **Country**: Sweden **Trial registration**: none Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact Authors also provided baseline group allocation data not present in original article: intervention group (n = 27), control group (n = 29)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Participants were randomised using dice, where even numbers meant intervention and odd numbers meant control condition.
Allocation concealment (selection bias)	Unclear risk	The intervention group received a code to enter the intervention, and the control group were told they were on a waiting list. There was no further information about allocation concealment.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	No further information about how assessments were completed.
Incomplete outcome data (attrition bias) All outcomes	Low risk	< 10% of participants dropped out during the whole study.
Selective reporting (reporting bias)	Unclear risk	No protocol was available; it is unclear if outcomes were reported as planned.

Buhrman 2011

Study characteristics

Methods	RCT; 2 arms; assessed pre- and post-treatment (11 weeks)
Participants	Start of treatment: N = 54 Post-treatment: N = 50 Sex: 37 F, 17 M Mean age: 43.2 years (SD 9.8) Diagnosis: chronic back pain Mean years of pain: 12.1 (SD 8.5)
Interventions	Intervention name: guided Internet-based cognitive behavioural treatment

Buhrman 2011 *(Continued)*

	Psychological approach: CBT Duration: 11 weeks Control type: WL
Outcomes	Primary pain outcome: pain intensity, MPI Primary disability outcome: none Primary quality-of-life outcome: QOLI Adverse events: none Primary anxiety outcome: HADS-Anxiety Primary depression outcome: HADS-Depression Intervention satisfaction: none Intervention engagement: none Other outcome measures: cognitive and behavioural coping strategies (Coping Strategies Questionnaire), Pain and Impairment Relationship Scale
Notes	**Funding:** in part by the Swedish Council for Working and Life Research **Conflicts of interest:** LS has a private clinic where the Internet treatment is provided. **Country:** Sweden **Trial registration:** NCT01329861 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation was made by an independent person through a webpage with a randomisation programme.
Allocation concealment (selection bias)	Unclear risk	No further information about the allocation concealment procedure; participants were told about inclusion in the trial and the treatment allocation after completion of the interview via email.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All participants were asked to complete the online questionnaire measures at pre- and post-treatment.
Incomplete outcome data (attrition bias) All outcomes	Low risk	< 10% of participants dropped out during the whole study.
Selective reporting (reporting bias)	Unclear risk	Trial registry and reported outcomes in the publication match, but the trial was not registered prospectively.

Buhrman 2013a

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment, post-treatment (8 weeks), and 6 months FU
Participants	Start of treatment: N = 72 Post-treatment: N = 56 Sex: 52 F, 20 M Mean age: 40.1 years (SD 8.94) Diagnosis: chronic back pain Mean years of pain: 6.2 (SD 2.07)
Interventions	Intervention name: guided Internet-based cognitive behavioural treatment Psychological approach: CBT Duration: 8 weeks Control type: active
Outcomes	Primary pain outcome: MPI Primary disability outcome: none Primary quality-of-life outcome: QOLI Adverse events: none Primary anxiety outcome: HADS Primary depression outcome: HADS Intervention satisfaction: none Intervention engagement: none Other outcome measures: Catastrophising subscale of the Coping Strategies Questionnaire; thoughts, attitudes, and opinions about pain (Pain and Impairment Relationship Scale); and acceptance of chronic pain (Chronic Pain Acceptance Questionnaire)
Notes	**Funding:** MB was sponsored in part by the Multidisciplinary Pain centres at Uppsala University Hospital. GA was sponsored in part by Linköping University, Swedish Council for Working and Life Research, and a grant from Rehsam/Vårdalsstiftelsen. **Conflicts of interest:** none **Country:** Sweden **Trial registration:** none Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomisation was made by an independent person using a true random number service

Buhrman 2013a *(Continued)*

Allocation concealment (selection bias)	Unclear risk	No further information about the allocation concealment procedure; participants were told about their assignment after the assessment procedure was completed
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Self-report measures were administered via the Internet.
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition. ITT was used in analysing data; missing values for continuous data were imputed using the expectation-maximisation method.
Selective reporting (reporting bias)	Unclear risk	No protocol was available; therefore, it is not clear if outcomes were reported as planned.

Buhrman 2013b

Study characteristics	
Methods	RCT; 2 arms; assessed pre- and post-treatment (7 weeks)
Participants	Start of treatment: N = 76 Post-treatment: N = 61 Sex: 45 F, 31 M Mean age: 49.1 years (SD 10.34) Diagnosis: chronic pain (multiple sites, including back, neck, head, shoulders, arms, hips, legs, feet, generalised pain) Mean years of pain: 15.3 (SD 11.65)
Interventions	Intervention name: guided Internet-delivered ACT Psychological approach: ACT Duration: 7 weeks Control type: active
Outcomes	Primary pain outcome: MPI Primary disability outcome: none Primary quality-of-life outcome: QOLI Adverse events: none Primary anxiety outcome: HADS Primary depression outcome: HADS Intervention satisfaction: none Intervention engagement: none Other outcome measures: Coping Strategies Questionnaire, Pain and Impairment Relationship Scale, Chronic Pain Acceptance Questionnaire

Buhrman 2013b *(Continued)*

Notes	**Funding:** GA was sponsored in part by a grant from Linköping University, a grant from Rehsam/ Vårdalsstiftelsen, and the Swedish Council for Working and Life Research **Conflicts of interest:** none **Country:** Sweden **Trial registration:** NCT01603797 (found from hand search) Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation was made by an independent person using a true random number computer-generated schedule.
Allocation concealment (selection bias)	Unclear risk	Participants were informed of their allocation prior to randomisation to their group.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Outcome measures were obtained pre- and post-intervention via the Internet.
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition in the intervention group compared to control (15%); however, analyses were conducted with "PASW" Missing Value Analysis to impute all missing data on the continuous measures with the expectation-maximisation method
Selective reporting (reporting bias)	Unclear risk	Protocol is available and outcomes are reported as planned; however, the trial was not registered prospectively.

Buhrman 2015

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, post-treatment (8 weeks), and FU (1 year; intervention group only; this info was buried in the statistical strategy section)
Participants	Start of treatment: N = 52 Post-treatment: N = 43 Sex: 44 F, 8 M Mean age: 50.69 years (SD 12.72) Diagnosis: chronic pain (reported locations: back, neck, shoulders, generalised pain) Mean years of pain: NR
Interventions	Intervention name: individualised guided Internet-delivered CBT Psychological approach: CBT Duration: 8 weeks

Buhrman 2015 *(Continued)*

	Control type: WL and online discussion forum
Outcomes	Primary pain outcome: MPI Primary disability outcome: PDI Primary quality-of-life outcome: QOLI Adverse events: one Primary anxiety outcome: BAI Primary depression outcome: MADRS-S Intervention satisfaction: none Intervention engagement: number of completed treatment sessions Other outcome measures: Pain Catastrophizing Scale, Anxiety Sensitivity Index, Chronic Pain Acceptance Questionnaire, Coping Strategies Questionnaire
Notes	**Funding:** NR **Conflicts of interest:** NR **Country:** Sweden **Trial registration:** NCT01329861 We did not receive further information from study authors regarding development or delivery of intervention and percentage of participant interaction with healthcare professional. We considered authors' responses to other included studies (Buhrman 2004; Buhrman 2011; Buhrman 2013a; Buhrman 2013b), alongside the study article, to determine that it likely met these criteria.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation was made by an independent person using a true random number service (www.randomizer.org).
Allocation concealment (selection bias)	Low risk	Randomisation was made by an independent person using a true random number service (www.randomizer.org).
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Measures were self-reported and completed online.
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% but ITT used: the intention-to-treat principle was followed with all available data regardless of completion of the actual treatment. Analyses were conducted with "PASW" Missing Value Analysis (SPSS Inc., IBM SPSS Statistics 20, IBM, New York, NY) to impute all missing data on the continuous measures with the expectation-maximization method. This method computes missing values based on maximum likelihood estimates with observed data in an iterative process.
Selective reporting (reporting bias)	High risk	Retrospectively registered, and the outcomes reported in the publication are different from the trial registry (e.g. Hospital Anxiety and Depression Scale (HADS) and Pain and Impairment Relationship Scale (PAIRS) are reported in the trial registry and not the publication)

Burke 2019

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment, post-treatment (6 weeks), and 3 months FU
Participants	Start of treatment: N = 69 Post-treatment: N = 57 Sex: 17 F, 52 M Mean age: 51 years (SD 13) Diagnosis: spinal cord injury Mean years of pain: NA
Interventions	Intervention name: CBT – pain management programme, Spinal Cord Injury Pain Ireland (SPIRE) Psychological approach: CBT Duration: 6 weeks Control type: TAU
Outcomes	Primary pain outcome: NRS Primary disability outcome: none Primary quality-of-life outcome: WHOQOL-BREF Adverse events: none Primary anxiety outcome: HADS Primary depression outcome: HADS Intervention satisfaction: none Intervention engagement: none Other outcome measures: BPI Interference subscale, PSQI, International Spinal Cord Injury Quality of Life Basic Data Set, International Spinal Cord Injury Pain Basic Data Set, CPAQ-8, DN4 interview
Notes	**Funding:** Irish Society of Physiotherapists Eastern Branch Research Bursary and Health Informatics Society of Ireland Research Bursary **Conflicts of interest:** authors listed were involved in the development of the intervention. They did not receive any payments for its use. **Country:** Ireland **Trial registration:** NCT03150017 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**

Burke 2019 *(Continued)*

Random sequence generation (selection bias)	Low risk	Randomisation was made by a member of the research team who was blinded to the recruitment and assessment process and used a sequence generator programme for randomisation into the intervention group or control group.
Allocation concealment (selection bias)	Unclear risk	No further information.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	An Internet-delivered battery of outcome measures were collected at each time point, so there was no interaction between participants or outcome assessors.
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition. The primary analysis included all available data in an intention-to-treat approach, using LMMs with maximum likelihood estimation to assess change in each outcome over time between both groups.
Selective reporting (reporting bias)	Unclear risk	Protocol is available and outcomes are reported as planned; however, the trial was not registered prospectively.

Carpenter 2012

Study characteristics	
Methods	RCT; 2 arms; assessed pre-baseline, post-baseline (3 weeks) and 6 weeks FU (NB: 6-week FU cannot be used because control was given intervention after 3-week assessment, so no comparison group)
Participants	Start of treatment: N = 141 Post-treatment: N = 131 Sex: 117 F, 24 M Mean age: 42.5 years (SD 10.3) Diagnosis: chronic low back pain Mean years of pain: 103.7 months (SD 94.1)
Interventions	Intervention name: Wellness Workbook Psychological approach: mixed cognitive-behavioural (different forms): "Therapeutic content was drawn from established and empirically-supported cognitive and behavioural strategies, including cognitive therapy, behavioural activation, acceptance and commitment therapy, and mindfulness-based stress reduction." Duration: 3 weeks (6 chapters designed to take 1 to 1.5 hours each) Control type: WL
Outcomes	Primary pain outcome: NRS Primary disability outcome: RMDQ Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: none Primary depression outcome: none

Carpenter 2012 *(Continued)*

	Intervention satisfaction: 15-item Usability/Satisfaction Questionnaire Intervention engagement: inspection "of server logs to obtain objective indices of participants' extent of engagement" Other outcome measures: miscellaneous: Survey of Pain Attitudes, Fear Avoidance Beliefs Questionnaire, Negative Mood Regulation Scale, Pain Catastrophizing Scale, Pain Self-Efficacy Scale, self-reported usage (participants were asked, "On average, how many hours per week did you spend on the Wellness Workbook over the past 3 weeks, including practising what you learned?")
Notes	**Funding:** National Institute of Arthritis and Musculoskeletal and Skin Diseases (grant number R43 AR052569) **Conflicts of interest:** none. However, the following people were acknowledged as contributors to the development of the intervention and assistance with the research: Dr Judith Turner, Dr Charles Chabal, Ms Tasha Mikko, and Ms KrisAnn Schmitz. **Country:** USA (researchers based in Seattle; participants from 40 states) **Trial registration:** NR Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Used a random number table
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Assessments completed by participants online. Also, a "password-protected document linking participant names to user IDs was maintained by the study coordinator, but this was not accessible to individuals involved in analysing outcome data."
Incomplete outcome data (attrition bias) All outcomes	Low risk	< 10% attrition. Used completer analysis; however, fully reported attrition and analysed completer/noncompleter group differences (some demographic differences but no differences on outcomes)
Selective reporting (reporting bias)	Unclear risk	Trial not registered

Dear 2013

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, post-treatment (8 weeks), and 3 months FU (FU only for the intervention group, not control)
Participants	Start of treatment: N = 63 Post-treatment: N = 60 Sex: 53 F, 9 M

Dear 2013 *(Continued)*

	Mean age: 49 years (SD 13) Diagnosis: mixed (e.g. back, hip/leg/foot, shoulder/arm/hand, neck/head/face) Mean years of pain: 7.36 (SD 8.10)
Interventions	Intervention name: Pain Course Psychological approach: CBT Duration: 8 weeks (recommended 1 lesson every 7 to 10 days) Control type: WL
Outcomes	Primary pain outcome: WBPQ Primary disability outcome: RMDQ Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: GAD-7 Primary depression outcome: PHQ-9 Intervention satisfaction: none Intervention engagement: percentage of participants completing each lesson reported Other outcome measures: miscellaneous: Pain Self-efficacy Questionnaire, Tampa Scale of Kinesophobia, Pain Responses Self-Statements Scale
Notes	**Funding:** research was enabled by funding from the Motor Accident's Authority of New South Wales. BFD is supported by a National Health and Medical Research Council (NHMRC) Public Health Fellowship. **Conflicts of interest:** none **Country:** Australia **Trial registration:** ACTRN12612000556842 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomisation method detail is vague: "a permuted randomisation process".
Allocation concealment (selection bias)	Unclear risk	Not mentioned
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Assessments completed by participants online via website
Incomplete outcome data (attrition bias) All outcomes	Low risk	< 10% attrition; last observation carried forward

Dear 2013 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	Retrospectively registered; reported outcomes consistent with registered trial (www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=362531&isReview=true)

Dear 2015

Study characteristics	
Methods	RCT; 4 arms; assessed pretreatment, post-treatment (8 weeks), FU at 3 months, FU at 12 months, FU at 24 months (FU only for intervention groups, not control)
Participants	Start of treatment: N = 490 Post-treatment: N = 421 Sex: 375 F, 96 M Mean age: 50 years (SD 13) Diagnosis: mixed (e.g. head/face/mouth, neck/shoulders/upper back, arms/forearms/hands, lower back/pelvis/sacrum, legs/knees/feet) Mean years of pain: 9.35 years (SD: 8.22)
Interventions	Intervention name: Pain Course (treatment arms included regular therapist contact, occasional therapist contact, no contact) Psychological approach: CBT Duration: 8 weeks Control type: TAU and WL
Outcomes	Primary pain outcome: Wisconsin Brief Pain Questionnaire (WPBQ) Primary disability outcome: RMDQ Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: GAD-7 Primary depression outcome: PHQ-9 Intervention satisfaction: acceptability, satisfaction Intervention engagement: lesson completion Other outcome measures: Pain Self-Efficacy Questionnaire, Tampa Scale of Kinesophobia, Chronic Pain Acceptance Questionnaire 8, prescription medication and healthcare service use
Notes	**Funding:** Motor Accidents Authority of New South Wales and the National Health and Medical Research Council (NHMRC) **Conflicts of interest:** BFD and NT are authors and developers of the Pain Course but derive no personal or financial benefit from it. They are funded by the Australian Government to develop and provide a free national online assessment and treatment service, the MindSpot Clinic (www.mindspot.org.au), for people with anxiety and depression. The remaining authors have no conflicts of interest to declare. **Country:** Australia

Dear 2015 *(Continued)*

Trial registration: ACTRN12613000252718

Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomly allocated to 1 of 4 groups using a permuted block randomisation sequence; randomisation sequence produced using online randomiser
Allocation concealment (selection bias)	Low risk	"Participant randomisation occurred at the point of application, through the eCentreClinic software system, before participants had any contact with the researchers or the researchers had the opportunity to review the details of participants' applications. Thus, the researchers were blind to group allocation until the participant was deemed to have made a successful or unsuccessful application."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Assessments completed by participants online
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition. ITT analysis principles used; multiple imputation for missing; some comparison of completers versus noncompleters (no differences in terms of age, pain duration, number of pain sites, average pain, or initial PHQ-9, GAD-7, or RMDQ scores). "Separate generalised linear models, utilising time effects and random intercepts, were used to impute missing data in the dependent variables consistent with intention-to-treat principles".
Selective reporting (reporting bias)	Low risk	Prospectively registered; consistent with trial registration. One measure (Pain Things You Do Questionnaire) stated in the trial registration was missing. (www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=363799&isReview=true)

Dear 2021

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, post-treatment (8 weeks), and 3 months FU (FU only for intervention groups, not control).
Participants	Start of treatment: N = 659 Post-treatment: N = 592 Sex: 560 F, 99 M Mean age: 48.58 years (SD 13.59) Diagnosis: mixed (e.g. head/face/jaw, throat/neck/shoulders, upper arms/forearms/wrist/hands, chest/abdomen/pelvis, upper back/lower back, buttocks/hips/anus, legs/feet/toes) Mean years of pain: 9.44 years (SD 7.02)
Interventions	Intervention name: Pain Course Psychological approach: CBT

Dear 2021 *(Continued)*

	Duration: 8 weeks Control type: WL
Outcomes	Primary pain outcome: WBPQ; Average Pain item only Primary disability outcome: PDI Primary quality-of-life outcome: EQ-5D-5L Adverse events: none Primary anxiety outcome: GAD-7 Primary depression outcome: PHQ-9 Intervention satisfaction: satisfaction item on a 5-point Likert scale (very unsatisfied to very satisfied); 2 yes/no questions: would recommend and worth their time? Intervention engagement: percentage of participants completing each lesson Other outcome measures: TiC-P
Notes	**Funding:** New South Wales State Insurance Regulatory Authority (SIRA) and Australian National Health and Medical Research Council (NHMRC) **Conflicts of interest:** none; "BFD and NT are authors and developers of the Pain Course but derive no personal or financial benefit from it" **Country:** Australia Trial registration: ACTRN12615001003561 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact Data for the number of people in each arm for average pain intensity (30% and 50%) were confirmed by the study authors. The authors also confirmed confidence interval data for the EQ-5D-5L.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation was performed using www.random.org with permuted blocks of 16 and a 1:1 ratio.
Allocation concealment (selection bias)	Low risk	Participants were assigned a randomisation number at commencement of the online screening assessment, ensuring that study investigators were unable to affect group allocation.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Assessments completed by participants online.
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition: ITT analysis principles used; multiple imputation for missing; no comparison of completers versus noncompleters: "all analyses were conducted using intention-to-treat principles. A stratified multiple imputation procedure was used to account for missing data, with group, time, lesson adherence, and all possible 2-way interactions considered in the imputation procedure".

Dear 2021 *(Continued)*

Selective reporting (reporting bias)	Low risk	Prospectively registered; reported outcomes consistent with registered trial (www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=369290&isReview=true)

Ferwerda 2017

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment, post-treatment at intervention completion (intervention group only), 6 months (for control), and at 3, 6, 9, and 12 months FU
Participants	Start of treatment: N = 133 Post-treatment: N = 105 Sex: 85 F, 48 M Mean age: 56.35 years (SD 10) Diagnosis: rheumatoid arthritis Mean years of pain: NR
Interventions	Intervention name: tailored-guided Internet-based CBT intervention Psychological approach: CBT Duration: variable treatment duration; treatment was tailored depending on participants' characteristics and goals. Time between assignments, number of goals, and time to practise in daily life varied; therefore, duration of treatment was between 9 and 65 weeks (M = 26.07, SD = 12.22). 25% of participants completed treatment within 17 weeks, and 75% of participants completed the intervention in 32 weeks. Control type: TAU
Outcomes	Primary pain outcome: IRGL Pain subscale Primary disability outcome: none Primary quality-of-life outcome: IRGL (Self-Care and Mobility scales), RAND-36 Health Status Inventory (Physical Health Problems and Emotional Problems subscales) (composite) Adverse events: none Primary anxiety outcome: Anxiety subscale of IRGL Primary depression outcome: BDI Intervention satisfaction: rated on 10-point scale, 10-point user-friendliness scale, and 4-point scale (e.g. belief intervention had sustained positive effect, if participants would recommend, preference of mode of delivery) Intervention engagement: compliance with standard rheumatological care (questionnaire made for this study) Other outcome measures: Negative Mood subscale of IRGL, Checklist Individual Strength (Fatigue subscale), Self-Care and Mobility subscales of IRGL, Rheumatoid Arthritis Disease Activity Index, RAND-36 Health Status Inventory

Ferwerda 2017 *(Continued)*

Notes	**Funding:** ZonMw (Netherlands Organisation for Health Research and Development, 80-82310-98-09060) and Pfizer (WS682746) **Conflicts of interest:** none **Country:** the Netherlands **Trial registration:** NTR2100 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Patients were randomised to the intervention or control condition by an independent researcher; using a restricted allocation programme with minimisation was applied (ie, adaptively stratified) on sex, hospital, education level, age, and baseline patient-reported disease activity (Rheumatoid Arthritis Disease Activity Index, RADAI24) to ensure equal distributions across groups."
Allocation concealment (selection bias)	Low risk	Allocation conducted by independent researcher; research team informed of allocation by independent researcher assistant
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Participants completed assessments independently but these were entered into a database by researcher: "Patients received a paper and pencil version of the questionnaires at home and were asked to fill these out within 2 weeks and send them back to the researchers in a pre-addressed and stamped envelope."
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10%: "Intention-to-treat analyses followed by per-protocol analyses were conducted for the main hypotheses." Per-protocol analyses: "All main analyses were repeated for intervention completers. This did not change the results, with the exception that the marginally significant difference found on the impact of RA [rheumatoid arthritis] on daily life became significant (P = 0.049)". "Intention-to-treat analyses followed by per-protocol analyses were conducted for the main hypotheses. A linear mixed model for longitudinal data (random intercept model) was applied using maximum likelihood estimated differences between the intervention and control groups in psychological functioning, physical functioning, and impact of RA on daily life".
Selective reporting (reporting bias)	Low risk	Prospectively registered; reported outcomes consistent with registered trial (trialsearch.who.int/Trial2.aspx?TrialID=NTR2100)

Friesen 2017

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, post-treatment (8 weeks), and 12 weeks FU (intervention FU only)
Participants	Start of treatment: N = 60 Post-treatment: N = 52

Friesen 2017 *(Continued)*

	Sex: 57 F, 3 M Mean age: 48 years (SD 11) Diagnosis: fibromyalgia Mean years of pain: 16 years (SD 10)
Interventions	Intervention name: Pain Course (adapted for fibromyalgia) Psychological approach: CBT Duration: 8 weeks Control type: TAU and WL
Outcomes	Primary pain outcome: Brief Pain Inventory: severity items Primary disability outcome: SF-12 – Physical subscale Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: GAD-7 Primary depression outcome: PHQ-9 Intervention satisfaction: 7-item Treatment Satisfaction Questionnaire (used in prior studies) Intervention engagement: number of logins Other outcome measures: Revised Fibromyalgia Impact Questionnaire, Hospital Anxiety and Depression Scale, Pain Self-Efficacy Questionnaire, Pain Responses Self-Statements (Catastrophising and Coping subscales), Fatigue Symptom Inventory, TAMPA Scale of Kinesophobia, Medical Outcomes Study Short Form (SF-12)
Notes	**Funding:** LNF received funding from Canadian Institutes of Health and Faculty of Graduate Students and Research (University of Regina). HH was funded by Canadian Institutes of Health Research, Saskatchewan Health Research Foundations, and Rx & D Health Research Foundation. Pain Course development was funded by Macquarie University, Australian National Health and Medical Research Council, and Australian New South Wales Motor Accidents Authority. **Conflicts of interest:** none **Country:** Canada **Trial registration:** SRCTN85116527 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	An online programme (www.randomizer.org/) was used to assign participants to each condition using a 1:1 ratio and a simple randomisation sequence.
Allocation concealment (selection bias)	Low risk	"To prevent selection bias, randomisation was conducted by a graduate student not involved in the study, who revealed the randomisation results via email to the study staff only after the completion of the full screening."

Friesen 2017 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	Low risk	All measures completed by participants online
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition; no comparison of completers versus noncompleters, but used ITT for missing data imputation. "Missing data was imputed using separate generalised linear models which utilised time effects and random intercepts".
Selective reporting (reporting bias)	High risk	Retrospectively registered; consistent with trial registration but one measure (VAS of pain: scheduled for baseline, weekly, and post-treatment) stated in the trial registration was missing (www.isrctn.com/ISRCTN85116527?q=&filters=conditionCategory:Mental%20and%20Behavioural%20Disorders,recruitmentCountry:Canada&sort=&offset=20&totalResults=78&page=1&pageSize=100&searchType=basic-search)

Gasslander 2022

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment, post-treatment (3 months after trial start), and FU (12 months after treatment)
Participants	Start of treatment: N = 226 Post-treatment: N = 144 Sex: 137 F, 50 M Mean age: 45.9 years (SD 11.1) Diagnosis: various chronic pain conditions: primary pain, postsurgical or traumatic pain, neuropathic pain, headache or orofacial pain, visceral pain, musculoskeletal pain Mean years of pain: 14.9 years (SD 10.4)
Interventions	Intervention name: iCBT Psychological approach: CBT Duration: 6 to 13 weeks (based on module information and nature of intervention module selection being tailored to individuals) Control type: WL
Outcomes	Primary pain outcome: MPI-Swedish language version, CPAQ Primary disability outcome: PDI Primary quality of life outcome: QOLI Adverse events: none Primary anxiety outcome: GAD-7 Primary depression outcome: MADRS-S Intervention satisfaction: none Intervention engagement: none

Gasslander 2022 *(Continued)*

	Other outcome measures: Hospital Anxiety and Depression Scale-Anxiety, ASI, Hospital Anxiety and Depression Scale-Depression, CSQ-R, PCS, Pain Self-Efficacy Questionnaire-2, Tampa Scale of Kinesiophobia, Insomnia Severity Index, Shirom-Melamed Burnout Questionnaire, PTSD Checklist (5th edition), TCS
Notes	**Funding:** Uppsala University and AFA Insurance **Conflicts of interest:** NR **Country:** Sweden **Trial registration:** NCT03316846 We did not receive further information from study authors regarding development or delivery of intervention and percentage of participant interaction with healthcare professional. We considered authors' responses to other included studies (Buhrman 2004; Buhrman 2011; Buhrman 2013a; Buhrman 2013b), alongside the study article itself, to determine this study likely met these criteria.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"All randomisations were carried out using an independent online random number service (http://www.random.org) to ensure complete randomness."
Allocation concealment (selection bias)	Unclear risk	No information beyond randomisation process.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"An online treatment platform used in regular care at the Uppsala University Hospital was used to administer the treatment and collect data."
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition; ITT used: "The intention-to-treat principle was used with all available data regardless of completion of the actual treatment. Missing data was imputed with the expectation-maximisation method."
Selective reporting (reporting bias)	High risk	Retrospectively registered; outcome measures match (trial/paper), but primary outcomes altered after study completion, and 5- and 10-week assessment time points not reported in paper.

Guarino 2018

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, during intervention (4 and 8 weeks), post-treatment (12 weeks), FU (1-month post-intervention), and FU (3 months post-intervention)
Participants	Start of treatment: N = 110 Post-treatment: N = 98 Sex: 70 F, 40 M Mean age: 51.3 years (SD 10.9) Diagnosis: chronic pain Mean years of pain: NR

Guarino 2018 *(Continued)*

Interventions	Intervention name: Take Charge of Pain Psychological approach: CBT Duration: 12 weeks Control type: TAU
Outcomes	Primary pain outcome: MPI – Pain Severity subscale Primary disability outcome: none Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: none Primary depression outcome: none Intervention satisfaction: intervention acceptability (7 items on VAS; overall satisfaction item extracted for review outcomes) Intervention engagement: engagement in CBT skills (use of skills in the last 30 days and VAS items assessing, for each skill used, how helpful they found the skill), number of modules completed Other outcome measures: COMM, Pain Catastrophizing Scale, and number of visits to ED in the past 6 months and how many specifically for pain (past 6 months at baseline, past 30 days for subsequent assessment points)
Notes	**Funding**: AR and LAM received funding from US National Institute on Drug Abuse (NIDA) (National Institutes of Health (R01DA026887)). HG received pilot grant from Centre for Technology and Behavioural Health (Dartmouth College to conduct qualitative process research component of this parent study). **Conflicts of interest**: DCT consulted for Pfizer, Nektar, Develco, Ironwood, GlaxoSmithKline, Mallincrodt, Orexo, Xydnia. RKP's organisation received funding from AstraZeneca and Pfizer (past 3 years). LAM has affiliation with HealthSim, LLC (company that developed the web-based platform for this study). Managed through LAM and her academic institution. No other conflicts reported. **Country**: USA **Trial registration**: NCT01498510 We did not obtain further information from study authors regarding development or delivery of intervention and percentage interaction of healthcare professional. We reviewed a related intervention development article (Moore 2013), and the study article itself, to determine that it likely met these criteria.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Permuted-block randomisation was conducted, stratified by the patient's pain provider and whether the patient met lifetime DSM-IV criteria for abuse or dependence on any substance (as assessed with the MINI International Neuropsychiatric Interview [MINI])". "Each participant's allocation was determined by means of an electronic spreadsheet prepared by the study's statistician, which the interviewer consulted at the conclusion of the baseline assessment."

Guarino 2018 *(Continued)*

Allocation concealment (selection bias)	Low risk	"Each participant's allocation was determined by means of an electronic spreadsheet prepared by the study's statistician, which the interviewer consulted at the conclusion of the baseline assessment."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"All assessments were administered by research staff using a computer based interface."
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% in intervention group alone; ITT used: "primary and secondary outcome was evaluated in separate analyses using generalised linear mixed-effects piecewise regression models for repeated measures to examine treatment effects, time effects, and treatment by-time interactions."
Selective reporting (reporting bias)	High risk	Prospectively registered, but secondary outcomes updated/changed after completion; current primary and second outcomes are consistent (trial/paper). 'Current other pre-specified outcomes' lists 6 measures not reported in the article (also these were submitted in 2017 when the study completed in 2014); two of these variables were used as mediators in secondary analysis (Xie 2021), although one variable in Xie 2021 paper does not feature in trial registration (Sensitivity to Reinforcement of Addictive and other Primary Rewards (STRAP-R)).

Hedman-Lagerlöf 2018

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment, post-treatment (10 weeks), 6 months (FU1), 12 months (FU2). FU cannot be used as WL group was provided intervention after post-assessment point.
Participants	Start of treatment: N = 140 Post-treatment: N = 140 Sex: 137 F, 3 M Mean age: 50.3 years (SD 10.9) Diagnosis: fibromyalgia Mean years of pain: 10.1 years (time since diagnosis, not pain duration; approximation though (SD 7.5))
Interventions	Intervention name: iExp Psychological approach: CBT Duration: 10 weeks Control type: WL
Outcomes	Primary pain outcome: FIQ – Pain subscale Primary disability outcome: World Health Organization Disability Assessment Schedule II Primary quality-of-life outcome: Brunnsviken Brief Quality of Life Scale Adverse events: participants self-reported if events occurred Primary anxiety outcome: GAD-7 Primary depression outcome: PHQ-9

Hedman-Lagerlöf 2018 *(Continued)*

	Intervention satisfaction: none Intervention engagement: none Other outcome measures: pain-related distress (Pain Reactivity Scale), change in PGIC, fatigue (Fatigue Severity Scale), insomnia (Insomnia Severity Index), Five Facets of Mindfulness Scale (Non-reactivity to Inner Experiences subscale), and inner experiences (Psychological Inflexibility in Pain Scale)
Notes	**Funding:** Fredrik and Ingrid Thuring Foundation, Stockholm, Sweden; The Söderström-König Foundation, Stockholm, Sweden; Stockholm County Council, Stockholm, Sweden; and Karolinska Institutet, Stockholm, Sweden **Conflict of interest:** none **Country:** Sweden **Trial registration:** NCT02638636 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Participants were randomised to either iExp or WL control in a 1:1 ratio without restriction or matching. An independent true random number service (random.org) was used to ensure complete randomness.
Allocation concealment (selection bias)	Unclear risk	The random sequence was generated after the inclusion of participants to ensure that assignment of intervention was concealed from assessing psychologists and researchers of the study. Comment: unclear how concealment was masked
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Administered online
Incomplete outcome data (attrition bias) All outcomes	Low risk	< 10% attrition
Selective reporting (reporting bias)	High risk	EQ-5D was included in protocol but not study (or additional 2019 publication). All other outcomes included

Hess Engström 2022

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, post-treatment (6 weeks) and 9 months FU (FU after post-assessment)
Participants	Start of treatment: N = 99 Post-treatment: N = 69 Sex: 88 F, 0 M Mean age: 24.5 years (SD 4.4)

Hess Engström 2022 *(Continued)*

	Diagnosis: vulvodynia Mean years of pain: 4.9 years (SD 4.2)
Interventions	Intervention name: Internet intervention based on ACT (no specific name) Psychological approach: ACT Duration: 6 weeks Control type: WL
Outcomes	Primary pain outcome: pain during intercourse (NRS) Primary disability outcome: impact of pain on sexual function Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: none Primary depression outcome: none Intervention satisfaction: none Intervention engagement: none Other outcome measures: pain during tampon insertion (NRS), pain-behaviour (binary outcomes for items: 1) attempts at intercourse, 2) sexual activities besides intercourse, 3) willingness to perform the tampon test), Chronic Pain Acceptance Questionnaire – Revised (acceptance)
Notes	**Funding:** Uppsala-Örebro Regional Research Council, grants RFR-845561 and RFR- 930098, and Centre for Clinical Research, Västerås **Conflicts of interest:** NR **Country:** Sweden **Trial registration:** NCT02809612 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact Study authors were contacted for confirmation of number of participants in ITT analyses and missing outcomes for depression, anxiety, and quality of life

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	For allocation of the participants, a computer-generated list of random numbers was used (www.graphpad.com/quick calculations/randomise2/). Participants were randomly assigned to either the Internet-based treatment or clinical treatment as usual until at least 26 participants were assigned to each group at all time points.
Allocation concealment (selection bias)	Unclear risk	Allocation was randomised using number generator. No additional information, so unclear if allocation was concealed from individual linking randomly-allocated numbers with participants
Blinding of outcome assessment (detection bias)	Low risk	Data collected through online self-assessment questionnaires.

Hess Engström 2022 *(Continued)*

All outcomes		
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	> 10% attrition; used ITT but LOCF and, although "worst-case imputation" mentioned in analytic ITT strategy, no clear report of these results in 'Results' section
Selective reporting (reporting bias)	High risk	Prospectively registered; many discrepancies between trial registration outcomes and those reported (e.g. CPAQ-R not mentioned in trial registration but reported in paper; lots of outcomes in registration not reported in paper, e.g. Satisfaction with Life Scale, Female Sexual Function Index, number of visits for clinical treatment, EQ-5D, Sexual Dysfunction Scale)

Lin 2017

Study characteristics	
Methods	RCT; 3 arms; assessed pretreatment, 9 weeks post-treatment, 6 months FU
Participants	Start of treatment: N = 302 Post-treatment: N = 229 Sex: 254 F, 48 M Mean age: 51.7 years (SD 13.1) Diagnosis: chronic pain – varied (back, head, neck, shoulders, other) Mean years of pain: 114.45 months (SD 121.55)
Interventions	Intervention name: ACTonPain (guided or unguided intervention arms) Psychological approach: ACT Duration: 9 weeks (seven 60-minute modules) Control type: WL
Outcomes	Primary pain outcome: pain intensity (NRS) Primary disability outcome: MPI – Interference subscale Primary quality-of-life outcome: EQ-5D Adverse events: none Primary anxiety outcome: GAD-7 Primary depression outcome: PHQ-9 Intervention satisfaction: CSQ-8 Intervention engagement: none Other outcome measures: Brief Pain Inventory, Assessment of Quality of Life, SF-12, Patient Global Impression of Change, Acceptance and Action Questionnaire II, Chronic Pain Acceptance Questionnaire, cost measures (in protocol)
Notes	**Funding:** none declared in paper, but trial registry reports funding from Wissenschaftliche Gesellschaft Freiburg

Lin 2017 *(Continued)*

Conflicts of interest: JLMB, GA, and HB are authors and developers of ACTonPain. DDE possesses shares in GET.ON Instituts Gesundheits Trainings and has received payments from several companies and health insurance providers (Lantern Inc., Minddistrict Holding, BARMER, Techniker Krankenkasse, Schön Kliniken, Agaplesion Kliniken, Ebel Kliniken) for advice on use of Internet-based interventions. He has received payments for lectures from Federal Psychotherapy Association (Bundespsychotherapeutenkammer) and psychotherapy state associations Hesse and Lower Saxony and has been beneficiary of third-party funding from health insurance provider BARMER, German Statutory Pension Insurance Scheme (DRV), Social Insurance for Agriculture, Forestry, and Horticulture (SVLFG), and Accident Insurance State Fund of North Rhine–Westphalia (Unfallkasse NRW). LS received payments for lectures on online-based psychotherapy from Freiburg Institute for Training in Cognitive Therapy (Freiburger Ausbildungsinstitut für Verhaltenstherapie (FAVT GmbH)) and Institute for Training in Psychotherapy, Saarland University (Weiterbildungsinstitut für Psychotherapie and der Universität des Saarlandes (WIPS GmbH)). HB received consultancy fees from Federal Psychotherapy Association (Bundespsychotherapeutenkammer) and reimbursement of congress attendance, travel costs, and payments for lectures from the Federal Psychotherapy Association, psychotherapy state association of Baden-Württemberg, and Community Psychiatry Confederation (Dachverband für Gemeindepsychiatrie). He has been the beneficiary of study support (third-party funding) from health insurance provider BARMER GEK; Social Insurance for Agriculture, Forestry, and Horticulture (SVLFG); and the German Statutory Pension Insurance Scheme (DRV). He has received payments for lectures on online-based psychotherapy from Freiburg Institute for Training in Cognitive Therapy (Freiburger Ausbildungsinstitut für Verhaltenstherapie (FAVT GmbH)). SP has no conflicts.

Country: Germany

Trial registration: DRKS00006183

Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	To obtain groups of the same size, an independent statistician performed permuted-block randomisation with variable block sizes of 6, 9, and 12 (randomly ordered) and an allocation ratio of 1:1:1 with an automated web-based programme (www.sealedenvelope.com).
Allocation concealment (selection bias)	Unclear risk	No description of how participants were allocated
Blinding of outcome assessment (detection bias) All outcomes	Low risk	All assessments conducted via online self-report (stated in protocol).
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition; effectiveness analysed using ITT. Missing data were imputed using the expectation–maximisation algorithm of the Statistical Package for the Social Sciences (SPSS, Version 22)
Selective reporting (reporting bias)	Low risk	All outcomes reported. Protocol published and adhered to

Morcillo-Muñoz 2022

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, post-treatment (6 weeks), and FU (3 months after intervention)

Morcillo-Muñoz 2022 *(Continued)*

Participants	Start of treatment: N = 209 Post-treatment: N = 171 Sex: 155 F, 39 M Mean age: 50.7 years (SD 10.7) Diagnosis: chronic musculoskeletal pain Mean years of pain: NR
Interventions	Intervention name: NO+Dolor (NO+Pain) Psychological approach: multimodal treatment Psychological component: ACT and mindfulness Duration: 6 weeks Control type: active
Outcomes	Primary pain outcome: pain intensity (Numerical Rating Scale 11-point; daily assessment) Primary disability outcome: none Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: none Primary depression outcome: none Intervention satisfaction: none Intervention engagement: none Other outcome measures: Pain Catastrophizing Scale, Chronic Pain Acceptance Questionnaire, EQ-5D, and authors also included an item of subjective global improvement rated by EQ-VAS 0-100
Notes	**Funding:** Regional Ministry of Health by Resolution of May 18, 2017, of General Secretariat for Biomedical Research, Development, and Innovation and in Health Sciences of Andalusia with collaboration of the Biomedical Research Foundation of Córdoba **Conflicts of interest:** NR **Country:** Spain **Trial registration:** NCT04509154 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Block randomisation with a block size of 4 was used. The only stratification criterion was the reference health centre of the patients. An automated recruitment form hosted on the REDCap (Research Electronic Data Capture; Vanderbilt University) platform of the Maimonides Biomedical Research Institute of Córdoba was used to randomise the patients by simply clicking a button".

Morcillo-Muñoz 2022 *(Continued)*

Allocation concealment (selection bias)	Unclear risk	Researcher and statistician were blinded; HCPs who recruited and randomised the participants (by "pressing the button") were not blinded, but if the randomisation process was automated and just button-triggered, then they should not have been able to influence.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Completed digitally by participants and emailed to researcher
Incomplete outcome data (attrition bias) All outcomes	High risk	> 10% attrition in intervention; completer analysis used (completer of all assessment points including FU)
Selective reporting (reporting bias)	Unclear risk	Retrospectively registered; generally consistent outcomes (although pain-intensity VAS not mentioned; neither is the additional item VAS added to the EQ-5D)

Peters 2017

Study characteristics	
Methods	RCT; 3 arms; assessed pretreatment, post-treatment (a little unclear: 9 weeks in Table 1, but WL control group contacted after 8 weeks), and 6 months after completion of the programme (FU) (Note: WL group was offered the intervention after 8 weeks, so no control comparison at FU)
Participants	Start of treatment: N = 284 Post-treatment: N = 206 Sex: 234 F, 42 M Mean age: 48.6 years (SD 12) Diagnosis: chronic musculoskeletal pain: localised in back, neck, or shoulders, or generalised (i.e. fibromyalgia). 67% fibromyalgia Mean years of pain: 12.8 years (SD 10.1)
Interventions	Intervention name: 1) ("iCBT") Internet-based CBT; 2) ("Happy Despite Pain") Internet-based positive psychology intervention Psychological approach: 1) CBT, 2) positive psychology Duration: 8 weeks (but range 7 to 16 weeks) Control type: WL
Outcomes	Primary pain outcome: NRS Primary disability outcome: FIQ – Physical Impairment items Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: HADS-Anxiety Primary depression outcome: HADS-Depression Intervention satisfaction: none

Peters 2017 *(Continued)*

	Intervention engagement: none Other outcome measures: Anxiety SCS-SF, Happiness (NRS – 1 item), Positive and Negative Mood (Brief Mood Introspection Scale), Optimism (Life Orientation Test – revised), Flexible Goal Adjustment scale, pain catastrophising (Pain Catastrophizing Scale), repetitive thinking (Perseverative Thinking Questionnaire), and Illness Coping Questionnaire.
Notes	**Funding:** VICI Innovative research grant, Netherlands Organisation for Scientific Research **Conflicts of Interest:** none. MLP was awarded funding. Remaining authors declared no conflicts **Country:** the Netherlands and Belgium **Trial registration:** NR Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomisation was performed, but there was no further information on how randomisation was achieved.
Allocation concealment (selection bias)	Unclear risk	No information provided about allocation concealment
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	"All pretreatment and postintervention and follow-up questionnaires were delivered via the Internet."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Attrition rates across all arms were > 10%. At post-treatment, iCBT was 31%, PPI was 27%, and WL control was 19%. Overall dropout at end of study: iCBT was 49%, and PPI was 60%; however, ITT was used (but no imputation of data).
Selective reporting (reporting bias)	Unclear risk	No protocol or trial registry information was found; therefore, it is unclear if outcomes were reported as planned. Pain intensity is reported as an outcome in the publication; however, there is no description of the outcome in the Methods section.

Rickardsson 2021

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, 8 weeks (post-treatment), 3 months (FU1), 6 months (FU2), and 12 months (FU3). No control condition for any FU
Participants	Start of treatment: N = 113 Post-treatment: N = 100 Sex: 85 F, 28 M Mean age: 49.5 years (SD 12.1)

Rickardsson 2021 *(Continued)*

	Diagnosis: mix of chronic pain conditions, including: nociceptive (i.e. spinal disc hernia, rheumatic diseases, whiplash), neuropathic (nerve damage), noci plastic (fibromyalgia, CRPS), headaches (migraine, Horton's), other/unclear Mean years of pain: 18.1 years (SD 13.1)
Interventions	Intervention name: iACT Psychological approach: ACT Duration: 8 weeks Control type: WL
Outcomes	Primary pain outcome: pain intensity (NRS) Primary disability outcome: none Primary quality of life outcome: health-related quality of life (EQ-5D) Adverse events: adverse events Primary anxiety outcome: GAD-7 Primary depression outcome: PHQ-9 Intervention satisfaction: none Intervention engagement: completion (completer if 50% of content was completed and all active components had been introduced) Other outcome measures: Pain Interference Index, psychological inflexibility (Psychological Inflexibility in Pain Scale), values (Valuing Questionnaire), and insomnia (Insomnia Severity Index)
Notes	**Funding:** AFA Insurance, Stockholm County Council ALF grants **Conflicts of interest:** none **Country:** Sweden **Trial registration:** NCT03105908 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A random list service (www.random.org) was used to allocate by an independent nurse who received study ID numbers anonymously.
Allocation concealment (selection bias)	Low risk	Allocation was concealed until the treatment start using anonymous study ID numbers provided to an external individual (nurse) to independently complete randomisation and allocation.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Only information provided: "background- and outcome variables were collected by self-report"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Attrition rate in the iACT group was 19.30% compared to 3.57% in the WL control group due to lost to FU. Used ITT (multilevel linear models with full infor-

Rickardsson 2021 *(Continued)*

		mation and maximum likelihood estimation were used to analyse outcomes, including all randomised participants using an intention-to-treat approach)
Selective reporting (reporting bias)	High risk	Prospectively registered. Most outcomes reported as registered. However, Perceived Stress Scale is not in paper, and although baseline occupational status and medication use are reported, change across time is not (despite being listed in the secondary outcomes).

Rini 2015

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment, 5 weeks (post-treatment), and 9 to 11 weeks (post-treatment)
Participants	Start of treatment: N = 113 Post-treatment: N = 109 Sex: 91 F, 22 M Mean age: 67.62 years (SD 9.45) Diagnosis: osteoarthritis knee or hip Mean years of pain: NR
Interventions	Intervention name: PainCOACH Psychological approach: CBT Duration: 8 weeks Control type: assessment only (no details of TAU)
Outcomes	Primary pain outcome: AIMS2 – Pain subscale Primary disability outcome: AIMS2 – subscales relevant to lower extremity functioning Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: PASS-20 Primary depression outcome: none Intervention satisfaction: none Intervention engagement: none Other outcome measures: self-efficacy for pain management (Arthritis Self-Efficacy Scale), positive and negative affect (Positive and Negative Affect Scale), sociodemographic and medical variables (AIMS2)
Notes	**Funding:** National Institute of Arthritis and Musculoskeletal Skin Diseases (National Institutes of Health). Part funding from Johnston County Osteoarthritis Project (from which some participants in this trial were derived), which is supported in part by cooperative agreements S043, S1734, and S3486 from Centers for Disease Control (CDC) and Prevention/Association of Schools of Public Health; NIAMS Multipurpose Arthritis and Musculoskeletal Disease Center grant 5-P60-AR30701; and NIAMS Multidisciplinary Clinical Research Center grants 5-P60-AR49465 and P60-AR064166

Rini 2015 *(Continued)*

Conflicts of interest: none (CR: payment from a grant supporting the study (institution/past), financial relationship (employment/ongoing UNC-Chapel Hill), grants pending, receiving travel/accommodation/meeting expenses related to NIH grant review. LSP, TJS, DCM, MS, GW, DKA, RG, JLS, CM, JMJ, DSC: payment from a grant supporting the study (institution/past). MS: employment at EMG Serono Inc, ownership of stock in BMS, AbbVie, Abbott labs. GW: consultancy payment/honorarium (ongoing), fees for participating in review activities, payment for writing/reviewing manuscript. DKA: consultation fee for honorarium from UNC-Chapel Hill. RG: employment with Memorial Hospital of RI. JLS: employment at UNC-Chapel Hill. CM: employment at Duke. CP: employment at UNC-Chapel Hill. JMJ: consultancy and grants pending. FJK: nothing to declare).

Country: USA

Trial registration: NCT01638871

Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	A computer-generated permuted block sequence was used and was stratified by sex and age.
Allocation concealment (selection bias)	Low risk	Sequentially-numbered opaque envelopes were used to conceal the allocation until after baseline assessments.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Staff blinded at baseline and post-assessment; unblinded staff at midpoint called to ask participants to complete and post-return questionnaires they already had in their possession (staff member did not take the assessment measures)
Incomplete outcome data (attrition bias) All outcomes	Low risk	Attrition rate in both groups < 10%
Selective reporting (reporting bias)	High risk	Prospectively registered. Secondary outcomes updated after study start date. More outcomes were reported in registry than the publication (change in bodily relaxation; behavioural observation task for 'change in problem-solving'; open-ended questions on programme usability; medication type and frequency of use across the study (baseline/midtreatment/post-treatment); adapted CSQ-R, CPCI subscales, WHYMPI subscales, and additional items that measure use of strategies taught; TIPI). Also, 6 months FU in registry: not mentioned in article. Many means reported are unadjusted (Table 3) despite use of covariates. Some adjusted means reported in text (e.g. pain) but only when significant, and for pain, no reported analysis of full sample (women only) (clinicaltrials.gov/ct2/show/record/NCT01638871)

Ruehlman 2012

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, post-treatment (7 weeks), FU (14 weeks)
Participants	Start of treatment: N = 330 Post-treatment: N = 241

Ruehlman 2012 *(Continued)*

	Sex: 196 F, 109 M Mean age: 44.93 years (SD: NR) Diagnosis: mixed (migraine headaches, back injury/disease, tension headaches, osteoarthritis, facial/jaw pain, premenstrual syndrome, pelvic injury/disease, RA, cancer) Mean years of pain: 89.5% had pain > 2 years
Interventions	Intervention name: Chronic Pain Management Programme Psychological approach: CBT (also mentions interpersonal and self-management approaches) Duration: 6 weeks Control type: WL
Outcomes	Primary pain outcome: PCP-Screen and PCP-Extended Assessment Primary disability outcome: PCP-Extended Assessment – perceived disability Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: DASS Primary depression outcome: CES-D Intervention satisfaction: none Intervention engagement: none Other outcome measures: pain knowledge
Notes	**Funding:** National Institute of Neurological Disorders and Stroke **Conflicts of interest:** pain programme described is product fully owned by the first two authors. Third author declares neither ownership nor conflict of interest **Country:** USA – recruited from online pain sites based in USA **Trial registration:** NR Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Randomised but no further information
Allocation concealment (selection bias)	Unclear risk	No information provided about allocation concealment
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Participants completed a battery of online assessments at each assessment interval."
Incomplete outcome data (attrition bias)	Low risk	Higher attrition in the intervention group versus control (> 10%); but used ITT ("we used Mplus 5.21 to estimate the growth models. Mplus accommodates

Ruehlman 2012 *(Continued)*

All outcomes		missing data by using maximum likelihood estimation. This approach makes the so-called missing at random assumption where the probability of missing data at a particular assessment is related to scores at previous assessments or to scores on the covariates")
Selective reporting (reporting bias)	Unclear risk	No trial registry information or published protocol found; therefore, it was not clear if outcomes were reported as planned.

Schlicker 2020

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment, post-treatment (9 weeks), and 6 months FU
Participants	Start of treatment: N = 76 Post-treatment: N = 60 Sex: 55 F, 21 M Mean age: 50.78 years (SD 7.85) Diagnosis: chronic back pain Mean years of pain: NR
Interventions	Intervention name: Get.Back Psychological approach: CBT Duration: 7 weeks Control type: WL/TAU
Outcomes	Primary pain outcome: NRS Primary disability outcome: ODI Primary quality-of-life outcome: AQOL-6D, also EQ-5D-5L Adverse events: participant report of any events Primary anxiety outcome: HADS Primary depression outcome: CES-D Intervention satisfaction: CSQ-8 Intervention engagement: log-in data Other outcome measures: QIDS Self-Report-16, Pain Self-Efficacy Questionnaire, Mood Disorder Questionnaire (to screen for bipolar disorder), Subjective Prognostic Employment Scale (working capacity), WAI-Short Revised (Working Alliance Industry), TiC-P illness (healthcare utilisation and sick leave data), Inventory for the Assessment of Negative Effects of Psychotherapy
Notes	**Funding:** FAU, German Federal Ministry of Education and Research (project “Effectiveness of a guided Web-based intervention for depression in back pain rehabilitation aftercare,” grant numbers: 01GY1330A; 01GY1330B) **Conflicts of interest:** "All authors were involved in the development of Get.Back or its predecessor versions. SaS and LS received payments for workshops on e-mental-health. SaS has received reimburse-

Schlicker 2020 *(Continued)*

ment of congress attendance and travel costs, and payments for lectures with Psychotherapy Training Institutes. HB, DL, and MB received consultancy fees, reimbursement of congress attendance, and travel costs, and payments for lectures with the Psychotherapy and Psychiatry Associations and Psychotherapy Training Institutes (discussing E-Mental-Health topics). They have been beneficiaries of study support (third-party funding) from several public funding organisations. DE has shares in GET.ON Institut GmbH, which works to transfer research findings on internet- and mobile phone-based health interventions into routine care. DE has received payments from several companies and health insurance providers for advice on use of internet-based interventions. He has received payments for lectures delivered for Psychotherapy and Psychiatry Associations and has been beneficiary of third-party funding from health insurance providers. DL is minor stakeholder of the GET.ON Institut GmbH, which aims to transfer scientific knowledge related to this research into routine health care. MB, HB, DE, and DL were not involved in the data analysis".

Country: Germany

Trial registration: DRKS00010820

Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"An automated, Web-based randomisation programme was used, which features permuted block randomisation. Variable randomly arranged block sizes of 4, 6, 8 and an allocation ratio of 1:1 were adopted."
Allocation concealment (selection bias)	Low risk	Randomisation determined a priori by independent researcher (not otherwise involved in the study)
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Participants completed self-report questionnaire online
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10%; used ITT analyses (missing data were multiply imputed using a Markov chain Monte Carlo [68] multivariate imputation algorithm with 50 estimations per missing value in accordance with the intention-to-treat principle); plus last observation carried forward; plus per-protocol analysis on primary outcomes for completers versus noncompleters
Selective reporting (reporting bias)	High risk	Appears prospectively registered; several secondary outcomes listed in trial registry are not reported: Child Trauma Questionnaire; Big-Five Personality Inventory; Personality Inventory; Questionnaire on Therapy Expectations, subscale Hopefulness; Questionnaire on Supportive Accountability (www.drks.de/drks_web/navigate.do?navigationId=trial.HTML&TRIAL_ID=DRKS00010820).

Scott 2018

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, post-treatment (3 months), and 9 months (FU)
Participants	Start of treatment: N = 63 Post-treatment: N = 48

Scott 2018 *(Continued)*

	Sex: 40 F, 23 M Mean age: 25.52 years (SD 13.98) Diagnosis: mixed (e.g. head/face/mouth, neck, upper shoulder/limbs, chest, lower back/spine, lower limbs, pelvic region, anal/genital, widespread pain) Mean years of pain: median 6.75 years (range: 0.75 to 47.50 years)
Interventions	Intervention name: ACT online Psychological approach: ACT Duration: 10 to 12 weeks Control type: TAU
Outcomes	Primary pain outcome: pain intensity over the previous week (NRS) Primary disability outcome: WSAS Primary quality-of-life outcome: none Adverse events: adverse events logged by therapist Primary anxiety outcome: none Primary depression outcome: PHQ-9 Intervention satisfaction: "Treatment satisfaction items were adapted from a validated measure of treatment credibility (Devilly and Borkovec, 2000)" Intervention engagement: mean number of sessions completed Other outcome measures: Brief Pain Inventory – interference scale, treatment completion measured as those completing at least 7 of 10 sessions (defined a priori), additional intervention experience items and open-ended questions (pg. 1478), Patient Global Impression of Change Scale, Pain-related distress, health care and medication use, CPAQ-8, Experiences Questionnaire (decentering), CAQ-8
Notes	**Funding:** International Association for the Study of Pain John J. Bonica Trainee Fellowship grant awarded to WS. Guy's and St. Thomas's Charity provided funding for the development of the online treatment materials. **Conflicts of interest:** WS, BG, and LMW deliver ACT-based treatment for pain within UK's National Health Service and provide training in ACT to students. LM is a section editor at the European Journal of Pain. Authors declare no further conflicts of interest. **Country:** UK **Trial registration:** ISRCTN81739991 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Following baseline assessment, participants were randomly assigned (1:1 ratio) to ACT online plus speciality medical treatment for pain, or speciality medical treatment only, using computer-generated random numbers (www.random.org)."

Scott 2018 *(Continued)*

Allocation concealment (selection bias)	Low risk	"Sealed, sequentially numbered opaque envelopes were used to conceal the sequence, which had been produced by an independent researcher who had no other involvement in the trial. The lead author (WS) enroled participants and informed them of their treatment condition after another researcher (AD) opening the envelope."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"Participants completed self-report questionnaires through Bristol Online Survey (https://www.onlinesurveys.ac.uk), a secure survey platform. The researcher who sent the questionnaire web link was aware of participants' treatment assignment; however, all participants received a standardised email and subsequently completed questionnaires independently."
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition; used ITT on continuous secondary outcomes (linear mixed-effects regression models with maximum-likelihood estimation were used (accounting for data missing at random)). Last observation carried forward imputation approach also used
Selective reporting (reporting bias)	Unclear risk	Retrospectively registered; reported outcomes consistent with registered trial (www.isrctn.com/ISRCTN81739991?q=ISRCTN81739991&filters=&sort=&offset=1&totalResults=1&page=1&pageSize=10&searchType=basic-search)

Serrat 2021

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment and post-treatment (12 weeks)
Participants	Start of treatment: N = 151 Post-treatment: N = 112 Sex: 141 F, M 10 Mean age: 54.35 years (SD 8.68) Diagnosis: fibromyalgia Mean years of pain: 15.75 years (since diagnosis; SD 9.16)
Interventions	Intervention name: FIBROWALK Psychological approach: multicomponent, CBT (also mindfulness) Duration: 12 weeks Control type: WL and TAU
Outcomes	Primary pain outcome: none Primary disability outcome: SF-36 Physical Functioning Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: HADS Primary depression outcome: HADS Intervention satisfaction: none

Serrat 2021 *(Continued)*

	Intervention engagement: none Other outcome measures: FIQ-R, Tampa Scale for Kinesiophobia
Notes	**Funding:** Vall d'Hebron Institute of Research Funding **Conflicts of interest:** NR **Country:** Spain **Trial registration:** NCT04284566 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"After completing baseline examinations, individuals who agreed to participate in the study were assigned to an alphanumeric code list and were randomised using the SPSS statistical package (v25) (Kaysville, UT, USA) to either the active group or control group (TAU)."
Allocation concealment (selection bias)	Low risk	"[Randomisation] was carried out using numbered envelopes containing sheets with information regarding participant allocation. The envelopes were prepared by a nurse from the CSSSU. Neither the participants nor the clinical professional who conducted the programme (MS) could be blinded. However, MS did not participate in any stage of the patient assessment process, and the researcher responsible for the outcome measures (MM) was blinded to the treatment allocation."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"The researcher responsible for the outcome measures (MM) was blinded to the treatment allocation."
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	> 10% in intervention group (very high compared to control); LOCF employed for missing values in ITT
Selective reporting (reporting bias)	Unclear risk	Retrospectively registered; outcomes consistent between registered trial and paper

Simister 2018

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment, post-treatment (8 weeks), and FU (3 months)
Participants	Start of treatment: N = 67 Post-treatment: N = 58 Sex: 64 F, 3 M Mean age: 39.7 years (SD 9.36) Diagnosis: fibromyalgia

Simister 2018 *(Continued)*

	Mean years of pain: 10.16 years (since diagnosis; SD 7.83)
Interventions	Intervention name: online ACT Psychological approach: ACT Duration: 8 weeks Control type: TAU
Outcomes	Primary pain outcome: SF-MPQ Primary disability outcome: 6-minute walk test (6MWT) Primary quality-of-life outcome: none Adverse events: none Primary anxiety outcome: none Primary depression outcome: CES-D Intervention satisfaction: none Intervention engagement: percentage of participants submitting optional unit assignments Other outcome measures: FIQ-R, PSQI, 6MWT, One-Minute Sit-to-Stand Test, CPAQ-R, FFMQ, CFQ-D, VLQ, TSK-11, PCS
Notes	**Funding:** doctoral dissertation of HDS and was supported by financial grant from Health Sciences Centre Foundation, Winnipeg, Manitoba, Canada **Conflicts of interest:** none **Country:** Canada **Trial registration:** NCT01642810 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomised by: "a randomisation sequence created by the first author (H.D.S.) using an online randomiser (www.random.org)"
Allocation concealment (selection bias)	Low risk	A research assistant blind to treatment conditions handed participants an envelope that contained their assigned unique user identification.
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Participants completed assessments online except for physical measures (e.g. 6-minute walk and sit-to-stand tests).
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition; linear mixed-effects modelling analysis/ITT
Selective reporting (reporting bias)	Low risk	Prospectively registered; mostly consistent report of outcomes based on registered trial. However, the Global Assessment Scale (unpublished scale) from the trial registry is not reported, and the physical outcome measures (6-minute walk and sit-to-stand) are not mentioned as outcomes

Simister 2018 *(Continued)*

	in the registry (www.clinicaltrials.gov/ct2/show/NCT01642810?term=NCT01642810&draw=2&rank=1)

Smith 2019

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment, 8 weeks (midpoint), post-treatment (16 to 17 weeks), and 3 months FU
Participants	Start of treatment: N = 91 Post-treatment: N = 65 Sex: 70 F, 10 M Mean age: 45 years (SD 13.86) Diagnosis: chronic pain Mean years of pain: < 5 years (33%); ≥ 5 years (47%)
Interventions	Intervention name: Reboot Online Psychological approach: multidisciplinary with CBT components Duration: 16 weeks Control type: TAU
Outcomes	Primary pain outcome: BPI Primary disability outcome: PDI Primary quality of life outcome: none Adverse events: none Primary anxiety outcome: none Primary depression outcome: PHQ-9 Intervention satisfaction: none Intervention engagement: number of participants completing each lesson Other outcome measures: PSEQ, PCS, CPAQ, K-10
Notes	**Funding:** St Vincent's Clinic Foundation (Sydney, Australia), Motor Accidents Authority, NSW Government (now State Insurance Regulatory Authority (SIRA)), and Australian National Health and Medical Research Council (NHMRC) and Medical Research Future Foundation (MRFF) **Conflicts of interest:** none **Country:** Australia **Trial registration:** ACTRN12616000249459 Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Smith 2019 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomised by "random number sequence generated at www.random.org by a person independent of the study."
Allocation concealment (selection bias)	Low risk	"Eligible participants were randomised based on a random number sequence generated at www.random.org by a person independent of the study. Telephone interviewers remained blinded to participants' group allocation; once randomisation occurred, participants and study staff could not remain blinded to group allocation."
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Some indication questionnaires were provided by email for completion by the participants (at least in TAU/usual care group) but not fully detailed.
Incomplete outcome data (attrition bias) All outcomes	Low risk	> 10% attrition; ITT analysis (intention-to-treat linear mixed models with random intercepts for participants were estimated separately for each of the dependent variables)
Selective reporting (reporting bias)	High risk	Prospectively registered; two missing secondary outcomes specified in trial (DASS-21; Fear Avoidance Beliefs Questionnaire; www.anzctr.org.au/Trial/Registration/TrialReview.aspx?id=370152&isReview=true)

Vallejo 2015

Study characteristics	
Methods	RCT; 3 arms; assessed pretreatment, post-treatment (10 weeks), FU (3, 6, 12 months)
Participants	Start of treatment: N = 40 Post-treatment: N = 40 Sex: 40 F, 0 M Mean age: 51.55 years (SD 9.87) Diagnosis: fibromyalgia Mean years of pain: 13.7 years (generalised pain) (SD 13.05)
Interventions	Intervention name: iCBT+ standard care Psychological approach: CBT Duration: 10 weeks Control type: WL and TAU
Outcomes	Primary pain outcome: none Primary disability outcome: none Primary quality of life outcome: none Adverse events: none

Vallejo 2015 *(Continued)*

	Primary anxiety outcome: HADS-Anxiety Primary depression outcome: BDI Intervention satisfaction: none Intervention engagement: none Other outcome measures: FIQ, PCS, CPSS, CPCI
Notes	**Funding:** Instituto de la Mujer, Ministerio de Sanidad, Servicios Sociales e Igualdad, Spanish Government (Exp. 2011-INV-00232) **Conflicts of interest:** none **Country:** Spain **Trial registration:** NR Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Participants were "randomly assigned by a computer-generated randomisation schedule".
Allocation concealment (selection bias)	Unclear risk	Limited information and unclear if research assistant was involved further in the study: "The randomisation was conducted by a research assistant."
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Outcome assessment method not detailed
Incomplete outcome data (attrition bias) All outcomes	Low risk	No attrition between pretreatment and post-treatment; ITT used on FU but not relevant as no control group at FU
Selective reporting (reporting bias)	Unclear risk	No protocol or trial registration for comparison

Williams 2010

Study characteristics

Methods	RCT; 2 arms; assessed pretreatment and 6 months
Participants	Start of treatment: N = 118 Post-treatment: N = 106 Sex: 112 F, 6 M Mean age: 50.46 years (SD 11.45) Diagnosis: fibromyalgia

Williams 2010 *(Continued)*

	Mean years of pain: 9.40 years (SD 6.46)
Interventions	Intervention name: Living Well with Fibromyalgia Psychological approach: CBT Duration: 26 weeks, 13 modules Control type: TAU
Outcomes	Primary pain outcome: BPI Primary disability outcome: SF-36 Primary quality of life outcome: none Adverse events: none Primary anxiety outcome: STAI Primary depression outcome: CES-D Intervention satisfaction: of the individual item reported: general satisfaction Intervention engagement: mean number of skills used by participants by month Other outcome measures: comorbid symptoms (fatigue (MFI), sleep problems (MOS Sleep Scale), patient impression of change (PGIC)
Notes	**Funding:** grant numbers R01-AR050044 (NIAMS/NIH) and DAMD 17-00-2-0018 (Department of Defense) **Conflicts of interest:** none **Country:** USA **Trial registration:** NR Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"A computerised randomisation programme assisted in the development of the allocation sequence for study."
Allocation concealment (selection bias)	Low risk	"Allocation concealment was utilised to prevent selection bias and group assignment was given to both the participant and selected study staff only after completion of the baseline assessments."
Blinding of outcome assessment (detection bias) All outcomes	Low risk	"All patient-reported outcome measures were obtained by asking the participant to complete the questionnaires online in a supervised clinic setting. Participants in both arms of the study were asked to return to the clinic at the end of 6 months in order to complete the same battery for a second time (i.e. study endpoint). Study personnel assigned to assist participants in the clinic setting were blinded to participants' treatment assignment."
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low attrition (10.2%) and ITT used

Williams 2010 *(Continued)*

Selective reporting (reporting bias)	Unclear risk	No protocol or trial registration for comparison

Wilson 2015

Study characteristics	
Methods	RCT; 2 arms; assessed pretreatment and post-treatment (8 weeks)
Participants	Start of treatment: N = 114 Post-treatment: N = 92 Sex: 72 F, 20 M Mean age: 49.3 years (SD 11.6) Diagnosis: chronic pain with opoid prescription (mixed; most common: back or spine conditions (45%), fibromyalgia (29%), arthritis/osteoarthritis (26%), migraine headache (22%), and chronic postsurgical pain (17%)) Mean years of pain: NR
Interventions	Intervention name: Chronic Pain Management Programme Psychological approach: not specified but included cognitive and behavioural components (as well as social and emotional regulation) Duration: 8 weeks Control type: WL and TAU
Outcomes	Primary pain outcome: BPI Primary disability outcome: none Primary quality of life outcome: none Adverse events: none Primary anxiety outcome: none Primary depression outcome: PHQ-9 – Depression scale Intervention satisfaction: Usability/Satisfaction Questionnaire (adapted from the IBM Computer Usability and Satisfaction Questionnaires) Intervention engagement: continuous variable based on activities completed Other outcome measures: PSEQ, Current Opioid Misuse Measure (COMM), Pain Self-Efficacy Questionnaire
Notes	**Funding:** Washington State Life Sciences Discovery Fund (part funding grant LSDF 08–02, John Roll, PI) **Conflicts of interest:** NR **Country:** USA **Trial registration:** NR

Wilson 2015 *(Continued)*

	Intervention development, intervention delivery, and percentage interaction of healthcare professional obtained and confirmed by study authors upon contact

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Article states study was randomised but does not provide any details of randomisation process
Allocation concealment (selection bias)	Unclear risk	No detail
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Participants completed measures online.
Incomplete outcome data (attrition bias) All outcomes	High risk	Attrition > 10%; no use of ITT or baseline observation carried forward
Selective reporting (reporting bias)	Unclear risk	No protocol or trial registration for comparison

ACT: acceptance and commitment therapy; **AIMS2:** Arthritis Impact Measurement 2; **AQOL:** Assessment of Quality of Life; **ASI:** Anxiety Sensitivity Index; **BAI:** Beck Anxiety Index;**BDI:** Beck Depression Inventory; **BPI:** Brief Pain Inventory; **CAQ:** Committed Action Questionnaire; **CBT:** cognitive behavioural therapy; **CES-D:** Center for Epidemiological Studies Depression Scale; **CFQ-D:** Cognitive Fusion Questionnaire;**COMM:** Current Opioid Misuse Measure; **CPAQ:** Chronic Pain Acceptance Questionnaire; **CPAQ-R:** Chronic Pain Acceptance Questionnaire-Revised; **CPCI:** Chronic Pain Coping Inventory; **CPSS:** Chronic Pain Self-Efficacy Scale; **CRPS:** complex regional pain syndrome; **CSQ-8:** Client Satisfaction Questionnaire; **CSQ-R:** Coping Strategies Questionnaire; **DASS:** Depression Anxiety Stress Scales; **DN4:** Douleur Neuropathique en 4 Questions; **DSM:** Diagnostic and Statistical Manual of Mental Disorders; **ED:** emergency department; **EQ-5D:** EuroQoL-5 Dimensions; **EQ-5D-5L:** EuroQoL-5 Dimensions-5 Level; **F:** female; **FFMQ**: Five Facets Mindfulness Questionnaire; **FIQ:** Fibromyalgia Impact Questionnaire; **FIQ-R:** Fibromyalgia Impact Questionnaire-Revised; **FU:** follow-up; **GAD-7:** Generalised Anxiety Disorder-7; **HADS:** Hospital Anxiety and Depression Scale; **HCP:** healthcare professional; **HDRS/HDS:** Hamilton Depression Rating Scale; **iCBT:** internet-based cognitive behavioural therapy; **iExp:** internet-delivered exposure therapy; **INEP:** Inventory for the assessment of Negative Effects of Psychotherapy; **IRGL:** Impact of Rheumatic Diseases on General Health and Lifestyle; **ITT:** intention-to-treat; **K-10:** 10-item Kessler Psychological Distress Scale; **LMM:** linear mixed model; **LOCF:** last observation carried forward; **MADRS-S:** Montgomery-Åsberg Depression Rating Scale; **MFI:** Multidimensional Fatigue Inventory; **MOS:** Medical Outcomes Study; **MPI:** Multidimensional Pain Inventory; **6MWT:** 6-Minute Walk Test;**M:** male; **N:** number of participants; **NA:** not applicable; **NHMRC:** National Health and Medical Research Council; **NIAMS:** National Institute of Arthritis and Musculoskeletal and Skin Diseases; **NIH:** National Institutes of Health; **NR:** not reported; **NRS:** Numerical Rating Scale; **ODI:** Oswestry Disability Index; **PASS-20:** Pain Anxiety Symptoms Scale-20; **PCP:** Profile of Chronic Pain; **PCS:** Pain Catastrophising Scale; **PDI:** Pain Disability Index; **PGIC:** Patient Global Impression of Change; **PHQ:** Patient Health Questionnaire; **PPI:** positive psychology intervention; **PSEQ:** Pain Self-Efficacy Questionnaire; **PSQI:** Pittsburgh Sleep Quality Index; **PTSD:** Post-Traumatic Stress Disorder; **QIDS:** Quick Inventory of Depressive Symptomatology; **QOLI:** Quality of Life Inventory; **RA:** rheumatoid arthritis; **RAND-36:** Research and Development Corporation 36-item health survey; **RCT:** randomised controlled trial; **RMDQ:** Roland-Morris Disability Questionnaire; **SCS-SF:** Self-Compassion Scale-Short Form; **SD:** standard deviation; **SF:** Short Form; **SF-MPQ:** McGill Pain Questionnaire Short Form; **SPE:** Subjective Prognostic Employment Scale; **STAI:** State-Trait Personality Inventory; **TAU:** treatment as usual; **TCS:** Treatment Credibility Scale; **TiC-P:** Treatment Inventory of Costs in Psychiatric Patients; **TIPI:** Ten-Item Personality Inventory; **TSK:** Tampa Scale for Kinesiophobia-11; **VAS:** Visual Analogue Scale; **VLQ:** Valued Living Questionnaire; **WBPQ:** Wisconsin Brief Pain Questionnaire; **WHOQOL-BREF:** World Health Organization Quality of Life Brief Version Questionnaire; **WHYMPI:** West Haven-Yale Multidimensional Pain Inventory; **WL:** waiting list; **WOMAC:** Western Ontario and McMaster Universities Osteoarthritis Index; **WSAS:** Work and Social Adjustment Scale

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Carleton 2020	Intervention: insufficient or ineligible psychological therapy content
Chiauzzi 2010	Intervention: does not meet the interactivity criteria
Dhokia 2020	Intervention: aim is not to facilitate pain management and coping
Dobson 2014	Intervention: more than 30% therapist/HCP involvement in delivery
Domenech 2013	Intervention: not remote delivery
Everitt 2019	Intervention: aim is not to facilitate pain management and coping
Forbes 2020	Intervention: mindfulness
Fraenkel 2020	Intervention: more than 30% therapist/HCP involvement in delivery
Garcia-Palacios 2015	Intervention: not remote delivery
Geraghty 2018	Intervention: not developed by or under the supervision of a qualified psychologist
Guillory 2015	Intervention: no psychological component
Kristjánsdóttir 2013	Other: received full pain-management programme, including cognitive behavioural therapy, immediately prior to tech intervention
Lin 2018	Intervention: does not target pain
Lorig 2008	Intervention: unclear how the intervention was developed and how much HCP involvement there was
Martin 2021	Intervention: more than 30% therapist/HCP involvement in delivery
Molinari 2018	Intervention: more than 30% therapist/HCP involvement in delivery
Nes 2017	Other: maintenance intervention post–inpatient treatment
Norton 2021	Other: although may include chronic pain, this was not a specific inclusion criterion (mixed symptoms), and inclusion of pain intervention component is dependent on relevance to participants
NTR3775	Study: no publication, registered protocol over 5 years old
Pach 2022	Intervention: not developed by a qualified psychologist
Riva 2014	Intervention: no psychological component
Rutledge 2018	Intervention: more than 30% therapist/HCP involvement in delivery
Sandal 2021	Intervention: no psychological component
Sander 2020	Intervention: insufficient pain content and primarily focused on depression
Suman 2019	Intervention: no psychological component
Trompetter 2015	Intervention: no response from authors; unclear how the intervention was developed

HCP: healthcare professional

Characteristics of ongoing studies *[ordered by study ID]*

Bartels 2022

Study name	Development, evaluation and implementation of a digital behavioural health treatment for chronic pain: study protocol of the multiphase DAHLIA project
Methods	**Study design**: randomised controlled trial with two arms **Comparison:** treatment as usual **Target sample size**: 360 **Masking**: single (outcome assessor) **Country**: Sweden
Participants	**Inclusion criteria**: chronic pain duration of ≥ 3 months
Interventions	**Arm 1**: 6-week behavioural DAHLIA treatment (CBT, ACT process-based treatment; microlearning format with 4 digital microsessions per week; exposure as the core process; guidance to be OPEN, AWARE, ACTIVE; weekly contact with therapist; booster sessions after 2 and 4 months) **Arm 2**: treatment as usual (usual treatment at their rehabilitation centre; detailed information will be collected to define what treatment as usual means in clinical settings)
Outcomes	**Primary outcomes (at baseline and 7 weeks, 3 months, and 6 months FU):** • Catastrophising (CSQ-8) • (Dis)ability/pain screening (ÖMPSQ) • Work ability (WAI) • Functioning (BPI-SF) **Secondary outcomes (at baseline and 7 weeks, 3 months, and 6 months FU):** • Wellbeing/depression (PHQ-9) • Perceived stress (PSS) • Sleep problems (ISI) **Tertiary outcomes (at baseline and 7 weeks, 3 months, and 6 months FU):** • Open/acceptance (CPAQ) • Awareness (FFMQ) • Engagement/commitment action (Valuing Questionnaire, Committed Action Questionnaire) • Psychological flexibility (MPFI) • Self-efficacy (S-GSE) • Pain self-efficacy (PSEQ-2) • Avoidance (PIPS)
Starting date	1 October 2021
Contact information	sara.bartels@ki.se
Notes	**Trial ID**: NCT05066087 **Source**: doi:10.1136/bmjopen-2021-059152 **Funding**: AFA Insurance

Bartels 2022 *(Continued)*

	Estimated trial completion date: 30 December 2024

Birckhead 2021

Study name	Home-based virtual reality for chronic pain: protocol for an NIH-supported randomised-controlled trial
Methods	**Study design:** randomised controlled study with 3 arms **Comparison:** skills-based virtual reality (VR) versus distraction-based VR versus sham VR **Target sample size**: 360 participants **Masking**: double (participant and care provider) **Country**: USA
Participants	**Inclusion criteria**: chronic pain duration of ≥ 3 months
Interventions	**Arm 1**: skills-based VR programme and VR device plus wearable motion- and sleep-tracking device **Arm 2**: distraction-based VR programme and VR device plus wearable motion- and sleep-tracking device **Arm 3**: placebo control: sham VR programme and VR device
Outcomes	**Primary outcomes:** • Pain interference at 30 days **Secondary outcomes:** • Pain interference at 60 and 90 days • Pain Catastrophizing Scale Short Form at 90 days • Anxiety at 90 days • Sleep disturbance at 90 days • Milligram morphine equivalent at 90 days **Tertiary outcomes:** • Physical function at 90 days • Depression at 90 days • Global Impression of Change at 90 days • Weekly total steps at 90 days measured by wearable device • Weekly total time asleep and sleep efficiency at 90 days measured by wearable device
Starting date	21 September 2020
Contact information	Brennan.Spiegel@cshs.org
Notes	**Trial ID**: NCT04409353 **Funding**: National Institute of Arthritis and Musculoskeletal and Skin Diseases of the National Institutes of Health **Estimated trial completion date**: 30 December 2023

DRKS00025256

Study name	Effectiveness of a dialogue-based online intervention for supportive symptom management in rheumatoid arthritis - Reclarit
Methods	**Study design**: randomised controlled trial with two arms **Comparison:** usual care **Target sample size**: 360 **Masking**: single (data analyst) **Country**: Germany
Participants	**Inclusion criteria**: chronic pain duration of ≥ 3 months
Interventions	**Arm 1**: 12-week Reclarit (online programme plus access to additional information on coping with rheumatoid arthritis (RA) plus usual care) **Arm 2**: usual care (plus access to information (brochures) on coping with RA)
Outcomes	**Primary outcomes (at baseline, 12 weeks, and 6 months):** • Health-related quality of life (SF-36) **Secondary outcomes (at baseline, 3 months, and 6 months):** • General pain level (numeric rating scale) • Physical function in RA (HAQ-DI) • Depression (PHQ-9) • Generalised anxiety (GAD-7) • Fatigue (BRAF-MDQ) • Work and social ability (WSAS/German ASAS) • Medication, physical/psychotherapy **Tertiary outcomes:** NA
Starting date	5 August 2021
Contact information	gitta.jacob@gaia-group.com
Notes	**Trial ID**: DRKS00025256 **Source**: www.drks.de/drks_web/navigate.do?navigationId=trial.HTML&TRIAL_ID=DRKS00025256 **Funding**: GAIA AG **Estimated trial completion date**: unknown

DRKS00026722

Study name	Efficacy and acceptability of the internet-based self-help program 'Lenio' for individuals with chronic pain and depressive symptoms: a randomized controlled trial
Methods	**Study design:** randomised controlled study with 3 arms **Comparison:** waiting-list control group

DRKS00026722 *(Continued)*

	Target sample size: 245 **Masking**: none **Country**: Germany
Participants	**Inclusion criteria**: chronic pain duration of ≥ 3 months
Interventions	**Arm 1**: 8-week Lenio online self-help programme (11 modules interactively designed to address chronic pain and depression. The modules consist of psychoeducational texts, graphics, audios, and worksheets. A smartphone app can be used combination with the programme). **Arm 2**: waiting-list control group (will receive the online Lenio self-help programme 16 weeks after baseline) **Arm 3**: active control group (have direct access to a transdiagnostic self-help app)
Outcomes	**Primary outcomes:** • Pain impairment (numeric rating scale; German Pain Questionnaire) at baseline and 8 weeks **Secondary outcomes (at baseline, 8 weeks, and 16 weeks FU):** • Depressive symptoms (PHQ-9) • Depression (BDI-II) • Severity of symptoms (pain severity (GPQ)) • Feelings of injustice (IEQ) • Catastrophising thinking (PCQ) • Fear-related avoidance attitudes (FABQ) • Pain perception and coping (FSS) • Quality of life (WHOQOL-BREF) • Side effects (PANEPS-I) • Readiness for change (URICA) **Tertiary outcomes:** none
Starting date	15 October 2021
Contact information	s.borsutzky@uke.de moritz@uke.de
Notes	**Trial ID:** DRKS00026722 **Source**: http://www.drks.de/DRKS00026722 **Funding:** Deutsche Gesetzliche Unfallversicherung (DGUV) **Estimated trial completion date:** unknown

DRKS00027176

Study name	HelloBetter chronic pain study
Methods	**Study design**: randomised controlled trial with 2 arms **Comparison**: usual care **Target sample size**: 360 participants

DRKS00027176 *(Continued)*	
	Masking: single (data analyst) **Country**: Germany
Participants	**Inclusion criteria**: chronic pain duration of ≥ 3 months
Interventions	**Arm 1**: 12-week online programme HelloBetter "ratiopharm" chronic pain (7 modules to help reduce pain interference) **Arm 2**: usual care. Unrestricted access to all treatment options of routine care, equivalent to the reality of care. Routine care for people with chronic pain includes care by general practitioners, pain physicians, and pain therapists; psychotherapeutic treatment as well as drug therapy; physical therapy; and exercise therapy.
Outcomes	**Primary outcomes (at 12 weeks, 6 months, and 12 months FU):** • Pain interference (MPI) **Secondary outcomes (at 12 weeks, 6 months, and 12 months FU):** • Health-related quality of life (AQOL-8D) • MPI (pain intensity, self-control, negative mood) • Pain impairment in everyday life (PDI) • Anxiety (GAD-7) • Pain processing (FESV) • Pain acceptance (CPAQ) • Psychological flexibility (AAQ, PIPS) • Pain-specific self-efficacy (PSEQ) • Patient satisfaction (CSQ-8) • Negative Effects Questionnaire (NEQ) • Subjective global assessment of change (PGIC) **Tertiary outcomes:** NA
Starting date	13 January 2022
Contact information	david.daniel.ebert@tum.de matthias.guth@uk-bonn.de antonia.barke@ku.de
Notes	**Trial ID:** DRKS00027176 **Source**: https://www.drks.de/drks_web/navigate.do?navigationId=trial.HTML&TRIAL_ID=DRKS00027176 **Funding:** GET.ON Institut für Online Gesundheitstrainings GmbH **Estimated trial completion date:** unknown

Hayes 2014	
Study name	Comparing the clinical-effectiveness and cost-effectiveness of an internet-delivered ACT intervention with a waiting list control among adults with chronic pain: study protocol for a randomised controlled trial
Methods	**Study design**: randomised controlled trial with 2 arms

Hayes 2014 *(Continued)*

	Comparison: waiting-list control **Target sample size**: 126 **Masking**: single (blinded statistician) **Country**: Ireland
Participants	**Inclusion criteria**: chronic pain duration of ≥ 3 months
Interventions	**Arm 1**: Internet-delivered ACT intervention (8 sessions over 8 weeks) **Arm 2**: waiting-list control
Outcomes	**Primary outcomes (at baseline, post-treatment/8 weeks, and 6 months FU):** • Pain intensity and interference (BPI-SF) **Secondary outcomes (at baseline, post-treatment/8 weeks, and 6 month FU):** • Depression (BDI) • Pain-related anxiety (PASS-20) • PGIC • Acceptance of chronic pain (CPAQ-8) • Health-related quality of life (EQ-5D) • Healthcare usage (CSRI) **Tertiary outcomes:** none
Starting date	1 March 2014
Contact information	brian.mcguire@nuigalway.ie
Notes	Study is complete. No publication including data. We contacted author, and they advised that they intend to write up the study results in the immediate future. Consequently, we continue to list this study as ongoing in the 2023 version of the review.

Menzies 2022

Study name	Randomised controlled trial of cognitive behaviour therapy versus mindfulness for people with rheumatoid arthritis with and without a history of recurrent depression: study protocol and design
Methods	**Study design:** randomised controlled trial with 3 arms **Comparison:** cognitive behavioural therapy (CBT) or mindfulness-based stress reduction (MBSR) versus waiting-list control **Target sample size**: 300 **Masking**: single (data analyst) **Country**: Australia
Participants	**Inclusion criteria**: confirmed diagnosis of rheumatoid arthritis (RA)
Interventions	**Arm 1**: 8-week adapted online CBT intervention based on the Pain Course (Dear 2013). The intervention consists of 5 modules covering topics on 1) pain education, 2) cognitive therapy (thought monitoring and challenging), 3) controlled breathing and pleasant activity scheduling, 4) pacing and graded exposure, 5) relapse prevention and goal setting.

Menzies 2022 *(Continued)*

	Arm 2: 8-week MBSR intervention tailored to needs and difficulties, consisting of 5 modules covering 1) an introduction to mindfulness meditation, 2) dealing with stress, 3) dealing with difficult sensations and emotions, 4) dealing with difficult thoughts, and 5) mindful communication, compassion, and relapse prevention. **Arm 3**: waiting-list control group will have access to the programme of their choice (MBSR or CBT) once they finish the trial (i.e. once the 6-month FU questionnaires are completed)
Outcomes	**Primary outcomes (at 8 weeks and 6 months FU):** • Pain interference (BPI-SF) **Secondary outcomes (at 8 weeks and 6 months FU):** • Depressive symptoms (PHQ-9) • Anxiety symptoms (GAD-7) • RA symptoms (HAQ-DI) • Pain catastrophising (PCS) • Pain acceptance (CPAQ-Short Form) • Pain self-efficacy (PSEQ) • Mindfulness (FFMQ-Short Form) • Fear of illness progression (FPQ-Short Form) • Existential concerns (ECQ) • Interpretation bias (ambiguous cues task) **Tertiary outcomes:** none
Starting date	1 August 2021
Contact information	louise.sharpe@sydney.edu.au rmen9233@uni.sydney.edu.au
Notes	**Trial ID:** ACTRN12621000997853 **Source:** doi:10.1136/bmjopen-2021-056504 **Funding:** Dorothy Reavley Tinsley Bequest. JD is supported by a Macquarie University Research Fellowship. BD is supported by a National Health and Medical Research Council (NHMRC) Investigator Grant Award. **Estimated trial completion date:** unknown

NCT03504904

Study name	Psychological treatment targeting acceptance and compassion in chronic pain patients: a randomized controlled, internet-delivered, treatment trial
Methods	**Study design**: randomised controlled trial with 2 arms **Comparison:** ACT and compassion-focused therapy (CFT) versus waiting-list control **Target sample size**: 71 **Masking**: none **Country**: Sweden

NCT03504904 *(Continued)*

Participants	**Inclusion criteria**: chronic pain duration of ≥ 3 months
Interventions	**Arm 1**: 8-week guided Internet-delivered ACT and CFT intervention **Arm 2**: waiting-list control (receive treatment at a later point)
Outcomes	**Primary outcomes (at 8 weeks and 6 months FU):** • Acceptance (CPAQ) • Compassion (SCS) • Disability (PDI) **Secondary outcomes (at 8 weeks and 6 months FU):** • Depression (MADRS-S) • Anxiety sensitivity (ASI) • Quality of life (QOLI) • Pain dimensions (MPI) • Persuasive thinking (PTQ) **Tertiary outcomes:** none
Starting date	13 November 2014
Contact information	Monica.Buhrman@psyk.uu.se
Notes	**Trial ID**: NCT03504904 **Funding**: not reported **Estimated trial completion date**: 23 January 2016

NCT03655132

Study name	Developing an online therapeutic intervention for chronic pain in veterans
Methods	**Study design**: randomised controlled trial with 2 arms **Comparison**: ACT versus waiting-list control **Target sample size**: 40 **Masking**: none **Country**: USA
Participants	**Inclusion criteria**: presence of chronic pain as diagnosed by ICD-9 or -10 code related to either musculoskeletal pain or joint problems or osteoarthritis
Interventions	**Arm 1**: 8-week Veteran Acceptance and Commitment Therapy for Chronic Pain programme (7 modules based on explanation of the treatment rationale, initial psychoeducation on pain-related symptoms, pain interference, and focal concepts of ACT, assessment of individual pain symptoms, values clarification, acceptance and willingness, mindfulness, emphasis on tolerance of pain-related experiences, continued focus, goal-creation, committed action exercises, consolidation, feedback on goal-related achievements, planning for the future) **Arm 2**: waiting-list control (participants will be provided with list of common pain resources)

NCT03655132 *(Continued)*

Outcomes	**Primary outcomes (at 8 weeks):** • System usability (SUS and usability survey) **Secondary outcomes (at 8 weeks):** • Engagement in functional activities of daily living (POQ-VA) • Pain recognition (CPAQ) • Experiential avoidance (MEAQ) • Disability- and pain-related anxiety (extent to which a person lives in accordance to their values – work, health, and family; CPVI) • Pain intensity (Pain NRS) • Satisfaction (CSQ-8) **Tertiary outcomes:** none
Starting date	17 March 2022
Contact information	Erin.Reilly@va.gov
Notes	**Trial ID**: NCT03655132 **Funding**: VA Office of Research and Development **Estimated trial completion date**: 31 October 2023

NCT04042090

Study name	A pilot study on the efficacy, acceptability, tolerability, and feasibility of a therapeutic virtual reality application on improving the quality of life in nonspecific chronic low-back pain patients
Methods	**Study design**: randomised controlled trial with 2 arms **Comparison**: ACT and 'eye movement and desensitization and reprocessing' (EMDR) versus waiting-list control **Target sample size**: 41 **Masking**: none **Country**: the Netherlands
Participants	**Inclusion criteria**: chronic nonspecific low-back pain (LBP) not attributable to a recognisable, known specific pathology; pain score related to chronic low-back pain ≥ 4
Interventions	**Arm 1**: Reducept virtual reality intervention at home for 28 to 35 days (hypnotherapy, mindfulness, ACT and EMDR, 25-minute module completion) **Arm 2**: waiting-list control (receiving normal chronic pain treatment)
Outcomes	**Primary outcomes (at 28 days and 148 days FU):** • Positive health (Positive Health Questionnaire) **Secondary outcomes (at 28 days and 148 days FU):** • Pain severity (NRS) • Pain inventory (BPI)

NCT04042090 *(Continued)*

	• Pain catastrophising (PCS) • Pain coping strategies (PCCL) • Anxiety (HADS) • Functioning (ADL) • Pain intensity (NRS) • Medication use (Medication Use Questionnaire) **Tertiary outcomes (at 28 days, via semi-structured interview):** • Feasibility of therapeutic virtual reality • Acceptability of therapeutic virtual reality • Tolerability of therapeutic virtual reality
Starting date	10 December 2019
Contact information	Harry.vanGoor@radboudumc.nl
Notes	**Trial ID**: NCT04042090 **Funding**: Radboud University Medical Centre, Rijnstate Hospital **Estimated trial completion date**: 15 June 2021

NCT04089670

Study name	Online acceptance and commitment therapy for chronic pain in sample of people with Chiari malformation
Methods	**Study design**: randomised controlled trial with 2 arms **Comparison**: ACT versus treatment as usual/waiting-list control **Target sample size**: 52 **Masking**: none **Country**: USA
Participants	**Inclusion criteria**: persistent pain for a minimum of 3 months
Interventions	**Arm 1**: 8-week online ACT intervention (8 modules based on establishing creative hopefulness, abandoning negative experiences and accepting new solutions, identifying experiential avoidance and focus on acceptance, mindfulness, goal setting, making commitments, practical assignment after each module) **Arm 2**: treatment as usual/waiting-list control (participants complete the same sleep diaries and questionnaires but will not be administered the intervention modules and will not receive telephone coaching. After 1 month FU, they will be offered the intervention.
Outcomes	**Primary outcomes (at 8 weeks and 3 months FU):** • Pain interference (BPI-SF) • Psychological flexibility (AAQ) • Sleep dysfunction (ISI, daily sleep diary) • Depression and anxiety (DASS-21) **Secondary outcomes:** none

NCT04089670 *(Continued)*

	Tertiary outcomes: none
Starting date	15 August 2019
Contact information	mgarci14@kent.edu
Notes	**Trial ID**: NCT04089670 **Funding**: Kent State University **Estimated trial completion date**: 30 October 2020

NCT04142177

Study name	Sequential and comparative evaluation of pain treatment effectiveness response: the SCEPTER Trial
Methods	**Study design**: 2-step randomised controlled trial with 6 arms **Comparison**: Pain EASE (Internet-based pain self-management programme) versus CBT versus enhanced physical therapy (active comparator) versus placebo (continued care and active monitoring) versus spinal manipulation therapy versus yoga **Target sample size**: 2529 **Masking**: single (outcome assessor) **Country**: USA
Participants	**Inclusion criteria**: low-back pain present for at least 6 months
Interventions	**Arm 1**: 12-week 10 module-based and Internet-based pain self-management programme Pain EASE (pain education, setting personal goals, planning meaningful activities, physical activity (stretching, body mechanics, and a pedometer-based walking programme), relaxation, developing healthy thinking patterns, pacing and problem-solving, improving sleep, effective communication, and future planning) (step 1 treatment) **Arm 2**: 12-week 10 module-based and Internet-based pain self-management programme (Pain EASE) plus physical therapy (tailored exercise and physical activity guided by a physical therapist involving up to 8 treatment sessions with ongoing home exercise. Exercise focus will be on walking, motor control, stabilisation exercises for low back with flexibility exercises for lumbar spine stiffness) (step 1 treatment) **Arm 3**: placebo (nonstandardised continued care and active monitoring including pharmacological and nonpharmacological treatments for chronic lower back pain, current analgesics (including opioids, acetaminophen, NSAIDs, topical analgesics (capsaicin), SNRIs, tricyclic antidepressants, skeletal muscle relaxants, and alpha-2-delta ligands (gabapentin-like drugs) and nonpharmacological treatments), discussion with physician about pain over 12 weeks (step 1 treatment) **Arm 4**: CBT treatment with a trained therapist using the VA's CBT-CP protocol involving 1 planning session and 9 treatment sessions (10 total) over 12 weeks (step 2 treatment) **Arm 5**: spinal manipulation therapy (SMT; up to 10 sessions over 12 weeks focusing on spinal manipulation and mobilisation of the lower thoracic lumbar and sacroiliac joints. Adjunctive use of myofascial and stretching techniques is allowed as it is commonly used along with SMT and can be considered a standard accompaniment to SMT) (step 2 treatment) **Arm 6**: 10 weekly, 60-minute instructor-led yoga sessions along with 15 to 20 minutes of yoga practiced at home each nonsession day. The yoga programme (classical Hatha yoga with influences from Iyengar and Viniyoga yoga) uses modifications and adaptations, e.g. props such as straps and

NCT04142177 *(Continued)*

	blocks, to minimise the risk of injury and make the poses accessible to people with health problems and limitations. The instructor leads participants through a series of 23 yoga poses (32 total variations) at a slow to moderate pace) (step 2 treatment)
Outcomes	**Primary outcomes (at 12 weeks):** • Pain interference (BPI) **Secondary outcomes:** none **Tertiary outcomes:** none
Starting date	13 June 2022
Contact information	Colleen.Fitzsimmons@va.gov
Notes	**Trial ID**: SCEPTER (NCT04142177) **Funding**: VA Office of Research and Development **Estimated trial completion date**: 17 June 2026

NCT04751825

Study name	Internet-based emotional awareness and expression therapy for somatic symptom disorder – a randomised controlled trial
Methods	**Study design**: randomised controlled trial with 2 arms **Comparison**: internet-based emotional awareness and expression therapy (I-EACT) versus waiting-list control **Target sample size**: 74 **Masking**: none **Country**: Sweden
Participants	**Inclusion criteria**: diagnosis of somatic symptom disorder (DSM-5), symptom duration ≥ 6 months
Interventions	**Arm 1**: 10-week I-EACT intervention (self-help treatment with therapist contact via text messages at least once a week) **Arm 2**: waiting-list control
Outcomes	**Primary outcomes (at 10 weeks and 12 months FU):** • Somatic symptoms (PHQ-15) • Pain symptoms (BPI) **Secondary outcomes (at 10 weeks and 12 months FU):** • Anxiety symptoms (GAD-7) • Depressive symptoms (PHQ-9) • Post-traumatic symptoms (PTSD Checklist-5) • Activity levels (SDS) • Sleepiness symptoms (ESS) • Insomnia symptoms (ISI) • Negative effects (NEQ)

NCT04751825 *(Continued)*

	• Emotional awareness capacity (LEAS) • Emotional processing capacity (EPS-25) **Tertiary outcomes (once a week for 10 weeks):** • Anxiety symptoms (GAD-7) • Depressive symptoms (PHQ-2) • Emotional processing capacity (EPS-25) • Diverse somatic symptoms (PHQ-15) • Pain symptoms (BPI)
Starting date	1 February 2021
Contact information	Robert Johansson, Karolinska Institute, Sweden
Notes	**Trial ID**: NCT04751825 **Funding**: unknown **Estimated trial completion date**: 15 April 2022

NCT05090683

Study name	Evaluation of a mind-body-based application for the treatment of chronic/persistent pain
Methods	**Study design:** randomised controlled trial with 2 arms **Comparison**: mind-body mobile application versus usual care **Target sample size**: 197 **Masking**: none **Country**: Canada
Participants	**Inclusion criteria**: nonmalignant chronic or persistent pain for at least 6 months
Interventions	**Arm 1**: 6-week mind-body mobile application (user-guided mobile application (app) that employs mind-based techniques that include: expressive writing, meditation, cognitive behavioural therapy, and pain education. The app also includes access to podcasts that focus on pain counselling and pain education). **Arm 2**: usual care (continuation of usual pain treatments, no new forms of treatment allowed)
Outcomes	**Primary outcomes (at 6 weeks post-intervention and 12 weeks FU):** • Pain intensity and interference (BPI-SF) **Secondary outcomes (at 6 weeks post-intervention and 12 weeks FU):** • Pain intensity (PROMIS Short Form) • Pain interference (PROMIS-Short Form 8a) • Emotional states (DASS-21) • Impact of health on daily life (SF-12) • Pain intensity and interference (BPI-SF) • Daily and occasional medication use **Tertiary outcomes:** none

NCT05090683 *(Continued)*

Starting date	15 October 2021
Contact information	cynthia.thomson@ufv.ca
Notes	**Trial ID:** NCT05090683 **Funding:** University of the Fraser Valley **Estimated trial completion date:** 15 November 2022

Schubert 2022

Study name	Internet-based cognitive behavioural therapy for improving health-related quality of life in patients with endometriosis: study protocol for a randomised controlled trial
Methods	**Study design:** randomised controlled trial with 2 arms **Comparison**: CBT versus waiting-list control **Target sample size**: 120 **Masking**: none **Country**: Denmark
Participants	**Inclusion criteria**: medically confirmed endometriosis diagnosis; impairment of quality of life due to endometriosis defined as a value of ≥ 15 points across all scales in the Endometriosis Health Profile 30 + 23
Interventions	**Arm 1**: 8-week, 8-module Internet-based CBT intervention (psychoeducation, cognitive strategies, pain and stress management, emotion regulation strategies, communication training, prophylaxis; weekly written contact with their assigned therapist via the news function of the training platform, receiving feedback on the content or getting answers to open questions) **Arm 2**: waiting-list control (no treatment; waiting list receives the same Internet-based CBT intervention after 5 months)
Outcomes	**Primary outcomes (at 8 to 10 weeks post-treatment and 12 months FU):** • Endometriosis-related quality of life (EHP-30 and 23; EHP-5) • Impairment due to pain (PDI) • Impairment due to pain during menstruation and at the moment (VAS) **Secondary outcomes (at 8 to 10 weeks post-treatment and 12 months FU):** • Depressive mood (PHQ-9) • Perceived stress (PSS) • Coping skills (Brief Cope) • Cognitive representation of illness (IPQ-R) • Psychological flexibility (AAQ) **Tertiary outcomes (pretreatment):** • Quality of partnership (RAS) • Personality factors (BFI-10) • Side effects of intervention (NEQ) • Satisfaction with treatment (self-developed questionnaire)

Schubert 2022 *(Continued)*

Starting date	October 2021
Contact information	weise@uni-marburg.de kathrin.schubert@uni-marburg.de johanna.lohse@uni-marburg.de
Notes	**Trial ID:** NCT05098444 **Funding:** "Open Access funding enabled and organized by Projekt DEAL. The researchers working on this trial are employed at Philipps-University Marburg through budgetary funds. No external funding was received for this trial. We received the local grant UMRvernetzt from Philipps-University Marburg for interdisciplinary exchange of medical and psychological expertise. The grant went to the construction of the iCBT platform." **Estimated trial completion date:** December 2023

Slattery 2019b

Study name	Investigating the effectiveness of an online ACT intervention vs a waiting-list control condition on pain interference and quality of life in adults with chronic pain and multimorbidity: protocol for a randomised controlled trial
Methods	**Study design:** randomised controlled trial with 2 arms **Comparison:** ACT versus usual care/waiting-list control **Target sample size**: 160 **Masking**: single (data analyst) **Country**: Ireland
Participants	**Inclusion criteria**: presence of chronic pain for at least 3 months
Interventions	**Arm 1**: 8-week, 8-module online ACT intervention (consisting of information, homework assignments, relevant metaphors, and mindfulness exercises to increase psychological flexibility by developing acceptance, patient-focused awareness, and engagement in values-based action) **Arm 2**: usual care/waiting-list control (participants will complete 8 weeks post-treatment and 3 months FU, after which they will be offered the online ACT intervention)
Outcomes	**Primary outcomes (at 8 weeks post-intervention and 3 months FU):** • Pain interference (BPI) • Quality of life (SF-12) **Secondary outcomes (at 8 weeks post-intervention and 3 months FU):** • Psychological inflexibility (AAQ) • Acceptance (CPAQ) • Perceptions of multimorbidity (MULTIPleS) • Depression (PHQ-9) • Anxiety (GAD-7) • Cost of chronic pain (CSRI) **Tertiary outcomes:** none

Slattery 2019b *(Continued)*

Starting date	15 June 2015
Contact information	brian.slattery@dcu.ie
Notes	**Trial ID**: ISRCTN22343024 **Funding**: Health Research Board **Estimated trial completion date:** 30 November 2019

Terhorst 2020

Study name	Clinical and cost-effectiveness of a guided internet-based acceptance and commitment therapy to improve chronic pain–related disability in green professions (PACT-A): study protocol of a pragmatic randomised controlled trial
Methods	**Study design**: randomised controlled trial with 2 arms **Comparison**: ACT plus treatment as usual versus treatment as usual/waiting-list control **Target sample size**: 286 **Masking**: single (data analyst) **Country**: Germany
Participants	**Inclusion criteria**: chronic pain for 6 months or more
Interventions	**Arm 1**: 7-week, 7-session online ACTonPAIN intervention (basic information on pain and focus on specific ACT processes (e.g. acceptance, defusion, etc.). Mindfulness and mindfulness exercises used throughout. Content includes videos, audio, illustrated examples, and exercises, and between-session homework. Supported by e-Coach (trained psychologist) providing feedback (relating to assignments and supporting adherence) via email or telephone. Intervention group also has access to treatment as usual **Arm 2**: treatment as usual/waiting list (access to psychoeducation, information about stress, depression, and chronic pain). Online audio CD with further information on stress and stress reduction. Information about different treatment options available in routine care
Outcomes	**Primary outcomes (at 9 weeks post-intervention):** • Pain interference (MPI) **Secondary outcomes (at 6, 12, 24, and 36 weeks FU):** • Pain interference (MPI) • Pain intensity (NRS) • Global improvement after treatment (PGIC) • Depression (QIDS-SR16) • Prevalence of major depressive episode (CIDI-SC and "Epi-Q" screening survey) • Stress (PSS-10) • Anxiety (GAD-7) • Sleep quality (ISI) • Hazardous alcohol use (AUDIT) • Quality of life (AQOL-8D) • Reliable change in primary outcome (Reliable Change Index) • Psychological flexibility (CPAQ)

Terhorst 2020 *(Continued)*

	• Cognitive fusion (CFQ-D) • Committed actions (CAQ-D) • Work capacity (SPE) • Satisfaction (CSQ-8) • Satisfaction with Internet-based interventions (CSQ-I) • Therapeutic alliance between participant and e-Coach (WAI-SR) • Technological alliance between participant and online intervention (Technological Alliance Inventor (TAI-OT)) • Side effects of psychotherapy (INEP) • Adherence • Usage time • Cost measures **Tertiary outcomes:** none
Starting date	16 April 2018
Contact information	yannik.terhorst@uni-ulm.de harald.baumeister@uni-ulm.de
Notes	**Trial ID**: DRKS00014619 **Funding**: The insurance company Social Insurance for Agriculture, Forestry, and Horticulture (SVLFG) gave a financial contribution to the University of Ulm and Friedrich-Alexander University of Erlangen-Nürnberg as expense allowance. **Estimated trial completion date**: unknown

AAQ: Acceptance and Action Questionnaire; **ACT:** acceptance and commitment therapy; **ADL:** activities of daily life/living; **AQOL:** Assessment of Quality of Life; **ASAS:** Assessment of Spondyloarthritis International Society Health Index;**ASI:** Anxiety Sensitivity Index; **AUDIT:** Alcohol Use Disorder Identification Test; **BDI:** Beck Depression Inventory; **BFI-10:** Big Five Inventory-10; **BPI:** Brief Pain Inventory; **BRAF-MDQ:** Bristol Rheumatoid Arthritis Fatigue Multi-Dimensional Questionnaire; **CAQ-D:** Committed Action Questionnaire (German version); **CBT:** cognitive behavioural therapy; **CFQ-D:** Cognitive Fusion Questionnaire (German version);**CFT:** compassion-focused therapy; **CIDI-SC:** Composite International Diagnosis Interview Screening Scale; **cLBP:** chronic lower back pain; **CP:** chronic pain; **CPAQ:** Chronic Pain Acceptance Questionnaire; **CPVI:** Chronic Pain Values Inventory; **CSQ-8:** Client Satisfaction Questionnaire-8; **CSQ-I:** Client Satisfaction Questionnaire Internet-based interventions; **CSQ-R:** Coping Strategies Questionnaire; **CSRI:** Client Services Receipt Inventory; **DASS:** Depression Anxiety Stress Scales; **DSM:** Diagnostic and Statistical Manual of Mental Disorders; **ECQ:** Existential Concerns Questionnaire; **EHP:** Endometriosis Health Profile; **EPS-25:** Emotional Processing Scale-25; **EQ-5D:** EuroQoL-5 Dimensions; **ESS:** Epworth Sleepiness Scale; **FABQ:** Fear Avoidance Belief Questionnaire; **FESV:** Fragebogen zur Erfassung der Schmerzverarbeitung; **FFMQ:** Five Facets Mindfulness Questionnaire; **FPQ:** Fear of Progression Questionnaire; **FSS:** Pain Related Self-Introspection Questionnaire; **GAD-7:** Generalised Anxiety Disorder-7; **GPQ:** German Pain Questionnaire; **HADS:** Hospital Anxiety and Depression Scale; **HAQ-DI:** Health Assessment Questionnaire-Disability Index; **ICD:** International Classification of Diseases; **I-EACT:** internet-based emotional awareness and expression therapy; **IEQ:** Injustice Experience Questionnaire;**INEP:** Assessment of Negative Effects of Psychotherapy;**IPQ-R:** Illness Perception Questionnaire; **ISI:** Insomnia Severity Index; **LBP:** lower back pain; **LEAS:** Level of Emotional Awareness Scale; **MADRS-S:** Montgomery-Åsberg Depression Rating Scale; **MBSR:** mindfulness-based stress reduction; **MEAQ:** Multidimensional Experiential Avoidance Questionnaire; **MPFI:** Multidimensional Psychological Flexibility Inventory; **MPI:** Multidimensional Pain Inventory; **MULTIPleS:** Multimorbidity Illness Perceptions Scale; **NA:** not applicable; **NEQ:** Negative Effects Questionnaire; **NIH:** National Institutes of Health; **NRS:** Numerical Rating Scale; **NSAID:** nonsteroidal anti-inflammatory drug; **ÖMPSQ:** Örebro Musculoskeletal Pain Screening Questionnaire; **PANEPS-I:** Positive and Negative Effects of Psychotherapy Scale for internet-based Interventions;**PASS-20:** Pain Anxiety Symptoms Scale-20; **PCCL:** Pain Coping and Cognition list; **PCQ:** Pain Catastrophizing Questionnaire; **PCS:** Pain Catastrophising Scale; **PDI:** Pain Disability Index; **PESQ:** Pain Self-Efficacy Questionnaire; **PGIC:** Patient Global Impression of Change; **PHQ**: Patient Health Questionnaire;**PIPS:** Psychological Inflexibility in Pain Scale; **POQ:** Pain Outcomes Questionnaire; **PROMIS:** Patient-Reported Outcomes Measurement Information System; **PSEQ:** Pain Self-Efficacy Questionnaire; **PSS:** Perceived Stress Scale; **PTQ:** Persuasive Thinking Questionnaire; **PTSD:** Post-Traumatic Stress Disorder; **QIDS:** Quick Inventory Depressive Symptomatology; **QOLI:** Quality of Life Inventory; **RA:** rheumatoid arthritis;**RAS:** Relationship Assessment Scale; **SCS:** Self-Compassion Scale; **SDS:** Shehan Disability Scale; **SF:** Short Form; **S-GSE:** General Self-Efficacy Scale; **SMT:** spinal manipulation therapy; **SNRI:** serotonin-norepinephrine reuptake inhibitor; **SPE:** Subjective Prognostic Employment Scale; **SUS:** System Usability Scale; **TAI-OT:** Technological Alliance Inventory-Online Therapy; **URICA:** University

of Rhode Island Change Assessment Scale;**VA:** Veteran Affairs; **VAS:** Visual Analogue Scale; **VR:** virtual reality; **WAI:** Work Ability Index; **WHOQOL-BREF:** World Health Organization Quality of Life Brief; **WSAS:** Work and Social Adjustment Scale

DATA AND ANALYSES

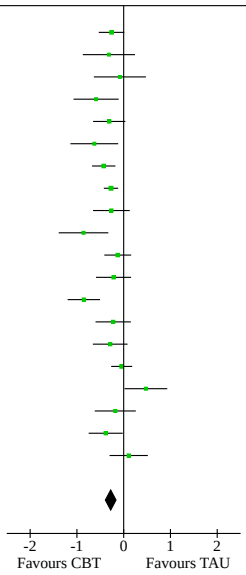
Comparison 1. Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (post-treatment)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 Pain intensity (post-treatment)	20	3206	Std. Mean Difference (IV, Random, 95% CI)	-0.28 [-0.39, -0.16]
1.2 Pain intensity (≥ 30% improvement) (post-treatment)	5	1347	Risk Ratio (IV, Random, 95% CI)	2.15 [1.62, 2.85]
1.3 Pain intensity (≥ 50% improvement)	4	1229	Risk Ratio (M-H, Random, 95% CI)	2.31 [1.14, 4.66]
1.4 Functional disability (post-treatment)	14	2672	Std. Mean Difference (IV, Random, 95% CI)	-0.38 [-0.53, -0.22]
1.5 Quality of life (post-treatment)	7	1423	Std. Mean Difference (IV, Random, 95% CI)	-0.16 [-0.43, 0.11]
1.6 Adverse events (post-treatment)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
1.7 Anxiety (post-treatment)	16	2686	Std. Mean Difference (IV, Random, 95% CI)	-0.29 [-0.40, -0.17]
1.8 Depression (post-treatment)	19	3046	Std. Mean Difference (IV, Random, 95% CI)	-0.42 [-0.58, -0.26]
1.9 Intervention satisfaction (post-treatment)	1		Risk Ratio (IV, Random, 95% CI)	Totals not selected

Analysis 1.1. Comparison 1: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (post-treatment), Outcome 1: Pain intensity (post-treatment)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI	Risk of Bias A B C D E F G
Baumeister 2021 (1)	1.43	0.79	104	1.63	0.74	105	6.6%	-0.26 [-0.53 , 0.01]	+ + + + +
Buhrman 2004 (2)	34.3	16.8	22	39.6	16.3	29	3.0%	-0.32 [-0.87 , 0.24]	+ ? ? + ?
Buhrman 2011 (3)	3.15	2.2	23	3.35	2.6	27	3.0%	-0.08 [-0.64 , 0.48]	+ ? + + ?
Burke 2019 (4)	3.86	2.39	35	5.15	1.9	34	3.6%	-0.59 [-1.07 , -0.11]	+ ? + + ?
Carpenter 2012 (5)	5.2	1.5	63	5.7	1.7	68	5.4%	-0.31 [-0.65 , 0.04]	+ ? + + ?
Dear 2013 (6)	4.68	1.7	31	5.81	1.85	31	3.4%	-0.63 [-1.14 , -0.12]	? ? + + ?
Dear 2015 (7)	4.97	1.77	397	5.71	1.5	74	7.0%	-0.43 [-0.68 , -0.18]	+ + + + +
Dear 2021 (8)	4.9	1.85	334	5.4	1.83	325	8.8%	-0.27 [-0.42 , -0.12]	+ + + + +
Ferwerda 2017 (9)	14.6	4.5	45	15.68	3.73	57	4.7%	-0.26 [-0.65 , 0.13]	? + ? + +
Friesen 2017 (10)	4.99	1.66	30	6.28	1.28	30	3.2%	-0.86 [-1.39 , -0.33]	+ + + + −
Gasslander 2022 (11)	3.75	1.02	95	3.88	1.02	92	6.3%	-0.13 [-0.41 , 0.16]	+ ? + + −
Guarino 2018 (12)	4.19	1.01	55	4.41	1.01	55	4.9%	-0.22 [-0.59 , 0.16]	+ + + + −
Hedman-Lagerlöf 2018 (13)	4.19	3.25	70	6.7	2.57	70	5.3%	-0.85 [-1.20 , -0.51]	+ ? + + −
Peters 2017 (2)	5.71	2.25	80	6.2	1.99	41	4.9%	-0.22 [-0.60 , 0.15]	? ? ? ? ?
Rini 2015 (14)	4.07	1.99	58	4.62	1.79	55	5.0%	-0.29 [-0.66 , 0.08]	+ + + + −
Ruehlman 2012 (15)	22.75	4.14	162	22.93	4.25	143	7.5%	-0.04 [-0.27 , 0.18]	? ? + + ?
Schlicker 2020 (16)	4.68	1.86	40	3.81	1.76	36	3.9%	0.47 [0.02 , 0.93]	+ + + + −
Smith 2019 (17)	4.44	1.56	41	4.73	1.63	39	4.1%	-0.18 [-0.62 , 0.26]	+ + ? + −
Williams 2010 (18)	4.3	1.6	59	4.9	1.5	59	5.1%	-0.38 [-0.75 , -0.02]	+ + + + ?
Wilson 2015 (19)	5.3	1.9	45	5.1	1.8	47	4.5%	0.11 [-0.30 , 0.52]	? ? + − ?
Total (95% CI)			**1789**			**1417**	**100.0%**	**-0.28 [-0.39 , -0.16]**	

Heterogeneity: Tau² = 0.03; Chi² = 40.23, df = 19 (P = 0.003); I² = 53%
Test for overall effect: Z = 4.79 (P < 0.00001)
Test for subgroup differences: Not applicable



Footnotes

(1) CBT vs. TAU, assessed at 9 weeks (Numerical Rating Scale)
(2) CBT vs. WLC, assessed at 8 weeks (Numerical Rating Scale)
(3) CBT vs. WLC, assessed at 11 weeks (Multidimensional Pain Inventory: pain severity subscale)
(4) CBT vs. TAU, assessed at 6 weeks (Numerical Rating Scale)
(5) CBT vs. WLC, assessed at 3 weeks (average pain in the last week)
(6) CBT vs. WLC, assessed at 8 weeks (Wisconsin Brief Pain Questionnaire: Average pain)
(7) CBT vs. TAU+WLC, assessed at 8 weeks (Wisconsin Brief Pain Questionnaire: Average pain)
(8) CBT vs. WLC, assessed at 8 weeks (Wisconsin Brief Pain Questionnaire: Average pain)
(9) CBT vs. TAU, post-intervention (variable duration) (Impact of Rheumatic Diseases on General Health and Lifestyle)
(10) CBT vs. TAU+WLC, assessed at 8 weeks (Brief Pain Inventory-pain severity item)
(11) CBT vs. WLC, assessed at 12 weeks (Multidimensional Pain Inventory: pain severity subscale)
(12) CBT vs. TAU, assessed at 12 weeks (Multidimensional Pain Inventory: pain severity subscale)
(13) CBT vs. WLC, assessed at 10 weeks (Fibromyalgia Impact Questionnaire-Pain)
(14) CBT vs. TAU, assessed at 9-11 weeks (Athritis Impact Scale 2 (AIMS2): pain subscale)
(15) CBT vs. WLC, assessed at 7 weeks (Profile of Chronic pain: Screen (PCP-S) - Severity)
(16) CBT vs. TAU+WLC, assessed at 9 weeks (Numerical Rating Scale)
(17) CBT vs. TAU, assessed at 16-17 weeks (Brief Pain Inventory: severity subscale)
(18) CBT vs. TAU, assessed at 24 weeks (Brief Pain Inventory)
(19) CBT vs. TAU+WLC, assessed at 8 weeks(Brief Pain Inventory)

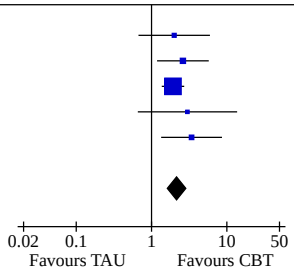
Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

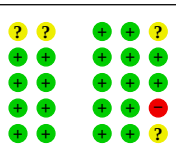
Analysis 1.2. Comparison 1: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (post-treatment), Outcome 2: Pain intensity (≥ 30% improvement) (post-treatment)

Study or Subgroup	CBT Events	CBT Total	TAU Events	TAU Total	Weight	Risk Ratio IV, Random, 95% CI
Dear 2013 (1)	8	31	4	31	6.7%	2.00 [0.67 , 5.96]
Dear 2015 (2)	84	397	6	74	12.8%	2.61 [1.18 , 5.75]
Dear 2021 (3)	80	320	41	316	67.8%	1.93 [1.37 , 2.71]
Friesen 2017 (4)	6	30	2	30	3.5%	3.00 [0.66 , 13.69]
Williams 2010 (5)	17	59	5	59	9.2%	3.40 [1.34 , 8.61]
Total (95% CI)		**837**		**510**	**100.0%**	**2.15 [1.62 , 2.85]**
Total events:	195		58			

Risk Ratio IV, Random, 95% CI



Risk of Bias



Heterogeneity: Tau² = 0.00; Chi² = 1.76, df = 4 (P = 0.78); I² = 0%
Test for overall effect: Z = 5.31 (P < 0.00001)
Test for subgroup differences: Not applicable

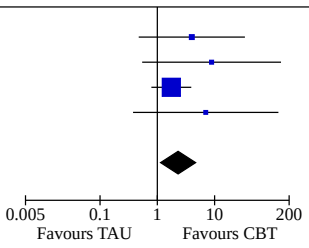
Footnotes
(1) CBT vs. WLC, assessed at 8 weeks (Wisconsin Brief Pain Questionnaire-average pain)
(2) CBT vs. TAU+WLC, assessed at 8 weeks (Wisconsin Brief Pain Questionnaire: average pain)(combined regular, optional and no contact groups)
(3) CBT vs. WLC, assessed at 8 weeks (Wisconsin Brief Pain Questionnaire-average pain)
(4) CBT vs. TAU+WLC, assessed at 8 weeks(Brief Pain Inventory-severity item)
(5) CBT vs. TAU, assessed at 24 weeks (mean pain score)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

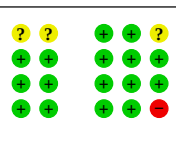
Analysis 1.3. Comparison 1: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (post-treatment), Outcome 3: Pain intensity (≥ 50% improvement)

Study or Subgroup	CBT Events	CBT Total	TAU Events	TAU Total	Weight	Risk Ratio M-H, Random, 95% CI
Dear 2013 (1)	4	31	1	31	10.9%	4.00 [0.47 , 33.79]
Dear 2015 (2)	23	397	0	74	6.4%	8.86 [0.54 , 144.23]
Dear 2021 (3)	16	320	9	316	77.0%	1.76 [0.79 , 3.91]
Friesen 2017 (4)	3	30	0	30	5.8%	7.00 [0.38 , 129.93]
Total (95% CI)		**778**		**451**	**100.0%**	**2.31 [1.14 , 4.66]**
Total events:	46		10			

Risk Ratio M-H, Random, 95% CI



Risk of Bias



Heterogeneity: Tau² = 0.00; Chi² = 2.35, df = 3 (P = 0.50); I² = 0%
Test for overall effect: Z = 2.33 (P = 0.02)
Test for subgroup differences: Not applicable

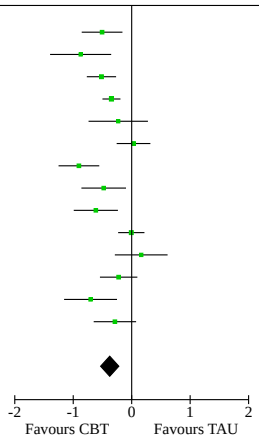
Footnotes
(1) CBT vs. WLC, assessed at 8 weeks (Wisconsin Brief Pain Questionnaire-average pain; change)
(2) CBT vs. TAU+WLC, assessed at 8 weeks (Wisconsin Brief Pain Questionnaire-average pain; change)
(3) CBT vs. WLC, assessed at 8 weeks (Wisconsin Brief Pain Questionnaire: Average pain; endpoint)
(4) CBT vs. TAU+WLC, assessed at 8 weeks (Brief Pain Inventory-pain severity item; change)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 1.4. Comparison 1: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (post-treatment), Outcome 4: Functional disability (post-treatment)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Carpenter 2012 (1)	13.5	5.8	63	16.3	5.2	68	7.2%	-0.51 [-0.85 , -0.16]
Dear 2013 (2)	10.1	5.23	31	14.77	5.33	31	5.0%	-0.87 [-1.40 , -0.35]
Dear 2015 (3)	11.12	5.56	397	13.97	5.17	74	8.7%	-0.52 [-0.77 , -0.27]
Dear 2021 (4)	31.2	16.7	334	36.5	13.7	325	10.1%	-0.35 [-0.50 , -0.19]
Friesen 2017 (5)	-34.7	7.94	30	-32.82	8.2	30	5.1%	-0.23 [-0.74 , 0.28]
Gasslander 2022 (6)	38.59	13.09	94	38.21	10.84	91	8.1%	0.03 [-0.26 , 0.32]
Hedman-Lagerlöf 2018 (7)	24.64	17.71	70	40.83	17.96	70	7.2%	-0.90 [-1.25 , -0.55]
Peters 2017 (8)	17.94	5.44	80	20.63	5.86	41	6.7%	-0.48 [-0.86 , -0.10]
Rini 2015 (9)	1	1.19	58	1.75	1.24	55	6.8%	-0.61 [-0.99 , -0.24]
Ruehlman 2012 (10)	10.31	6.12	162	10.35	5.8	143	9.1%	-0.01 [-0.23 , 0.22]
Schlicker 2020 (11)	28.26	16.29	40	25.56	16.52	36	5.8%	0.16 [-0.29 , 0.61]
Serrat 2021 (12)	-38.72	22.91	75	-33.95	19.55	76	7.6%	-0.22 [-0.54 , 0.10]
Smith 2019 (13)	26.59	9.88	41	33.64	9.97	39	5.8%	-0.70 [-1.16 , -0.25]
Williams 2010 (14)	-41.4	8.7	59	-38.9	8.6	59	7.0%	-0.29 [-0.65 , 0.08]
Total (95% CI)			**1534**			**1138**	**100.0%**	**-0.38 [-0.53 , -0.22]**

Heterogeneity: Tau² = 0.06; Chi² = 42.21, df = 13 (P < 0.0001); I² = 69%
Test for overall effect: Z = 4.74 (P < 0.00001)
Test for subgroup differences: Not applicable



Footnotes

(1) CBT vs. WLC, assessed at 3 weeks (Roland-Morris Disability Questionnaire)
(2) CBT vs. WLC, assessed at 8 weeks (Roland-Morris Disability Questionnaire)
(3) CBT vs. TAU+WLC, assessed at 8 weeks (Roland-Morris Disability Questionnaire) (combined regular, optional and no contact interventions)
(4) CBT vs. WLC, assessed at 8 weeks (Pain Disability Index)
(5) CBT vs. TAU+WLC, assessed at 8 weeks (Short Form 12 physical subscale)
(6) CBT vs. WLC, assessed at 12 weeks (Pain Disability Index)
(7) CBT vs. WLC, assessed at 10 weeks (WHO-Disability Assessment Schedule (WHO-DAS II))
(8) CBT vs. WLC, assessed at 8 weeks (Fibromyalgia Impairment Scale-physical impairment)
(9) CBT vs. TAU, assessed at 9 to 11 weeks (Arthritis Impact Scale 2)
(10) CBT vs WLC, assessed at 7 weeks (Profile of Chronic Pain: Extended Assessment (PCP-EA) - Perceived Disability)
(11) CBT vs. TAU+WLC, assessed at 9 weeks (Oswestry Disability Index-functional disability)
(12) CBT vs. TAU+WLC, assessed at 12 weeks (Physical functioning component of SF-36 scale)
(13) CBT vs. TAU, assessed at 16 to 17 weeks (Pain Disability Index)
(14) CBT vs. TAU, assessed at 24 weeks (SF-36 physical functioning subscale)

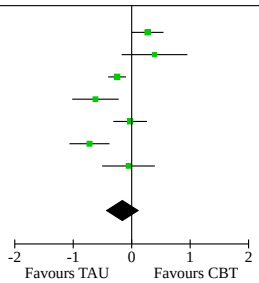
Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 1.5. Comparison 1: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (post-treatment), Outcome 5: Quality of life (post-treatment)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Baumeister 2021 (1)	-48.32	9.85	104	-51.2	11.23	105	15.9%	0.27 [-0.00 , 0.54]
Buhrman 2011 (2)	1.7	1.4	23	1.1	1.6	27	10.4%	0.39 [-0.17 , 0.95]
Dear 2021 (3)	-0.5	0.4	334	-0.4	0.4	325	17.9%	-0.25 [-0.40 , -0.10]
Ferwerda 2017 (4)	2.02	0.7	45	2.49	0.79	59	13.4%	-0.62 [-1.02 , -0.22]
Gasslander 2022 (5)	0.77	2.13	94	0.82	1.77	91	15.6%	-0.03 [-0.31 , 0.26]
Hedman-Lagerlöf 2018 (6)	-63.83	24.44	70	-46.86	22.29	70	14.5%	-0.72 [-1.06 , -0.38]
Schlicker 2020 (7)	0.67	0.19	40	0.68	0.17	36	12.4%	-0.05 [-0.51 , 0.40]
Total (95% CI)			**710**			**713**	**100.0%**	**-0.16 [-0.43 , 0.11]**

Heterogeneity: Tau² = 0.10; Chi² = 31.05, df = 6 (P < 0.0001); I² = 81%
Test for overall effect: Z = 1.16 (P = 0.24)
Test for subgroup differences: Not applicable

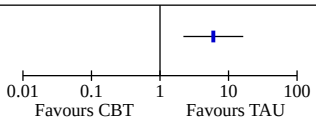


Footnotes
(1) CBT vs. TAU, assessed at 9 weeks (Assessment of Quality of Life (AQoL 6D))
(2) CBT vs. WLC, assessed at 11 weeks (Quality of Life Inventory)
(3) CBT vs. WLC, assessed at 8 weeks (EuroQol-5D-5L)
(4) CBT vs. TAU, post-intervention (variable duration) (Impact of Rheumatic Diseases on General Health and Lifestyle Scale, RAND-36 Health Status Inventory)
(5) CBT vs. WLC, assessed at 12 weeks (Quality of Life Inventory)
(6) CBT vs. WLC, assessed at 10 weeks (Brunnsviken Brief Quality of Life)
(7) CBT vs. TAU+WLC, assessed at 9 weeks (Assessment of Quality of Life)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 1.6. Comparison 1: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (post-treatment), Outcome 6: Adverse events (post-treatment)

Study or Subgroup	CBT Events	CBT Total	TAU Events	TAU Total	Risk Ratio M-H, Random, 95% CI
Hedman-Lagerlöf 2018 (1)	24	70	4	70	6.00 [2.20 , 16.40]



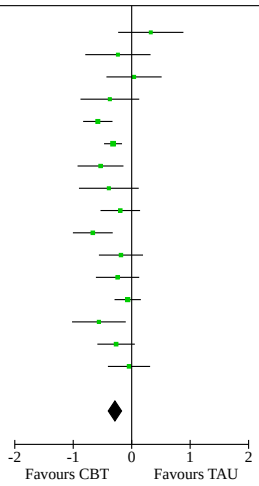
Footnotes
(1) CBT vs. WLC, assessed at 10 weeks (number of people with adverse events e.g. increased pain)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 1.7. Comparison 1: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (post-treatment), Outcome 7: Anxiety (post-treatment)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Buhrman 2004 (1)	7.2	4	22	6	3.3	29	3.3%	0.33 [-0.23 , 0.88]
Buhrman 2011 (2)	5.8	3.5	23	7	6	27	3.3%	-0.24 [-0.79 , 0.32]
Burke 2019 (3)	6.58	3.98	35	6.42	3.88	34	4.3%	0.04 [-0.43 , 0.51]
Dear 2013 (4)	7.23	4.76	31	9.03	4.76	31	3.9%	-0.37 [-0.88 , 0.13]
Dear 2015 (5)	5.24	4.42	397	7.89	5.29	74	9.2%	-0.58 [-0.83 , -0.33]
Dear 2021 (4)	5.5	5.57	334	7.5	6.9	325	12.8%	-0.32 [-0.47 , -0.17]
Ferwerda 2017 (6)	18.12	4.13	46	20.61	4.99	59	5.6%	-0.53 [-0.93 , -0.14]
Friesen 2017 (7)	7.83	5.7	30	9.98	5.15	30	3.8%	-0.39 [-0.90 , 0.12]
Gasslander 2022 (8)	6.41	4.26	65	7.22	4.01	70	6.8%	-0.19 [-0.53 , 0.14]
Hedman-Lagerlöf 2018 (9)	4.29	4.98	70	7.66	5.1	70	6.7%	-0.66 [-1.01 , -0.32]
Peters 2017 (1)	6.63	3.41	80	7.27	3.58	41	5.9%	-0.18 [-0.56 , 0.19]
Rini 2015 (10)	23.21	17.29	58	27.39	17.06	55	6.1%	-0.24 [-0.61 , 0.13]
Ruehlman 2012 (11)	4.5	4.62	162	4.82	4.74	143	10.1%	-0.07 [-0.29 , 0.16]
Schlicker 2020 (12)	9.34	3.43	40	11.2	3.11	36	4.5%	-0.56 [-1.02 , -0.10]
Serrat 2021 (13)	11.75	5.05	75	13.04	4.57	76	7.2%	-0.27 [-0.59 , 0.05]
Williams 2010 (14)	18.1	7.1	59	18.4	5.9	59	6.3%	-0.05 [-0.41 , 0.32]
Total (95% CI)			**1527**			**1159**	**100.0%**	**-0.29 [-0.40 , -0.17]**

Heterogeneity: Tau² = 0.02; Chi² = 25.76, df = 15 (P = 0.04); I² = 42%
Test for overall effect: Z = 4.93 (P < 0.00001)
Test for subgroup differences: Not applicable



Footnotes

(1) CBT vs. WLC, assessed at 8 weeks (Hospital Anxiety and Depression Scale-Anxiety)
(2) CBT vs. WLC, assessed at 11 weeks (Hospital Anxiety and Depression Scale-Anxiety)
(3) CBT vs. TAU, assessed at 6 weeks (Hospital Anxiety and Depression Scale-Anxiety)
(4) CBT vs. WLC, assessed at 8 weeks (Generalised Anxiety Disorder-7)
(5) CBT vs. TAU+WLC, assessed at 8 weeks (Generalised Anxiety Disorder -7) (combined regular, optional and no contact)
(6) CBT vs. TAU, post-treatment (variable duration) (Impact of Rheumatic Diseases on General Health and Lifestyle)
(7) CBT vs. TAU+WLC, assessed at 8 weeks (Generalised Anxiety Disorder-7)
(8) CBT vs. WLC, assessed at 12 weeks (Generalised Anxiety Disorder-7)
(9) CBT vs. WLC, assessed at 10 weeks (Generalised Anxiety Disorder-7)
(10) CBT vs. TAU, assessed at 9 to 11 weeks (Pain Anxiety Symptoms Scale); unadjusted data
(11) CBT vs. WLC, assessed at 7 weeks (Depression Anxiety Stress Scales (DASS) - Anxiety)
(12) CBT vs. TAU+WLC, assessed at 9 weeks (Hospital Anxiety and Depression Scale-Anxiety)
(13) CBT vs. TAU+WLC, assessed at 12 weeks (Hospital Anxiety and Depression Scale-Anxiety)
(14) CBT vs. TAU, assessed at 26 weeks (State-Trait Personality Inventory)

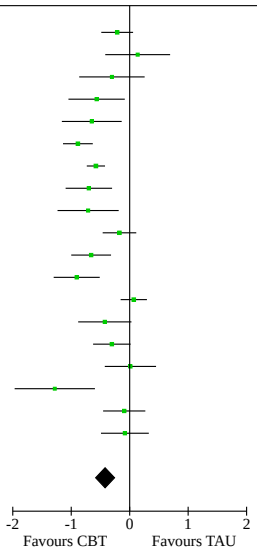
Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 1.8. Comparison 1: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (post-treatment), Outcome 8: Depression (post-treatment)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI	Risk of Bias A B C D E F G
Baumeister 2021 (1)	9.67	6.41	104	11.14	7.26	105	6.3%	-0.21 [-0.49 , 0.06]	+ + + + +
Buhrman 2004 (2)	6	4.7	22	5.4	4	29	4.0%	0.14 [-0.42 , 0.69]	+ ? ? + ?
Buhrman 2011 (3)	4.9	3.6	23	6.3	5.2	27	4.0%	-0.30 [-0.86 , 0.26]	+ ? + + ?
Burke 2019 (4)	5.18	3.22	35	7.26	4.02	34	4.6%	-0.57 [-1.05 , -0.08]	+ ? + + ?
Dear 2013 (5)	7.55	5.54	31	11.32	5.93	31	4.3%	-0.65 [-1.16 , -0.14]	? ? + + ?
Dear 2015 (6)	6.82	4.7	397	11.11	5.51	74	6.5%	-0.89 [-1.14 , -0.63]	+ + + + +
Dear 2021 (7)	7.4	5.57	334	10.6	5.49	325	7.2%	-0.58 [-0.73 , -0.42]	+ + + + +
Ferwerda 2017 (8)	8.16	5.67	46	12.27	5.97	59	5.3%	-0.70 [-1.10 , -0.30]	? + ? + +
Friesen 2017 (9)	10.13	5.3	30	14	5.44	30	4.3%	-0.71 [-1.23 , -0.19]	+ + + + -
Gasslander 2022 (10)	17.61	10.47	95	19.29	8.55	92	6.2%	-0.17 [-0.46 , 0.11]	+ ? + + -
Hedman-Lagerlöf 2018 (11)	7.12	5.57	70	10.57	4.81	70	5.7%	-0.66 [-1.00 , -0.32]	+ ? + + -
Peters 2017 (12)	4.99	2.86	80	7.73	3.27	41	5.3%	-0.91 [-1.30 , -0.51]	? ? ? ? ?
Ruehlman 2012 (13)	22.37	12.51	162	21.49	12.61	143	6.7%	0.07 [-0.16 , 0.29]	? ? + + ?
Schlicker 2020 (14)	25.66	8.48	40	28.91	6.38	36	4.8%	-0.43 [-0.88 , 0.03]	+ + + + -
Serrat 2021 (15)	10.53	5.82	75	12.17	4.85	76	5.9%	-0.30 [-0.63 , 0.02]	+ + + ? ?
Smith 2019 (16)	9.58	5.36	41	9.51	5.7	39	4.9%	0.01 [-0.43 , 0.45]	+ + ? + -
Vallejo 2015 (17)	11.32	3.33	20	18.83	7.41	20	3.2%	-1.28 [-1.97 , -0.59]	+ ? ? + ?
Williams 2010 (18)	16.4	11.9	59	17.5	11.5	59	5.6%	-0.09 [-0.45 , 0.27]	+ + + + ?
Wilson 2015 (19)	10.1	6.4	45	10.6	5.7	47	5.2%	-0.08 [-0.49 , 0.33]	? ? + - ?
Total (95% CI)			**1709**			**1337**	**100.0%**	**-0.42 [-0.58 , -0.26]**	

Heterogeneity: Tau² = 0.09; Chi² = 72.06, df = 18 (P < 0.00001); I² = 75%
Test for overall effect: Z = 5.10 (P < 0.00001)
Test for subgroup differences: Not applicable



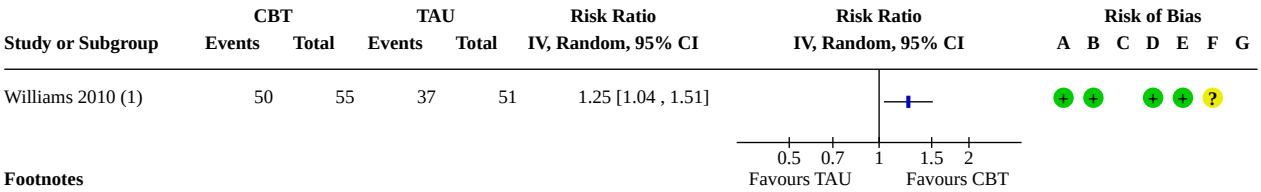
Footnotes

(1) CBT vs. TAU, assessed at 9 weeks (Hamilton Depression Scale (HAM-D))
(2) CBT vs. WLC, assessed at 8 weeks (Hospital Anxiety and Depression Scale-depression subscale)
(3) CBT vs. WLC, assessed at 11 weeks (Hospital Anxiety and Depression Scale-depression subscale)
(4) CBT vs. TAU, assessed at 6 weeks (Hospital Anxiety and Depression Scale-depression subscale)
(5) CBT vs. WLC, assessed at 8 weeks (Patient Health Questionnaire-9)
(6) CBT vs. TAU+WLC, assessed at 8 weeks (Patient Health Questionnaire-9) (combined regular, optional, and no contact interventions)
(7) CBT vs. WLC, assessed at 8 weeks (Patient Health Questionnaire-9)
(8) CBT vs. TAU, post-treatment (variable duration) (Beck's Depression Inventory)
(9) CBT vs. TAU+WLC, assessed at 8 weeks (Patient Health Questionnaire-9)
(10) CBT vs. WLC, assessed at 12 weeks (Montgomery-Asberg Depression Rating Scale)
(11) CBT vs. WLC, assessed at 10 weeks (Patient Health Questionnaire-9)
(12) CBT vs. WLC, assessed at 8 weeks (Hospital Anxiety and Depression Scale-depression subscale)
(13) CBT vs. WLC, assessed at 7 weeks (Centre for Epidemiological Studies Depression Scale)
(14) CBT vs. TAU+WLC, assessed at 9 weeks (Centre for Epidemiological Studies Depression Scale)
(15) CBT vs. TAU+WLC, assessed at 12 weeks (Hospital Anxiety and Depression Scale-Depression)
(16) CBT vs. TAU, assessed at 16 to 17 weeks (Patient Health Questionnaire-9)
(17) CBT vs. TAU+WLC, assessed at 10 weeks (Beck Depression Inventory)
(18) CBT vs. TAU, assessed at 26 weeks (Centre for Epidemiological Studies -depression Scale)
(19) CBT vs. TAU+WLC, assessed at 8 weeks (Patient Health Questionnaire-9)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 1.9. Comparison 1: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (post-treatment), Outcome 9: Intervention satisfaction (post-treatment)



Footnotes

(1) CBT vs. TAU, assessed at 24 weeks (number of people reporting general satisfaction item of the Client Satisfaction Questionnaire-12)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

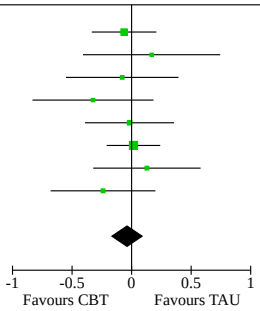
Comparison 2. Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (follow-up)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.1 Pain intensity	8	959	Std. Mean Difference (IV, Random, 95% CI)	-0.04 [-0.17, 0.09]
2.2 Pain intensity (≥ 30 % improvement) (follow-up)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
2.3 Functional disability (follow-up)	3	461	Std. Mean Difference (IV, Random, 95% CI)	-0.05 [-0.23, 0.14]
2.4 Quality of life (follow-up)	3	352	Std. Mean Difference (IV, Random, 95% CI)	-0.16 [-0.37, 0.05]
2.5 Anxiety (follow-up)	5	565	Std. Mean Difference (IV, Random, 95% CI)	-0.16 [-0.33, 0.00]
2.6 Depression (follow-up)	7	853	Std. Mean Difference (IV, Random, 95% CI)	-0.16 [-0.35, 0.04]

Analysis 2.1. Comparison 2: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (follow-up), Outcome 1: Pain intensity

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Baumeister 2021 (1)	1.62	0.76	104	1.67	0.81	105	21.9%	-0.06 [-0.33 , 0.21]
Buhrman 2004 (2)	36.2	20.4	21	32.6	21.6	26	4.9%	0.17 [-0.41 , 0.74]
Burke 2019 (2)	4.44	2.21	35	4.62	2.3	34	7.2%	-0.08 [-0.55 , 0.39]
Ferwerda 2017 (3)	14.36	4.68	25	15.79	4.13	38	6.2%	-0.32 [-0.83 , 0.18]
Guarino 2018 (4)	4.41	1.09	55	4.43	1.22	55	11.5%	-0.02 [-0.39 , 0.36]
Ruehlman 2012 (5)	22.41	4.31	162	22.34	4.61	143	31.9%	0.02 [-0.21 , 0.24]
Schlicker 2020 (6)	3.89	1.6	40	3.67	1.8	36	7.9%	0.13 [-0.32 , 0.58]
Smith 2019 (7)	4.38	1.58	41	4.77	1.64	39	8.3%	-0.24 [-0.68 , 0.20]
Total (95% CI)			**483**			**476**	**100.0%**	**-0.04 [-0.17 , 0.09]**

Heterogeneity: Tau² = 0.00; Chi² = 3.34, df = 7 (P = 0.85); I² = 0%
Test for overall effect: Z = 0.59 (P = 0.55)
Test for subgroup differences: Not applicable

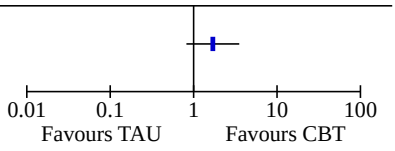


Footnotes
(1) CBT vs. TAU, 24 weeks follow-up (Numerical Rating Scale)
(2) CBT vs. WLC, 12 weeks follow-up (Numerical Rating Scale)
(3) CBT vs. TAU, 52 weeks follow-up (Impact of Rheumatic Diseases on general Health and Lifestyle-pain subscale)
(4) CBT vs. TAU, 12 weeks follow-up (Multidimensional Pain Inventory-pain subscale)
(5) CBT vs. WLC, 14 weeks follow-up (Profile of Chronic Pain: Screen (PCP-S)-severity)
(6) CBT vs. TAU+WLC, 24 weeks follow-up (Numerical Rating Scale)
(7) CBT vs. TAU, 12 weeks follow-up (Brief Pain Inventory: severity subscale)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 2.2. Comparison 2: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (follow-up), Outcome 2: Pain intensity (≥ 30 % improvement) (follow-up)

Study or Subgroup	CBT Events	CBT Total	TAU Events	TAU Total	Risk Ratio M-H, Random, 95% CI
Burke 2019 (1)	14	35	8	34	1.70 [0.82 , 3.53]

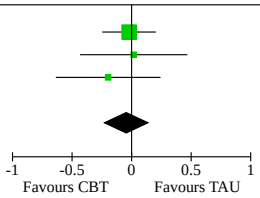


Footnotes
(1) CBT versus TAU, 13 weeks follow-up

Analysis 2.3. Comparison 2: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (follow-up), Outcome 3: Functional disability (follow-up)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI	Risk of Bias A B C D E F G
Ruehlman 2012 (1)	9.6	6.28	162	9.73	5.77	143	66.2%	-0.02 [-0.25 , 0.20]	? ? + + ?
Schlicker 2020 (2)	25.15	13.43	40	24.9	15.27	36	16.5%	0.02 [-0.43 , 0.47]	+ + + + -
Smith 2019 (3)	30.47	9.89	41	32.44	9.94	39	17.3%	-0.20 [-0.64 , 0.24]	+ + ? + -
Total (95% CI)			**243**			**218**	**100.0%**	**-0.05 [-0.23 , 0.14]**	

Heterogeneity: Tau² = 0.00; Chi² = 0.57, df = 2 (P = 0.75); I² = 0%
Test for overall effect: Z = 0.49 (P = 0.63)
Test for subgroup differences: Not applicable



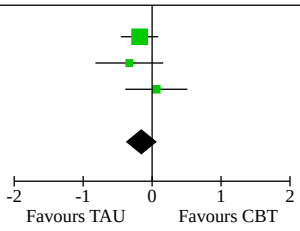
Footnotes
(1) CBT vs. WLC, 14 weeks follow-up (Profile of Chronic Pain: Screen (PCP-S) - Perceived Disability)
(2) CBT vs. TAU+WLC, 24 weeks follow-up (Oswestry Disability Index-functional disability)
(3) CBT vs. TAU, 12 weeks follow-up (Pain Disability Index)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 2.4. Comparison 2: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (follow-up), Outcome 4: Quality of life (follow-up)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Baumeister 2021 (1)	47.45	10.93	104	49.5	11.44	105	59.9%	-0.18 [-0.45 , 0.09]
Ferwerda 2017 (2)	2	0.66	27	2.25	0.8	40	18.3%	-0.33 [-0.82 , 0.16]
Schlicker 2020 (3)	0.69	0.17	40	0.68	0.15	36	21.8%	0.06 [-0.39 , 0.51]
Total (95% CI)			**171**			**181**	**100.0%**	**-0.16 [-0.37 , 0.05]**

Heterogeneity: Tau² = 0.00; Chi² = 1.42, df = 2 (P = 0.49); I² = 0%
Test for overall effect: Z = 1.46 (P = 0.14)
Test for subgroup differences: Not applicable

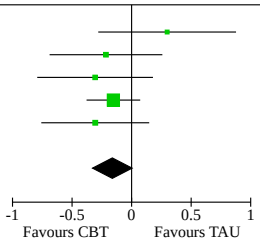


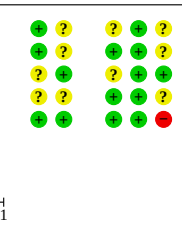
Footnotes
(1) CBT vs. TAU, 24 weeks follow-up (Assessment of Quality of Life)
(2) CBT vs. TAU, 52 weeks follow-up (Impact of Rheumatic Diseases on General Health and Lifestyle Scale, RAND-36 Health Status Inventory composite)
(3) CBT vs. TAU, 24 weeks follow-up (EuroQOL-5D)

Analysis 2.5. Comparison 2: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (follow-up), Outcome 5: Anxiety (follow-up)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Buhrman 2004 (1)	7.3	4.5	21	6	4.1	26	8.2%	0.30 [-0.28 , 0.88]
Burke 2019 (2)	5.78	3.93	35	6.63	3.88	34	12.3%	-0.22 [-0.69 , 0.26]
Ferwerda 2017 (3)	18.31	5.44	28	20.06	5.78	40	11.7%	-0.31 [-0.79 , 0.18]
Ruehlman 2012 (4)	4.26	4.08	162	4.93	4.67	143	54.3%	-0.15 [-0.38 , 0.07]
Schlicker 2020 (5)	8.57	3.21	40	9.56	3.21	36	13.4%	-0.31 [-0.76 , 0.15]
Total (95% CI)			**286**			**279**	**100.0%**	**-0.16 [-0.33 , 0.00]**

Heterogeneity: Tau² = 0.00; Chi² = 3.21, df = 4 (P = 0.52); I² = 0%
Test for overall effect: Z = 1.91 (P = 0.06)
Test for subgroup differences: Not applicable





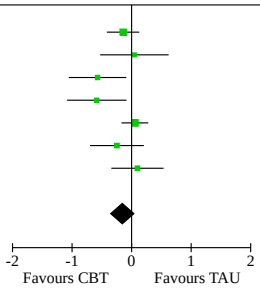
Footnotes
(1) CBT vs. WLC, 12 weeks follow-up (Hospital Anxiety and Depression Scale-Anxiety)
(2) CBT vs. TAU, 13 weeks follow-up (Hospital Anxiety and Depression Scale-Anxiety)
(3) CBT vs. TAU, 52 weeks follow-up (Impact of Rheumatic Diseases on General Health and Lifestyle)
(4) CBT vs. WLC, 14 weeks follow-up (Depression Anxiety Stress Scales- Anxiety)
(5) CBT vs. TAU+WLC, 26 weeks follow-up (Hospital Anxiety and Depression Scale-Anxiety)

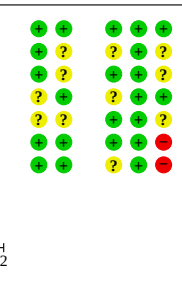
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 2.6. Comparison 2: Cognitive behavioural therapy (CBT) versus treatment as usual (TAU) (follow-up), Outcome 6: Depression (follow-up)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Baumeister 2021 (1)	8.97	6.44	104	9.95	7.13	105	20.9%	-0.14 [-0.42 , 0.13]
Buhrman 2004 (2)	5.3	3.2	21	4.8	13.8	26	8.7%	0.05 [-0.53 , 0.62]
Burke 2019 (3)	4.67	3.32	35	6.92	4.4	34	11.2%	-0.57 [-1.05 , -0.09]
Ferwerda 2017 (4)	8.11	6.87	27	12.36	7.38	40	10.6%	-0.59 [-1.08 , -0.09]
Ruehlman 2012 (5)	21.98	12.45	162	21.25	14.36	143	23.9%	0.05 [-0.17 , 0.28]
Schlicker 2020 (6)	24.36	9.03	40	26.4	7.13	36	12.2%	-0.25 [-0.70 , 0.21]
Smith 2019 (7)	9.81	5.45	41	9.26	5.65	39	12.6%	0.10 [-0.34 , 0.54]
Total (95% CI)			**430**			**423**	**100.0%**	**-0.16 [-0.35 , 0.04]**

Heterogeneity: Tau² = 0.03; Chi² = 10.62, df = 6 (P = 0.10); I² = 44%
Test for overall effect: Z = 1.57 (P = 0.12)
Test for subgroup differences: Not applicable





Footnotes
(1) CBT vs. TAU, 26 weeks follow-up (Hamilton Depression Scale)
(2) CBT vs. WLC, 12 weeks follow-up (Hospital Anxiety and Depression Scale-depression subscale)
(3) CBT vs. TAU, 13 weeks follow-up (Hospital Anxiety and Depression Scale-depression subscale)
(4) CBT vs. TAU, 52 weeks follow-up (Beck's Depression Inventory)
(5) CBT vs. WLC, 14 weeks follow-up (Centre for Epidemiological Studies Depression Scale)
(6) CBT vs. TAU+WLC, 26 weeks follow-up (Centre for Epidemiological Studies Depression Scale)
(7) CBT vs. TAU, 12 weeks follow-up (Patient Health Questionnaire-9)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

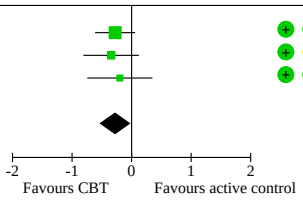
Comparison 3. Cognitive behavioural therapy (CBT) versus active control (post-treatment)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.1 Pain intensity	3	261	Std. Mean Difference (IV, Random, 95% CI)	-0.28 [-0.52, -0.04]
3.2 Functional disability	2	189	Std. Mean Difference (IV, Random, 95% CI)	-0.26 [-0.55, 0.02]
3.3 Quality of life	3	261	Std. Mean Difference (IV, Random, 95% CI)	-0.22 [-1.11, 0.66]
3.4 Adverse events (number of people experiencing adverse events)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
3.5 Anxiety	3	261	Std. Mean Difference (IV, Random, 95% CI)	-0.20 [-0.53, 0.14]
3.6 Depression	3	261	Std. Mean Difference (IV, Random, 95% CI)	-0.12 [-0.38, 0.14]

Analysis 3.1. Comparison 3: Cognitive behavioural therapy (CBT) versus active control (post-treatment), Outcome 1: Pain intensity

Study or Subgroup	CBT Mean	CBT SD	CBT Total	Active control Mean	Active control SD	Active control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Bennell 2018 (1)	4	1.8	67	4.5	1.8	70	52.6%	-0.28 [-0.61 , 0.06]
Buhrman 2013a (2)	3.7	1.1	36	4.1	1.2	36	27.5%	-0.34 [-0.81 , 0.12]
Buhrman 2015 (3)	3.75	1.05	28	3.95	0.93	24	19.9%	-0.20 [-0.74 , 0.35]
Total (95% CI)			**131**			**130**	**100.0%**	**-0.28 [-0.52 , -0.04]**

Heterogeneity: Tau² = 0.00; Chi² = 0.16, df = 2 (P = 0.92); I² = 0%
Test for overall effect: Z = 2.24 (P = 0.03)
Test for subgroup differences: Not applicable



Footnotes

(1) CBT vs. active control (education and exercise), assessed at 8 weeks (Numerical Rating Scale)
(2) CBT vs. active control (moderated weekly online discussion forum), assessed at 8 weeks (Multidimensional Pain Inventory- pain severity subscale)
(3) CBT vs. active control (moderated weekly online discussion forum), assessed at 8 weeks (Multidimensional Pain Inventory)

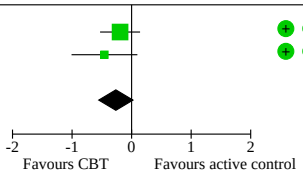
Risk of bias legend

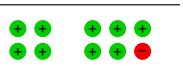
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 3.2. Comparison 3: Cognitive behavioural therapy (CBT) versus active control (post-treatment), Outcome 2: Functional disability

Study or Subgroup	CBT Mean	CBT SD	CBT Total	Active control Mean	Active control SD	Active control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Bennell 2018 (1)	24.2	10.2	67	26.3	11.3	70	73.0%	-0.19 [-0.53 , 0.14]
Buhrman 2015 (2)	32.13	9.64	28	36.65	9.91	24	27.0%	-0.46 [-1.01 , 0.10]
Total (95% CI)			**95**			**94**	**100.0%**	**-0.26 [-0.55 , 0.02]**

Heterogeneity: Tau² = 0.00; Chi² = 0.63, df = 1 (P = 0.43); I² = 0%
Test for overall effect: Z = 1.81 (P = 0.07)
Test for subgroup differences: Not applicable





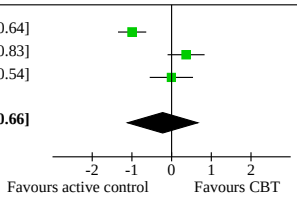
Footnotes
(1) CBT vs. active control (education and exercise), assessed at 8 weeks (Western Ontario and McMaster Universities Osteoarthritis Index- physical function)
(2) CBT vs. active control (moderated online discussion forum), assessed at 8 weeks (Pain Disability Index)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 3.3. Comparison 3: Cognitive behavioural therapy (CBT) versus active control (post-treatment), Outcome 3: Quality of life

Study or Subgroup	CBT Mean	CBT SD	CBT Total	Active control Mean	Active control SD	Active control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Bennell 2018 (1)	0.7	0.1	67	0.8	0.1	70	34.6%	-0.99 [-1.35 , -0.64]
Buhrman 2013a (2)	1.3	2.07	36	0.61	1.65	36	33.3%	0.36 [-0.10 , 0.83]
Buhrman 2015 (3)	1.38	1.78	28	1.39	1.59	24	32.2%	-0.01 [-0.55 , 0.54]
Total (95% CI)			**131**			**130**	**100.0%**	**-0.22 [-1.11 , 0.66]**

Heterogeneity: Tau² = 0.55; Chi² = 23.08, df = 2 (P < 0.00001); I² = 91%
Test for overall effect: Z = 0.50 (P = 0.62)
Test for subgroup differences: Not applicable

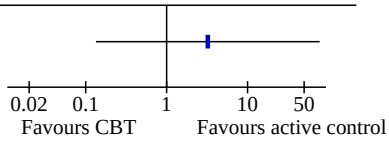


Footnotes
(1) CBT vs. active control (education and exercise), assessed at 8 weeks (Assessment of Quality of Life scale)
(2) CBT vs. active control (moderated weekly online discussion forum), assessed at 8 weeks (Quality of LIfe Inventory)
(3) CBT vs. active control (moderated weekly online discussion forum), assessed at 8 weeks (Quality of Life Inventory)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 3.4. Comparison 3: Cognitive behavioural therapy (CBT) versus active control (post-treatment), Outcome 4: Adverse events (number of people experiencing adverse events)

Study or Subgroup	CBT Events	CBT Total	Active control Events	Active control Total	Risk Ratio M-H, Random, 95% CI
Bennell 2018 (1)	1	65	0	70	3.23 [0.13 , 77.84]



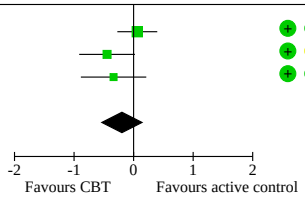
Footnotes

(1) CBT versus. active control (education and exercise), assessed at 8 weeks

Analysis 3.5. Comparison 3: Cognitive behavioural therapy (CBT) versus active control (post-treatment), Outcome 5: Anxiety

Study or Subgroup	CBT Mean	CBT SD	CBT Total	Active control Mean	Active control SD	Active control Total	Weight	Std. Mean Difference IV, Random, 95% CI	Risk of Bias A B C D E F G
Bennell 2018 (1)	2.9	3.4	67	2.7	3	70	43.7%	0.06 [-0.27 , 0.40]	+ + + + +
Buhrman 2013a (2)	7.24	3.93	36	9.11	4.36	36	31.0%	-0.45 [-0.91 , 0.02]	+ ? + + ?
Buhrman 2015 (3)	11.99	8.13	28	14.57	6.81	24	25.3%	-0.34 [-0.89 , 0.21]	+ + + + −
Total (95% CI)			**131**			**130**	**100.0%**	**-0.20 [-0.53 , 0.14]**	

Heterogeneity: Tau² = 0.04; Chi² = 3.51, df = 2 (P = 0.17); I² = 43%
Test for overall effect: Z = 1.14 (P = 0.25)
Test for subgroup differences: Not applicable



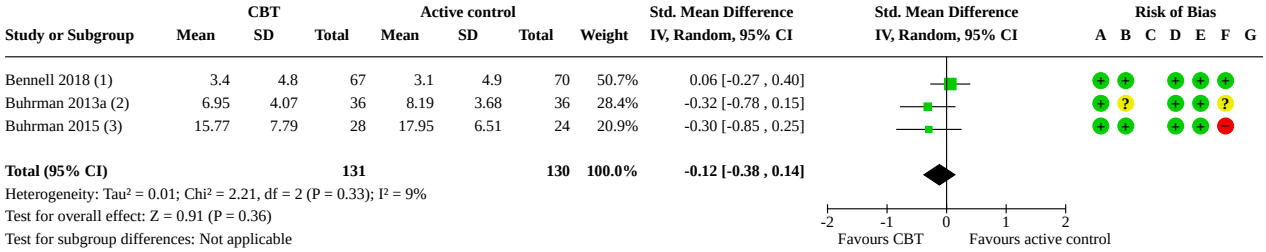
Footnotes

(1) CBT vs. active control (education and exercise), assessed at 8 weeks (Depression Anxiety and Stress Scale-Anxiety subscale)
(2) CBT vs. active control (moderated weekly online forum), assessed at 8 weeks (Hospital Anxiety and Depression Scale-Anxiety)
(3) CBT vs. active control (moderated weekly online forum), assessed at 8 weeks (Beck Anxiety Inventory)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 3.6. Comparison 3: Cognitive behavioural therapy (CBT) versus active control (post-treatment), Outcome 6: Depression



Footnotes

(1) CBT vs. active control (education and exercise), assessed at 8 weeks (Depression, Anxiety and Stress Scale-Depression subscale)
(2) CBT vs. active control (moderated online discussion forum), assessed at 8 weeks (Hospital Anxiety and Depression Scale-depression subscale)
(3) CBT vs. active control (moderated online discussion forum), assessed at 8 weeks (Montgomery and Asberg Depression Rating Scale)

Risk of bias legend

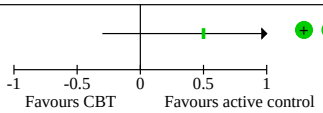
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Comparison 4. Cognitive behavioural therapy (CBT) versus active control (follow-up)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
4.1 Pain intensity	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
4.2 Functional disability	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
4.3 Quality of life	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
4.4 Anxiety	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
4.5 Depression	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

Analysis 4.1. Comparison 4: Cognitive behavioural therapy (CBT) versus active control (follow-up), Outcome 1: Pain intensity

Study or Subgroup	CBT Mean	CBT SD	CBT Total	Active control Mean	Active control SD	Active control Total	Mean Difference IV, Random, 95% CI	Risk of Bias A B C D E F G
Bennell 2018 (1)	3.2	2.3	65	2.7	2.3	62	0.50 [-0.30 , 1.30]	+ + + + +



Footnotes

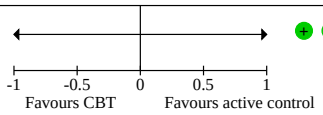
(1) CBT vs. active control (education and exercise), 52 weeks follow-up (Numerical Rating Scale)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 4.2. Comparison 4: Cognitive behavioural therapy (CBT) versus active control (follow-up), Outcome 2: Functional disability

Study or Subgroup	CBT Mean	CBT SD	CBT Total	Active control Mean	Active control SD	Active control Total	Mean Difference IV, Random, 95% CI	Risk of Bias A B C D E F G
Bennell 2018 (1)	18.7	12.6	65	15.3	13.5	62	3.40 [-1.15 , 7.95]	+ + + + +



Footnotes

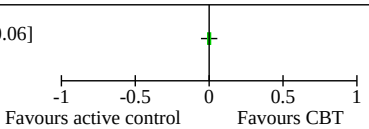
(1) CBT vs. active control (education and exercise), 52 weeks follow-up (Western Ontario and McMaster Universities Osteoarthritis Index)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 4.3. Comparison 4: Cognitive behavioural therapy (CBT) versus active control (follow-up), Outcome 3: Quality of life

Study or Subgroup	CBT Mean	CBT SD	CBT Total	Active control Mean	Active control SD	Active control Total	Mean Difference IV, Random, 95% CI
Bennell 2018 (1)	0.8	0.1	65	0.8	0.2	62	0.00 [-0.06 , 0.06]

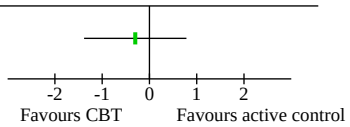


Footnotes

(1) CBT vs. active control (education and exercise), 52 weeks follow-up (Assessment of Quality of Life scale)

Analysis 4.4. Comparison 4: Cognitive behavioural therapy (CBT) versus active control (follow-up), Outcome 4: Anxiety

Study or Subgroup	CBT Mean	CBT SD	CBT Total	Active control Mean	Active control SD	Active control Total	Mean Difference IV, Random, 95% CI
Bennell 2018 (1)	2	2.9	65	2.3	3.3	62	-0.30 [-1.38 , 0.78]

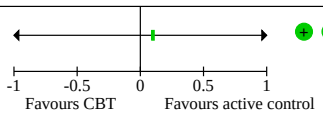


Footnotes

(1) CBT vs. active control (education and exercise), 52 weeks follow-up (Depression Anxiety and Stress Scale -Anxiety subscale)

Analysis 4.5. Comparison 4: Cognitive behavioural therapy (CBT) versus active control (follow-up), Outcome 5: Depression

Study or Subgroup	CBT Mean	CBT SD	CBT Total	Active control Mean	Active control SD	Active control Total	Mean Difference IV, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Bennell 2018 (1)	2.7	4.2	65	2.6	3.9	62	0.10 [-1.31 , 1.51]	+	+		+	+	+	



Footnotes

(1) CBT vs. active control (education and exercise), 52 weeks follow-up (Depression, Anxiety and Stress Scale-depression subscale)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Comparison 5. Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (post-treatment)

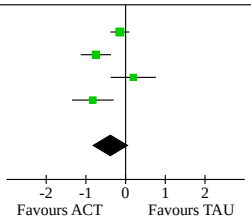
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
5.1 Pain intensity	4	524	Std. Mean Difference (IV, Random, 95% CI)	-0.38 [-0.82, 0.05]
5.2 Pain intensity (≥ 30 % improvement)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5.3 Pain intensity (≥ 50% improvement)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5.4 Functional disability	2	350	Std. Mean Difference (IV, Random, 95% CI)	-0.16 [-0.52, 0.21]
5.5 Quality of life	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
5.6 Adverse events (number of people experiencing serious adverse events)	1		Risk Ratio (M-H, Random, 95% CI)	Totals not selected
5.7 Anxiety	2	415	Std. Mean Difference (IV, Random, 95% CI)	-0.44 [-0.65, -0.24]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
5.8 Depression	4	524	Std. Mean Difference (IV, Random, 95% CI)	-0.48 [-0.68, -0.28]

Analysis 5.1. Comparison 5: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (post-treatment), Outcome 1: Pain intensity

Study or Subgroup	ACT Mean	ACT SD	ACT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Lin 2017 (1)	4.69	1.57	201	4.92	1.61	101	30.2%	-0.14 [-0.38 , 0.09]
Rickardsson 2021 (2)	3.7	2.26	57	5.4	2.25	56	26.4%	-0.75 [-1.13 , -0.37]
Scott 2018 (3)	6.3	1.85	23	5.9	2.18	25	21.1%	0.19 [-0.37 , 0.76]
Simister 2018 (4)	13.8	8.81	30	21	8.41	31	22.3%	-0.83 [-1.35 , -0.30]
Total (95% CI)			**311**			**213**	**100.0%**	**-0.38 [-0.82 , 0.05]**

Heterogeneity: Tau² = 0.15; Chi² = 13.62, df = 3 (P = 0.003); I² = 78%
Test for overall effect: Z = 1.75 (P = 0.08)
Test for subgroup differences: Not applicable

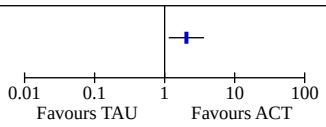


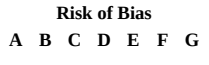
Footnotes
(1) ACT vs. WLC, assessed at 9 weeks (Numerical Rating Scale) (combined guided and unguided interventions)
(2) ACT vs. WLC, assessed at 8 weeks (Numerical Rating Scale)
(3) ACT vs. TAU, assessed at 12 weeks (Numerical Rating Scale)
(4) ACT vs. TAU, assessed at 8 weeks (McGill Pain Questionnaire-short form)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 5.2. Comparison 5: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (post-treatment), Outcome 2: Pain intensity (≥ 30 % improvement)

Study or Subgroup	ACT Events	ACT Total	TAU Events	TAU Total	Risk Ratio M-H, Random, 95% CI
Rickardsson 2021 (1)	25	57	12	56	2.05 [1.14 , 3.66]



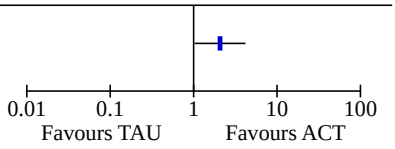


Footnotes
(1) ACT vs. WLC, assessed at 8 weeks (number of people with ≥ 30% improvement in pain)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 5.3. Comparison 5: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (post-treatment), Outcome 3: Pain intensity (≥ 50% improvement)

Study or Subgroup	ACT Events	ACT Total	TAU Events	TAU Total	Risk Ratio M-H, Random, 95% CI
Rickardsson 2021 (1)	19	57	9	56	2.07 [1.03 , 4.19]



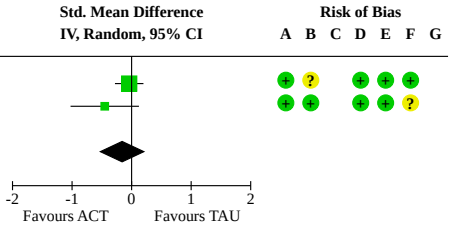
Footnotes

(1) ACT vs. WLC, assessed at 8 weeks (number of people with ≥ 50% improvement in pain)

Analysis 5.4. Comparison 5: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (post-treatment), Outcome 4: Functional disability

Study or Subgroup	ACT Mean	ACT SD	ACT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Lin 2017 (1)	-37.96	8.68	201	-37.6	9.27	101	71.0%	-0.04 [-0.28 , 0.20]
Scott 2018 (2)	20.2	6.93	23	23.4	7.02	25	29.0%	-0.45 [-1.03 , 0.12]
Total (95% CI)			**224**			**126**	**100.0%**	**-0.16 [-0.52 , 0.21]**

Heterogeneity: Tau² = 0.03; Chi² = 1.68, df = 1 (P = 0.20); I² = 40%
Test for overall effect: Z = 0.86 (P = 0.39)
Test for subgroup differences: Not applicable



Footnotes

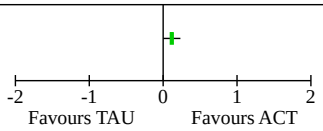
(1) ACT versus waitlist assessed at 9 weeks (Short form-12)(combined guided and unguided interventions)
(2) ACT vs. TAU, assessed at 12 weeks (Work and Social Adjustment scale)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 5.5. Comparison 5: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (post-treatment), Outcome 5: Quality of life

Study or Subgroup	ACT Mean	ACT SD	ACT Total	TAU Mean	TAU SD	TAU Total	Mean Difference IV, Random, 95% CI
Rickardsson 2021 (1)	0.478	0.325	57	0.361	0.306	56	0.12 [0.00 , 0.23]

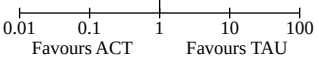


Footnotes

(1) ACT vs. WLC, assessed at 8 weeks (EuroQoL-5D)

Analysis 5.6. Comparison 5: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (post-treatment), Outcome 6: Adverse events (number of people experiencing serious adverse events)

Study or Subgroup	ACT Events	ACT Total	TAU Events	TAU Total	Risk Ratio M-H, Random, 95% CI	Risk Ratio M-H, Random, 95% CI	Risk of Bias A B C D E F G
Rickardsson 2021 (1)	0	57	0	56	Not estimable		+ + ? + −



Footnotes

(1) ACT vs. WLC, assessed at 8 weeks (serious adverse events (e.g. suicide))

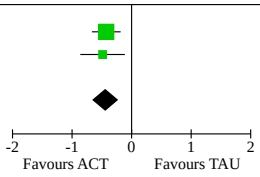
Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 5.7. Comparison 5: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (post-treatment), Outcome 7: Anxiety

Study or Subgroup	ACT Mean	ACT SD	ACT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI	Std. Mean Difference IV, Random, 95% CI	Risk of Bias A B C D E F G
Lin 2017 (1)	6.19	3.92	201	7.99	4.75	101	70.6%	-0.43 [-0.67 , -0.18]		+ ? + + +
Rickardsson 2021 (2)	5	4.3	57	7.1	4.26	56	29.4%	-0.49 [-0.86 , -0.11]		+ + ? + −
Total (95% CI)			**258**			**157**	**100.0%**	**-0.44 [-0.65 , -0.24]**		

Heterogeneity: Tau² = 0.00; Chi² = 0.07, df = 1 (P = 0.79); I² = 0%
Test for overall effect: Z = 4.29 (P < 0.0001)
Test for subgroup differences: Not applicable



Footnotes

(1) ACT vs. WLC, assessed at 9 weeks (Generalised Anxiety Disorder-7) (combined guided and unguided interventions)
(2) ACT vs. WLC, assessed at 8 weeks (Generalised Anxiety Disorder-7 scale)

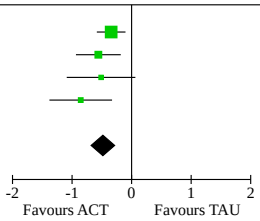
Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 5.8. Comparison 5: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (post-treatment), Outcome 8: Depression

Study or Subgroup	ACT Mean	ACT SD	ACT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Lin 2017 (1)	8.67	4.84	201	10.38	5.21	101	51.2%	-0.34 [-0.58 , -0.10]
Rickardsson 2021 (2)	7.5	5.36	57	10.5	5.31	56	24.4%	-0.56 [-0.93 , -0.18]
Scott 2018 (3)	10	3.93	23	12.1	4.11	25	11.1%	-0.51 [-1.09 , 0.06]
Simister 2018 (4)	17.76	10.83	30	26.97	10.46	31	13.2%	-0.85 [-1.38 , -0.33]
Total (95% CI)			**311**			**213**	**100.0%**	**-0.48 [-0.68 , -0.28]**

Heterogeneity: Tau² = 0.00; Chi² = 3.35, df = 3 (P = 0.34); I² = 10%
Test for overall effect: Z = 4.79 (P < 0.00001)
Test for subgroup differences: Not applicable



Footnotes
(1) ACT vs. WLC, assessed at 9 weeks (Patient Health Questionnaire-9) (combined guided and unguided interventions)
(2) ACT vs. WLC, assessed at 8 weeks (Patient Health Questionnaire-9)
(3) ACT vs. TAU, assessed at 12 weeks (Patient Health Questionnaire-9)
(4) ACT vs. TAU, assessed at 8 weeks (Centre for Epidemiological Studies Depression Scale)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

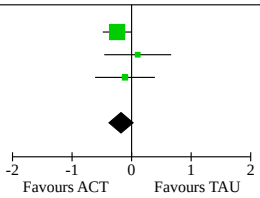
Comparison 6. Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (follow-up)

Outcome or sub-group title	No. of studies	No. of partici-pants	Statistical method	Effect size
6.1 Pain intensity	3	412	Std. Mean Difference (IV, Random, 95% CI)	-0.18 [-0.38, 0.02]
6.2 Functional disabil-ity	2	351	Std. Mean Difference (IV, Random, 95% CI)	-0.25 [-0.55, 0.05]
6.3 Quality of life	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
6.4 Anxiety	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
6.5 Depression	3	412	Std. Mean Difference (IV, Random, 95% CI)	-0.42 [-0.62, -0.21]

Analysis 6.1. Comparison 6: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (follow-up), Outcome 1: Pain intensity

Study or Subgroup	ACT Mean	ACT SD	ACT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Lin 2017 (1)	4.57	1.67	201	4.97	1.56	101	70.9%	-0.24 [-0.48 , -0.00]
Scott 2018 (2)	6.1	1.85	23	5.9	1.98	26	12.9%	0.10 [-0.46 , 0.66]
Simister 2018 (3)	21.46	9.1	30	22.49	9.21	31	16.2%	-0.11 [-0.61 , 0.39]
Total (95% CI)			**254**			**158**	**100.0%**	**-0.18 [-0.38 , 0.02]**

Heterogeneity: Tau² = 0.00; Chi² = 1.32, df = 2 (P = 0.52); I² = 0%
Test for overall effect: Z = 1.73 (P = 0.08)
Test for subgroup differences: Not applicable



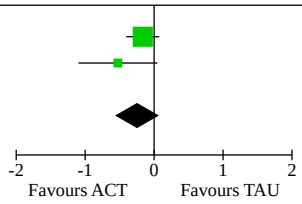
Footnotes
(1) ACT vs. TAU, 24 weeks follow-up (Numerical Rating Scale)(combined guided and unguided interventions)
(2) ACT vs. TAU, 36 weeks follow-up (Numerical Rating Scale)
(3) ACT vs. TAU, 20 weeks follow-up (McGill Pain Questionnaire-short form)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 6.2. Comparison 6: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (follow-up), Outcome 2: Functional disability

Study or Subgroup	ACT Mean	ACT SD	ACT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Lin 2017 (1)	-39.07	8.93	201	-37.6	8.96	101	76.8%	-0.16 [-0.40 , 0.08]
Scott 2018 (2)	20	6.93	23	23.7	6.93	26	23.2%	-0.53 [-1.10 , 0.05]
Total (95% CI)			**224**			**127**	**100.0%**	**-0.25 [-0.55 , 0.05]**

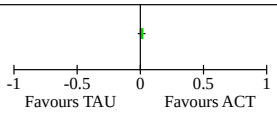
Heterogeneity: Tau² = 0.02; Chi² = 1.31, df = 1 (P = 0.25); I² = 23%
Test for overall effect: Z = 1.63 (P = 0.10)
Test for subgroup differences: Not applicable



Footnotes
(1) ACT vs. WLC, 24 weeks follow-up (Short form-12)(combined guided and unguided interventions)
(2) ACT vs. TAU, 36 weeks follow-up (Work and Social Adjustment Scale)

Analysis 6.3. Comparison 6: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (follow-up), Outcome 3: Quality of life

Study or Subgroup	ACT Mean	ACT SD	ACT Total	TAU Mean	TAU SD	TAU Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Lin 2017 (1)	0.26	0.12	201	0.25	0.13	101	0.01 [-0.02 , 0.04]		+	?		+	+	+	

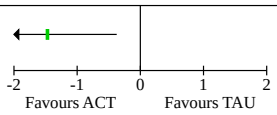


Footnotes
(1) ACT vs. WLC, 24 weeks follow-up (EuroQoL-5D-3L) (combined guided and unguided interventions)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 6.4. Comparison 6: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (follow-up), Outcome 4: Anxiety

Study or Subgroup	ACT Mean	ACT SD	ACT Total	TAU Mean	TAU SD	TAU Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI	Risk of Bias A	B	C	D	E	F	G
Lin 2017 (1)	6.13	4.03	201	7.6	4.84	101	-1.47 [-2.57 , -0.37]		+	?		+	+	+	



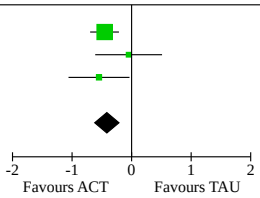
Footnotes
(1) ACT vs. WLC, 24 weeks follow-up (Generalised Anxiety Disorder-7)(combined guided and unguided interventions)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 6.5. Comparison 6: Acceptance and commitment therapy (ACT) versus treatment as usual (TAU) (follow-up), Outcome 5: Depression

Study or Subgroup	ACT Mean	ACT SD	ACT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
Lin 2017 (1)	8.44	4.92	201	10.73	5.23	101	71.0%	-0.45 [-0.70 , -0.21]
Scott 2018 (2)	11.8	3.93	23	12	3.96	26	13.2%	-0.05 [-0.61 , 0.51]
Simister 2018 (3)	18.36	12.12	30	25.13	12.29	31	15.8%	-0.55 [-1.06 , -0.04]
Total (95% CI)			**254**			**158**	**100.0%**	**-0.42 [-0.62 , -0.21]**

Heterogeneity: Tau² = 0.00; Chi² = 1.99, df = 2 (P = 0.37); I² = 0%
Test for overall effect: Z = 4.00 (P < 0.0001)
Test for subgroup differences: Not applicable



Footnotes
(1) ACT vs. WLC, 24 weeks follow-up (Patient Health Questionnaire-9)(combined guided and unguided interventions)
(2) ACT vs. TAU, 36 weeks follow-up (Patient Health Questionnaire-9)
(3) ACT vs. TAU, 21 weeks follow-up (Centre for Epidemiological Studies Depression Scale)

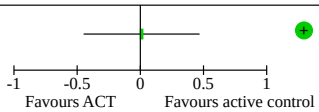
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Comparison 7. Acceptance and commitment therapy (ACT) versus active control (post-treatment)

Outcome or sub-group title	No. of studies	No. of partici-pants	Statistical method	Effect size
7.1 Pain intensity	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
7.2 Quality of life	2	126	Std. Mean Difference (IV, Random, 95% CI)	0.36 [-0.23, 0.95]
7.3 Anxiety	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
7.4 Depression	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

Analysis 7.1. Comparison 7: Acceptance and commitment therapy (ACT) versus active control (post-treatment), Outcome 1: Pain intensity

Study or Subgroup	ACT Mean	ACT SD	ACT Total	Active control Mean	Active control SD	Active control Total	Mean Difference IV, Random, 95% CI
Buhrman 2013b (1)	4.3	1.04	38	4.29	1	38	0.01 [-0.45 , 0.47]



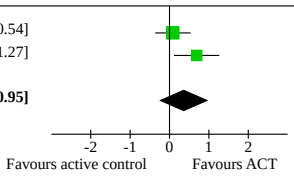
Footnotes
(1) ACT vs. active control (weekly online discussion forum), assessed at 7 weeks (Multidimensional Pain Inventory)

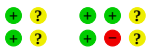
Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 7.2. Comparison 7: Acceptance and commitment therapy (ACT) versus active control (post-treatment), Outcome 2: Quality of life

Study or Subgroup	ACT Mean	ACT SD	ACT Total	Active control Mean	Active control SD	Active control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Buhrman 2013b (1)	0.56	2.07	38	0.39	1.77	38	54.6%	0.09 [-0.36 , 0.54]
Morcillo-Muñoz 2022 (2)	0.55	0.17	22	0.41	0.22	28	45.4%	0.69 [0.11 , 1.27]
Total (95% CI)			**60**			**66**	**100.0%**	**0.36 [-0.23 , 0.95]**

Heterogeneity: Tau² = 0.11; Chi² = 2.61, df = 1 (P = 0.11); I² = 62%
Test for overall effect: Z = 1.20 (P = 0.23)
Test for subgroup differences: Not applicable



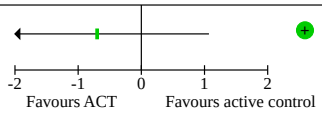


Footnotes
(1) ACT vs. active control (weekly moderated online discussion forum), assessed at 7 weeks (Quality of LIfe Inventory)
(2) ACT vs. active control (access to information, advice and exercise part of app), assessed at 6 to 7 weeks (EuroQol 5D)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 7.3. Comparison 7: Acceptance and commitment therapy (ACT) versus active control (post-treatment), Outcome 3: Anxiety

Study or Subgroup	ACT Mean	ACT SD	ACT Total	Active control Mean	Active control SD	Active control Total	Mean Difference IV, Random, 95% CI
Buhrman 2013b (1)	8.97	4.33	38	9.67	3.5	38	-0.70 [-2.47 , 1.07]

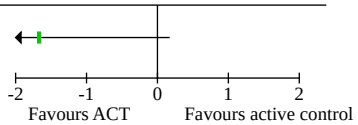


Footnotes
(1) ACT vs active control (weekly moderated online discussion forum), assessed at 7 weeks (Hospital Anxiety and Depression Scale-Anxiety)

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 7.4. Comparison 7: Acceptance and commitment therapy (ACT) versus active control (post-treatment), Outcome 4: Depression

Study or Subgroup	ACT Mean	ACT SD	ACT Total	Active control Mean	Active control SD	Active control Total	Mean Difference IV, Random, 95% CI
Buhrman 2013b (1)	8.85	4.4	38	10.52	3.77	38	-1.67 [-3.51 , 0.17]

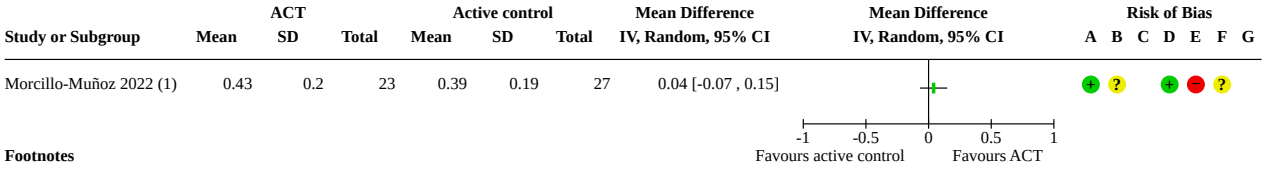


Footnotes
(1) ACT vs. active control (weekly moderated online discussion forum), assessed at 7 weeks (Hospital Anxiety and Depression Scale-Depression)

Comparison 8. Acceptance and commitment therapy (ACT) versus active control (follow-up)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
8.1 Quality of life	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

Analysis 8.1. Comparison 8: Acceptance and commitment therapy (ACT) versus active control (follow-up), Outcome 1: Quality of life



Footnotes

(1) ACT vs. active control (access to information, advice and exercise part of app), 12 weeks follow-up (EuroQoL-5D)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

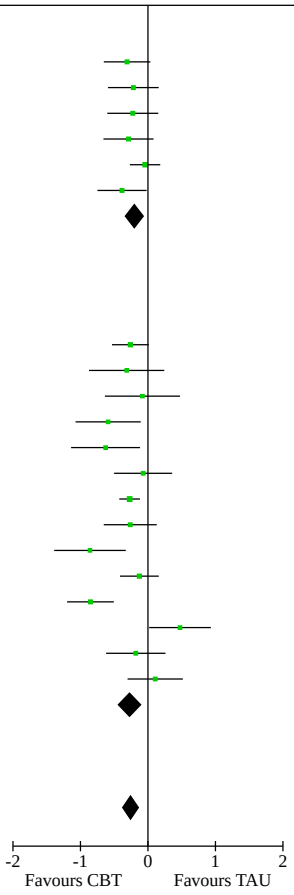
Comparison 9. Subgroup analyses and sensitivity analyses: CBT versus TAU (post-treatment)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
9.1 Pain intensity subgroup analysis: no therapist involvement versus therapist involvement (post-treatment)	20	2883	Std. Mean Difference (IV, Random, 95% CI)	-0.26 [-0.37, -0.14]
9.1.1 No therapist involvement	6	898	Std. Mean Difference (IV, Random, 95% CI)	-0.20 [-0.33, -0.07]
9.1.2 Therapist involvement	14	1985	Std. Mean Difference (IV, Random, 95% CI)	-0.27 [-0.44, -0.11]
9.2 Functional disability subgroup analysis: no therapist involvement versus therapist involvement (post-treatment)	14	2349	Std. Mean Difference (IV, Random, 95% CI)	-0.37 [-0.53, -0.21]
9.2.1 No therapist involvement	5	788	Std. Mean Difference (IV, Random, 95% CI)	-0.35 [-0.60, -0.10]
9.2.2 Therapist involvement	9	1561	Std. Mean Difference (IV, Random, 95% CI)	-0.38 [-0.60, -0.16]
9.3 Pain intensity sensitivity analysis (< 50 versus > 50 participants per arm) (post-treatment)	20	3206	Std. Mean Difference (IV, Random, 95% CI)	-0.28 [-0.39, -0.16]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
9.3.1 <50 participants per arm	7	448	Std. Mean Difference (IV, Random, 95% CI)	-0.30 [-0.64, 0.04]
9.3.2 > 50 participants per arm	13	2758	Std. Mean Difference (IV, Random, 95% CI)	-0.27 [-0.38, -0.16]
9.4 Functional disability: sensitivity analysis (< 50 participants versus > 50 participants per arm) (post-treatment)	14	2672	Std. Mean Difference (IV, Random, 95% CI)	-0.38 [-0.53, -0.22]
9.4.1 < 50 participants	5	429	Std. Mean Difference (IV, Random, 95% CI)	-0.36 [-0.70, -0.02]
9.4.2 > 50 participants	9	2243	Std. Mean Difference (IV, Random, 95% CI)	-0.39 [-0.57, -0.20]
9.5 Pain intensity: sensitivity analysis (studies at low versus high or unclear risk of bias across domains) (post-treatment)	20	3206	Std. Mean Difference (IV, Random, 95% CI)	-0.28 [-0.39, -0.16]
9.5.1 Low risk of bias across all domains	3	1339	Std. Mean Difference (IV, Random, 95% CI)	-0.30 [-0.42, -0.19]
9.5.2 Risk of bias with high or unclear domains	17	1867	Std. Mean Difference (IV, Random, 95% CI)	-0.27 [-0.42, -0.12]
9.6 Functional disability: sensitivity analysis (studies at low versus high or unclear risk of bias across domains) (post-treatment)	14	2672	Std. Mean Difference (IV, Random, 95% CI)	-0.38 [-0.53, -0.22]
9.6.1 Low risk of bias	2	1130	Std. Mean Difference (IV, Random, 95% CI)	-0.40 [-0.56, -0.24]
9.6.2 High or unclear risk of bias	12	1542	Std. Mean Difference (IV, Random, 95% CI)	-0.37 [-0.57, -0.17]
9.7 Functional disability: sensitivity analysis (high or unclear risk of bias studies eliminated with no difference of effect) (post-treatment)	6	647	Std. Mean Difference (IV, Random, 95% CI)	-0.66 [-0.82, -0.50]

Analysis 9.1. Comparison 9: Subgroup analyses and sensitivity analyses: CBT versus TAU (post-treatment), Outcome 1: Pain intensity subgroup analysis: no therapist involvement versus therapist involvement (post-treatment)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
9.1.1 No therapist involvement								
Carpenter 2012 (1)	5.2	1.5	63	5.7	1.7	68	5.5%	-0.31 [-0.65 , 0.04]
Guarino 2018 (2)	4.19	1.01	55	4.41	1.01	55	5.1%	-0.22 [-0.59 , 0.16]
Peters 2017 (3)	5.71	2.25	80	6.2	1.99	41	5.0%	-0.22 [-0.60 , 0.15]
Rini 2015 (4)	4.07	1.99	58	4.62	1.79	55	5.1%	-0.29 [-0.66 , 0.08]
Ruehlman 2012 (5)	22.75	4.14	162	22.93	4.25	143	7.7%	-0.04 [-0.27 , 0.18]
Williams 2010 (6)	4.3	1.6	59	4.9	1.5	59	5.2%	-0.38 [-0.75 , -0.02]
Subtotal (95% CI)			**477**			**421**	**33.6%**	**-0.20 [-0.33 , -0.07]**
Heterogeneity: Tau² = 0.00; Chi² = 3.49, df = 5 (P = 0.63); I² = 0%								
Test for overall effect: Z = 3.00 (P = 0.003)								
9.1.2 Therapist involvement								
Baumeister 2021 (7)	1.43	0.79	104	1.63	0.74	105	6.7%	-0.26 [-0.53 , 0.01]
Buhrman 2004 (8)	34.3	16.8	22	39.6	16.3	29	3.1%	-0.32 [-0.87 , 0.24]
Buhrman 2011 (9)	3.15	2.2	23	3.35	2.6	27	3.1%	-0.08 [-0.64 , 0.48]
Burke 2019 (10)	3.86	2.39	35	5.15	1.9	34	3.7%	-0.59 [-1.07 , -0.11]
Dear 2013 (11)	4.68	1.7	31	5.81	1.85	31	3.5%	-0.63 [-1.14 , -0.12]
Dear 2015 (12)	5.9	1.54	123	6.01	1.51	25	4.3%	-0.07 [-0.50 , 0.36]
Dear 2021 (13)	4.9	1.85	334	5.4	1.83	325	9.1%	-0.27 [-0.42 , -0.12]
Ferwerda 2017 (14)	14.6	4.5	45	15.68	3.73	57	4.8%	-0.26 [-0.65 , 0.13]
Friesen 2017 (15)	4.99	1.66	30	6.28	1.28	30	3.3%	-0.86 [-1.39 , -0.33]
Gasslander 2022 (16)	3.75	1.02	95	3.88	1.02	92	6.5%	-0.13 [-0.41 , 0.16]
Hedman-Lagerlöf 2018 (17)	4.19	3.25	70	6.7	2.57	70	5.5%	-0.85 [-1.20 , -0.51]
Schlicker 2020 (18)	4.68	1.86	40	3.81	1.76	36	4.0%	0.47 [0.02 , 0.93]
Smith 2019 (19)	4.44	1.56	41	4.73	1.63	39	4.2%	-0.18 [-0.62 , 0.26]
Wilson 2015 (20)	5.3	1.9	45	5.1	1.8	47	4.6%	0.11 [-0.30 , 0.52]
Subtotal (95% CI)			**1038**			**947**	**66.4%**	**-0.27 [-0.44 , -0.11]**
Heterogeneity: Tau² = 0.06; Chi² = 35.04, df = 13 (P = 0.0008); I² = 63%								
Test for overall effect: Z = 3.25 (P = 0.001)								
Total (95% CI)			**1515**			**1368**	**100.0%**	**-0.26 [-0.37 , -0.14]**
Heterogeneity: Tau² = 0.03; Chi² = 39.21, df = 19 (P = 0.004); I² = 52%								
Test for overall effect: Z = 4.37 (P < 0.0001)								
Test for subgroup differences: Chi² = 0.43, df = 1 (P = 0.51), I² = 0%								

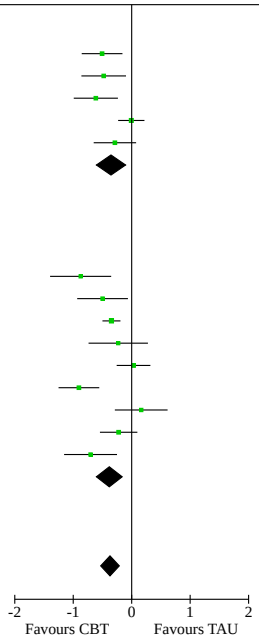


Footnotes

(1) CBT versus waitlist assessed at 3 weeks (average pain in the last week)
(2) CBT versus treatment as usual assessed at 12 weeks (Multidimensional Pain Inventory: pain severity subscale)
(3) CBT versus waitlist assessed at 8 weeks (Numerical Rating Scale)
(4) CBT versus treatment as usual assessed at 9-11 weeks (Athritis Impact Scale 2 (AIMS2): pain subscale)
(5) CBT versus waitlist assessed at 7 weeks (Profile of Chronic pain: Screen (PCP-S) - Severity)
(6) CBT versus treatment as usual assessed at 26 weeks (Brief Pain Inventory)
(7) CBT versus treatment as usual assessed at 9 weeks (Numerical Rating Scale)
(8) CBT versus waitlist assessed at 8 weeks (Numerical Rating Scale)
(9) CBT versus waitlist assessed at 11 weeks (Multidimensional Pain Inventory: pain severity subscale)
(10) CBT versus treatment as usual assessed at 6 weeks (Numerical Rating Scale)
(11) CBT versus waitlist assessed at 8 weeks (Wisconsin Brief Pain Questionnaire: Average pain)
(12) CBT vs. TAU+WLC, assessed at 8 weeks (Roland-Morris Disability Questionnaire) (no therapist contact arm)
(13) CBT versus waitlist assessed a8 weeks post-treatment (Wisconsin Brief Pain Questionnaire: Average pain)
(14) CBT versus TAU, post-intervention (variable duration) (Impact of Rheumatic Diseases on General Health and Lifestyle)
(15) CBT versus TAU+waitlist assessed at 8 weeks (Brief Pain Inventory-pain severity item)
(16) CBT versus waitlist control assessed at 12 weeks (Multidimensional Pain Inventory: pain severity subscale)
(17) CBT versus waitlist assessed at 10 weeks (Fibromyalgia Impact Questionnaire-Pain)
(18) CBT versus treatment as usual+waitlist assessed at 9 weeks (Numerical Rating Scale)
(19) CBT versus treatment as usual assessed at 16-17 weeks (Brief Pain Inventory: severity subscale)
(20) CBT versus treatment as usual+waitlist assessed at 8 weeks (Brief Pain Inventory)

Analysis 9.2. Comparison 9: Subgroup analyses and sensitivity analyses: CBT versus TAU (post-treatment), Outcome 2: Functional disability subgroup analysis: no therapist involvement versus therapist involvement (post-treatment)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI	Risk of Bias A B C D E F G
9.2.1 No therapist involvement									
Carpenter 2012 (1)	13.5	5.8	63	16.3	5.2	68	7.4%	-0.51 [-0.85 , -0.16]	+ ? + + ?
Peters 2017 (2)	17.94	5.44	80	20.63	5.86	41	6.9%	-0.48 [-0.86 , -0.10]	? ? ? ? ?
Rini 2015 (3)	1	1.19	58	1.75	1.24	55	6.9%	-0.61 [-0.99 , -0.24]	+ + + + -
Ruehlman 2012 (4)	10.31	6.12	162	10.35	5.8	143	9.3%	-0.01 [-0.23 , 0.22]	? ? + + ?
Williams 2010 (5)	-41.4	8.7	59	-38.9	8.6	59	7.2%	-0.29 [-0.65 , 0.08]	+ + + + ?
Subtotal (95% CI)			**422**			**366**	**37.7%**	**-0.35 [-0.60 , -0.10]**	
Heterogeneity: Tau² = 0.05; Chi² = 11.33, df = 4 (P = 0.02); I² = 65%									
Test for overall effect: Z = 2.78 (P = 0.005)									
9.2.2 Therapist involvement									
Dear 2013 (6)	10.1	5.23	31	14.77	5.33	31	5.1%	-0.87 [-1.40 , -0.35]	? ? + + ?
Dear 2015 (7)	11.36	5.22	123	13.97	5.17	25	6.2%	-0.50 [-0.93 , -0.06]	+ + + + +
Dear 2021 (8)	31.2	16.7	334	36.5	13.7	325	10.3%	-0.35 [-0.50 , -0.19]	+ + + + +
Friesen 2017 (9)	-34.7	7.94	30	-32.82	8.2	30	5.3%	-0.23 [-0.74 , 0.28]	+ + + + -
Gasslander 2022 (10)	38.59	13.09	94	38.21	10.84	91	8.3%	0.03 [-0.26 , 0.32]	+ ? + + -
Hedman-Lagerlöf 2018 (11)	24.64	17.71	70	40.83	17.96	70	7.4%	-0.90 [-1.25 , -0.55]	+ ? + + -
Schlicker 2020 (12)	28.26	16.29	40	25.56	16.52	36	6.0%	0.16 [-0.29 , 0.61]	+ + + + -
Serrat 2021 (13)	-38.72	22.91	75	-33.95	19.55	76	7.8%	-0.22 [-0.54 , 0.10]	+ + + ? ?
Smith 2019 (14)	26.59	9.88	41	33.64	9.97	39	5.9%	-0.70 [-1.16 , -0.25]	+ + ? + -
Subtotal (95% CI)			**838**			**723**	**62.3%**	**-0.38 [-0.60 , -0.16]**	
Heterogeneity: Tau² = 0.08; Chi² = 28.85, df = 8 (P = 0.0003); I² = 72%									
Test for overall effect: Z = 3.41 (P = 0.0007)									
Total (95% CI)			**1260**			**1089**	**100.0%**	**-0.37 [-0.53 , -0.21]**	
Heterogeneity: Tau² = 0.06; Chi² = 40.71, df = 13 (P = 0.0001); I² = 68%									
Test for overall effect: Z = 4.57 (P < 0.00001)									
Test for subgroup differences: Chi² = 0.03, df = 1 (P = 0.86), I² = 0%									



Footnotes

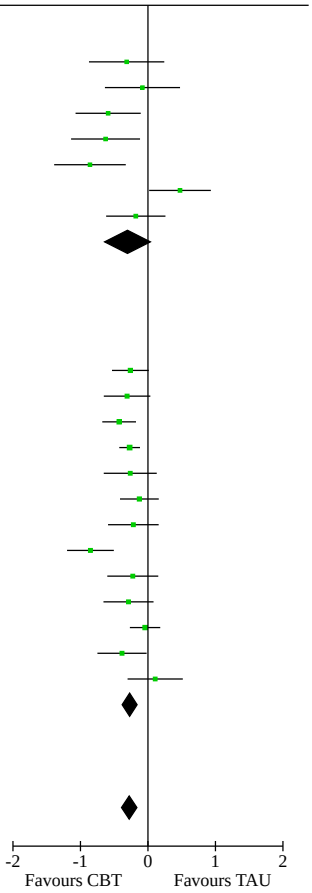
(1) CBT vs. WLC, assessed at 3 weeks (Roland-Morris Disability Questionnaire)
(2) CBT vs. WLC, assessed at 8 weeks (Fibromyalgia Impairment Scale-physical impairment)
(3) CBT vs. TAU, assessed at 9 to 11 weeks (Arthritis Impact Scale 2)
(4) CBT vs WLC, assessed at 7 weeks (Profile of Chronic Pain: Screen (PCP-S) - Perceived Disability)
(5) CBT vs. TAU, assessed at 24 weeks (SF-36 physical functioning subscale)
(6) CBT vs. WLC, assessed at 8 weeks (Roland-Morris Disability Questionnaire)
(7) CBT vs. TAU+WLC, assessed at 8 weeks (Roland-Morris Disability Questionnaire) (combined regular, optional and no contact interventions)
(8) CBT vs. WLC, assessed at 8 weeks (Pain Disability Index)
(9) CBT vs. TAU+WLC, assessed at 8 weeks (Short Form 12 physical subscale)
(10) CBT vs. WLC, assessed at 12 weeks (Pain Disability Index)
(11) CBT vs. WLC, assessed at 10 weeks (WHO-Disability Assessment Schedule (WHO-DAS II))
(12) CBT vs. TAU+WLC, assessed at 9 weeks (Oswestry Disability Index-functional disability)
(13) CBT vs. TAU+WLC, assessed at 12 weeks (Physical functioning component of SF-36 scale)
(14) CBT vs. TAU, assessed at 16 to 17 weeks (Pain Disability Index)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 9.3. Comparison 9: Subgroup analyses and sensitivity analyses: CBT versus TAU (post-treatment), Outcome 3: Pain intensity sensitivity analysis (< 50 versus > 50 participants per arm) (post-treatment)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
9.3.1 <50 participants per arm								
Buhrman 2004 (1)	34.3	16.8	22	39.6	16.3	29	3.0%	-0.32 [-0.87 , 0.24]
Buhrman 2011 (2)	3.15	2.2	23	3.35	2.6	27	3.0%	-0.08 [-0.64 , 0.48]
Burke 2019 (3)	3.86	2.39	35	5.15	1.9	34	3.6%	-0.59 [-1.07 , -0.11]
Dear 2013 (4)	4.68	1.7	31	5.81	1.85	31	3.4%	-0.63 [-1.14 , -0.12]
Friesen 2017 (5)	4.99	1.66	30	6.28	1.28	30	3.2%	-0.86 [-1.39 , -0.33]
Schlicker 2020 (6)	4.68	1.86	40	3.81	1.76	36	3.9%	0.47 [0.02 , 0.93]
Smith 2019 (7)	4.44	1.56	41	4.73	1.63	39	4.1%	-0.18 [-0.62 , 0.26]
Subtotal (95% CI)			**222**			**226**	**24.2%**	**-0.30 [-0.64 , 0.04]**
Heterogeneity: Tau² = 0.14; Chi² = 19.13, df = 6 (P = 0.004); I² = 69%								
Test for overall effect: Z = 1.76 (P = 0.08)								
9.3.2 > 50 participants per arm								
Baumeister 2021 (8)	1.43	0.79	104	1.63	0.74	105	6.6%	-0.26 [-0.53 , 0.01]
Carpenter 2012 (9)	5.2	1.5	63	5.7	1.7	68	5.4%	-0.31 [-0.65 , 0.04]
Dear 2015 (10)	4.97	1.77	397	5.71	1.5	74	7.0%	-0.43 [-0.68 , -0.18]
Dear 2021 (11)	4.9	1.85	334	5.4	1.83	325	8.8%	-0.27 [-0.42 , -0.12]
Ferwerda 2017 (12)	14.6	4.5	45	15.68	3.73	57	4.7%	-0.26 [-0.65 , 0.13]
Gasslander 2022 (13)	3.75	1.02	95	3.88	1.02	92	6.3%	-0.13 [-0.41 , 0.16]
Guarino 2018 (14)	4.19	1.01	55	4.41	1.01	55	4.9%	-0.22 [-0.59 , 0.16]
Hedman-Lagerlöf 2018 (15)	4.19	3.25	70	6.7	2.57	70	5.3%	-0.85 [-1.20 , -0.51]
Peters 2017 (16)	5.71	2.25	80	6.2	1.99	41	4.9%	-0.22 [-0.60 , 0.15]
Rini 2015 (17)	4.07	1.99	58	4.62	1.79	55	5.0%	-0.29 [-0.66 , 0.08]
Ruehlman 2012 (18)	22.75	4.14	162	22.93	4.25	143	7.5%	-0.04 [-0.27 , 0.18]
Williams 2010 (19)	4.3	1.6	59	4.9	1.5	59	5.1%	-0.38 [-0.75 , -0.02]
Wilson 2015 (20)	5.3	1.9	45	5.1	1.8	47	4.5%	0.11 [-0.30 , 0.52]
Subtotal (95% CI)			**1567**			**1191**	**75.8%**	**-0.27 [-0.38 , -0.16]**
Heterogeneity: Tau² = 0.02; Chi² = 21.07, df = 12 (P = 0.05); I² = 43%								
Test for overall effect: Z = 4.82 (P < 0.00001)								
Total (95% CI)			**1789**			**1417**	**100.0%**	**-0.28 [-0.39 , -0.16]**
Heterogeneity: Tau² = 0.03; Chi² = 40.23, df = 19 (P = 0.003); I² = 53%								
Test for overall effect: Z = 4.79 (P < 0.00001)								
Test for subgroup differences: Chi² = 0.03, df = 1 (P = 0.86), I² = 0%								

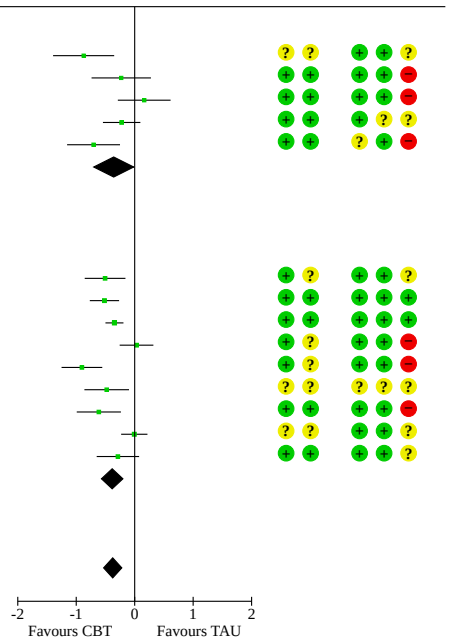


Footnotes

(1) CBT versus waitlist assessed at 8 weeks (Numerical Rating Scale)
(2) CBT versus waitlist assessed at 11 weeks (Multidimensional Pain Inventory: pain severity subscale)
(3) CBT versus treatment as usual assessed at 6 weeks (Numerical Rating Scale)
(4) CBT versus waitlist assessed at 8 weeks (Wisconsin Brief Pain Questionnaire: Average pain)
(5) CBT versus TAU+waitlist assessed at 8 weeks (Brief Pain Inventory-pain severity item)
(6) CBT versus treatment as usual+waitlist assessed at 9 weeks (Numerical Rating Scale)
(7) CBT versus treatment as usual assessed at 16-17 weeks (Brief Pain Inventory: severity subscale)
(8) CBT versus treatment as usual assessed at 9 weeks (Numerical Rating Scale)
(9) CBT versus waitlist assessed at 3 weeks (average pain in the last week)
(10) CBT versus TAU+waitlist assessed at 8 weeks (Wisconsin Brief Pain Questionnaire: Average pain)
(11) CBT versus waitlist assessed at 8 weeks (Wisconsin Brief Pain Questionnaire: Average pain)
(12) CBT versus TAU at post-intervention (variable duration) (Impact of Rheumatic Diseases on General Health and Lifestyle)
(13) CBT versus waitlist control assessed at 12 weeks (Multidimensional Pain Inventory: pain severity subscale)
(14) CBT versus treatment as usual assessed at 12 weeks (Multidimensional Pain Inventory: pain severity subscale)
(15) CBT versus waitlist assessed at 10 weeks (Fibromyalgia Impact Questionnaire-Pain)
(16) CBT versus waitlist assessed at 8 weeks (Numerical Rating Scale)
(17) CBT versus treatment as usual assessed at 9-11 weeks (Athritis Impact Scale 2 (AIMS2): pain subscale)
(18) CBT versus waitlist assessed at 7 weeks (Profile of Chronic pain: Screen (PCP-S) - Severity)
(19) CBT versus treatment as usual assessed at 26 weeks (Brief Pain Inventory)
(20) CBT versus treatment as usual+waitlist assessed at 8 weeks (Brief Pain Inventory)

Analysis 9.4. Comparison 9: Subgroup analyses and sensitivity analyses: CBT versus TAU (post-treatment), Outcome 4: Functional disability: sensitivity analysis (< 50 participants versus > 50 participants per arm) (post-treatment)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
9.4.1 < 50 participants								
Dear 2013 (1)	10.1	5.23	31	14.77	5.33	31	5.0%	-0.87 [-1.40 , -0.35]
Friesen 2017 (2)	-34.7	7.94	30	-32.82	8.2	30	5.1%	-0.23 [-0.74 , 0.28]
Schlicker 2020 (3)	28.26	16.29	40	25.56	16.52	36	5.8%	0.16 [-0.29 , 0.61]
Serrat 2021 (4)	-38.72	22.91	75	-33.95	19.55	76	7.6%	-0.22 [-0.54 , 0.10]
Smith 2019 (5)	26.59	9.88	41	33.64	9.97	39	5.8%	-0.70 [-1.16 , -0.25]
Subtotal (95% CI)			**217**			**212**	**29.2%**	**-0.36 [-0.70 , -0.02]**
Heterogeneity: Tau² = 0.10; Chi² = 11.94, df = 4 (P = 0.02); I² = 66%								
Test for overall effect: Z = 2.06 (P = 0.04)								
9.4.2 > 50 participants								
Carpenter 2012 (6)	13.5	5.8	63	16.3	5.2	68	7.2%	-0.51 [-0.85 , -0.16]
Dear 2015 (7)	11.12	5.56	397	13.97	5.17	74	8.7%	-0.52 [-0.77 , -0.27]
Dear 2021 (8)	31.2	16.7	334	36.5	13.7	325	10.1%	-0.35 [-0.50 , -0.19]
Gasslander 2022 (9)	38.59	13.09	94	38.21	10.84	91	8.1%	0.03 [-0.26 , 0.32]
Hedman-Lagerlöf 2018 (10)	24.64	17.71	70	40.83	17.96	70	7.2%	-0.90 [-1.25 , -0.55]
Peters 2017 (11)	17.94	5.44	80	20.63	5.86	41	6.7%	-0.48 [-0.86 , -0.10]
Rini 2015 (12)	1	1.19	58	1.75	1.24	55	6.8%	-0.61 [-0.99 , -0.24]
Ruehlman 2012 (13)	10.31	6.12	162	10.35	5.8	143	9.1%	-0.01 [-0.23 , 0.22]
Williams 2010 (14)	-41.4	8.7	59	-38.9	8.6	59	7.0%	-0.29 [-0.65 , 0.08]
Subtotal (95% CI)			**1317**			**926**	**70.8%**	**-0.39 [-0.57 , -0.20]**
Heterogeneity: Tau² = 0.05; Chi² = 30.25, df = 8 (P = 0.0002); I² = 74%								
Test for overall effect: Z = 4.12 (P < 0.0001)								
Total (95% CI)			**1534**			**1138**	**100.0%**	**-0.38 [-0.53 , -0.22]**
Heterogeneity: Tau² = 0.06; Chi² = 42.21, df = 13 (P < 0.0001); I² = 69%								
Test for overall effect: Z = 4.74 (P < 0.00001)								
Test for subgroup differences: Chi² = 0.02, df = 1 (P = 0.89), I² = 0%								



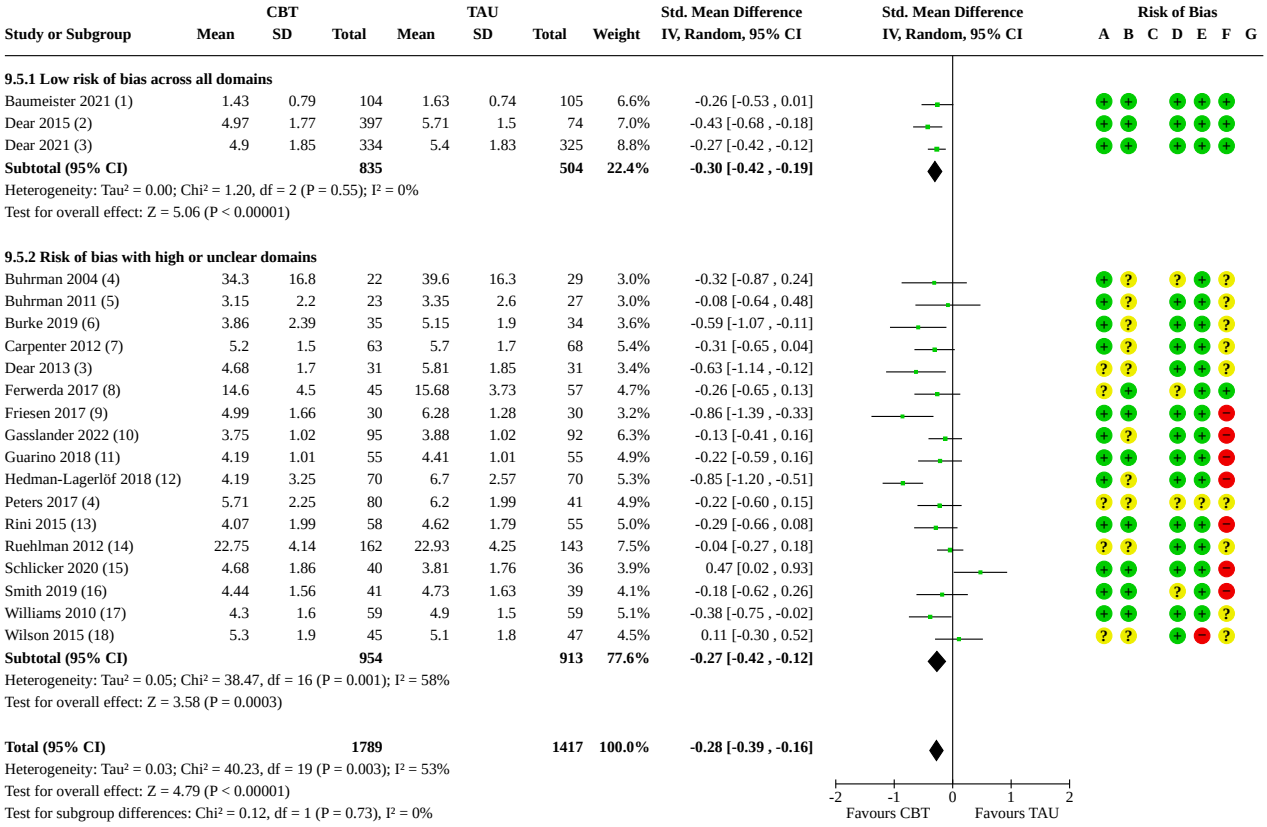
Footnotes

(1) CBT vs. WLC, assessed at 8 weeks (Roland-Morris Disability Questionnaire)
(2) CBT vs. TAU+WLC, assessed at 8 weeks (Short Form 12 physical subscale)
(3) CBT vs. TAU+WLC, assessed at 9 weeks (Oswestry Disability Index-functional disability)
(4) CBT vs. TAU+WLC, assessed at 12 weeks (Physical functioning component of SF-36 scale)
(5) CBT vs. TAU, assessed at 16 to 17 weeks (Pain Disability Index)
(6) CBT vs. WLC, assessed at 3 weeks (Roland-Morris Disability Questionnaire)
(7) CBT vs. TAU+WLC, assessed at 8 weeks (Roland-Morris Disability Questionnaire) (combined regular, optional and no contact interventions)
(8) CBT vs. WLC, assessed at 8 weeks (Pain Disability Index)
(9) CBT vs. WLC, assessed at 12 weeks (Pain Disability Index)
(10) CBT vs. WLC, assessed at 10 weeks (WHO-Disability Assessment Schedule (WHO-DAS II))
(11) CBT vs. WLC, assessed at 8 weeks (Fibromyalgia Impairment Scale-physical impairment)
(12) CBT vs. TAU, assessed at 9 to 11 weeks (Arthritis Impact Scale 2)
(13) CBT vs WLC, assessed at 7 weeks (Profile of Chronic Pain: Screen (PCP-S) - Perceived Disability)
(14) CBT vs. TAU, assessed at 24 weeks (SF-36 physical functioning subscale)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 9.5. Comparison 9: Subgroup analyses and sensitivity analyses: CBT versus TAU (post-treatment), Outcome 5: Pain intensity: sensitivity analysis (studies at low versus high or unclear risk of bias across domains) (post-treatment)



Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI	Risk of Bias A B C D E F G
9.5.1 Low risk of bias across all domains									
Baumeister 2021 (1)	1.43	0.79	104	1.63	0.74	105	6.6%	-0.26 [-0.53 , 0.01]	+ + + + +
Dear 2015 (2)	4.97	1.77	397	5.71	1.5	74	7.0%	-0.43 [-0.68 , -0.18]	+ + + + +
Dear 2021 (3)	4.9	1.85	334	5.4	1.83	325	8.8%	-0.27 [-0.42 , -0.12]	+ + + + +
Subtotal (95% CI)			**835**			**504**	**22.4%**	**-0.30 [-0.42 , -0.19]**	
Heterogeneity: Tau² = 0.00; Chi² = 1.20, df = 2 (P = 0.55); I² = 0%									
Test for overall effect: Z = 5.06 (P < 0.00001)									
9.5.2 Risk of bias with high or unclear domains									
Buhrman 2004 (4)	34.3	16.8	22	39.6	16.3	29	3.0%	-0.32 [-0.87 , 0.24]	+ ? ? + ?
Buhrman 2011 (5)	3.15	2.2	23	3.35	2.6	27	3.0%	-0.08 [-0.64 , 0.48]	+ ? + + ?
Burke 2019 (6)	3.86	2.39	35	5.15	1.9	34	3.6%	-0.59 [-1.07 , -0.11]	+ ? + + ?
Carpenter 2012 (7)	5.2	1.5	63	5.7	1.7	68	5.4%	-0.31 [-0.65 , 0.04]	+ ? + + ?
Dear 2013 (3)	4.68	1.7	31	5.81	1.85	31	3.4%	-0.63 [-1.14 , -0.12]	? ? + + ?
Ferwerda 2017 (8)	14.6	4.5	45	15.68	3.73	57	4.7%	-0.26 [-0.65 , 0.13]	? + ? + +
Friesen 2017 (9)	4.99	1.66	30	6.28	1.28	30	3.2%	-0.86 [-1.39 , -0.33]	+ + + + -
Gasslander 2022 (10)	3.75	1.02	95	3.88	1.02	92	6.3%	-0.13 [-0.41 , 0.16]	+ ? + + -
Guarino 2018 (11)	4.19	1.01	55	4.41	1.01	55	4.9%	-0.22 [-0.59 , 0.16]	+ + + + -
Hedman-Lagerlöf 2018 (12)	4.19	3.25	70	6.7	2.57	70	5.3%	-0.85 [-1.20 , -0.51]	+ ? + + -
Peters 2017 (4)	5.71	2.25	80	6.2	1.99	41	4.9%	-0.22 [-0.60 , 0.15]	? ? ? ? ?
Rini 2015 (13)	4.07	1.99	58	4.62	1.79	55	5.0%	-0.29 [-0.66 , 0.08]	+ + + + -
Ruehlman 2012 (14)	22.75	4.14	162	22.93	4.25	143	7.5%	-0.04 [-0.27 , 0.18]	? ? + + ?
Schlicker 2020 (15)	4.68	1.86	40	3.81	1.76	36	3.9%	0.47 [0.02 , 0.93]	+ + + + -
Smith 2019 (16)	4.44	1.56	41	4.73	1.63	39	4.1%	-0.18 [-0.62 , 0.26]	+ + ? + -
Williams 2010 (17)	4.3	1.6	59	4.9	1.5	59	5.1%	-0.38 [-0.75 , -0.02]	+ + + + ?
Wilson 2015 (18)	5.3	1.9	45	5.1	1.8	47	4.5%	0.11 [-0.30 , 0.52]	? ? + - ?
Subtotal (95% CI)			**954**			**913**	**77.6%**	**-0.27 [-0.42 , -0.12]**	
Heterogeneity: Tau² = 0.05; Chi² = 38.47, df = 16 (P = 0.001); I² = 58%									
Test for overall effect: Z = 3.58 (P = 0.0003)									
Total (95% CI)			**1789**			**1417**	**100.0%**	**-0.28 [-0.39 , -0.16]**	
Heterogeneity: Tau² = 0.03; Chi² = 40.23, df = 19 (P = 0.003); I² = 53%									
Test for overall effect: Z = 4.79 (P < 0.00001)									
Test for subgroup differences: Chi² = 0.12, df = 1 (P = 0.73), I² = 0%									

Footnotes

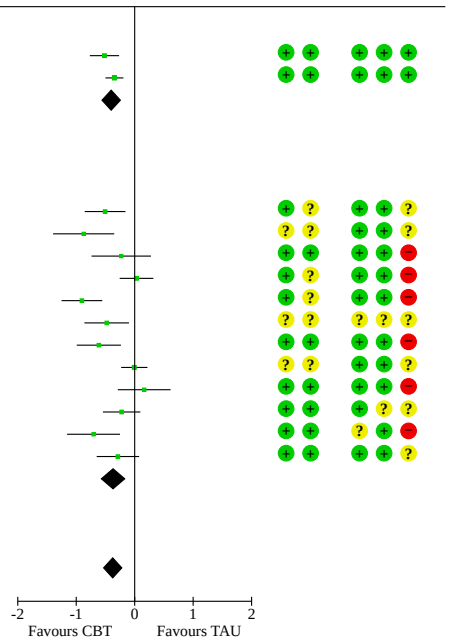
(1) CBT vs. TAU, assessed at 9 weeks (Numerical Rating Scale)
(2) CBT vs. TAU+WLC, assessed at 8 weeks (Wisconsin Brief Pain Questionnaire: Average pain)
(3) CBT vs. WLC, assessed at 8 weeks (Wisconsin Brief Pain Questionnaire: Average pain)
(4) CBT vs. WLC, assessed at 8 weeks (Numerical Rating Scale)
(5) CBT vs. WLC, assessed at 11 weeks (Multidimensional Pain Inventory: pain severity subscale)
(6) CBT vs. TAU, assessed at 6 weeks (Numerical Rating Scale)
(7) CBT vs. WLC, assessed at 3 weeks (average pain in the last week)
(8) CBT vs. TAU, assessed at post-intervention (variable duration) (Impact of Rheumatic Diseases on General Health and Lifestyle)
(9) CBT vs. TAU+WLC, assessed at 8 weeks (Brief Pain Inventory-pain severity item)
(10) CBT vs. WLC, assessed at 12 weeks (Multidimensional Pain Inventory: pain severity subscale)
(11) CBT vs. TAU, assessed at 12 weeks (Multidimensional Pain Inventory: pain severity subscale)
(12) CBT vs. WLC, assessed at 10 weeks (Fibromyalgia Impact Questionnaire-Pain)
(13) CBT vs. TAU, assessed at 9-11 weeks (Athritis Impact Scale 2 (AIMS2): pain subscale)
(14) CBT vs. WLC, assessed at 7 weeks (Profile of Chronic pain: Screen (PCP-S) - Severity)
(15) CBT vs. TAU+WLC, assessed at 9 weeks (Numerical Rating Scale)
(16) CBT vs. TAU, assessed at 16-17 weeks (Brief Pain Inventory: severity subscale)
(17) CBT vs. TAU, assessed at 24 weeks (Brief Pain Inventory)
(18) CBT vs. TAU+WLC, assessed at 8 weeks (Brief Pain Inventory)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 9.6. Comparison 9: Subgroup analyses and sensitivity analyses: CBT versus TAU (post-treatment), Outcome 6: Functional disability: sensitivity analysis (studies at low versus high or unclear risk of bias across domains) (post-treatment)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI
9.6.1 Low risk of bias								
Dear 2015 (1)	11.12	5.56	397	13.97	5.17	74	8.7%	-0.52 [-0.77 , -0.27]
Dear 2021 (2)	31.2	16.7	334	36.5	13.7	325	10.1%	-0.35 [-0.50 , -0.19]
Subtotal (95% CI)			**731**			**399**	**18.8%**	**-0.40 [-0.56 , -0.24]**
Heterogeneity: Tau² = 0.00; Chi² = 1.30, df = 1 (P = 0.25); I² = 23%								
Test for overall effect: Z = 5.01 (P < 0.00001)								
9.6.2 High or unclear risk of bias								
Carpenter 2012 (3)	13.5	5.8	63	16.3	5.2	68	7.2%	-0.51 [-0.85 , -0.16]
Dear 2013 (4)	10.1	5.23	31	14.77	5.33	31	5.0%	-0.87 [-1.40 , -0.35]
Friesen 2017 (5)	-34.7	7.94	30	-32.82	8.2	30	5.1%	-0.23 [-0.74 , 0.28]
Gasslander 2022 (6)	38.59	13.09	94	38.21	10.84	91	8.1%	0.03 [-0.26 , 0.32]
Hedman-Lagerlöf 2018 (7)	24.64	17.71	70	40.83	17.96	70	7.2%	-0.90 [-1.25 , -0.55]
Peters 2017 (8)	17.94	5.44	80	20.63	5.86	41	6.7%	-0.48 [-0.86 , -0.10]
Rini 2015 (9)	1	1.19	58	1.75	1.24	55	6.8%	-0.61 [-0.99 , -0.24]
Ruehlman 2012 (10)	10.31	6.12	162	10.35	5.8	143	9.1%	-0.01 [-0.23 , 0.22]
Schlicker 2020 (11)	28.26	16.29	40	25.56	16.52	36	5.8%	0.16 [-0.29 , 0.61]
Serrat 2021 (12)	-38.72	22.91	75	-33.95	19.55	76	7.6%	-0.22 [-0.54 , 0.10]
Smith 2019 (13)	26.59	9.88	41	33.64	9.97	39	5.8%	-0.70 [-1.16 , -0.25]
Williams 2010 (14)	-41.4	8.7	59	-38.9	8.6	59	7.0%	-0.29 [-0.65 , 0.08]
Subtotal (95% CI)			**803**			**739**	**81.2%**	**-0.37 [-0.57 , -0.17]**
Heterogeneity: Tau² = 0.09; Chi² = 39.95, df = 11 (P < 0.0001); I² = 72%								
Test for overall effect: Z = 3.63 (P = 0.0003)								
Total (95% CI)			**1534**			**1138**	**100.0%**	**-0.38 [-0.53 , -0.22]**
Heterogeneity: Tau² = 0.06; Chi² = 42.21, df = 13 (P < 0.0001); I² = 69%								
Test for overall effect: Z = 4.74 (P < 0.00001)								
Test for subgroup differences: Chi² = 0.06, df = 1 (P = 0.81), I² = 0%								



Footnotes

(1) CBT vs. TAU+WLC, assessed at 8 weeks (Roland-Morris Disability Questionnaire) (combined regular, optional and no contact interventions)
(2) CBT vs. WLC, assessed at 8 weeks (Pain Disability Index)
(3) CBT vs. WLC, assessed at 3 weeks (Roland-Morris Disability Questionnaire)
(4) CBT vs. WLC, assessed at 8 weeks (Roland-Morris Disability Questionnaire)
(5) CBT vs. TAU+WLC, assessed at 8 weeks (Short Form 12 physical subscale)
(6) CBT vs. WLC, assessed at 12 weeks (Pain Disability Index)
(7) CBT vs. WLC, assessed at 10 weeks (WHO-Disability Assessment Schedule (WHO-DAS II))
(8) CBT vs. WLC, assessed at 8 weeks (Fibromyalgia Impairment Scale-physical impairment)
(9) CBT vs. TAU, assessed at 9 to 11 weeks (Arthritis Impact Scale 2)
(10) CBT vs WLC, assessed at 7 weeks (Profile of Chronic Pain: Screen (PCP-S) - Perceived Disability)
(11) CBT vs. TAU+WLC, assessed at 9 weeks (Oswestry Disability Index-functional disability)
(12) CBT vs. TAU+WLC, assessed at 12 weeks (Physical functioning component of SF-36 scale)
(13) CBT vs. TAU, assessed at 16 to 17 weeks (Pain Disability Index)
(14) CBT vs. TAU, assessed at 24 weeks (SF-36 physical functioning subscale)

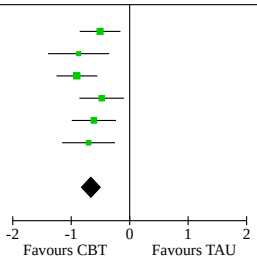
Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Analysis 9.7. Comparison 9: Subgroup analyses and sensitivity analyses: CBT versus TAU (post-treatment), Outcome 7: Functional disability: sensitivity analysis (high or unclear risk of bias studies eliminated with no difference of effect) (post-treatment)

Study or Subgroup	CBT Mean	CBT SD	CBT Total	TAU Mean	TAU SD	TAU Total	Weight	Std. Mean Difference IV, Random, 95% CI	Risk of Bias A B C D E F G
Carpenter 2012 (1)	13.5	5.8	63	16.3	5.2	68	21.2%	-0.51 [-0.85 , -0.16]	+ ? + + ?
Dear 2013 (2)	10.1	5.23	31	14.77	5.33	31	9.4%	-0.87 [-1.40 , -0.35]	? ? + + ?
Hedman-Lagerlöf 2018 (3)	24.64	17.71	70	40.83	17.96	70	21.2%	-0.90 [-1.25 , -0.55]	+ ? + + -
Peters 2017 (4)	17.94	5.44	80	20.63	5.86	41	17.7%	-0.48 [-0.86 , -0.10]	? ? ? ? ?
Rini 2015 (5)	1	1.19	58	1.75	1.24	55	18.0%	-0.61 [-0.99 , -0.24]	+ + + + -
Smith 2019 (6)	26.59	9.88	41	33.64	9.97	39	12.6%	-0.70 [-1.16 , -0.25]	+ + ? + -
Total (95% CI)			**343**			**304**	**100.0%**	**-0.66 [-0.82 , -0.50]**	

Heterogeneity: Tau² = 0.00; Chi² = 4.21, df = 5 (P = 0.52); I² = 0%
Test for overall effect: Z = 8.12 (P < 0.00001)
Test for subgroup differences: Not applicable



Footnotes

(1) CBT vs. WLC, assessed at 3 weeks (Roland-Morris Disability Questionnaire)
(2) CBT vs. WLC, assessed at 8 weeks (Roland-Morris Disability Questionnaire)
(3) CBT vs. WLC, assessed at 10 weeks (WHO-Disability Assessment Schedule (WHO-DAS II))
(4) CBT vs. WLC, assessed at 8 weeks (Fibromyalgia Impairment Scale-physical impairment)
(5) CBT vs. TAU, assessed at 9 to 11 weeks (Arthritis Impact Scale 2)
(6) CBT vs. TAU, assessed at 16 to 17 weeks (Pain Disability Index)

Risk of bias legend

(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance bias)
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

ADDITIONAL TABLES

Table 1. Intervention characteristics

Study ID	Intervention name	Therapy type/ psychological approach	Intervention description	Therapeutic activity requiring participant interaction/involvement	Delivery mode	Description of human support	Intervention duration, modules
Baumeister 2021	eSano Backcare-D plus TAU	CBT	Intervention included homework assignments, exercises, and 2 booster sessions following the intervention. eSano Back-Care-D focuses on psychoeducation, behaviour activation, and problem-solving, pain-specific content on psychoeducation, coping and acceptance, physical activity, and communication with HCPs. Additional optional sessions target sleep, partnership and sexuality, and return to work	Guided self-help intervention; participants advised to complete 1 session per week (homework and assignments)	Internet	Participants had an option to receive automated text messages to complete sessions. Manualised written feedback received after each session. e-Coaches sent reminders when session completion was overdue	6 weeks, 6 modules plus 3 optional modules
Bennell 2018	Pain coping skills training	CBT	Intervention included progressive muscle relaxation, brief relaxation practices, activity-rest cycling, pleasant activity scheduling, cognitive restructuring, pleasant imagery, distraction techniques, problem-solving, education, and physiotherapy exercises	Participants fed back to therapist on scheduled modules	Internet	Five 30-minute physiotherapy sessions face-to-face, reminder emails	8 weeks, 1 module per week, 35- to 45-minute module, then 16-week exercise programme
Buhrman 2004	Self-help programme	CBT	Intervention included applied relaxation, included psychological components (e.g. dealing with unhelpful thoughts and beliefs, changing focus), stretching and physical exercises (on an individualised graded activity basis but with structured information). Main component of intervention was learning different coping strategies. Aim was to identify more active ways of coping with pain and to improve level of functioning	Self-help intervention; participants received reminders via email once weekly to promote treatment compliance	Internet	Weekly telephone call with CBT therapist	7 weeks
Buhrman 2011	Guided Internet-based	CBT	Management programme based on cognitive behavioural model of chronic	Guided self-help intervention; par-	Internet	Therapist provided feedback and	11 weeks, 8 modules

Table 1. Intervention characteristics *(Continued)*

	cognitive behavioural treatment		pain. Participants are instructed to test and practice different coping strategies (e.g. relaxation, cognitive skills, stress management stretching, and physical exercise techniques). Individualised graded activity basis with structured instructions	ticipants prompted to submit weekly reports on treatment progress (e.g. homework assignments)		encouragement on weekly basis via email on module and homework assignment completion	
Buhrman 2013a	Guided Internet-based cognitive behavioural treatment	CBT	Intervention included general introduction to the treatment programme and information about chronic pain and CBT. Exercises include applied relaxation, goal setting, physical exercise, cognitive restructuring, activity planning, mindfulness, stress management techniques, sleep hygiene and stimulus control, setbacks, maintenance planning	Guided intervention; activity completion and weekly homework assignments	Internet	CBT therapist feedback on homework via email	8 weeks, 8 modules
Buhrman 2013b	Guided Internet-delivered ACT	ACT	Intervention included information, assignments, relevant metaphors, and mindfulness exercises. Modules included outlining former pain coping strategies, behavioural medicine approach, acceptance of pain. Physiological and psychological consequences of chronic pain were distinguished between defusion exercises, goal planning, maintenance planning, and mindfulness exercises	Guided intervention; activities and weekly homework assignment completion	Internet and MP3 player	Written feedback from therapist via email and 2 phone calls	7 weeks, 7 sections
Buhrman 2015	Individualised guided Internet-delivered CBT	CBT	Intervention included information, exercises, and assignments. The first and last modules of the intervention were the same for all participants. Modules included introduction to treatment and CBT, participants were asked to formulate goals and values. Participants used this content to achieve goals and move according values for the remaining weeks. The last module included "maintenance and strategies to handle pitfalls and set backs". The remaining 17 sections were individualised (by therapists) and included behavioural activa-	Guided intervention; assignments, exercises, and homework	Internet	Therapist fed back to participants (positive reinforcement and replies to queries). Therapists contacted participants via telephone to promote completion (after 2 emails). Participants were contacted via telephone regarding technical issues	8 weeks, 8 modules

Table 1. Intervention characteristics *(Continued)*

			tion, insomnia, or worry treatment. One section focused on stress, problem-solving, mindfulness, assertiveness training, relaxation, or exposure			in a structured motivational and encouraging format after 4 weeks. Participants who completed assessments after treatment received a 30-minute telephone assessment	
Burke 2019	CBT-pain management programme (SPIRE)	CBT	Intervention included CBT and educational sessions (delivered by rehabilitation consultant, clinical psychologist, physiotherapist, pharmacist, occupational therapist, and SCI liaison nurse), guided audio relaxation practice, and a progressive exercise programme (video-based; 1 minute 30 seconds long to 4 minutes 15 seconds long) adaptable to different levels of mobility and involved flexibility, strength, aerobic, and Pilates exercise with accompanying images and text instructions	Interactive slides with images, summarised text, voice-over explanation, and short introductory video (6 to 40 seconds). Hyperlinks to external websites with useful sources were included where applicable. Video interviews with individuals with SCI (2 to 37 seconds long) successfully engaging in pain self-management strategies were also included	Internet	Phone calls and weekly emails; contact with physiotherapist and feedback on participant progress via weekly emails to remind them of the courses and tasks, live webinar in week 4 with the lead investigator and chartered physiotherapist, completion of weekly homework assignments	6 weeks, 6 modules
Carpenter 2012	Wellness Workbook	Multicomponent (CBT, BA, ACT, MBSR)	Intervention consisted of mind/body treatment rationale, pain education, and CBT techniques including cognitive restructuring, stress management, relaxation training, mindfulness, and values-based behavioural activation. Sequential chapters introducing topics from explaining chronic pain and biopsychosocial treatment model to cognitive-behavioural rationale and techniques and relaxation, stress reduc-	Self-help intervention; interactive exercises: drag and drop (e.g. matching unhelpful thoughts to their category), fill in the blank (with feedback), and skill prac-	Internet	Minimal; research assistant emailed participants if they did not log in at least once per week	3 weeks (6 chapters designed to take 1 to 1.5 hours each)

Table 1. Intervention characteristics *(Continued)*

			tion, and meditation and mindfulness. Chapters include didactic material, patient stories, reflection and interactive exercises, guided relaxation, and meditation audio	tice (e.g. identifying thoughts generating positive, negative, or neutral emotions; listing unhelpful thoughts and challenging them). Interactive exercises (from participants' life experience or fictional examples). Feedback was provided (either as an example of a target answer or the correct answer with an explanation). Chapters included examples of how to integrate skills into daily life with printable tracker form			
Dear 2021	Pain Course	CBT	Intervention included "information about sleep hygiene, treatments for chronic pain, problem-solving, assertiveness, managing attention, and core beliefs." Components released sequentially; component completion required before new component could be accessed. Also included patient case studies learning to apply the course skills. Didactic lessons were supported by automated emails (informing of new content, reminders to access content, encouragement to apply skills)	Self-help; homework assignments aligned with lessons; practice of lesson skills	Internet	Clinical psychologist weekly contact with participants via telephone (content summary, answering questions, reinforcing progress/encouragement, feedback about course/skill use). From post-treatment to follow-up, participants contacted once every 4 to 6 weeks	8 weeks, 5 lessons (recommended 1 lesson every 7 to 10 days)

Table 1. Intervention characteristics *(Continued)*

Dear 2015	Pain Course	CBT	Intervention included provision of therapeutic information and teaching self-management; education on chronic pain, anxiety, and depression; introduction to cognitive therapy; controlled relaxation and activity scheduling; activity pacing and graded exposure; relapse prevention and goal setting. Also, automated email to inform of new content and reminders to engage	Clinical contact, optional contact, no contact groups; lesson summaries with homework assignments, access to comprehensive case studies of patients with chronic pain to apply skills taught in the course, practising skills learned, and provided feedback about the course and their practice of skills	Internet	1 arm had no clinician contact; additional 2 arms had either regular contact (10- to 15-minute telephone or email per week) or optional contact (optional 10- to 15-minute telephone or email per week; contact initiated by participants)	8 weeks, 5 lessons
Dear 2021	Pain Course	CBT	Intervention included provision of therapeutic information and teaching self-management skills; lessons covered education on chronic pain, anxiety, and depression; introduction to cognitive therapy; controlled relaxation and activity scheduling; activity pacing and graded exposure; relapse prevention and goal setting. Also, automated email to inform of new content and reminders to engage	Practice exercises; homework to learn and apply skills	Internet	Each participant was allocated a single registered psychologist, and could contact the psychologist as needed (via asynchronous messages through the platform). Psychologist contact provided support, discussion about materials, and help with application of ideas and skills from the course	8 weeks, 5 lessons
Hess Engström 2022	Multidisciplinary Internet intervention based on ACT (no specific name)	ACT	Intervention included introductory information about vulvodynia, pain and pelvic floor function, values, thoughts, relationships, and maintenance. Participants received written information, videos, and audio files. Throughout the	ACT exercises and mindfulness	Internet	Access via secure platform with 2-step authentication was used to deliver the treatment and self-as-	6 weeks, 6 modules

Table 1. Intervention characteristics *(Continued)*

			intervention, participants were instructed to not engage in painful sexual activities. In the context of this study, acceptance implies to have an open and non-judgemental acceptance of the experiences and to be able to engage in meaningful, sexual or nonsexual, activities according to the one's values and goals			sessment questionnaires and for communication with e-Coaches. e-Coaches were: trained research assistants providing written feedback and responses to participants questions after completion of each module (after completion of 1 module per week)	
Ferwerda 2017	Tailored-guided Internet-based CBT intervention	CBT	Intervention and goals tailored to participants based on face-to-face discussion with therapist during in-take sessions. Participants completed at least 1 of 4 modules (pain and functional disability, fatigue, negative mood, or social functioning). Therapists selected components (assignments and texts) based on treatment goals and patient characteristics. All modules contained cognitive strategies (e.g. cognitive restructuring, problem-solving, goal setting) relevant to the specific module subject (i.e. pain, fatigue, negative mood, social functioning). Final module for all participants was relapse prevention and long-term goals	Several assignments and psychoeducational texts	Internet	Therapists contacted participants once or twice weekly via secure email messaging service (part of intervention website). Participants responded at their own discretion. Therapist responses typically consisted of empathic reactions regarding personal events described by participants, feedback on treatment assignments, explanation of rationale for next assignment, practical tips, and encouragement	9 to 65 weeks; participants consecutively completed at least 1 of 4 tailored modules at their own pace
Friesen 2017	Pain Course (adapted for fibromyalgia)	CBT	Intervention consisted of slide show information, lesson summaries, patient stories. Information included an adapted supplemental resource describing common symptoms in FM and high incidence of anxiety and depression, modi-	Homework assignments, reviewing modules, learning skills	Internet	5- to 10-minute weekly telephone contact with 'guide' (doctorate-level clinical psychology grad-	8 weeks, 5 modules

Table 1. Intervention characteristics *(Continued)*

			fications to patient stories to reflect stories of individuals with FM struggling with anxiety or depression, minor modifications to slide content (e.g. statistics, examples) to help individuals with FM understand how the Pain Course applies to them. Lessons included: prevalence of chronic pain and symptoms of depression and anxiety (pain perception/nervous system; cognitive behavioural model; functional relationship between physical, thought, and behavioural symptoms; principles of CBT, thought monitoring, and challenging thought strategies; physical symptoms of chronic pain, anxiety, and depression, instructions on de-arousal strategies; scheduling pleasant activities for managing physical symptoms; behavioural symptoms of anxiety, low mood, and chronic pain, pacing, graded exposure to physical activities; education on occurrence of relapse in pain, depression, and anxiety; information about signs of relapse/goal setting			uate student supervised by registered psychologist) to summarise content, answer questions, reinforce progress, and encourage skills practice, normalise challenges of treatment, and obtain feedback about course. No new therapeutic skills were introduced	
Gasslander 2022	iCBT	CBT	Intervention was based on Buhrman 2015. Six to 13 modules (each designed to take a week). "Modules included written information and instructions, concluding with 1–3 exercises to be carried out during the week. Treatment content was mainly text and images format, and audio files provided for some exercises." Modules covered: intro, relaxation, stress coping, communication, behavioural activation, worry coping, anxiety and exposure, sleep, trauma, goal evaluation and maintenance (as mid-treatment and final modules). Modules were tailored to the individual corresponding to their reported types of distress.	Modules included 1 to 3 exercises to be carried out across the week; participants report results of exercises at the end of each module	Internet	Therapists provided participants feedback within 24 hours on weekdays (i.e. treatment-related questions and clarifications, positive reinforcement/treatment compliance; SMS text reminders on 6 days of inactivity/late or no assignment submission). Inactivity of treatment within 2 days prompted therapist to telephone participants	6 to 13 weeks (based on module information and the fact the intervention module selection is tailored to individual), 6 to 13 modules

Table 1. Intervention characteristics *(Continued)*

						to promote treatment adherence	
Guarino 2018	Take Charge of Pain	CBT	Intervention included strategies on restructuring dysfunctional thinking about pain, coping with pain skills. Modules were self-paced (20 to 30 minutes each; accessed via computer) and consisted of information on common physical/psychological effects of chronic pain, effective coping strategies (e.g. text, images, interactive exercises), education on CBT skills (pacing, identifying/challenging automatic negative thoughts, controlled breathing, muscle relaxation), opioid, medication misuse, and medication management. Modules were accessible in a fixed sequence so that CBT skills were presented early in the sequence; all module text was accompanied by optional voice-over narration	Interactive exercises (common physical and psychological effects of chronic pain, effective coping strategies). Interactive activity (calendar with progress graphs/pain interference tracking). Teaching CBT skills (pacing activity, identifying and challenging automatic negative thoughts, controlled breathing, and muscle relaxation)	Internet	Participants completed face-to-face introductory/training module at study research office. During intervention, participants received regular telephone and email prompts (reminders to complete modules). Research staff was available for basic technical assistance as needed (telephone, email, face-to-face)	12 weeks, 27 self-paced modules
Hedman-Lagerlöf 2018	iExp	CBT	Intervention included information about avoidance behaviours, psychoeducation re-exposure, and exposure (e.g. approaching situations/behaviours normally avoided; mindfulness as a form of exposure to bodily sensations); intervention ended with relapse prevention and coping with setbacks	Exposure exercises, homework assignments	Internet	Regular therapist contact (1 to 3 times/week) via asynchronous text messages (i.e. chat/video conferencing not used) to coach/guide and participants through treatment and assisted with problem-solving as needed. Therapists responded to messages on the platform within 24 hours on weekdays. The therapist sent text message reminders via the	10 weeks, 8 modules

Table 1. Intervention characteristics *(Continued)*

						platform (or called) if they were inactive for 4 days	
Lin 2017	ACTonPain (1. Guided and 2. Unguided)	ACT	Intervention included information about programme and acute/chronic pain, life consequences, introduction to mindfulness, control and acceptance, introduction to primary and secondary suffering, short- and long-term consequences, information about thoughts and emotions and goal setting, information about self as contexts/to live a good life despite pain, information about values and committed action, information about willingness, committed action, and living according to one's values, summary of programme and information about maintenance	Guided or unguided; assignments after each session is completed	Internet	Guided ACTonPain group: e-Coaches (psychologists) under supervision of experienced psychological psychotherapist, provided personalised and standardised (pre-formulated) feedback by email within 2 working days after completion of each module. Guidance took an average of 105 minutes per participant	9 weeks, 7 modules
Morcillo-Muñoz 2022	NO+Dolor (NO +Pain)	Multimodal treatment. Psychotherapeutic component: ACT and mindfulness	Intervention was a pain management app enabling automatic monitoring, skill training, social support, education, goal setting, and achievement of 4 components: psychological wellness, exercise, pharmacological treatment, and health assets. Each week, the participants received 3 activities via the NO +Dolor app. The intervention consisted of information on medication management, activities promoting self-esteem/health, and links to multimedia resources (audio/video) based on gamification (to improve concentration, attention, and motivation). All the activities were designed to be performed weekly except for the walking challenge, which was performed daily.	Both arms received two 8-hour face-to-face sessions (education). ACT and mindfulness exercises (promoting greater pain acceptance, reducing aversive component associated with pain, and helping participants dispassionately recognise and observe both pain and related thoughts and emotions). Raising awareness of individ-	Smartphone app	Unclear component of intervention design where participants met for two 8-hour face-to-face sessions, unclear what happened during these sessions. Participants could contact researchers via form in the consultation section of intervention to ask questions/provide comments. The form was sent via email to researchers to respond	6 weeks

Table 1. Intervention characteristics *(Continued)*

				ual's own values through series of activities to recover meaningful life project. Every week participants looked at digital presentations about every component, doing 3 activities related to each at home and returning them by email			
Peters 2017	1) iCBT; 2) "Happy Despite Pain" Internet-based PPI	1) CBT, 2) PPI	iCBT intervention included teaching active ways of coping with pain/improving functioning (relaxation, stretching exercises, cognitive restructuring, coping skills), body scan (text/MP3), relapse prevention plan. PPI included exercise/cognitive exercise, self-compassion exercises (self-reliance/dealing with emotional consequences of CP), exercises (awareness of suffering, self-criticism, self-compassion (diary/letter)), positive awareness, shifting negative thoughts to positive thoughts, savouring techniques (frequency/intensity/reinforcing positive experiences, engagement in pleasant reminiscence, diary, writing/imagining (increase optimism), future goals/ideas, planning for future exercises, relapse prevention	Additional supportive workbook for both: both treatment formats were same (i.e. online written information provided about topic of week/practical assignments). Assignments could be completed online or in paper workbook containing all assignment information and online information summary (provided at start of intervention). Paper workbook was not to replace Internet program because extended information was provided online only	Internet	Support provided by 5 graduate/recently graduated students in psychology; each participant assigned a single assistant. To promote adherence, telephone and email support provided weekly – alternative between phone and email. Average telephone call was 15 to 20 minutes. Participants called 6 months after completion by email// telephone, to promote completion of long-term follow-up assessment	8 weeks (but range 7 to 16 weeks), 8 modules

Table 1. Intervention characteristics *(Continued)*

Rickardsson 2021	iACT	ACT	Intervention aimed at acceptance, defusion, and present moment awareness and engagement in value oriented exposure. Microlearning format, short interactive practical/experiential exercises. 8 levels to complete every weekday for 8 weeks; levels could only be accessed if previous levels had been completed. Levels of ACT treatment, short learning modules every weekday for 8 weeks	Practical/experiential exercises and 'value-orientated' exposure (associated with the intervention levels)	Internet	Therapists provided feedback, support, clarifications, encouragement, and reminders by text message (telephone support was also available by request)	8 weeks
Rini 2015	PainCOACH	CBT	Intervention aimed to focus on: coping skills, progressive muscle relaxation, mini-practices, activity/rest cycling, pleasant activity scheduling and negative automatic thoughts, negative automatic thoughts and coping thoughts, pleasant imagery and other distraction techniques, problem-solving, and monitoring for maintenance. Participants led through programme by a female 'virtual coach'	Self-directed; included interactive exercises (enhancing mastery of new skills), modules provided interactive training (cognitive/ behavioural pain coping skills), participants practised new skills after learning. Participants could post experiences on section of website (COACHchat)	Internet	Minimal: participants were called via telephone if did they not sign in to module within 10 days	8 weeks, 8 modules (once weekly)
Ruehlman 2012	Chronic Pain Management Program	CBT	Intervention was individualised, customised learning plan based on PCP scores that mapped onto the 4 learning modules. Modules included "Thinking better" (cognitive), "Doing more" (behavioural), "Relating better" (social), and "Feeling better" (emotional regulation). Programme recommendations were generated suggesting order of completion	Online activities (didactic and interactive exercises); offline activities: 1) homework (self-monitoring exercises and practice of new skills), and 2) lifestyle activities (e.g. exercise, relaxation, implementation of	Internet	Intended to be completely self-directed/self-paced	6 weeks, 4 learning modules

Table 1. Intervention characteristics *(Continued)*

				goal-directed behaviour)			
Schlicker 2020	Get.Back	CBT	Intervention included "psychoeducation, behavioral activation, problem-solving, cognitive restructuring, return to work, self-esteem, and relapse prevention". It included content on returning to work and a mix of depression- and pain-focused topics (seemingly equal focus on both); optional modules on partnership, sexuality, and sleep habits; and optional mini-modules on perfectionism, social support, communication, and appreciation (because of their relevance to returning to work). There was a booster module 4 weeks after completion of the intervention	Homework applying skills learned in modules (no other detail provided), interactive elements (emails, text messages), reminders	Internet	e-Coach provided feedback through online system in response to module completion, to encourage participants, and as reminders for adherence in case of non-completion. Feedback was semi-standardised by manual; e-Coaches were trained and supervised by qualified cognitive and behavioural psychotherapist. Participants could contact the e-Coach as need for any questions	7 weeks, 7 modules (weekly)
Scott 2018	ACT online	ACT	Intervention consisted of therapist contact/review of pain problem; how to manage pain, exercise, treatment goal; expectation setting for treatment, building openness (awareness through breathing/exercise), opening up to thoughts (controlling thoughts, labelling thoughts exercise), connecting with values (focus exercise, values assessment rating form), flexible present focused awareness (tracking thoughts in time exercise), building committed action (small steps exercise, goal setting), the observer self (self-observing exercise), putting all together (self-observer exercise, long-term goal setting/worksheet), final therapist face-to-face contact (review/changes during treatment, goal review for following months, identify/plan	Videos guided participants through experiential exercises and metaphors. Participants responded to questions assessing their experiences after each session. "Each week, participants were also asked to rate three items assessing the extent to which their behaviour reflected the qualities of being	Internet	Therapist supported intervention; face-to-face/telephone session at start (e.g. introducing treatment model, setting goals) and end (e.g. reviewing progress, long-term goals) of online intervention package. Therapists provided emailed written feedback after each session (24 to 72 hours after), focusing on reinforcing session com-	10 to 12 weeks, 8 sessions (twice weekly for first 3 weeks, once weekly for final 2 weeks) and 2 therapist sessions (face-to-face or telephone) at beginning and end of package

Table 1. Intervention characteristics *(Continued)*

			for barriers). Therapists could add to core treatment with additional exercises depending on participant progress	'open, aware and engaged'."		pletions and shaping and reinforcing psychological flexibility. Therapists also emailed session reminders and could "request brief telephone contact to discuss disengagement" after several reminders	
Serrat 2021	FIBROWALK	Multicomponent. Psychotherapeutic component: CBT (also mindfulness)	Intervention included therapeutic exercise, pain neuroscience education, CBT and mindfulness training. After the first face-to-face session, the FIBROWALK programme was moved to a virtual format due to COVID pandemic. Each video provided detailed guidelines explaining how to perform different home-based aerobic exercises (i.e. walking down hallway at home); education (neuroscience of pain (based on book "Explain Pain" by David Butler, Lorimer Moseley, and Arte Sunyata and educational recommendations of Pain in Motion team, Jo Nijs); CBT based on analysis of basic psychological processes and aimed at decreasing anxiety and depressive symptoms, at reducing pain catastrophising, and at changing inadequate emotional regulation strategies	Exercises, homework	Internet (video only)	Minimal; therapy was completely virtual but delivered via prerecorded videos. Therapists and participants had no contact other than they could ask questions/doubts via email whenever they wanted and replies were returned by the same email	12 weeks, 1 face-to-face session at start followed by 11 Internet-based sessions due to pandemic
Simister 2018	Online ACT	ACT	Intervention included psychoeducation, acceptance, values clarification, cognitive defusion, contact with present moment, self-as-context, willingness, and committed action. "Each module contained a written unit reading of 5 to 8 pages that included metaphors, experiential exercises, and introductory and recurring vignettes describing the experiences of 4 people with FM to help the	Written unit reading (5 to 8 pages) including metaphors, experiential exercises, introductory/recurring descriptions of experiences of 4 people with FM to help connect	Internet	Research team contacted participants via email weekly to remind them to complete programme/contact team member for questions or concerns. Participants could submit written assign-	8 weeks, 7 modules

Table 1. Intervention characteristics *(Continued)*

			participants connect to each of the key components of ACT"	participants with key ACT components. MP3 audio, videos, experiential homework exercises were provided plus written unit materials		ments via system, and were reviewed by first author, who provided written feedback to participants (clarification and positive reinforcement)	
Smith 2019	Reboot Online	Multidisciplinary with CBT components	Intervention included information on chronic pain/management, goal setting/acceptance, movement/pacing/daily activity scheduling, monitoring thoughts/reconciling unhelpful thought patterns, mood/pain/thought challenging/managing arousal, stress management/getting better sleep, communications/relationships, managing flare-ups/continuing CP management. Core components of sessions included physiotherapy and psychology combined with graded exercise program focusing on activity and exercise reactivation within pacing and goal-setting; coupled with evidence-based CBT skills (thought challenging, activity planning, problem-solving, effective communication, and flare-up management). In each session, participants followed fictional main character story (illustrated) who learns to self-manage CP using multidisciplinary approach, aiming to provide psychoeducation on social-psychological-biological-medical nature of CP. Educational videos with each session incorporated specialist medical information (pain, rehabilitation, medicine, psychiatry, anaesthetics, rheumatology, radiology, allied health disciplines, OT, dietetics)	Homework assignments (exercises and skills for between lessons)	Internet	Minimal: technology support (after first 2 sessions, then as required) or clinician support over email or telephone if required	16 weeks, 8 sessions (sessions released every 2 weeks)
Vallejo 2015	iCBT+standard care	CBT	Intervention included psychoeducation, relaxation training, emotional training, daily activities to improve pain, techniques for insomnia and sexual dys-	Homework assignments; reading materials, performing sug-	Internet	Therapist (junior therapist under supervision of senior clinical psycholo-	10 weeks, 10 modules

Table 1. Intervention characteristics *(Continued)*

			functions, problem-solving, cognitive restructuring and managing negative thoughts, attentional control and illness behaviours, cognitive processing and memory, revision and relapse	gested activities, relaxation exercises (on MP3 audio), questions to assess comprehension, individual messages to therapist with feedback		gist) was available to answer questions and provide feedback. Participants encouraged at end of session to answer questions whether they understood topic	
Williams 2010	Living Well with Fibromyalgia	CBT	Intervention included education lectures providing FM background information, educational, behavioural, and cognitive skills to help with symptom management; behavioural/cognitive skills to help to adapt lifestyle changes to manage FM. Each module featured video lecture on the topic by clinician experienced in applying selected topic on FM, written summaries of video lecture for reading or downloading, homework and self-monitoring forms for applying the behavioural strategies described in the video lecture, and supplemental educational materials unique to each topic (e.g. audio relaxation exercises and readings)	Video lecture, written summaries for reading/downloading, homework and self-monitoring forms to apply behavioural strategies, supplemental educational materials (e.g. audio relaxation exercises/readings)	Internet	No contact	26 weeks, 13 modules
Wilson 2015	Chronic Pain Management Programme	Not specified but includes cognitive and behavioural components (as well as social and emotional regulation)	Intervention consisted of individualised custom plan and summary report based on the results of the PCP assessment. PCP scores mapped onto learning modules falling into 4 categories: cognitive, behavioural, social, and emotional regulation. Learning modules included didactic materials and interactive activities	Didactic materials for learning, interactive activities (e.g. thinking better module (asks participants to evaluate/redirect self-defeating thoughts)). At the end of each activity, participants were asked to rate activity	Internet	Minimal; additional assistance offered by researcher via telephone/in person at public setting with computer for participants living within 150-mile radius	8 weeks, 4 modules

ACT: acceptance and commitment therapy; **BA:** behavioural activation; **CBT:** cognitive behavioural therapy; **CP:** chronic pain; **FM:** fibromyalgia; **HCP:** healthcare professional;**iCBT:** internet-based cognitive behavioural therapy; **iExp:** internet-delivered exposure therapy; **MBSR:** mindfulness-based stress reduction; **OT:** occupational therapist; **PCP:** Profile of Chronic Pain; **PPI:** positive psychology intervention; **SCI:** spinal cord injury; **SPIRE:** Spinal Cord Injury Pain Ireland; **TAU:** treatment as usual

APPENDICES

Appendix 1. CENTRAL, MEDLINE (OVID), EMBASE (OVID) and PsycINFO (EBSCO) search strategies

CENTRAL (Cochrane Library)

#1 MeSH descriptor: [Pain] explode all trees

#2 MeSH descriptor: [Fibromyalgia] this term only

#3 ((pain* or fibromyalgia* or neuralgia*)):ti,ab,kw (Word variations have been searched)

#4 #1 or #2 or #3

#5 MeSH descriptor: [Internet] explode all trees

#6 ((Internet or web or blog* or "social media" or online or www or email* or e-mail*)):ti,ab,kw (Word variations have been searched)

#7 MeSH descriptor: [Telecommunications] explode all trees

#8 ((telemedicine or tele-medicine)):ti,ab,kw (Word variations have been searched)

#9 ((telehealth or tele-health)):ti,ab,kw (Word variations have been searched)

#10 ((ehealth or e-health)):ti,ab,kw (Word variations have been searched)

#11 ((mobile health or mhealth or m-health)):ti,ab,kw (Word variations have been searched)

#12 (ICT):ti,ab,kw (Word variations have been searched)

#13 (((inform* or communicat* or interact*) Near (computer* or technolog* or software))):ti,ab,kw (Word variations have been searched)

#14 (((health* or treat* or therap* or intervention* or assist* or selfmanag* or self-manag*) near (computer* or technolog* or software))):ti,ab,kw (Word variations have been searched)

#15 ("world wide web"):ti,ab,kw (Word variations have been searched)

#16 ((telephone* or phone* or mobile* or cellphone* or apps or text* or SMS or smartphone*)):ti,ab,kw (Word variations have been searched)

#17 ((virtual reality or augmented reality or VR or AR)):ti,ab,kw (Word variations have been searched)

#18 (("Interactive voice response" or IVR)):ti,ab,kw (Word variations have been searched)

#19 #5 or #6 or #7 or #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18

#20 MeSH descriptor: [Psychotherapy] explode all trees

#21 MeSH descriptor: [Psychology] explode all trees

#22 (((behavio#r* next therapy) or (behavio#r* next therapies))):ti,ab,kw (Word variations have been searched)

#23 (((cognitive next therapy) or (cognitive next therapies))):ti,ab,kw (Word variations have been searched)

#24 (mindfulness):ti,ab,kw (Word variations have been searched)

#25 (meditat*):ti,ab,kw (Word variations have been searched)

#26 (psychotherap*):ti,ab,kw (Word variations have been searched)

#27 ((psychological next treatment*)):ti,ab,kw (Word variations have been searched)

#28 (((psychological next therapy) or (psychological next therapies))):ti,ab,kw (Word variations have been searched)

#29 #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28

#30 MeSH descriptor: [Child] explode all trees

#31 MeSH descriptor: [Adolescent] explode all trees

#32 MeSH descriptor: [Infant Behavior] explode all trees

#33 #30 or #31 or #32

#34 #4 and #19 and #29

#35 #34 not #33

MEDLINE (OVID)

1. exp Pain/

2. Fibromyalgia/

3. (pain* or fibromyalgia* or neuralgia*).tw.

4. 1 or 2 or 3

5. exp Internet/

6. (Internet or web or blog* or "social media" or online or www or email* or e-mail*).tw.

7. exp Telecommunications/

8. (telemedicine or tele-medicine).tw.

9. (telehealth or tele-health).tw.

10. (ehealth or e-health).tw.

11. (mobile health or mhealth or m-health).tw.

12. ICT.tw.

13. ((inform* or communicat* or interact*) adj6 (computer* or technolog* or software)).tw.

14. ((health* or treat* or therap* or intervention* or assist* or selfmanag* or self-manag*) adj6 (computer* or technolog* or software)).tw.

15. "world wide web".tw.

16. (telephone* or phone* or mobile* or cellphone* or apps or text* or SMS or smartphone*).tw.

17. (virtual reality or augmented reality or VR or AR).tw.

18. ("Interactive voice response" or IVR).tw.

19. 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 17 or 18

20. 4 and 19

21. randomized controlled trial.pt.

22. controlled clinical trial.pt.

23. randomized.ab.

24. placebo.ab.

25. drug therapy.fs.

26. randomly.ab.

27. trial.ab.

28. or/21-27

29. exp animals/ not humans.sh.

30. 28 not 29

31. 20 and 30

32. exp Child/ or exp Adolescent/ or exp infant/

33. 31 not 32

34. exp Psychotherapy/

35. exp PSYCHOLOGY/

36. ((behavio#r* adj therapy) or (behavio#r* adj therapies)).tw.

37. ((cognitive adj therapy) or (cognitive adj therapies)).tw.

38. mindfulness.tw.

39. meditat*.tw.

40. psychotherap*.tw.

41. (psychological adj treatment*).tw.

42. ((psychological adj therapy) or (psychological adj therapies)).tw.

43. 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42

45. 33 and 43

EMBASE (OVID)

1 exp Pain/

2 Fibromyalgia/

3 (pain* or fibromyalgia* or neuralgia*).tw.

4 1 or 2 or 3

5 exp Internet/

6 (Internet or web or blog* or "social media" or online or www or email* or e-mail*).tw.

7 exp Telecommunications/

8 (telemedicine or tele-medicine).tw.

9 (telehealth or tele-health).tw.

10 (ehealth or e-health).tw.

11 (mobile health or mhealth or m-health).tw.

12 ICT.tw.

13 ((inform* or communicat* or interact*) adj6 (computer* or technolog* or software)).tw.

14 ((health* or treat* or therap* or intervention* or assist* or selfmanag* or self-manag*) adj6 (computer* or technolog* or software)).tw.

15 "world wide web".tw.

16 (telephone* or phone* or mobile* or cellphone* or apps or text* or SMS or smartphone*).tw.

17 (virtual reality or augmented reality or VR or AR).tw.

18 ("Interactive voice response" or IVR).tw.

19 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 16 or 17 or 18

20 4 and 19

21 exp Psychotherapy/

22 exp PSYCHOLOGY/

23 ((behavio#r* adj therapy) or (behavio#r* adj therapies)).tw.

24 ((cognitive adj therapy) or (cognitive adj therapies)).tw.

25 mindfulness.tw.

26 meditat*.tw.

27 meditat*.tw.

28 psychotherap*.tw.

29 (psychological adj treatment*).tw.

30 ((psychological adj therapy) or (psychological adj therapies)).tw.

31 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30

32 20 and 31

33 exp Child/ or exp Adolescent/ or exp infant/

34 32 not 33

35 random$.tw.

36 factorial$.tw

37 crossover$.tw.

38 cross over$.tw.

39 cross-over$.tw.

40 placebo$.tw.

41 (doubl$ adj blind$).tw.

42 (singl$ adj blind$).tw.

43 assign$.tw.

44 allocat$.tw.

45 volunteer$.tw.

46 Crossover Procedure/

47 double-blind procedure.tw.

48 Randomized Controlled Trial/

49 Single Blind Procedure/

50 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49

51 (animal/ or nonhuman/) not human/

52 50 not 51

53 34 and 52

PsycINFO (EBSCO)

S38 S28 AND S37

S37 S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36

S36 ((psychological N therapy) or (psychological N therapies))

S35 (psychological N treatment*)

S34 psychotherap*

S33 meditat*

S32 mindfulness

S31 ((cognitive N therapy) or (cognitive N therapies))

S30 ((behavio#r* N therapy) or (behavio#r* N therapies))

S29 DE "Psychotherapy" OR DE "Adlerian Psychotherapy" OR DE "Adolescent Psychotherapy" OR DE "Affirmative Therapy" OR DE "Analytical Psychotherapy" OR DE "Autogenic Training" OR DE "Brief Psychotherapy" OR DE "Brief Relational Therapy" OR DE "Child Psychotherapy" OR DE "Client Centered Therapy" OR DE "Conversion Therapy" OR DE "Couples Therapy" OR DE "Eclectic Psychotherapy" OR DE "Emotion Focused Therapy" OR DE "Existential Therapy" OR DE "Experiential Psychotherapy" OR DE "Expressive Psychotherapy" OR DE "Eye Movement Desensitization Therapy" OR DE "Feminist Therapy" OR DE "Geriatric Psychotherapy" OR DE "Gestalt Therapy" OR DE "Group Psychotherapy" OR DE "Guided Imagery" OR DE "Humanistic Psychotherapy" OR DE "Hypnotherapy" OR DE "Individual Psychotherapy" OR DE "Insight Therapy" OR DE "Integrative Psychotherapy" OR DE "Interpersonal Psychotherapy" OR DE "Logotherapy" OR DE "Narrative Therapy" OR DE "Network Therapy" OR DE "Persuasion Therapy" OR DE "Primal Therapy" OR DE "Psychoanalysis" OR DE "Psychodrama" OR DE "Psychodynamic Psychotherapy" OR DE "Psychotherapeutic Counseling" OR DE "Psychotherapeutic Techniques" OR DE "Rational Emotive Behavior Therapy" OR DE "Reality Therapy" OR DE "Relationship Therapy" OR DE "Solution Focused Therapy" OR DE "Strategic Therapy" OR DE "Supportive Psychotherapy" OR DE "Transactional Analysis"

S28 S4 AND S19 AND S27

S27 S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26

S26 DE "Treatment Effectiveness Evaluation"

S25 DE "Treatment Outcomes" OR DE "Psychotherapeutic Outcomes" OR DE "Side Effects (Treatment)" OR DE "Treatment Compliance" OR DE "Treatment Duration" OR DE "Treatment Refusal" OR DE "Treatment Termination" OR DE "Treatment Withholding"

S24 DE "Placebo"

S23 DE "Followup Studies"

S22 placebo* OR random* OR "comparative stud*"

S21 clinical N3 trial* OR research N3 design OR evaluat* N3 stud* OR prospectiv* N3 stud*

S20 (singl* OR doubl* OR trebl* OR tripl*) N3 (blind* OR mask*)

S19 S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18

S18 ("Interactive voice response" or IVR)

S17 (virtual reality or augmented reality or VR or AR)

S16 (telephone* or phone* or mobile* or cellphone* or apps or text* or SMS or smartphone*)

S15 "world wide web"

S14 ((health* or treat* or therap* or intervention* or assist* or selfmanag* or self-manag*) N6 (computer* or technolog* or software))

S13 ((inform* or communicat* or interact*) N6 (computer* or technolog* or software))

S12 ICT

S11 (mobile health or mhealth or m-health)

S10 (ehealth or e-health)

S9 (telehealth or tele-health)

S8 (telemedicine or tele-medicine)

S7 DE "Teleconsultation" OR DE "Telemedicine"

S6 (Internet or web or blog* or "social media" or online or www or email* or e-mail*)

S5 DE "Internet" OR DE "Blog"

S4 S1 OR S2 OR S3

S3 (pain* or fibromyalgia* or neuralgia*)

S2 DE "Fibromyalgia"

S1 DE "Pain" OR DE "Acute Pain" OR DE "Aphagia" OR DE "Back Pain" OR DE "Chronic Pain" OR DE "Headache" OR DE "Myofascial Pain" OR DE "Neuralgia" OR DE "Neuropathic Pain" OR DE "Somatoform Pain Disorder"

HISTORY

Protocol first published: Issue 1, 2021

CONTRIBUTIONS OF AUTHORS

Ben Rosser oversaw the project and is responsible for updating the review.

All authors contributed to the design, analysis, and authoring of the final review.

DECLARATIONS OF INTEREST

BR: None known.

EF: None known. EF is an editor with PaPaS Cochrane and was not involved in the editorial process of this review.

CE: Institutional funding from Orion Pharma and Reckitt Benkiser for advice on the psychology of pain, unrelated to this project. CE is an editor with PaPaS Cochrane and was not involved in the editorial process of this review.

GD: None known; GD is a clinical psychologist and works with clients with chronic pain.

EK: Institutional funding from Reckitt Benkiser Health Limited for consultancy advice on pain, unrelated to this project.

SJ: None known.

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DIFFERENCES BETWEEN PROTOCOL AND REVIEW

The following changes were made to the review from the protocol (Rosser 2021):

- We excluded mindfulness-only interventions to maintain consistency and comparability with the Williams 2020 review of face-to-face psychological therapies. The approach also differentiates interventions originating from psychology from practices that may hold therapeutic benefit but that originate outside of psychology. We included studies where mindfulness was a component of a broader psychological intervention.

- We further clarified our definition of the inclusion criterion of qualified psychologist involvement in intervention development. Qualified psychologists were limited to those with clinically relevant, rather than purely academic, training. Additionally, we included studies where authors informed us of psychiatrist involvement, as we considered these professionals to have the requisite knowledge of psychological interventions.
- We analysed attrition from baseline to post-intervention, rather than baseline to follow-up as stated in the protocol. We considered the former to be most representative of participant retention during intervention delivery, and a more useful outcome in terms of intervention acceptability than retention of participants within the study follow-up.
- We narrowed our definition of eligible measures of 'functional disability' to those that did not include emotional or psychological components within the composite measure, unless a subscale was reported that removed these components. We did this to reduce overlap with our assessment of psychological outcomes (e.g. depression and anxiety) and avoid duplication of effects.
- A third author reviewed and resolved *all* discrepancies between the two review authors' screening of full texts. We considered that including a third evaluation as standard practice increased the reliability of the screening process.
- Two review authors independently extracted data from every included study. A third author reviewed and resolved any discrepancies between the extractions in discussion with the extracting authors. We considered the 'dual extraction with third author review', rather than the 'single extraction and review' approach planned in the protocol, increased the reliability of the extraction process.
- We further refined our criterion for risk of bias assessment of selective reporting. A judgement of high risk of bias was only considered appropriate where there was notable deviation from the protocol/trial registration outcomes, such as numerous and/or impactful outcome alteration or omissions (e.g. outcomes relevant to the review). We wished to avoid grouping studies with relatively minor deviations with studies with major deviations, as we considered such an amalgamation would be misleading.
- Although a component of the protocol, we more explicitly stated in the review methods section that dichotomous data were only extracted: 1) for pain intensity (alongside continuous data), or 2) when continuous data were not reported for other outcomes (e.g. adverse events).
- Whereas the original protocol stated that active and treatment-as-usual control groups would be collapsed into a single comparison control, we elected to follow the same analysis strategy as Williams 2020 by collapsing waiting-list and treatment-as-usual controls into a singular comparison group (labelled 'TAU control'). Whilst we acknowledge that the variability of treatment as usual can include some participants who receive active treatment, overall we considered treatment as usual to be more comparable to waiting-list control. Furthermore, this approach supported comparability with Williams 2020.
- To clarify our approach to GRADE ratings: one review author (SJ) independently rated the certainty of the body of evidence for the outcomes, and a second review author (EF) independently reviewed these ratings. The authors resolved any discrepancies through discussion and with the input of a third author (CE) where necessary.
- We provided summary of findings tables for CBT only, rather than each therapy type (e.g. ACT), as originally intended. We made this decision in order to provide a comprehensive summary of effects versus both control groups at post-treatment and follow-up. This summary provides an indication of intervention effects against treatment as usual and active control, as well as the longevity of such effects. We focused on CBT as it represents the most commonly available and utilised therapy type within the field, thus representing the psychological intervention most likely to be accessible to decision-makers and individuals experiencing chronic pain.
- This review supercedes our previous related review on Internet interventions for chronic pain (Eccleston 2014). This review is most accurately conceived as a replacement rather than update of Eccleston 2014 due to its expansion in scope and refinement in methodology. Consequently, Eccleston 2014 has been removed from 'References to other published versions of this review' and relocated under 'Additional references'.