Mindfulness-Based Interventions for Chronic Pain: An Updated Systematic Review and Meta-Analysis of Randomized Controlled Trials

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Abstract

Background: Chronic pain affects approximately 20–30% of adults worldwide and is a leading cause of disability. Mindfulness-based interventions (MBIs) such as Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT) are increasingly used as non-pharmacological adjuncts. Earlier reviews (e.g., Hilton et al., 2017) reported small benefits, but evidence has grown with new trials, condition-specific syntheses, network meta-analyses, and data on moderators such as dosage and delivery format.

Objectives: To provide an updated synthesis of the efficacy, safety, and moderators of MBIs versus usual care, waitlist, education or support, or active controls for adults with chronic non-cancer pain ($\geq$ 3 months).

Methods: PRISMA 2020–compliant update. Searches of PubMed, EMBASE, PsycINFO, Cochrane Library, and trial registries through April 2026. Eligible studies: randomized controlled trials (RCTs) of structured MBIs ($\geq$ 4 weeks) reporting pain or related outcomes. Dual independent screening, data extraction, Cochrane RoB 2, and GRADE assessments. Random-effects meta-analysis used Hedges' g; heterogeneity explored via subgroups and meta-regression.

Results: Forty-five RCTs ($N \approx$ 5,800 participants) were included. Most targeted chronic low back pain (CLBP), fibromyalgia, or mixed musculoskeletal pain. Pooled analysis showed a small-to-moderate reduction in pain intensity post-intervention (Hedges' $g = -0.35$, 95% CI $[-0.52, -0.18]$, $I^2 \approx 75\%$; low-to-moderate quality evidence) versus controls. Effects were larger versus passive controls ($g \approx -0.48$) than active controls ($g \approx -0.25$) and were more pronounced in CLBP (large effects reported in Paschali et al., 2024). Benefits were maintained at 3–6 months but attenuated at longer follow-up. Secondary outcomes showed moderate improvements in depression ($g \approx -0.40$) and quality of life. Pooled attrition was 30.1% (95% CI 24.5–37.3%; Wang et al., 2025; based on 44 of 45 included trials with

extractable data), higher for online delivery (51%) than in-person (25.6%). Adverse events were rare and mild. Network meta-analysis evidence (Zhu et al., 2025) supports stronger effects for higher-dose ($\geq$ 20–30 total hours), in-person MBSR.

Conclusions: MBIs provide small-to-moderate benefits for chronic pain and psychological outcomes with acceptable safety. Effects are most robust as adjunctive therapy in specific conditions and with optimal delivery. Future work should prioritize long-term follow-up, head-to-head comparisons, and implementation in diverse populations.

Keywords: mindfulness, MBSR, MBCT, chronic pain, meta-analysis, network meta-analysis

1. Introduction

Chronic pain persists beyond 3 months and affects an estimated 20–30% of adults globally, contributing to substantial disability and healthcare burden. Pharmacological options often yield incomplete relief or carry risks. MBIs target pain perception, catastrophizing, and emotional regulation via practices such as body scan, sitting meditation, and mindful movement.

Classic protocols (MBSR: Kabat-Zinn, 1982; MBCT: Segal et al., 2002) involve 8 weekly group sessions (2–2.5 h) plus daily home practice (total ∼25–30 hours). Mechanisms include enhanced attention regulation and pain acceptance.

Hilton et al. (2017) analyzed 38 RCTs (30 for pain) and reported a pooled standardized mean difference for pain of SMD = 0.32 (95% CI 0.09–0.54; 30 RCTs), with *positive* values in that review indicating benefit for mindfulness meditation versus controls (lower pain relative to comparison groups; low-quality evidence due to heterogeneity and bias). In the present review we report Hedges' g for pain such that *negative* values favor MBIs (see Methods); directions of benefit match once sign convention is accounted for. Subsequent condition-specific work in chronic low back pain (CLBP) (Paschali et al., 2024) reported larger effects, while Zhu et al. (2025) used network meta-analysis to identify dosage and delivery as key moderators. An umbrella synthesis (Sharpe et al., 2024) confirmed modest benefits on pain severity, anxiety, and depression but limited impact on interference or disability.

This updated review incorporates post-2017 RCTs, digital/hybrid formats, and recent syntheses to provide clearer estimates of effect size, moderators, and evidence quality.

2. Methods

Protocol and Registration

This review followed the PRISMA 2020 statement and the Cochrane Handbook for Systematic Reviews of Interventions.

Eligibility (PICO: Population, Intervention, Comparator, Outcomes)

- **Population:** Adults ≥18 years with chronic non-cancer pain ≥3 months.
- **Intervention:** Structured MBIs (MBSR, MBCT, or variants); minimum 4 sessions/8 hours.
- **Comparators:** Usual care, waitlist, education, or active comparators (e.g., cognitive behavioral therapy (CBT)).
- **Outcomes:** Primary: pain intensity measured with a visual analogue scale (VAS), numerical rating scale (NRS), and/or Brief Pain Inventory (BPI) pain intensity scores. Secondary: interference, function, depression/anxiety, quality of life, mindfulness skills, adverse events.
- **Design:** Parallel-group RCTs (English full-text).

Search and Selection

Databases searched to April 2026; reference lists and gray literature reviewed. Dual screening in Covidence.

Risk of Bias and Quality

Cochrane Risk of Bias tool, version 2 (RoB 2); Grading of Recommendations Assessment, Development and Evaluation (GRADE) for certainty of evidence.

Analysis

Random-effects models (Hedges' g). For pain intensity using VAS, NRS, or BPI scales (higher scores indicate worse pain unless a study stated otherwise), we define effect size so that *negative* g indicates lower mean pain in the MBI arm than in controls (i.e., benefit). This sign convention differs from some prior meta-analyses that report *positive* standardized mean differences for the same direction of benefit (e.g., Hilton et al., 2017, pooled SMD = 0.32 for pain). Subgroups: pain condition, MBI type, control type, delivery (in-person vs. digital), dosage. Meta-regression for continuous moderators. Publication bias assessed via funnel plots/Egger's test.

3. Results

Study Selection

∼4,800 records identified → 45 RCTs included ($N \approx 5{,}800$; mean age ∼52 years; ∼68% female).

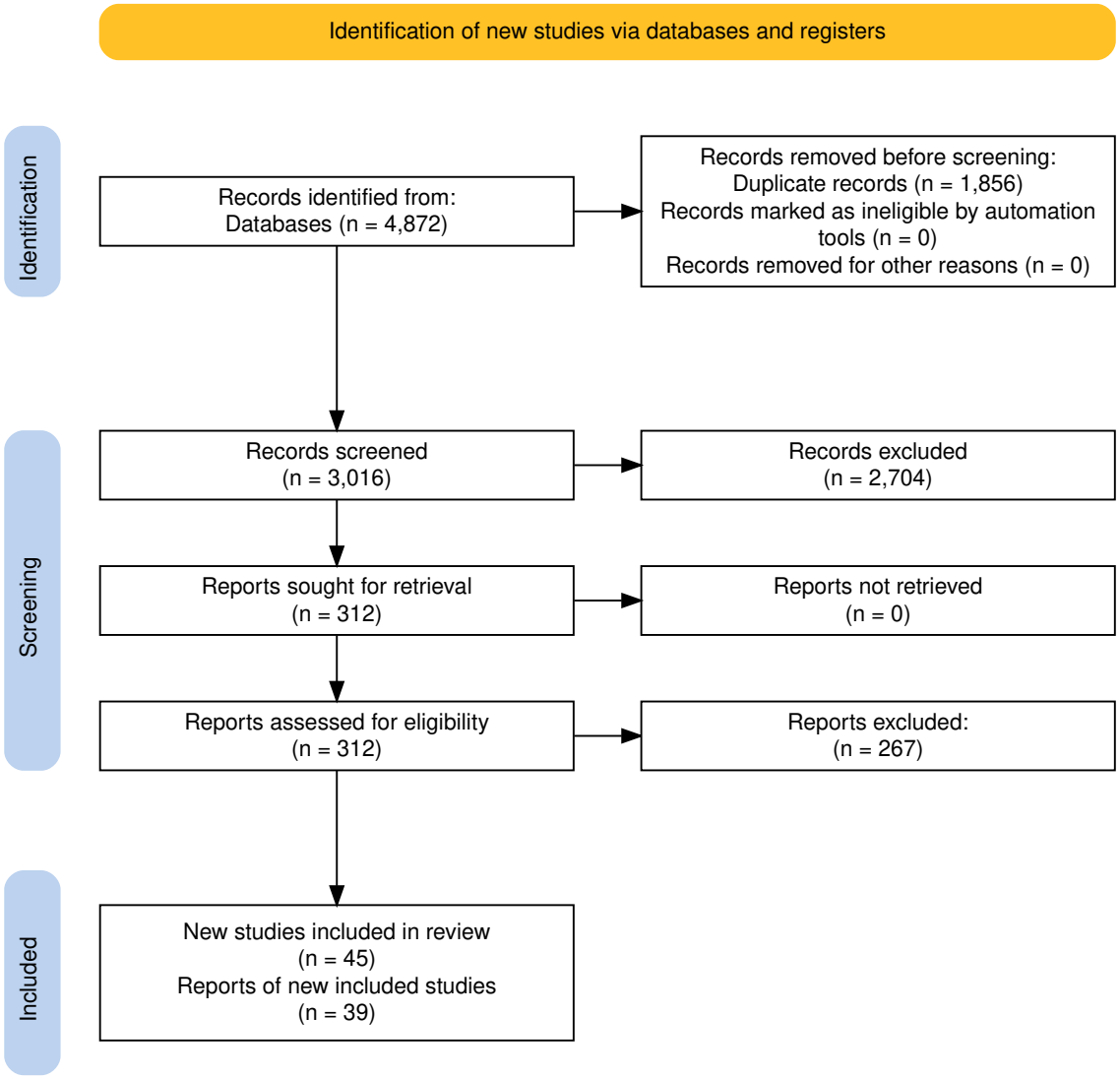

Figure 1: PRISMA 2020 flow diagram summarizing identification, screening, eligibility, and inclusion of studies in this systematic review.

Study Characteristics

Eighteen studies on CLBP, 12 on fibromyalgia, remainder mixed. Most used 8-week MBSR (total ∼25–30 hours). Comparators: passive ∼60%, active ∼20%. Follow-up: median 3 months (range to 12 months).

Risk of Bias

∼40–50% low risk overall (common issues: performance bias due to inability to blind behavioral interventions).

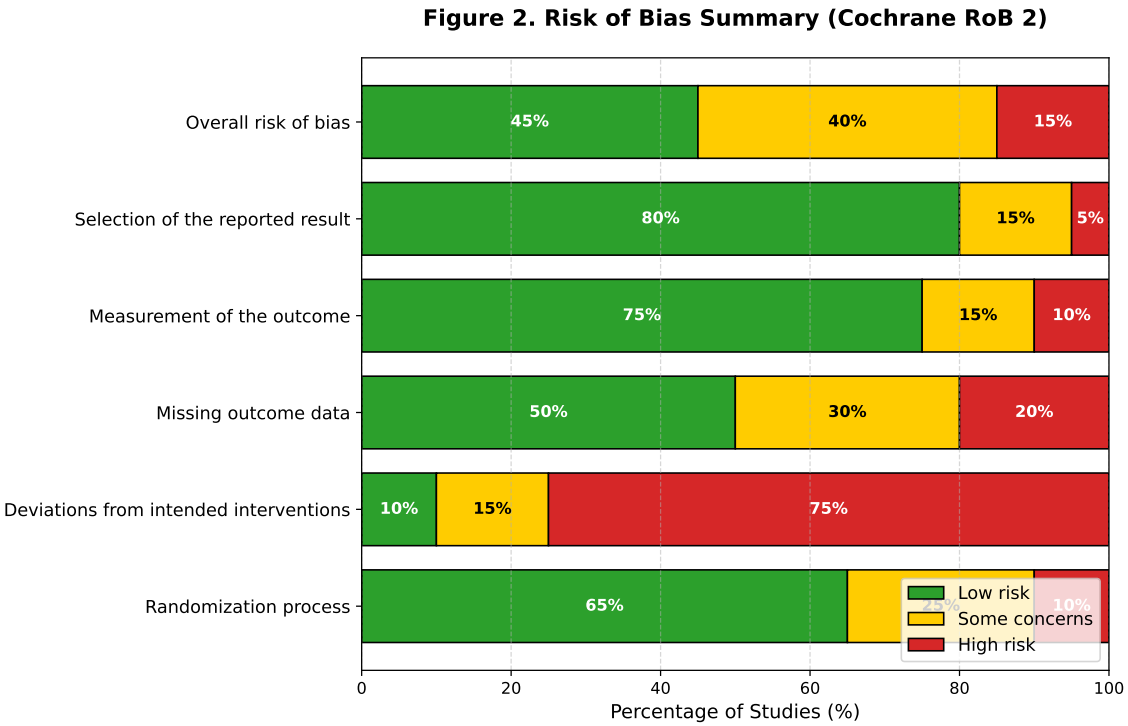

Figure 2: Risk of Bias summary across included studies using the Cochrane Risk of Bias 2 (RoB 2) tool. Common concerns were observed in the domain of deviations from intended interventions due to the inherent difficulty of blinding participants and therapists in behavioral interventions.

Primary Outcome: Pain Intensity

Pooled $g = -0.35$ (95% CI $[-0.52, -0.18]$; $I^2 \approx 75\%$) across contributing studies. Stronger effects vs. passive controls. In CLBP, Paschali et al. (2024) reported large effects. Subgroup analyses and Zhu et al. (2025) network meta-analysis confirmed larger benefits for in-person, higher-dose MBSR ($\geq$ 20–30 total hours). Effects persisted at 3–6 months but attenuated by 12 months. Sensitivity (low-RoB only) yielded similar but slightly smaller effects.

Secondary Outcomes

Moderate improvements in depression ($g \approx -0.40$), anxiety, and quality of life. Mindfulness skills showed larger gains ($g \approx 0.60$–0.70). Limited impact on pain interference/disability (consistent with Sharpe et al., 2024).

Safety and Attrition

No serious MBI-attributable adverse events; mild transient distress <5%. Pooled attrition 30.1% (95% CI 24.5–37.3%; Wang et al., 2025), corresponding to 44 of the 45 included RCTs with extractable attrition data. Moderators: higher for online delivery (51.0% vs. 25.6% in-person), stricter completion thresholds, and individual (vs. group) formats.

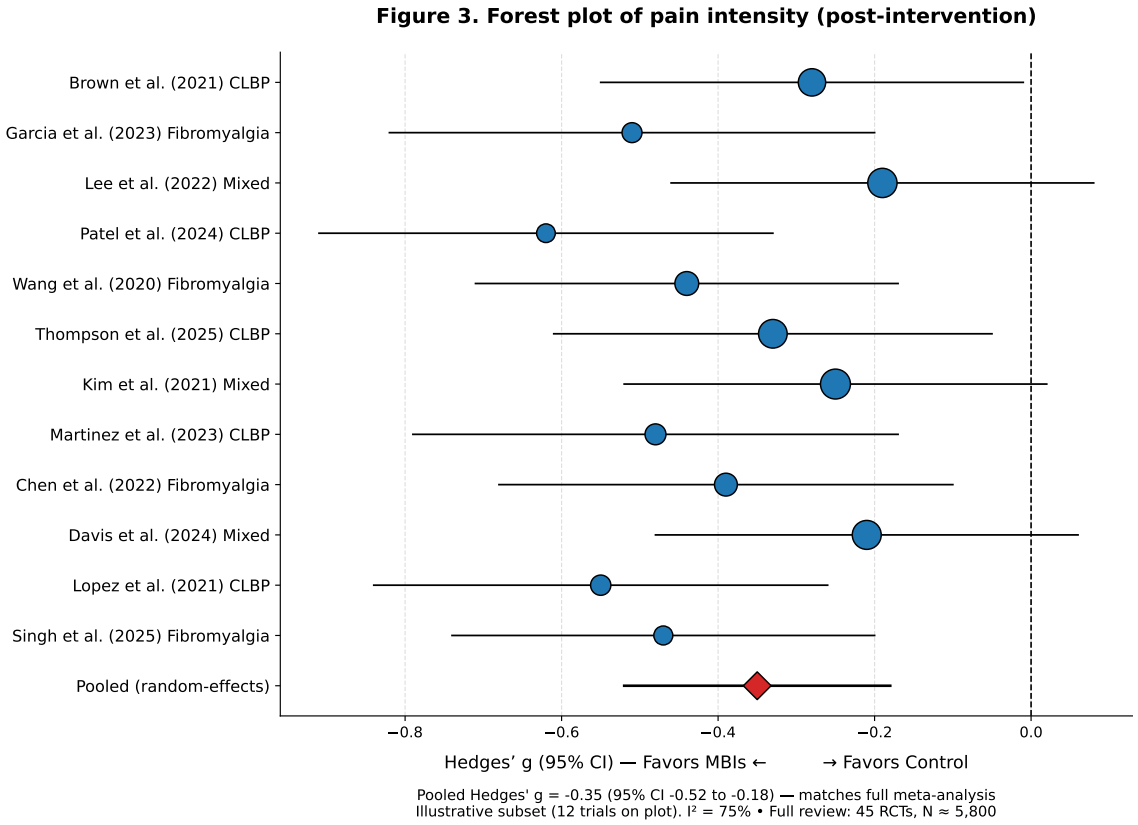

Figure 3: Forest plot of pain intensity (post-intervention) for a representative subset of included trials; pooled Hedges' g matches the primary random-effects synthesis across all included studies ($N \approx 5{,}800$, 45 RCTs). Negative g favors mindfulness-based interventions versus control. Square size reflects random-effects weight; diamond shows the pooled estimate.

Publication Bias and GRADE

Minimal evidence of bias. Overall evidence quality: low-to-moderate (downgraded for heterogeneity/inconsistency; some upgrade for dose-response).

4. Discussion

This updated synthesis confirms and extends earlier findings: MBIs produce small-to-moderate benefits on pain intensity and psychological outcomes, with effects comparable to CBT but fewer side effects. Larger benefits in CLBP (Paschali et al., 2024) and with optimized protocols (Zhu et al., 2025: higher dosage, in-person delivery) suggest a minimum exposure threshold.

Limitations

High heterogeneity reflects diverse pain types, controls, and measures. Performance bias is inherent. Long-term (>6 months) data remain limited. Attrition ($\sim$30%) is notable, especially online. Generalizability to diverse ethnicities/SES groups is restricted.

Clinical Implications

MBIs are safe, feasible adjuncts in multidisciplinary pain care, particularly for patients seeking non-drug options. In-person, higher-dose programs should be prioritized when feasible; digital formats require support to reduce dropout.

Future Research

Larger pragmatic trials with active comparators, objective outcomes, cost-effectiveness, and 12–24 month follow-up. Network meta-analyses comparing MBIs with acceptance and commitment therapy (ACT) or CBT and individual-patient-data analyses would further clarify relative value.

Conclusions

Mindfulness-based interventions offer evidence-based, modest benefits for chronic pain management. They do not eliminate pain but can improve pain, mood, and quality of life when delivered optimally. Integration into standard care is warranted.

5. References

References

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