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Review Article

Are Positive Psychology Interventions Efficacious in Chronic Pain Treatment? A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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Abstract

Objective. Although positive psychology interventions (PPIs) are increasingly popular in chronic pain treatment their efficacy is still unclear. The objective is to summarize evidence on the effect of PPIs on pain, physical functioning, and emotional functioning in adults with chronic pain. **Methods.** Four electronic databases and additional references were searched for randomized controlled trials (RCTs) published between 1990 and 2020. Findings from included studies were qualitatively and quantitatively synthesized, and study quality was assessed for risk of bias. A random effects meta-analysis model was applied for outcomes with more than four findings. **Results.** Of 16 included RCTs, almost half delivered PPIs as self-help online interventions, and half conducted guided face-to-face interventions which lasted mostly eight weeks. Results from meta-analysis showed beneficial effects of PPIs compared to the control group on pain intensity and emotional functioning (i.e., less depressive symptoms, pain catastrophizing, negative affect; more positive affect) post-intervention. At 3-month follow-up, beneficial effects were maintained for depressive symptoms and positive and negative affect, but not for pain catastrophizing. However, the evidence on the long-term efficacy of PPIs and the efficacy of PPIs on physical functioning remains limited. **Conclusions.** This review supports the notion that PPIs are beneficial to chronic pain treatment, although further, high quality research is needed to support this conclusion.

Key words: Positive Psychology; Chronic Pain; Randomized Controlled Trials; Systematic Review; Meta-Analysis

Introduction

Chronic pain, defined as pain persisting or recurring over 3 months, is a highly prevalent health issue, that affects about 20%–40% of adults worldwide [1–3]. The most common locations for chronic pain are in the back, knee, and head, and the most common causes are arthritis, herniated discs, and traumatic injury [4]. Chronic pain often severely affects life as it is frequently associated with distress, reduced well-being, comorbidities (e.g., depression, anxiety disorders), and reduced participation [4–6]. Moreover, chronic pain causes high societal costs related to health care expenditures, reduced work productivity, or labor market dropouts [7, 8]. Given the complex interaction of biological, psychological, and social factors that contribute to the chronicity of pain, pharmacological treatments are mostly insufficient in the long term [9, 10]. Therefore, the current guidelines of the International Association for the Study of Pain (IASP) promote a multidisciplinary approach including non-pharmacological treatments such as psychological interventions [11], with a resource-oriented approach receiving increasing attention.

Positive psychology interventions (PPIs) represent such a resource-oriented approach focusing on strengthening positive individual aspects that may prove beneficial in chronic pain treatment. PPIs aim to increase positive feelings, cognitions, and behaviors [12] and empirical evidence documents their efficacy in promoting well-being or increasing specific well-being components, such as positive relationships [13]. PPIs exist in various forms, either including extensive therapy programs or brief interventions focusing on one or multiple components. Often, simple self-determined positive psychology exercises are used to increase specific components (e.g., increasing optimism by "imaging the best possible future self"; increasing positive orientations by "writing down three good things a day") [14]. Practicing these exercises has been found to decrease depressive symptoms and psychological distress in general and clinical populations [15, 16]. Emotional functioning is particularly affected when experiencing chronic pain. Negative emotions, which serve a protective function in the acute pain situation (e.g., fear of movement), can become maladaptive in the long-term (e.g., catastrophizing), contributing to an exacerbation of pain [9]. PPIs enable the experience of positive emotions through specific behavior and changing cognitions and may lead the focus of attention away from pain towards positive stimuli which can alter the perceived unpleasantness and intensity of pain [17]. Moreover, focusing on the positive strengthens psychosocial resources which may increase the individuals' ability to better manage chronic pain, leading toward resilience and adaptation to chronic pain [18].

Although the outlined findings would generally support the benefits of PPIs on chronic pain, their efficacy is still controversial and not yet empirically established. To date, one systematic review from 2016 summarized evidence on PPIs in chronic pain populations, with a focus on wellbeing and psychosocial factors, and concluded that PPIs can have beneficial effects for chronic pain patients [19]. However, its search strategy consisted of limited terms and thus might not comprehensively cover current evidence. Moreover, it remains unclear to what extent PPIs affect chronic pain. Therefore, the objective of this systematic review and meta-analysis is to summarize knowledge on the effect of PPIs on pain, physical functioning, and emotional functioning from randomized controlled trials (RCTs) in adults with chronic pain. In addition, this review aims to identify research gaps, evaluate the methodological quality of the evidence, and provide directions for future research.

Methods

This work follows an established guide on conducting a systematic review and meta-analyses [20], the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [21], and the American Psychological Association's (APA) quantitative Meta-Analysis Article Reporting Standards (JARS-Quant) [22]. The review protocol was registered in the International Prospective Register of Systematic Reviews (PROSPERO; registration-number: CRD42020208386).

Data Sources and Search Strategy

Studies were primarily identified through searches conducted in four electronic databases, that is, PsycINFO, Ovid MEDLINE, CINAHL, and ClinicalTrials.gov (last searches: August 13, 2020). Search strategies were developed in collaboration with a medical librarian experienced in conducting search strategies for systematic reviews. Three key concepts of the research question were identified: population (i.e., chronic pain), intervention (i.e., PPIs) and outcomes (i.e., pain, physical functioning, and emotional functioning). The search strategy was based on a building blocks approach, as for each concept, a block with subject headings (e.g., MeSH terms) and free text search terms was created. Relevant terms for the concept "population" were derived from the ICD-11 classification, including diagnosis identified as primary (e.g., fibromyalgia) or secondary chronic pain (e.g., arthritis) [3]. The concept "intervention" was covered by terms from the Values in Action (VIA) classification of character strengths [23] and the PERMA model, including Positive Emotions, Engagement, Relationships, Meaning, and Accomplishment as key elements [24], which are commonly used in positive psychology research, as well as from key reviews of PPIs. The concept "outcomes" included terms representing three core outcome domains described in guidelines of the Initiative on Methods, Measurement, and Pain Assessment in Clinical Trials (IMMPACT), namely pain (e.g., intensity, quality), physical functioning (e.g., physical impairment, interference) and emotional functioning (e.g., depression, anxiety, affect) [25]. Lastly, a filter for RCTs was applied [26]. The search strategy was devised in Ovid MEDLINE and adapted to each database (Supplementary Data Figure S1).

To identify additional studies, references and citations of included studies, drawn from Scopus database, were screened and reference lists of topic-related reviews were checked [15, 19, 27, 28]. Finally, first authors of included studies were contacted by the end of 2020 to ask for recently published studies or studies closely to acceptance that might be relevant for this review.

Eligibility Criteria and Study Selection

Studies were eligible if they met the following criteria: (1) published in English as original research in a peer-reviewed journal from January 1, 1990, onward (not earlier as positive psychology was founded in the 1990s), (2) RCT design, (3) adult population (i.e., ≥18 years) with chronic pain (i.e., 3 months of pain, or diagnosis of chronic pain condition/main symptom, such as fibromyalgia or arthritis), (4) included a PPI, following the definition in the introduction, and (5) reported at least one outcome of the three core outcome domains of the IMMPACT guidelines.

Excluded were studies examining populations in palliative care or with a cancer diagnosis due to medical (e.g., pharmacological treatment) and psychosocial (e.g., fear of progression) differences to other chronic pain populations [29]. Studies were also excluded if not all participants met inclusion criteria for chronic pain and if interventions did not focus solely on increasing well-being or a component of well-being (e.g., hope). For example, mindfulness-based stress reduction (MBSR), music therapy, or emotion-focused therapy were excluded. To include as many studies as possible, no restrictions were placed for sample size and the trial control group as long as quantitative analysis methods were used.

Following the selection criteria, two authors independently screened titles and abstracts for eligibility. In this step, psychotherapy studies were included for full-text screening to check whether a potential PPI-part was analyzed separately. Full-texts of potentially eligible studies were assessed by two authors independently. Studies derived from additional reference searches were screened for eligibility by the first author and potentially eligible full-texts were screened by two independent reviewers. Disagreement was solved by consensus of the two reviewers and if necessary, a third reviewer was consulted.

Data Extraction

Data on characteristics of the RCT (i.e., design, country, sample size), participants (i.e., health condition, mean age, percentage of female gender), intervention (i.e., topic, delivery mode, number of sessions, period, follow-up measure, control group), and outcome (i.e., core outcome domain, measurement instrument/scale) and results on the efficacy of the PPI (i.e., within and between-group effects from pre- to post-intervention and follow-up) were extracted. For meta-analysis, mean, standard deviation (SD) and number of participants (N) at baseline and post-intervention was extracted for outcomes with more than four findings. Data extraction was performed by the first author using a piloted extraction form in Microsoft Excel. For quality assurance, extracted data were reviewed for potential errors.

Quality and Risk of Bias Assessment

Study quality was assessed by two independent reviewers based on the Cochrane risk-of-bias tool for randomized trials (RoB 2) [30]. The tool considers five domains through which risk of bias might impact study results, namely bias arising from randomization process, deviations from intended interventions, missing outcome data, outcome measurement, and selection of reported results. Within each domain, a series of signaling questions were completed to assess the risk of bias with response options yes, probably yes, no, probably no, and no information. Responses to these questions feed into judgements about risk of bias (i.e., no risk, some concerns, high risk) in each domain and finally, an overall risk of bias judgment across all domains was provided. A study was judged to be at "low risk of bias" if there were no concerns in all domains, at "some risk of bias" if some concerns in at least one domain was detected, and at "high risk of bias" if there were concerns in more than three domains or if a high risk of bias was detected in at least one domain. Due to feasibility reasons, one assessment was conducted for each RCT, and not for each outcome of one study.

Statistical Analysis

Analyses were performed using STATA version 16.0 for Windows (College Station, TX, USA). Meta-analysis was conducted for outcomes with at least four findings at post-intervention and 3-month follow-up. Standardized mean difference (SMD) was calculated from N, mean, and SD for each finding of RCTs using a parallel design. In one study reporting findings from multiple control groups, findings from treatment as usual were chosen before waiting list. If several results for the same outcome were given, the closest to the outcomes reported by other studies was chosen (e.g., anxiety state for anxiety). For the outcome domain physical functioning, results on disease specific physical impairment were reported if this was assessed by a disease specific measurement instrument, such as the Fibromyalgia Impact Questionnaire (FIQ) for fibromyalgia populations. An overall SMD was calculated to estimate the overall effect of PPIs on the outcome compared to control group from pre- to post-intervention and if relevant to 3-month follow-up, which was the most frequently reported follow-up period in included studies. A random effects meta-analysis model was applied to account for expected between- and within-study heterogeneity. Estimations for between-study variance were based on the non-iterative DerSimonian-Laird method because it is as reliable as an iterative method and can be utilized without holding to normal distribution assumptions [31]. The resulting estimates and 95% confidence intervals (CI) are presented in forest plots for outcomes with at least eight findings. Negative estimates imply beneficial effects of PPIs compared to control group for negative symptomatology (e.g., lower pain intensity, less depressive symptoms). Heterogeneity was quantified using the I^2 statistic, classified as low ($I^2 \leq 25\%$), moderate ($I^2 > 25$ and $< 75\%$), or high ($I^2 \geq 75\%$) [32]. Due to the small number of included RCTs, it was not possible to investigate potential sources of heterogeneity by subgroup analysis. Leave-one-out sensitivity analysis was performed for outcomes with at least eight findings to evaluate influence of single studies on overall estimates from meta-analysis. Last, publication bias for outcomes with at least five findings were assessed through a funnel plot and asymmetry was checked using Egger's test [33]. P values $< .05$ from two-tailed tests were considered significant.

Results

Study Identification and Selection

The selection process is presented in Figure 1 [34]. A total of 5,151 records were identified through searches in Ovid MEDLINE (1,915), PsycINFO (1,582), CINAHL (1,201), and ClinicalTrials.gov (453). After removing 1,056 duplicates, 3,938 records were excluded after screening title and abstracts. Full-texts of the remaining 157 articles were screened. Of these, 143 articles were excluded mainly because they did not contain a PPI or the PPI was part of a broader intervention and was not separately analyzed, resulting in a total of 14 studies. Three additional studies were identified through additional reference search, leading to a final set of 17 included studies from 16 different RCTs. Fourteen studies reported sufficient data for meta-analysis.

Study Characteristics

Table 1 provides information on the main characteristics of included RCTs and study participants. The majority of the RCTs were conducted in the USA (n = 9) followed by Europe (n = 6) and Iran (n = 1). A parallel group design was used by all RCTs, except one using a cross-over design (No. 16). The sample size ranged from 11 to 393 (median = 69.5) and 11 RCTs had a sample size <100. Mean age of participants ranged from 38.9 to 73.9 years (median = 52.4), and the proportion of women was more than half in 12 RCTs. The most frequent health conditions were fibromyalgia (n = 6) and chronic pain secondary to another health condition (e.g., osteoarthritis; n = 5). Half of the PPIs were delivered as guided, face-to-face sessions, almost half were performed as self-help, online interventions. Most interventions were conducted over eight weeks and used active control groups (n = 9), followed by waiting list (n = 5) and treatment as usual (n = 2). Follow-up effects were assessed by nine RCTs, mostly 3 or 6 months post-intervention. Based on the risk of bias assessment, seven RCTs were considered as having a low risk of bias, seven showed some concerns, and two showed high risk of bias (Supplementary Data Table S2).

Results from Qualitative and Quantitative Synthesis

Tables 2 and 3 present results from qualitative and quantitative synthesis, respectively. Results are described along the different outcome domains pain, physical

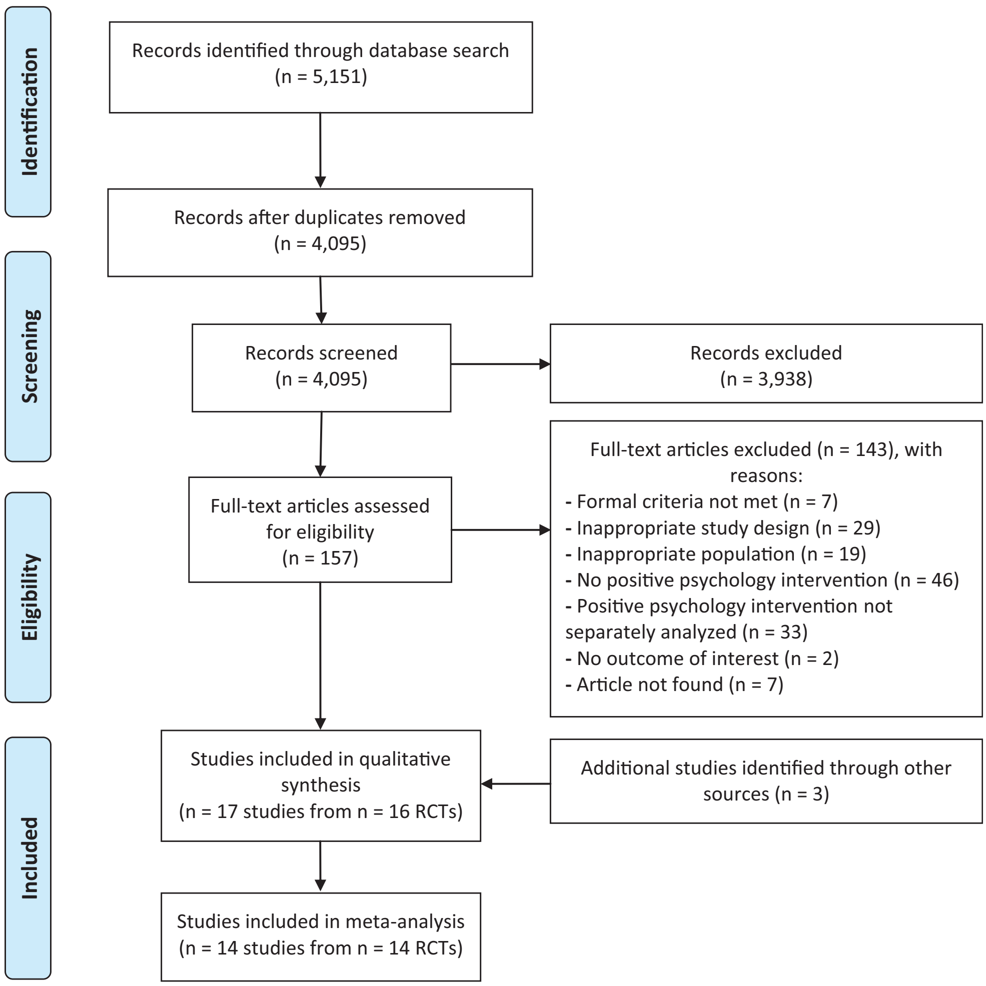

Figure 1. Selection process of included studies.

Table 1. Descriptive summary of RCTs included in this systematic review

No.	First author, year of publication	Country	Health condition	Sample size at baseline	Female gender (%)	Mean age (SD), years	Intervention characteristics: Topic of intervention	Delivery mode	No, of sessions, period	Follow-up measure	Control condition	Risk of bias
1	Alschuler, 2018 [35]	USA	Multiple sclerosis	28	92.9	59.8 (7.0)	Resilience intervention "Everyday Matters"	Guided group telephone conference and online platform	6, 6 weeks	–	WL	Concerns
2	Bartley, 2019 [36]	USA	Orofacial pain	29	75.9	38.87 (14.2)	Resilience-oriented hope intervention	Guided face-to-face sessions	3, 3 weeks	–	AC (pain education)	Concerns
3	Behrouz, 2017 and 2019 [37, 38]	IR	Chronic non-cancer pain	55	70.9	73.9 (5.1)	Humor therapy	Guided face-to-face group sessions	6, 6 weeks	–	WL	High
4	Boselie, 2018 [39]	NL	Fibromyalgia or musculoskeletal pain	221	96.7	44.63 (9.8)	PPI "Happy despite pain"	Self-help instructions via online platform	8, 8 weeks	–	WL	Concerns
5	Carson, 2005 [40]	USA	Low back pain	43	61.0	51.1 (n.a.)	Loving-kindness meditation	Guided face-to-face group session and practice at home	8, 8 weeks	3 months	TAU (standard care)	High
6	Guillory, 2015 [41]	USA	Mixed chronic pain conditions	68	75.0	48.55 (11.6)	Message-based social support intervention	Daily SMS text messages	28 messages, 2 weeks	–	TAU (standard care)	Concerns
7	Hausmann, 2017 [42]	USA	Hip or knee osteoarthritis	42	16.7	67.5 (10.3)	Positive psychological skill-building activities	Self-help instructions via telephone	6, 6 weeks	3 and 6 months	AC (neutral control activities)	Low
8	Hausmann, 2018 [43]	USA	Knee osteoarthritis	360	23.6	64.2 (8.8)	Positive psychological skill-building activities	Self-help instructions via telephone	6, 6 weeks	3 and 6 months	AC (neutral control activities)	Low
9	Lee, 2014 [44]	USA	Fibromyalgia	11	100.0	43.55 (17.7)	Forgiveness intervention	Individualized face-to-face sessions	24, 24 weeks	3 months	AC (health intervention)	Concerns
10	Molinari, 2018 [45]	ES	Fibromyalgia	71	100.0	51.08 (10.5)	Best Possible Self intervention	Individual face-to-face instructions and practice at home via online platform	minimum 12, 4 weeks	1 and 3 months	AC (diary of daily activities)	Low
11	Montero-Marin, 2018 [46]	ES	Fibromyalgia	42	100.0	51.45 (7.6)	Attachment-based compassion therapy	Individual face-to-face sessions	8, 8 weeks	3 months	AC (relaxation techniques)	Low
12	Müller, 2016 [47]	USA	Physical disabilities	96	69.8	59.4 (11.8)	Tailored positive psychology intervention	Self-help instructions via email	minimum 8, 8 weeks	2.5 months	AC (being mindful and writing about current life events)	Concerns
13	Müller, 2020 [48]	CH	Spinal cord injury	168	35.7	55.5 (12.0)	Tailored positive psychology intervention	Self-help instructions via email or post mail	minimum 8, 8 weeks	3 months	AC (being mindful and writing about current life events)	Low

(continued)

Table 1. (continued)

No.	First author, year of publication	Country	Health condition	Sample size at baseline	Female gender (%)	Mean age (SD), years	Intervention characteristics: Topic of intervention	Delivery mode	No. of sessions, period	Follow-up measure	Control condition	Risk of bias
14	Oliver, 2001 [49]	USA	Fibromyalgia	393	94.9	53.31 (11.7)	Social support intervention	Guided face-to-face group sessions	20, 24 weeks	–	WL	Concerns
15	Peters, 2017 [50]	NL	Fibromyalgia or musculoskeletal pain	276	85.0	48.6 (12.0)	Positive psychology program "Happy despite pain"	Self-help instructions online	8, 8 weeks	6 months	WL and TAU (cognitive behavioral therapy)	Low
16	Shaygan, 2017 [51]	DE	Mixed chronic pain conditions	88	74.4	53.36 (12.8)	Photographs of loved ones	Individual face-to-face sessions	4, 4 days	–	AC (Photographs of strangers)	Low

n.a. = not available, WL = waiting list, AC = active control condition, TAU = treatment as usual.

functioning, and emotional functioning, reporting on effects between intervention and control groups (i.e., between-group effects) from qualitative synthesis and from pooled findings from quantitative synthesis (i.e., meta-analysis).

Effects of PPIs on Pain

Pain intensity. Twelve RCTs investigated the effect of PPIs on average pain intensity, with four RCTs reporting beneficial between-group effects at post-intervention and all RCTs reporting zero effects at follow-up. Pooled findings from seven RCTs ($n = 682$) showed significantly lower average pain intensity at post-intervention in the PPIs group compared to control group, SMD -1.31, (95% CI -2.60 to -0.02), $I^2 = 97.9$, $P < .001$ (Figure 2). Two RCTs examined the effect of PPIs on worst pain intensity, with one reporting beneficial between-group effects at post-intervention. Similarly, the one RCT reporting on worst pain intensity demonstrated beneficial between-group effects on least pain intensity at post-intervention.

Quality of pain. Three RCTs examined the effect of PPIs on quality of pain, with two RCTs reporting beneficial between-group effects on emotional impact and one on sensory intensity at post-intervention. None of the RCTs investigated follow-up effects on quality of pain.

Effects of PPIs on Physical Functioning

General pain interference was investigated by six RCTs, one of which reported beneficial between-group effects at post-intervention and two reported zero effects at follow-up. The estimate from pooled findings of four RCTs ($n = 382$) suggests no significant differences between PPIs and control group at post-intervention, SMD -0.48 (95% CI -1.04 to 0.07), $I^2 = 84.0$, $P < .001$). Additionally, one study reported a beneficial between-group effect on interference in relationships and no effect on sleep interference at post-intervention.

Disease-specific physical impairment in fibromyalgia was examined by five RCTs, with three RCTs reporting beneficial between-group effects at post-intervention and one at follow-up. Pooled findings from these five RCTs ($n = 736$) indicate a positive between-group effect on physical impairment in fibromyalgia at post-intervention, SMD -1.31 (95% CI -2.17 to -0.44), $I^2 = 95.2$, $P < .001$. Furthermore, one of two RCTs reported beneficial between-group effects on functioning in arthritis at post-intervention and follow-up.

Effects of PPIs on Emotional Functioning

Depressive symptoms. Ten RCTs examined the effect on depressive symptoms, three of which showed beneficial between-group effects at post-intervention and one reported a beneficial effect at follow-up. Pooled findings from nine RCTs ($n = 1119$) suggest that the PPIs group showed fewer depressive symptoms at post-intervention than the control group, SMD -1.15 (95% CI -1.71 to -0.58), $I^2 = 93.9$ (Figure 3). These beneficial effects were

Table 2. Narrative synthesis of changes in pain, and physical and emotional functioning from baseline to post-intervention or follow-up

Outcome	No. of studies	Pre- to post-intervention effect within intervention group		Pre- to post-intervention effect between intervention and control group		Pre-intervention to follow-up effect between intervention and control group		Results from meta-analysis (No. of studies included in meta-analysis)		Measurement instruments/scale
		Beneficial	Zero	Beneficial	Zero	Beneficial	Zero	Pre- to post-intervention	Pre- to 3-month follow-up	
Pain										
Pain intensity										
Average	12	2, 3, 5*, 8, 12, 13	6	3, 12, 13, 16	1, 2, 4, 6, 7, 8, $15^{WL, TAU}$		7, 8, 12, 13, 15^{TAU}	Beneficial (7)	–	NRS 0 to 10 [1, 3, 5, 12, 13, 16], NRS 0 to 100 [2, 15], VAS 0 to 100 [4], CS 0 to 10 [6], WOMAC Index [7, 8]
Worst	2	3	5*	3				–	–	BPI NRS 0 to 10 [3, 5]
Least	1	3		3				–	–	BPI NRS 0 to 10 [3]
Quality of pain										
Sensory intensity	3	3	5*	3	16			–	–	MPQ [3, 5], PES [16]
Emotional impact	3	3	5*	3, 16				–	–	MPQ [3, 5], PES [16]
Cognitive evaluation	1		5*					–	–	MPQ [5]
Physical functioning										
Pain interference										
General interference	6	6, 12, 13	2	6	1, 2, 4, 12, 13		12, 13	Zero (4)	–	BPI NRS 0 to 10 [12, 13], NRS 0 to 100 [2], CS 0 to 10 [6], VAS 0 to 100 [4], PDI [4], PROMIS [1]
Interference on relations	1	6		6				–	–	CS 0 to 10 [6]
Interference on sleep	1		6		6			–	–	CS 0 to 10 [6]
Disease-specific physical impairment										
Fibromyalgia	5	9, 14	10	9, 11, $15^{WL, TAU}$	10, 14	11	9, 10, 15^{TAU}	Beneficial (5)	–	FIQ [9, 10, 11, 14, 15]
Osteoarthritis	2	8		7	8	7	8	–	–	WOMAC Index [7, 8]
Emotional functioning										
Depressive symptoms	10	9, 10, 12, 13, 14	2	4, 11, 15^{WL}	1, 2, 9, 10, 12, 13, 14, 15^{TAU}	11	9, 10, 12, 13, 15^{TAU}	Beneficial (9)	Beneficial (5)	HADS [4, 11, 12,13, 15], BDI-II [9, 10], CES-D [2, 14], PROMIS [1]
Anxiety	6	5*, 9^{trait}	9^{state}	4, 11, 15^{WL}	1, $9^{trait, state}$, 15^{TAU}	11	$9^{trait, state}$, 15^{TAU}	Zero (4)	–	HADS [4, 11, 15], PROMIS [1], BSI [5], STAI [9]
Positive affect	8	10, 12, 13^{+}	2, 6	4, 15^{WL}	2, 6, 7, 10, 12, 13, 15^{TAU}		7, 10, 12, 13, 15^{TAU}	Beneficial (7)	Beneficial (4)	PANAS [2, 4, 7, 8, 10, 12, 13], participants choice of photo [6]
Negative affect	7	10, 13	2, 12	7, 15^{WL}	2, 4, 10, 12, 13, 15^{TAU}	7	10, 12, 13, 15^{TAU}	Beneficial (7)	Beneficial (4)	PANAS [2, 4, 7, 8, 10, 12, 13]
Pain catastrophizing	8	9, 10, 12, 13	2	4, 15^{WL}	2, 9, 10, 11, 12, 13, 15^{TAU}		9, 10, 11, 12, 13, 15^{TAU}	Beneficial (8)	Zero (5)	PCS [2, 4, 10, 11, 12, 13, 15], CSQ [9]

(continued)

Table 2. (continued)

Outcome	No. of studies	Pre- to post-intervention effect within intervention group		Pre- to post-intervention effect between intervention and control group		Pre-intervention to follow-up effect between intervention and control group		Results from meta-analysis (No. of studies included in meta-analysis)		Measurement instruments/scale
		Beneficial	Zero	Beneficial	Zero	Beneficial	Zero	Pre- to post-intervention	Pre- to 3-month follow-up	
Fear of pain	1	3		3				–	–	FPQ-III [3]
Pain control	2	12, 13		12	13		12, 13	–	–	SOPA [12, 13]
Trait anger	2	9	5*		9		9	–	–	STAXI-II [5, 9]
State anger	2		5*, 9		9	9		–	–	STAXI-II [5, 9]
Distress	1	5*						–	–	BSI [5]

Effects were classified as beneficial if a significant effect ($P < .05$) in the desired direction was reported or as zero if the effect was nonsignificant ($P > .05$). Significant effects in the nondesired direction were not reported. Results from meta-analysis refer to between-group effects.

WL = waiting list; TAU = treatment as usual; NRS = numeric rating scale; VAS = visual analog scale; CS = concentric scale; WOMAC = Western Ontario McMaster Osteoarthritis; BPI = Brief Pain Inventory; MPQ = McGill Pain Questionnaire; PES = Pain Experience Scale; PDI = Pain Disability Index; PROMIS = Patient-Reported Outcomes Measurement Information System; FIQ = Fibromyalgia Impact Questionnaire; HADS = Hospital Anxiety and Depression Scale; BDI-II = Beck Depression Inventory-II; CES-D = Center for Epidemiological Studies—Depression scale; BSI = Brief Symptom Inventory; STAI = State Trait Anxiety Inventory; PANAS = Positive and Negative Affect Schedule; PCS = Pain Catastrophizing Scale; CSQ = Coping Strategies Questionnaire; FPQ-III = Fear of Pain Questionnaire—III; SOPA = Survey of Pain Attitudes; STAXI-II = State-Trait Anger Expression Inventory-II.

*Did not report between group effects.

maintained at 3-month follow-up as indicated by pooled findings from five RCTs (n = 381), SMD −1.04 (95% CI −2.02 to −0.07), $I^2 = 93.9$, $P < .001$.

Anxiety. Anxiety was investigated by six RCTs of which three reported beneficial between-group effects at post-intervention and one reported beneficial effects at follow-up. Pooled estimates from four RCTs (n = 361) indicated not significantly less anxiety at post-intervention for the PPI group compared to the control group, SMD −0.76 (95% CI −2.35 to 0.82), $I^2 = 96.8$, $P < .001$.

Positive and negative affect. The effect of PPIs on positive and negative affect was assessed by eight and seven RCTs, respectively, with two RCTs reporting significant differences in positive and negative affect between groups at post-intervention and one RCT reporting a beneficial between-group effect in negative affect at follow-up. Pooled estimates of seven RCTs (n = 721) indicate that the PPI group showed more positive and less negative affect at post-intervention compared to control groups, SMD 1.00 (95% CI 0.22 to 1.79), $I^2 = 95.5$, $P < .001$; SMD −1.19 (95% CI −1.77 to −0.60), $I^2 = 91.8$, $P < .001$. At 3-month follow-up, pooled estimates from four RCTs (n = 377) suggest maintenance of beneficial effects, SMD 1.31 (95% CI 0.64 to 1.99), $I^2 = 87.7$, $P < .001$; SMD −1.48 (95% CI −2.09 to −0.87), $I^2 = 84.1$, $P < .001$.

Pain catastrophizing. Of eight RCTs examining effects on pain catastrophizing, two reported significant differences between PPIs and control group at post-intervention and one reported a beneficial effect at follow-up. Pooled estimates of these RCTs (n = 721) showed beneficial between-group effects on pain catastrophizing at post-intervention, SMD −0.93 (95% CI −1.69 to −0.18), $I^2 = 95.0$, $P < .001$ (Figure 4). No significant difference in pain catastrophizing between groups was shown by pooled findings from five RCTs (n = 381) at 3-month follow-up, SMD −0.76 (95% CI −1.70 to 0.19), $I^2 = 93.8$, $P < .001$.

Fear of pain, pain control, anger, and distress. One RCT reported less fear of pain between intervention and control group at post-intervention. Two RCTs assessed pain control, of which one reported a beneficial between-group effect at post-intervention and neither of them reported beneficial effects at follow-up. Anger was assessed by two RCTs, with one showing a beneficial between-group effect for state anger at follow-up. Although the single RCT on psychological distress did not report between-group effects, less psychological distress from pre- to post-intervention within the PPI group was observed.

Heterogeneity, Sensitivity Analysis, and Publication Bias

Table 3 shows evidence for high between study heterogeneity for all analyses. Leave-one-out sensitivity analysis for outcomes with at least eight findings indicates that no single study changes the overall estimate for depressive symptoms and pain catastrophizing but the estimate for average pain intensity could be driven by a single study.

Table 3. Overall estimates of standardized mean differences (SMD) in chronic pain outcomes between PPIs and control group from pre- to post-intervention and 3-month follow-up

Outcome	No. of estimates	No. of persons in intervention group	No. of persons in control group	SMD (95% CI)	Heterogeneity	
					I^2	*P*-value
Pre- to post-intervention effects						
Pain						
Average pain intensity	7	354	328	**−1.31 (−2.60 to −0.02)**	97.9	<.001
Physical functioning						
General pain interference	4	209	173	−0.48 (−1.04 to 0.07)	84.0	<.001
Impairment in fibromyalgia	5	371	365	**−1.31 (−2.17 to −0.44)**	95.2	<.001
Emotional functioning						
Depressive symptoms	9	580	539	**−1.15 (−1.71 to −0.58)**	93.9	<.001
Anxiety	4	195	166	−0.76 (−2.35 to 0.82)	96.8	<.001
Positive affect	7	382	339	**1.00 (0.22 to 1.79)**	95.5	<.001
Negative affect	7	382	339	**−1.19 (−1.77 to −0.60)**	91.8	<.001
Pain catastrophizing	8	386	339	**−0.93 (−1.69 to −0.18)**	95.0	<.001
Pre- to 3-month follow-up effects						
Emotional functioning						
Depressive symptoms	5	201	180	**−1.04 (−2.02 to −0.07)**	93.9	<.001
Positive affect	4	197	180	**1.31 (0.64 to 1.99)**	87.7	<.001
Negative affect	4	197	180	**−1.48 (−2.09 to −0.87)**	84.1	<.001
Pain catastrophizing	5	201	180	−0.76 (−1.70 to 0.19)	93.8	<.001

Bold fonts indicate standardized mean differences with $P < .05$. Estimates and 95% confidence intervals (CI) presented were calculated using random effects models. *P*-values for heterogeneity comes from Q statistics.

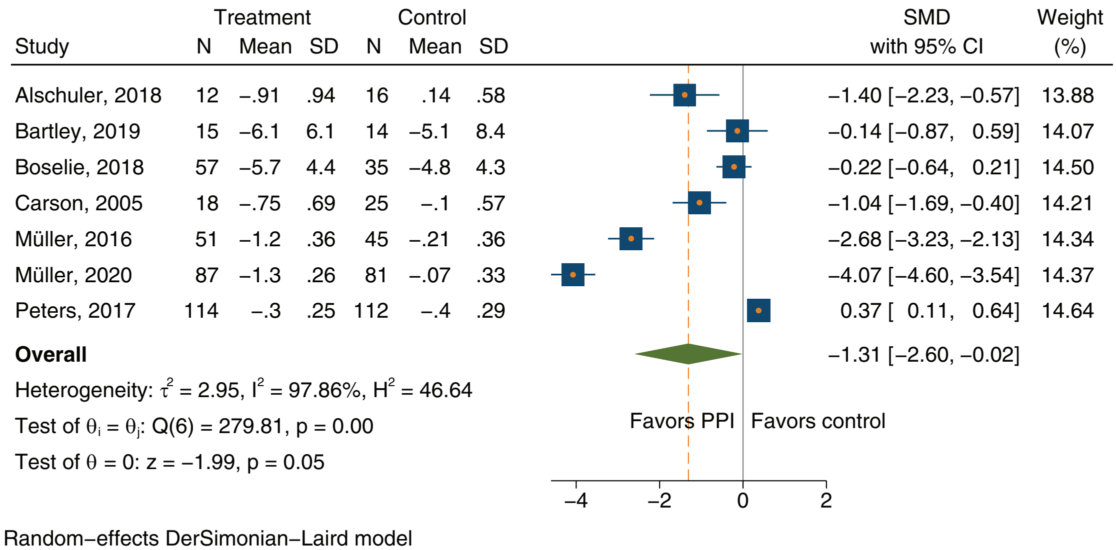

Figure 2. Effects of positive psychology interventions (PPIs) on average pain intensity: Standardized mean difference (SMD) and 95% confidence intervals (CI) from random effects model.

More specifically, large between-group differences were reported in study No. 3 which might explain loss of strength of effects on average pain intensity but not of significance when removing it (see Supplementary Data Figure S3). As this can be explained by high risk of bias due to cluster randomization and not individual randomization as done by all the other RCTs, study No. 3 was excluded from final meta-analysis. Leave-one-out sensitivity analysis without study No. 3 revealed that no single study influences the overall estimate. Risk for publication bias was found for overall estimates of physical impairment in fibromyalgia due to a somewhat asymmetric funnel plots and Egger's-test $P < .05$. A symmetric funnel plot and non-significant Egger's test was shown for average pain intensity ($P = .632$), depressive symptoms ($P = 0.342$), positive and negative affect ($P = .145$; $P = .069$), and pain catastrophizing ($P = .635$) at post-intervention and for depressive symptoms ($P = .067$) and pain catastrophizing ($P = .665$) at follow-up indicating no risk for publication bias (results not shown).

Discussion

This is the first systematic review and meta-analysis summarizing evidence on the effect of PPIs on pain, physical functioning, and emotional functioning in individuals with chronic pain. Across all outcomes, qualitative

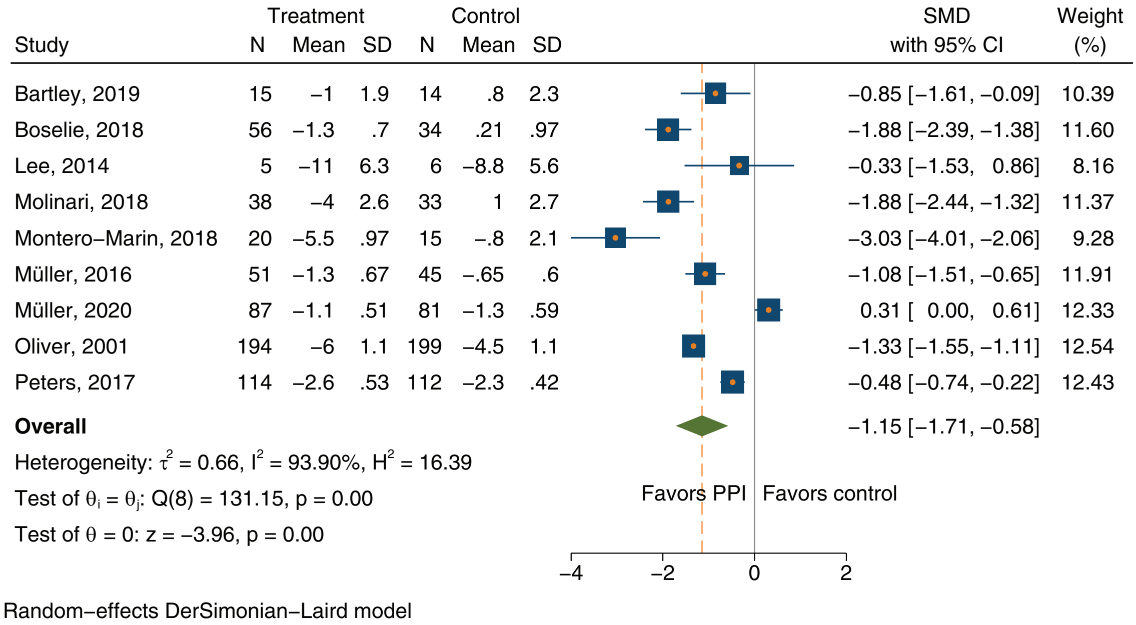

Figure 3. Effects of positive psychology interventions (PPIs) on depressive symptoms: Standardized mean difference (SMD) and 95% confidence intervals (CI) from random effects model.

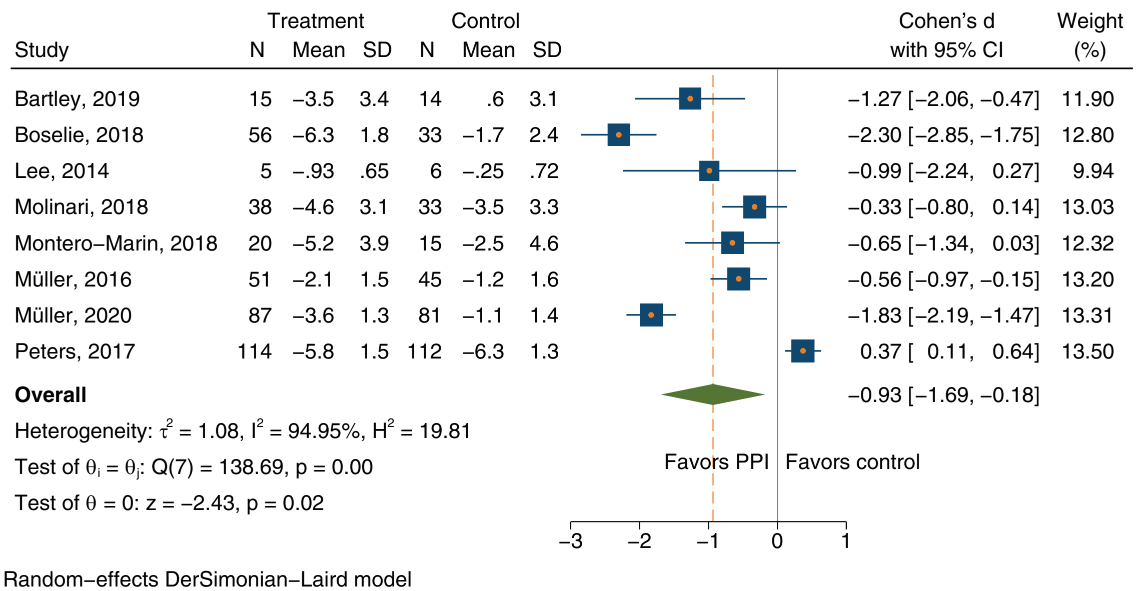

Figure 4. Effects of positive psychology interventions (PPIs) on pain catastrophizing: Standardized mean difference (SMD) and 95% confidence intervals (CI) from random effects model.

synthesis showed mostly beneficial effects from pre- to post-intervention within the PPIs group, however, inconsistent findings were reported for between-group differences at post-intervention, and most effects were not maintained to follow-up. Findings from meta-analysis suggest beneficial between-group effects of PPIs on average pain intensity and emotional functioning (i.e., less depressive symptoms, pain catastrophizing, and negative affect and higher positive affect) at post-intervention, while beneficial effects on physical functioning were only observed for physical impairment in fibromyalgia populations, and not so for average pain interference. At 3-month follow-up, beneficial effects were maintained for depressive symptoms and positive and negative affect but not for pain catastrophizing. Discrepancies between qualitative and quantitative synthesis can be explained by an increase in sample size. Since effects often do not reach the conventional statistical significance with small sample size, and therefore are not interpreted as beneficial, the direction of non-significant effects can still indicate a trend towards beneficial effects. Moreover, findings from original studies differ from pooled results as in meta-analysis summary level data (e.g., mean pain score) were pooled, while in original studies statistical analysis is based on individual level data (e.g., pain score is available for each study participant).

Beneficial effects of PPIs on average pain intensity at post-intervention found in this meta-analysis are in line with recent systematic reviews showing that positive emotions or cognitions are related to lower pain in clinical and general populations [27, 28]. Findings might be explained by different neurobiological pathways. Experimentally induced positive emotions (e.g., by viewing pictures of romantic partners) leads to a neural activation in reward-processing centers, which could explain analgesic effects of positive emotions [52]. Beneficial effects might also be explained by an inhibition of neural pain pathways due to changes in the attentional state while practicing PPI exercises [17]. Lastly, an increase in positive emotions and cognitions may lower stress, leading to a physical relaxation that reduces pain [53]. The findings from qualitative synthesis of this review showed that beneficial effects for pain intensity were not maintained to follow-up, suggesting that positive psychology exercises only affect pain when practiced. However, no conclusion can be made in this respect as most included RCTs did not investigate potential reasons for loss of long-term effects, such as practice adherence. Only one included RCT (i.e., No. 13) assessed practice adherence throughout follow-up measurements, reporting that 40% of the PPI and control group continued practicing the exercises, however, it was not investigated whether this 40% of people reported different pain outcomes than people who stopped practicing. Furthermore, limited evidence was found for the effect of PPIs on lowest and worst pain intensity and quality of pain, thus precluding any conclusion for those outcomes.

In line with systematic reviews from general and clinical populations [15, 16], results from this meta-analysis suggest beneficial effects of PPIs on emotional functioning. The reported increase in positive affect in PPIs group may be explained by a stronger, mindful focus on positive aspects of one's life. Focusing on positive aspects could further build psychosocial resources (e.g., positive relationships) which in turn lead to more positive emotions and may protect against difficulties in emotional functioning [54]. Moreover, PPIs encouraged participants to engage in activities with easy to implement exercises that possibly interrupt ruminating, which may lead to a reduction of negative affect and depressive symptoms, which in turn buffer negative pain-related cognitions, such as pain catastrophizing [55, 56]. However, the overall changes in affective states may also be driven by some non-specific effects as similar changes were found for positive and negative affect. This finding is particularly interesting as PPIs mainly strengthen positive cognitions and do not focus on negative symptomatology. When PPIs are compared to psychological interventions addressing maladaptive cognitions, such as cognitive behavioral therapy (CBT), similar effects on depressive symptoms were reported by study No. 15 for PPIs and CBT, whereas PPIs was slightly in favor concerning effects on positive affect at post-intervention. These findings may indicate that PPIs are better suited to increase positive affect than CBT and that PPIs have a similarly beneficial effect on depressive symptoms than CBT in the short term. However, since this meta-analysis showed nonsignificant effects on anxiety at post-intervention and on pain catastrophizing at 3-month follow-up, it seems that more complex negative affective states need to be specifically addressed in therapy and cannot be improved by increasing positive emotions solely. Also, whether there are beneficial effects on other psychological outcomes, such as anger or psychological distress, cannot be conclusively evaluated as there is only few empirical evidence available.

The effect of PPIs on physical functioning seems to be weak as pooled estimates suggest that PPIs do not significantly lower pain interference in daily activities at post-intervention. However, nonsignificance may be due to small sample size, rather than indicating the absence of an effect since trends toward reduced interference are detectable. It may be that PPIs alter physical functioning through indirect pathways, such as through a reduction in pain catastrophizing [57]. When considering findings on disease-specific physical impairment, beneficial effects of PPIs in individuals with fibromyalgia were shown at post-intervention. As fibromyalgia is usually highly related to fear of pain, increasing positive emotions by PPIs may enhance physical functioning through a reduction in pain-related fear and activity avoidance [58]. Besides, it has been shown that inducing positive emotions in individuals with fibromyalgia leads to higher activity engagement and motivation which could be beneficial for physical functioning [59].

The presented meta-analysis showed rather large effects for most outcomes, especially if compared to meta-analysis investigating effects of other psychological interventions on chronic pain, such as CBT or acceptance and commitment therapy (ACT) [60, 61]. These meta-analyses further showed that the selection of control group affects overall findings as, for example, small benefits for pain, pain interference, and depressive symptoms at post-intervention were reported when CBT was compared with treatment as usual, but no effects on depressive symptoms were shown when CBT was compared to active control [60]. In our meta-analysis, different control groups were combined, including waiting list control for some RCTs. As comparisons to waiting list or no treatment groups usually lead to larger effects, the type of control group may partly explain large effects observed in our meta-analysis. Furthermore, weights presented in our meta-analysis are not directly proportional to sample sizes, as in other meta-analysis [60]. The small samples of most included RCTs may affect reliability of pooled estimates and the high heterogeneity between

RCTs indicates that differences in interventions or populations may have an impact on results, which was not the case in other meta-analyses. Although the sizes of the effects of our meta-analysis should be interpreted with caution, our findings support the conclusion that PPIs present a beneficial treatment option for chronic pain.

Limitations

Several limitations need to be considered when interpreting the findings of this review. First, beneficial effects of PPIs on chronic pain outcomes might be overestimated as publication bias risk was indicated for some outcomes (i.e., average pain intensity, functioning in fibromyalgia). For other outcomes, underreporting of negative findings cannot be excluded either as methods used are limited by a qualitative evaluation of funnel plots and a small number of studies. Second, considerable between-study heterogeneity was found for all outcomes, indicating that pooled estimates might not be reliable as results are based on potentially heterogenous interventions, control groups, or differences in population characteristics, such as age or gender. However, potential sources of heterogeneity could not be investigated due to limited number of studies. Besides, most of the included RCTs used pilot-sized interventions that applied a variety of techniques of which some have not been validated as appropriate intervention tools. Third, a risk of bias in about half of RCTs was indicated based on the quality assessment, with missing outcome data as the main reason for concerns. Findings of RCTs relying on full case analysis instead of intention-to-treat analysis as recommended must be interpreted with caution because the probability of overestimating effects might be enhanced in full case analysis. Fourth, as indirect effects were not assessed in this review, conclusions about potential moderators or mediating paths cannot be drawn. More evidence is needed to better understand for whom and how PPIs work best [62]. Fifth, findings of other outcomes not included in the IMMPACT guidelines, such as pain acceptance or subjective well-being, were ignored although they were reported as potentially relevant in chronic pain treatment. This might contribute to a further underestimation of the importance of psychological factors in pain treatment. Sixth, the findings might not be generalizable to everyone with chronic pain since results were based on predominantly female populations, studies originating in the United States and Europe, and comprising limited types of chronic pain conditions. For example, effects could be affected by an underrepresentation of males as previous research suggests gender differences in pain sensitivity [63]. Seventh, only one included RCT (i.e., No. 13) assessed practice adherence throughout follow-up measurements, which limits the interpretation of reported and pooled follow-up effects. Lastly, conclusions about clinical meaningful changes in the outcomes cannot be drawn from this review because actual changes, for example in pain intensity, were not reported as sometimes different measurement instruments were used to assess the same outcome.

Clinical Implications

This review provides promising findings for using PPIs to target a reduction in average pain intensity and improve emotional functioning in chronic pain treatment. Included RCTs present a variety of interventions and specific exercises that could be implemented in line with a person's preferences, such as "writing a gratitude letter" to be more thankful or "counting funny things" to increase humor. In general populations, PPIs were shown most effective when implemented in an individual setting over several weeks using different activities [64]. Many PPIs are suitable to be delivered as self-help, online interventions since their exercises are easy to apply and do not need much guidance, enabling high accessibility at low cost and allowing flexibility of exercising, which may increase treatment adherence. In addition, undesirable side effects are unlikely and exercises can be tailored to an individual's preferences (as done by RCTs No. 12 and 13). PPIs may not only be promising as single interventions, but could also be combined with existing therapies as part of comprehensive multidisciplinary pain treatments. For example, exercises, such as "imaging the best possible future self," could be given as homework to foster a resource-oriented approach in pain management. Providing individuals with chronic pain a starting point to broaden the attention and cognitions towards positive stimuli could further build psychosocial resources and in turn increase the experience of positive emotions which might be specifically relevant when dealing with a highly treatment-resistant condition.

Implications for Future Research

Several research gaps were identified by this review. More high-quality RCTs with larger sample sizes in different chronic pain populations are needed to increase confidence in results. More evidence would further enable sociodemographic or pain condition-related subgroup analysis for detailed examinations of facilitating factors and profiles of people who profit from PPIs. Future research may also investigate indirect pathways to better understand potential mechanisms of the effect of PPIs on chronic pain. Besides, additional trials from non-western countries would allow to investigate ethnical differences in how persons with chronic pain potentially benefit from PPIs in different cultural contexts. Future trials may compare PPIs with multiple control groups, such as treatment as usual or active control, to better estimate the effect of PPIs on chronic pain. As shown in RCT No. 15, type of control group has an impact on the strength of the effect. Potential benefits of a PPI as additional intervention to CBT or other pain treatments should be further addressed to investigate whether PPIs have an additional or cumulative benefit since pain is modulated by different pathways. More insights into efficacy of specific exercises would be worthwhile to decide on its inclusion in existing treatment protocols. Also, validation of positive psychology exercises by large sample-sized trials and detailed examination of delivery mode and dosage are needed to enable recommendations for intervention planning. In this context, it is suggested to additionally assess intervention costs to investigate cost-effectiveness of PPIs, possibly also in comparison to other pain treatments. Lastly, further investigation of long-term effects of PPIs would be needed to better determine the duration of effects and potential reasons for loss of effects. In this regard, practice adherence should be assessed throughout follow-up measurements in future trials to be able to attribute possible long-term effects to the intervention.

Conclusion

Findings from this review and meta-analysis suggest that PPIs have beneficial effects on pain and emotional functioning for individuals with chronic pain, whereas evidence on its efficacy on physical functioning and on long-term effects is limited. Furthermore, high-quality research with large samples is needed to better suggest PPIs as effective evidence-based intervention in chronic pain treatment and to clarify potential long-term benefits. Nevertheless, this systematic review and meta-analysis provides a first overview on current evidence and shows promising findings for applying PPIs as a resource-oriented approach in the treatment of chronic pain.

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Supplementary Data

Supplementary data are available at *Pain Medicine* online.

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