**Positive Affect and Chronic Pain:
A Preregistered Systematic Review and Meta-Analysis**

Anthony D. Ong^{1,2}, Felix Thoemmes¹, Kaylin Ratner¹
Kate Ghezzi-Kopel², and M. Carrington Reid³

¹Department of Human Development, Cornell University

²Albert R. Mann Library, Cornell University

³Division of Geriatrics, Weill Cornell Medical College

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Corresponding Author: Anthony Ong, Department of Human Development, G77 Martha Van Rensselaer Hall, Cornell University, Ithaca, NY 14853-4401, Tel: (607) 255-9993; Fax: (607) 255-9856; Email address: anthony.ong@cornell.edu

KEY POINTS

Question – What is the association between positive affect and pain severity among adults with chronic non-cancer pain?

Findings – In this pre-registered systematic review and meta-analysis including 26 studies, positive affect was associated with reduced pain severity in both observation and experimental studies.

Meaning – The findings suggest that among adults with chronic non-cancer pain, augmenting positive affect can reduce pain severity.

ABSTRACT

Importance: Chronic non-cancer pain (CNCP) is a significant health burden among adults. Standard behavioral therapies typically focus on targeting negative affect and yield only modest treatment effects.

Objective: To systematically review and investigate the association between positive affect (PA) and pain severity among adults with chronic non-cancer pain.

Data Sources: Databases search included MEDLINE (PubMed), PsycINFO, CINAHL, ProQuest Dissertations and Theses, OLAster, Open Grey, PeerJ, and PsyArXiv (inception to September 24, 2018).

Study Selection: We analyzed studies that: 1) employed a daily diary, longitudinal, laboratory, or intervention study design; 2) enrolled individuals with CNCP (pain $\geq$ 12 weeks); and 3) reported full quantitative results on outcomes.

Data Extraction and Synthesis: At least 2 researchers independently screened articles, extracted data, and assessed the risk of bias. The main meta-analysis was followed by subgroup analyses. All analyses were performed using random-effects models. Formal tests for heterogeneity (Q -statistic; I^2) and publication bias (p -curve and p -uniform*) were performed.

Main Outcome: Pain severity.

Results: We analyzed 26 studies with 2702 participants. Positive affect was associated with reduced pain severity in both observational and experimental studies. In subgroup analyses, only gender demonstrated a consistent effect: Higher PA was associated with lower pain in observational studies that had higher percentages of female participants.

Conclusion and Relevance: Positive affect is associated with a reduction in pain severity, with the strongest association observed among women with CNCP.

INTRODUCTION

It is estimated that 70 million Americans—more than the number affected by diabetes, heart disease, and cancer combined—suffer from chronic non-cancer pain (hereafter referred to as chronic pain) each year.¹ With an increased prevalence among persons ages 65 and over,² chronic pain is a significant health burden—not just in terms of pain-related health care expenditures and disability, but also in terms of the inestimable costs to families and individual daily living and quality of life. Although there is increasing interest in the use of evidence-based non-pharmacological approaches to managing chronic pain,^{3,4} standard behavioral therapies for chronic pain, such as cognitive-behavioral therapy (CBT) and mindfulness-based stress reduction (MBSR), typically focus on targeting negative affective states (e.g., anxiety and depression)^{5,6} and yield only modest treatment effects.^{7,8} Efforts are therefore needed to develop more effective psychological treatments for chronic pain by identifying additional targets for intervention.

A growing body of theory and research suggest that positive affective states (e.g., gratitude and happiness) play a uniquely important role in promoting psychological adjustment in the face of chronic pain.⁹⁻¹² Specifically, PA has been theorized to facilitate adaptive coping in the context of chronic pain by countering the negative effects of fear on attention;¹³ by buffering negative pain-related cognitions (i.e., rumination, helplessness, magnification);¹⁴ by promoting neutral reappraisal processes related to pain;¹⁵ and by enhancing engagement in valued activities in the face of pain.¹⁶ PA may decrease pain severity through mediating central pathways of pain processing and by reducing inflammation.¹⁷

Although various narrative reviews¹⁸⁻²⁰ have been conducted, to our knowledge, no meta-analyses have investigated the association of PA and pain. Thus, the primary aim of this paper was to comprehensively review the literature on the association of PA and pain severity. We use systematic methods and standardized procedures^{21,22} for locating and evaluating the relevance and quality of ambulatory, longitudinal, and experimental studies. A secondary aim of this review was to investigate the effects of study characteristics and moderators on the association between PA and pain severity.

METHODS

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.²¹ All methods and planned analyses were preregistered on the Open Science Framework (OSF; [link redacted for blind review]).

Data Sources and Searches

MEDLINE (PubMed), PsycINFO, and CINAHL databases were searched electronically from inception to March 21, 2017. An updated search was performed (from April 7, 2017 through September 24, 2018) to include research from gray literature sources (ProQuest Dissertations and Theses, OLAster, Open Grey, PeerJ, and PsyArXiv) and to identify new publications. Search terms for PA used keywords drawn from prior reviews of health outcomes associated with PA²³⁻²⁵, and included variations of *happy, cheerful, joy, vigor, excited, elated, enthusiastic, energetic interest, content, amused, humor, calm, relaxed, grateful, satisfied, positive affect, positive emotions, and positive mood*. Search terms for chronic pain included variations of *widespread pain, recurrent pain, persistent pain, and long-term pain*. The details of the full search strategy are presented in eAppendix 1 in the Supplement.

Eligibility Criteria and Study Selection

Studies were considered eligible for inclusion if they met the following criteria: (1) the study design was daily diary, longitudinal, laboratory, or intervention (e.g., single-group pre-post, non-randomized group comparison, randomized controlled trial); (2) participants were adults (18 years or older) with chronic pain (12 weeks or more in duration); and (3) results were reported in sufficient quantitative detail to discern a directional effect of PA on pain severity. For all intervention studies, data from the baseline to first follow-up were included, with the baseline vs. first follow-up contrast serving as the primary outcome. In the case of two or more groups receiving different PA interventions within one study, all were independently included.

Studies were excluded if they: (1) were not an empirical study; (2) did not involve human subjects; (3) did not include a measure of PA or a positive mood manipulation (e.g., humorous

films, pleasant images); (4) used a reversed indicator of negative affect (NA) as a measure of PA (e.g., hopelessness vs. hopefulness; pessimism vs. optimism; fatigue vs. vigor/vitality); (5) did not include a subjective or objective measure of pain severity; (6) assessed affect about a particular domain for specific life experience (e.g., “How happy are you about being pregnant?”); (7) examined only the directional effect of pain on PA or mean differences in PA between pain impaired and non-impaired samples; (8) did not utilize a sample of individuals identified as suffering from chronic pain; (9) assessed acute or experimentally induced pain; (10) did not employ an eligible study design; (11) did not examine or report a directional effect of PA on pain; (12) exclusively used a sample of patients with a primary cancer diagnosis; (13) were published in languages other than English; (14) did not include adults (18 years and above); (15) exclusively used a sample of patients presenting with a primary psychological disorder; (16) did not directly target PA; or (17) did not include sufficient quantitative information on study outcomes.

After duplicates were removed, two authors (K.R. and K.G-K.) independently screened the titles and abstracts to determine whether the citation met eligibility criteria. After that, two independent authors (A.O. and F.T.) assessed the full text of potentially eligible studies for inclusion.

Data Extraction and Quality Assessment

Two reviewers (A.O. and F.T.) independently extracted study characteristics and outcome data from published articles. Risk of bias was independently assessed by two reviewers (A.O. and F.T.) using the Effective Public Health Practice Project (EPHPP) tool.²² Specifically, the included studies were assessed for (1) selection bias, (2) study design, (3) confounders, (4) blinding, (5) data collection, and (6) withdrawals/dropouts. Each domain was rated as strong, moderate, or weak, and domain scores were averaged to provide a global rating for each study (inter-rater reliability 86%, Cohen’s kappa .77, Fleiss’ kappa .77). Discrepancies were resolved by consensus.

Data Synthesis and Analysis

Meta-analyses were performed using the *metaphor* and *meta* packages²⁶ in R, version 3.4.3 (R Project for Statistical Computing). For experimental studies (i.e., laboratory, interventions), effects sizes (Hedges' g) were extracted from descriptive statistics. For observational studies (i.e., diary, longitudinal), standardized regression coefficients were extracted from regression results.²⁷ For comparative purposes, we also computed $r_{\text{equivalent}}$ effect sizes²⁸ from exact p -values reported in observational and experiment studies. Meta-analyses yielded a point estimate, confidence interval, and p -value, along with statistics for heterogeneity, assessed using the Cochran Q -statistic and the Higgins-Thompson I^2 values.²⁹ Publication bias was evaluated using the Egger test, with $p < .10$ indicating substantial asymmetry,³⁰ and funnel plots. For completeness, we conducted p -curves³¹ (the distribution of statistically significant p values for a set of findings, with right-skewed p -curves suggesting findings that contain evidentiary value) and p -uniform* tests (a publication bias test based on the effect size in a set of studies).³²

Subgroup Analyses

A priori subgroup analyses were performed to investigate the effects of study characteristics, including overall risk of bias, demographics (percentage female, percentage racial minority, mean age), chronic pain status (fibromyalgia, rheumatoid arthritis, osteoarthritis, back pain, multiple), PA measurement (state vs. trait), covariate adjustment, and study design. A false discovery rate (FDR) Type I error control was used for all comparisons to correct for multiple testing.³³

RESULTS

From a total of 2356 retrieved articles, 107 were identified based on title and abstract screening for full-text review. A total of 26 studies fulfilled the eligibility criteria and were included in the final meta-analysis.³⁴⁻⁵⁹ The flow chart of the study selection process is presented in Figure 1.

Study Characteristics

Descriptive details of the eligible studies are presented in eTable 1 in the Supplement. The included studies were published between 1981⁴⁸ and 2018⁴⁵; came from 9 countries,^{34,38,40,42,46,50,54-56} with 16 from the United States^{35-37,39,41,43-45,47-49,51-53,57-59}; had sample sizes ranging from 10⁴⁸ to 306⁴⁵, and included a total of 2702 participants (mean [SD] age was 54.42 [9.15] years and 75% were women). Among the 26 included studies, seven were observational studies (four diary^{39,42,47,58}, three longitudinal^{51,53,55}) and 19 were experimental studies (seven laboratory experiments^{37,40,46,48,52,54,57}, 12 interventions^{34-36,38,41,43-45,49,50,56,59}). Among observational studies reviewed, the majority used self-report adjective ratings of positive valence (e.g., *active*, *energetic*, *happy*, *cheerful*, *joyful*) to assess PA. Among experimental studies, examples of targeted PA-based inductions and interventions included viewing emotionally evocative images, humorous film clips, guided imagery, as well as engaging in structured positive activities that targeted positive emotions (e.g., expressing thanks, practicing acts of kindness, savoring positive moments).

Risk of Bias

The assessment of the quality of the study methodology for the five domains (selection bias, study design, confounders, blinding, and data collection) is reported in eFigure 1 in the Supplement. Risk-of-bias assessments for individual studies are summarized in eTable 1 in the Supplement. Following the EPHPP tool, six studies^{41,43-45,50,59} (23.08%) were classified as “strong” or having low risk of bias; 10 studies^{34-37,40,48,49,52,54,56} (38.46%) were categorized as having “moderate” risk; and 10 studies^{38,39,42,46,47,51,53,55,57,58} (38.46%) were categorized as “weak” or having high risk of bias. Weakness ratings derived from the inadequate control of confounders and insufficient information regarding study design, as well as lack of blinding.

Meta-analyses

Observational Studies

Seven observational studies^{39,42,47,51,53,55,58} were included in the primary analysis, totaling 1228 participants in the model. Figure 2 displays the forest plots for the meta-analyses of the association between PA and pain severity. PA was associated with decreased pain severity ($\beta = -0.12$, $z = -4.18$, $p < .001$; $r_{\text{equivalent}} = -0.25$, $p < .0001$), but heterogeneity across studies was substantial ($I^2 = 89.43\%$; 95% CI, 72.42 - 96.81; $Q(11) = 75.63$, $p < .001$), indicating significant variation in the effect sizes. Egger's test suggested no important asymmetry ($z = -1.68$, $p = .09$). The funnel plot (Figure 3) suggested the presence of bias, with small studies presenting inflated positive effect sizes. We also conducted p -uniform* as an additional measure of publication bias. This test did not yield a significant result ($L_{pb} = 0.73$, $p = .69$), failing to indicate the presence of publication bias. Expected p -curve for observational studies are reported in eFigure 2 in the Supplement. The shape of the p -curve is significantly right-skewed ($z = -7.64$, $p < .0001$), indicating the set of studies contains evidentiary value.

Experimental Studies

Nineteen experimental studies^{34-38,40,41,43-46,48-50,52,54,56,57,59} provided data on pain severity for 1474 participants. As shown in Figure 4, PA had a significant effect in decreasing pain severity (Hedges' $g = -0.39$; $r_{\text{equivalent}} = -0.22$; $p < .0001$). Heterogeneity was high ($I^2 = 82.70\%$; 95% CI, 77.40 - 96.15; $Q(20) = 82.14$, $p < .001$), and funnel plots (Figure 5) and the Egger's test ($z = -4.86$, $p < .0001$) suggested asymmetry. Likewise, the p -uniform* test yielded a significant result ($L_{pb} = 6.98$, $p = .03$), indicating the presence of publication bias. eFigure 3 in Supplement reports the expected p -curve for experimental studies, which was significantly right-skewed ($z = -4.37$, $p < .0001$), suggesting the set of significant findings contains evidentiary value.

Subgroup Analyses

PA was associated with lower pain severity in observational ($Q(1) = 26.07$, $p < .001$) studies that had higher percentages of female participants. Likewise, in subgroup analysis by chronic pain condition, we found the association between PA and pain severity was significantly

attenuated in observational studies that evaluated participants with back pain compared with studies evaluating participants with multiple pain conditions ($Q(4) = 10.95$, $p = .027$). After FDR Type I error control, only the moderating effect of gender remained significant ($p < .001$). All other preplanned subgroup analyses (i.e., risk of bias, state vs. trait PA measurement) did not reach significance.

DISCUSSION

Main Findings

This systematic review and meta-analysis provides quantitative evidence that PA is associated with reduced pain severity among adults with chronic non-cancer pain. Previous narrative reviews¹⁸⁻²⁰ have reported links between PA and pain. In the present review, we undertook a meta-analysis of daily diary, longitudinal, laboratory, and intervention studies, enabling the quantification of these links and the exploration of key sources of heterogeneity across studies.

Strengths and Limitations

There are several strengths to this review, including its pre-registered comprehensive search strategy, its systematic study inclusion, its thorough assessment of study quality, its use of a priori subgroup analyses, and its formal tests for heterogeneity (Q -statistic; I^2) and publication bias (p -curve and p -uniform*). There are also limitations to our review. First, although inspection of the funnel plot and Egger test did not identify strong evidence of publication bias in any of our analyses, we found high heterogeneity in terms of study population. Given that we included somewhat diverse interventions and assessment methods, this may indicate that not all studies were consistently measuring the same effect. Second, the small number of studies prevented us from performing stringent subgroup analysis. Thus, a critical direction for future research will be to replicate these findings in high-powered pre-registered studies. Third, few of the included studies examined the effect of PA on other pain relevant outcomes (e.g., perceived interference due to pain), so the effects of PA on other salient outcomes need to be established.

Finally, despite the inclusion of gray literature, we used English search terms, which may have prevented us from identifying relevant studies published in other languages.

Implications for Research and Practice

Our findings support guideline recommendations^{60,61} that encourage clinicians to consider psychological treatments in the care of patients with chronic pain, particularly interventions that have a PA component. Nevertheless, it is unclear whether the elements of CBT and MBSR that promote PA are sufficient in alleviating pain or whether an explicit focus on modifying maladaptive pain-related cognitions is also required to maximize pain treatments. Future research is therefore needed to evaluate the potential utility of targeted-PA interventions as a novel nonpharmacological adjunct to traditional CBT and MBSR approaches. An additional critical question is what methods of administration (e.g., via web-based platforms, text messages, virtual reality) are most effective in inducing PA in individuals with chronic pain. Future work should therefore be aimed at further exploring the differential effects of delivery mode of PA as a treatment target for chronic pain.

CONCLUSION

To our knowledge, this is the first pre-registered systematic review and meta-analysis to examine the association between PA and pain severity in adults with chronic non-cancer pain. The results indicated that PA is associated with a modest decrease in pain severity across both observation and experimental studies. The findings suggest that among adults with chronic non-cancer pain, PA may be a factor that promotes resilience in the face of chronic pain.

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Figure 1: Study Flow Diagram

Full text articles were excluded if they met any one of the following criteria: (1) were not an empirical study; (2) did not involve human subjects; (3) did not include a measure of PA or a positive mood manipulation (e.g., humorous films, pleasant images); (4) used a reversed indicator of negative affect (NA) as a measure of PA (e.g., hopelessness versus hopefulness; pessimism versus optimism; fatigue versus vigor/vitality); (5) did not include a subjective or objective measure of pain; (6) assessed affect about a particular domain for specific life experience (e.g., “How happy are you about being pregnant?”); (7) examined only the directional effect of pain on PA or mean differences in PA between pain impaired and non-impaired samples; (8) did not utilize a sample of individuals identified as suffering from chronic pain; (9) assessed acute or experimentally induced pain; (10) did not employ an eligible study design; (11) did not examine or report a directional effect of PA on pain; (12) exclusively used a sample of patients with a primary cancer diagnosis; (13) were published in languages other than English; (14) did not include adults (18 years and above); (15) exclusively used a sample of patients presenting with a primary psychological disorder; (16) did not directly target PA; or (17) did not include full quantitative results on outcomes.

Figure 2: Forest Plot for Positive Affect and Pain in Observational Studies

Figure 3: Funnel Plot for Positive Affect and Pain in Observational Studies

Figure 4: Forest Plot for Positive Affect and Pain in Experimental Studies

Figure 5: Funnel Plot for Positive Affect and Pain in Experimental Studies

Supplemental Online Content

Ong, A. D., Thoemmes, F., Ratner, K., et al. Positive affect and chronic pain: A preregistered systematic review and meta-analysis

eAppendix 1. Positive Affect and Chronic Pain Systematic Review Search Strategy

eTable 1. Descriptive Characteristics of Included Studies

eFigure 1. Summary of quality assessment results from the Effective Health Public Practice Project (EPHPP) tool

eFigure 2. Expected p -Curve for Observational Studies

eFigure 3. Expected p -Curve for Experimental Studies

This supplementary material has been provided by the authors to give readers additional information about their work.

eAppendix 1: Positive Affect and Chronic Pain Systematic Review Search Strategy

MEDLINE (PubMed)

- #1 happiness[MeSH] OR hope[MeSH] OR love[MeSH] OR pleasure[MeSH] OR positive affect[tiab] OR positive emotion*[tiab] OR positive mood[tiab] OR at ease[tiab] OR calm[tiab] OR cheerful*[tiab] OR elated*[tiab] OR energetic[tiab] OR enjoy*[tiab] OR enthusiastic[tiab] OR excite*[tiab] OR fondness[tiab] OR happi*[tiab] OR happy[tiab] OR hopeful*[tiab] OR jovial*[tiab] OR joy[tiab] OR lively[tiab] OR love[tiab] OR optimis*[tiab] OR pep[tiab] OR pleas*[tiab] OR relaxed[tiab] OR satisfied[tiab] OR surgency[tiab] OR vigor[tiab] OR vigour[tiab] OR amused[tiab] OR contentment[tiab] OR humor[tiab] OR humour[tiab] OR gratitude[tiab] OR psychological well-being[tiab] OR psychological wellbeing[tiab] OR subjective well-being[tiab] OR subjective wellbeing[tiab] OR hedonic well-being[tiab] OR hedonic wellbeing[tiab] OR mood manipulat*[tiab] OR experimental manipulat*[tiab] OR emotion elicitation[tiab] OR emotional stimuli[tiab]
- #2 chronic pain[Mesh] OR chronic pain[tiab] OR long-term pain[tiab] OR longterm pain[tiab] OR recurrent pain[tiab] OR persistent pain[tiab]
- #3 #1 AND #2
- #4 Limits: English

PsycINFO

- #1 TX (“positive affect” OR “positive emotion*” OR “positive mood” OR at ease OR calm OR cheerful* OR elated* OR energetic OR enjoy* OR enthusiastic OR excite* OR fondness OR happi* OR happy OR hopeful* OR jovial* OR joy OR lively OR love OR optimis* OR “pep” OR pleas* OR relaxed OR satisfied OR surgency OR vigor OR vigour OR amused OR contentment OR humor OR humour OR gratitude OR “psychological well-being” OR “psychological wellbeing” OR “subjective well-being” OR “subjective wellbeing” OR “hedonic well-being” OR “hedonic wellbeing” OR “mood manipulat*” OR “experimental manipulat*” OR “emotion elicitation” OR “emotional stimuli”) OR DE (happiness OR hope OR love OR pleasure)
- #2 TX (“chronic pain” OR “long-term pain” OR “longterm pain” OR “recurrent pain” OR “persistent pain”) OR DE (chronic pain)
- #3 #1 AND #2
- #4 Limits: English

CINAHL

- #1 TX (“positive affect” OR “positive emotion*” OR “positive mood” OR at ease OR calm OR cheerful* OR elated* OR energetic OR enjoy* OR enthusiastic OR excite* OR fondness OR happi* OR happy OR hopeful* OR jovial* OR joy OR lively OR love OR optimis* OR “pep” OR pleas* OR relaxed OR satisfied OR surgency OR vigor OR vigour OR amused OR contentment OR humor OR humour OR gratitude OR “psychological well-being” OR “psychological wellbeing” OR “subjective well-being” OR “subjective wellbeing” OR “hedonic well-being” OR “hedonic wellbeing” OR “mood manipul*” OR “experimental manipul*” OR “positive emotion induc*” OR “emotion elicitation” OR “emotional stimuli”) OR MH (happiness OR hope OR love OR pleasure)
- #2 TX (“chronic pain” OR “long-term pain” OR “longterm pain” OR “recurrent pain” OR “persistent pain”) OR MH (chronic pain +)
- #3 #1 AND #2
- #4 Limits: English

ProQuest Dissertations and Theses

- #1 TS (“positive affect” OR “positive emotion*” OR “positive mood” OR at ease OR calm OR cheerful* OR elated* OR energetic OR enjoy* OR enthusiastic OR excite* OR fondness OR happi* OR happy OR hopeful* OR jovial* OR joy OR lively OR love OR optimis* OR “pep” OR pleas* OR relaxed OR satisfied OR surgency OR vigor OR vigour OR amused OR contentment OR humor OR humour OR gratitude OR “psychological well-being” OR “psychological wellbeing” OR “subjective well-being” OR “subjective wellbeing” OR “hedonic well-being” OR “hedonic wellbeing” OR “mood manipul*” OR “experimental manipul*” OR “emotion elicitation” OR “emotional stimuli”) OR DE (happiness OR hope OR love OR pleasure)
- #2 TS (“chronic pain” OR “long-term pain” OR “longterm pain” OR “recurrent pain” OR “persistent pain”) OR DE (chronic pain)
- #3 #1 AND #2
- #4 Limits: English

Abbreviated search strategy for Grey Literature Databases (OLASTER, Open Grey, PeerJ, PsyArXiv)

(“positive affect” OR “positive emotion*” OR “positive mood” OR happi* OR "happy" OR joy OR vigor) AND (“chronic pain” OR “long-term pain” OR “longterm pain” OR “recurrent pain” OR “persistent pain”)

eTable 1: Descriptive Characteristics of Included Studies

Source [Country]	Year	Study Type	Risk of bias	Sample size	Effect size (d / β) *	Mean Age	% white	% female	Pain condition**
Basler et al ³⁴ [Germany]	1997	I	M	76	-.06	49	---	75	B
Carson et al ³⁵ [US]	2005	I	M	43	.29	54	63	61	B
Davis & Zautra ³⁶ [US]	2013	I	M	79	.01	46	83	98	F
Davis et al ³⁷ [US]	2014	LE	M	78	.05	57	91	100	M
Dowd et al ³⁸ [Ireland]	2015	I	H	62	-.50 .04	44	---	90	F
Finan et al ³⁹ [US]	2013	D	H	150	-.12 -.08	61	61	68	O
Fors, & Gotestam ⁴⁰ [Norway]	2000	LE	M	63	-1.06	45	---	100	F
Garland et al ⁴¹ [US]	2014	I	L	115	-.58	48	---	68	M
Gruszczynska & Knoll ⁴² [Poland]	2015	D	H	95	-.29 -.25 -.05	51	---	100	R
Guillory et al ⁴³ [US]	2015	I	L	68	-.39	49	63	75	M
Hausmann et al ⁴⁴ [US]	2017	I	L	34	-1.13	68	57	17	O

Hausmann et al ⁴⁵ [US]	2018	I	L	306	.14	64	50	24	O
Herrero et al ⁴⁶ [Spain]	2014	LE	H	40	-.12	49	---	100	F
Kruszewski ⁴⁷ [US]	2010	D	H	143	-.24	58	89	100	M
McKee ⁴⁸ [US]	1981	LE	M	10	-2.95	36	90	50	M
Muller et al ⁴⁹ [US]	2016	I	M	77	-.54	59	96	70	O
Peters et al ⁵⁰ [the Netherlands]	2017	I	L	121	.04	49	---	85	F
Potter ⁵¹ [US]	1999	L	H	285	-.14	63	---	100	M
Raft et al ⁵² [US]	1986	LE	M	13	-3.09	---	---	---	M
Seebach et al ⁵³ [US]	2012	L	H	128	.00	59	81	58	B
				123	-.02				
Shaygan et al ⁵⁴ [Germany]	2017	LE	M	88	-.35	53	---	67	M
					-.05				
Strand et al ⁵⁵ [Norway]	2007	L	H	40	-.05	50	---	73	R
Tse, et al ⁵⁶ [Hong Kong]	2010	I	M	70	-1.29	79	---	54	M
Wilkinson ⁵⁷ [US]	2003	LE	H	60	-.10	---	---	75	M
Zautra, et al ⁵⁸ [US]	2001	D	H	175	-.21	64	---	100	M
				89	-.18				F
Zautra, et al ⁵⁹ [US]	2008	I	L	71	-.22	53	87	63	R

Notes. For experimental studies, effect size is Hedges' *g*. For observational studies, effect size is standardized regression coefficient. Study type: D = diary, L = longitudinal; LE = laboratory experiment, I = intervention; Risk of bias: W = weak; M = moderate; S = strong. Pain conditions: F = fibromyalgia, O = osteoarthritis, R = rheumatoid arthritis, B = back pain, M = multiple.

eFigure 1: Summary of quality assessment results from the Effective Health Public Practice Project (EPHPP) tool.

eFigure 2: Expected p -Curve for Observational Studies

eFigure 3: Expected p -Curve for Experimental Studies