A Systematic Review and Meta-analysis of Yoga for Low Back Pain

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Objectives: To systematically review and meta-analyze the effectiveness of yoga for low back pain.

Methods: MEDLINE, the Cochrane Library, EMBASE, CAMBASE, and PsycINFO, were screened through January 2012. Randomized controlled trials comparing yoga to control conditions in patients with low back pain were included. Two authors independently assessed risk of bias using the risk of bias tool recommended by the Cochrane Back Review Group. Main outcome measures were pain, back-specific disability, generic disability, health-related quality of life, and global improvement. For each outcome, standardized mean differences (SMD) and 95% confidence intervals (CI) were calculated.

Results: Ten randomized controlled trials with a total of 967 chronic low back pain patients were included. Eight studies had low risk of bias. There was strong evidence for short-term effects on pain (SMD = −0.48; 95% CI, −0.65 to −0.31; $P < 0.01$), back-specific disability (SMD = −0.59; 95% CI, −0.87 to −0.30; $P < 0.01$), and global improvement (risk ratio = 3.27; 95% CI, 1.89-5.66; $P < 0.01$). There was strong evidence for a long-term effect on pain (SMD = −0.33; 95% CI, −0.59 to −0.07; $P = 0.01$) and moderate evidence for a long-term effect on back-specific disability (SMD = −0.35; 95% CI, −0.55 to −0.15; $P < 0.01$). There was no evidence for either short-term or long-term effects on health-related quality of life. Yoga was not associated with serious adverse events.

Discussion: This systematic review found strong evidence for short-term effectiveness and moderate evidence for long-term effectiveness of yoga for chronic low back pain in the most important patient-centered outcomes. Yoga can be recommended as an additional therapy to chronic low back pain patients.

Key Words: low back pain, yoga, complementary therapies, meta-analysis, review

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Low back pain (LBP) is a major public health problem in industrialized societies. Up to 85% of the population can expect to experience at least some low back pain in their lifetime.[1] Although 90% of all patients with acute LBP recover quite rapidly without any specific treatment, the remaining 10% are at risk of developing chronic pain and disability. Thereby, LBP has become the largest category of medical claims, placing a major burden on individuals and health care systems.[2]

LBP is the most common condition for which complementary therapies are used.[3] In the United States, more than half of patients suffering from LBP use complementary therapies[4] and yoga is among the most commonly used complementary treatments.[4] An estimated 15 million American adults report having practiced yoga at least once in their lifetime, 20% of those using yoga explicitly for back pain relief.[5] Deriving from ancient Indian philosophy, yoga comprise physical exercise, relaxation, and lifestyle modification.[6] In North America and Europe, yoga is most often associated with physical postures (asana), breathing techniques (pranayama), and meditation (dyana).[7]

The American Pain Society's guidelines recommend that clinicians consider offering yoga to patients with chronic LBP.[8] However, this recommendation is limited to Viniyoga-style yoga as the net benefit for other yoga styles could not be estimated. To the best of our knowledge, no meta-analysis on yoga for LBP has been published yet. A recent meta-analysis on yoga for chronic pain found evidence for effects of yoga on pain and pain-specific disability but did not separately meta-analyze studies on yoga for LBP.[9] A qualitative systematic review on yoga for LBP that included studies until 2010 concluded that yoga might have the potential to alleviate chronic LBP but that the total sample size was too small to allow definite judgments.[10] In the meantime, further large studies on yoga for LBP have been published. Therefore, the aim of this review was to systematically assess and meta-analyze the effectiveness of yoga in patients with LBP.

METHODS

The review was planned and conducted in accordance with PRISMA guidelines for systematic reviews and meta-analyses,[11] and the recommendations of the Cochrane Back Review Group.[12,13]

Literature Search

The following electronic databases were searched from their inception through January 2012: Medline, EMBASE, the Cochrane Library, PsycINFO, and CAMBASE. The literature search was constructed around search terms for "yoga" and "low back pain" and adapted for each database as necessary. For Medline, the following search strategy was used: (*yoga*[*MeSH Terms*] *OR yog**[*Title/Abstract*]) *AND* (*low back pain* [*MeSH Terms*] *OR low back pain*[*Title/Abstract*] *OR lower back pain*[*Title/Abstract*] *OR lumbago* [*Title/Abstract*] *OR low backache*[*Title/Abstract*] *OR low back ache*[*Title/Abstract*] *OR sciatica*[*MeSH Terms*] *OR sciatica*[*Title/Abstract*]).

No language restrictions were applied. Reference lists of identified original articles or reviews were searched

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manually. Abstracts of identified records were screened and the full articles of potentially eligible studies were retrieved.

Eligibility Criteria

To be eligible, studies had to meet the following conditions:

(1) *Types of studies*. Randomized controlled trials (RCTs) were eligible. Studies were eligible only if they were published as full paper.
(2) *Types of participants*. Studies of adult (older than 18 y) patients with low back pain were eligible regardless of pain cause, duration, intensity, and radiation pattern.
(3) *Types of interventions*. Studies that compared yoga with no treatment, usual care, or any active treatment were eligible. Studies were excluded if yoga was not the main intervention but a part of a multimodal intervention, such as mindfulness-based stress reduction. As in North America and Europe, physical exercise is perceived as a main component of yoga,[7] studies examining meditation or yogic lifestyle without physical component were also excluded. No restrictions were made regarding yoga tradition, length, frequency, or duration of the program. Cointerventions were allowed.
(4) *Types of outcome measures*. Studies were eligible if they assessed at least 1 important patient-centered outcome, namely: (1) pain; (2) back-specific disability; (3) quality of life; (4) generic disability (eg, activities of daily living, work absenteeism); (5) global improvement.[13,14] If available, safety data served as secondary outcome measures.

Data Extraction

Two reviewers independently extracted data on characteristics of participants, interventions, control conditions, cointerventions, outcome measures, and results. Discrepancies were rechecked with a third reviewer and consensus achieved by discussion.

Risk of Bias in Individual Studies

Risk of bias was assessed by 2 reviewers independently using the 12 criteria (rating: yes, no, unclear) recommended in the 2009 Updated Method Guidelines for Systematic Reviews in the Cochrane Back Review Group.[13] This list assesses risk of bias on the following domains: selection bias, performance bias, attrition bias, reporting bias, and detection bias. Discrepancies were rechecked with a third reviewer and consensus achieved by discussion. Trial authors were contacted for further details if necessary. Studies that met at least 6 of the 12 criteria and had no serious flaw were rated as having low risk of bias. Studies that met fewer than 6 criteria or had a serious flaw were rated as having high risk of bias.[13]

Data Analysis

Studies were analyzed separately for short-term and long-term follow-ups. For the purpose of this review, short-term follow-up was defined as outcome measures taken after the end of the intervention and closest to 12 weeks after randomization, and long-term follow-up as measures taken closest to 12 months after randomization.[13]

Assessment of Overall Effect Size

If at least 2 studies were available on a specific outcome, meta-analyses were calculated using Review Manager 5 software (Version 5.1, The Nordic Cochrane Centre, Copenhagen). If studies had 2 or more control groups, the control groups for assessment of overall effect were selected in the following order of preference: no treatment, usual care, education, and exercise.

For continuous outcomes, standardized mean differences (SMD) with 95% confidence intervals (CI) were calculated as the difference in means between groups divided by the pooled SD. Where no SDs were available, they were calculated from SEs, CIs, or t values,[12] or attempts were made to obtain the missing data from the trial authors by email.

The Cohen categories were used to evaluate the magnitude of the overall effect size with: (1) SMD = 0.2 to 0.5, small; (2) SMD = 0.5 to 0.8, moderate, and (3) SMD > 0.8, large effect sizes.[15]

A positive SMD was defined to indicate beneficial effects of yoga compared with the control intervention for quality of life (eg, increased well-being), whereas a negative SMD was defined to indicate beneficial effects for the other outcomes (eg, decreased disability). If necessary, scores were inverted by subtracting the mean from the maximum score of the instrument.[12,16]

For dichotomous outcomes, risk ratios (RR) with 95% CI were calculated by dividing the risk of event in the experimental group (ie, the number of participants with the respective outcome divided by the total number of participants) by the risk of event in the control group.[12]

Levels of evidence were determined according to the recommendations of the Cochrane Back Review Group with: (1) Strong evidence: consistent findings among multiple RCTs with low risk of bias; (2) Moderate evidence: consistent findings among multiple high-risk RCTs and/or 1 low-risk RCT; (3) Limited evidence: 1 RCT with high risk of bias; (4) Conflicting evidence: inconsistent findings among multiple RCTs; (5) No evidence: no RCTs.[17]

Assessment of Heterogeneity

Statistical heterogeneity between studies was quantified using the I^2 statistics. $I^2 > 30\%$, $I^2 > 50\%$, and $I^2 > 75\%$ were regarded to indicate moderate, substantial, and considerable heterogeneity, respectively.[12] The χ^2 test was used to assess whether differences in results are compatible with chance alone. A P value ≤ 0.10 was regarded to indicate significant heterogeneity.[12]

Subgroup and Sensitivity Analyses

Besides assessment of overall effect, subgroup analyses were conducted for type of control intervention. Control interventions were grouped into 4 clusters: (1) no treatment; (2) usual care; (3) education; (4) exercise.[18] Moreover, subgroup analyses were conducted for duration of back pain. Acute pain was defined as less than 6 weeks in duration, subacute pain as 6 to 12 weeks in duration, and chronic pain as more than 12 weeks in duration.[13]

Sensitivity analyses were conducted for studies with high risk versus low risk of bias to test the robustness of significant results. If statistical heterogeneity was present in the respective meta-analysis, subgroup and sensitivity analyses were also used to explore possible reasons for heterogeneity.

Risk of Bias Across Studies

If at least 10 studies were included in a meta-analysis, publication bias was assessed by visual analysis of funnel plots, which were generated using Review Manager 5

software. Roughly symmetrical funnel plots were regarded to indicate low risk, whereas asymmetrical funnel plots were regarded to indicate high risk of publication bias.[19]

RESULTS

Literature Search

Literature search retrieved 160 records, 52 of them were duplicates (Fig. 1). Twelve full-text articles were assessed for eligibility[20–31] (Fig. 1). One RCT was excluded as it did not provide any short-term or long-term outcomes.[20] Two articles reported different outcomes of 1 single RCT, these articles were treated as 1 single study.[27,28] Ten RCTs, involving a total of 967 patients, were included in qualitative analysis.[21–31] Two RCTs did not provide raw data of outcome measures.[21,25] As these data could not be retrieved from trial authors, these RCTs were excluded from meta-analysis.

Study Characteristics

Characteristics of the sample, interventions, outcome assessment, and results are shown in Table 1.

Setting and Participant Characteristics

Six RCTs originated from the United States,[23–26,30–31] 2 from the United Kingdom,[22,29] and 2 from India.[21,27,28] Patients were recruited from private practices,[22–24,29–31] health centers,[24,27,28] or integrated health care systems.[25,26] One RCT did not state the specific setting from which patients were recruited.[21]

One study included patients with acute, subacute, or chronic LBP,[21] all other studies only included chronic LBP patients. Eight studies only included patients with nonspecific LBP, 2 did not exclude patients with specific pain.[22,23] Patients mean age ranged from 44 to 48 years. Between 45% and 83% of patients in each study were female, 0% to 93% of patients were Caucasians.

Intervention Characteristics

One study used an integrated approach to yoga therapy,[27,28] 3 studies used Iyengar yoga,[22,30,31] and 2 studies each used Hatha yoga,[23,24] or Viniyoga.[25,26] Two studies did not state the specific yoga style.[21,29] Program length and intensity varied, ranging from daily interventions over 1 week[27,28] to 2 interventions per week over 24 weeks.[31] Yoga was taught by at least 1 certified and experienced yoga teacher in all trials but 2 studies[21,27,28] did not state qualification of yoga teachers. Eight studies had 1 control arm and 2 studies[25,26] had 2 control arms. Two studies compared yoga to usual care.[23,31] Seven studies compared yoga to education; 5 of these provided patients with an educational book on self-care strategies for LBP[22,24–26,29]; patients in 1 study were advised to adhere to a detailed lifestyle and diet plan[21]; and patients in 1 study received weekly newsletter on back care and two 60-minute sessions on physical therapy education.[30] Three studies compared yoga to exercise programs[25–28]; program length, frequency, and duration were exactly matched with the yoga interventions in all 3 studies. Eight studies reported

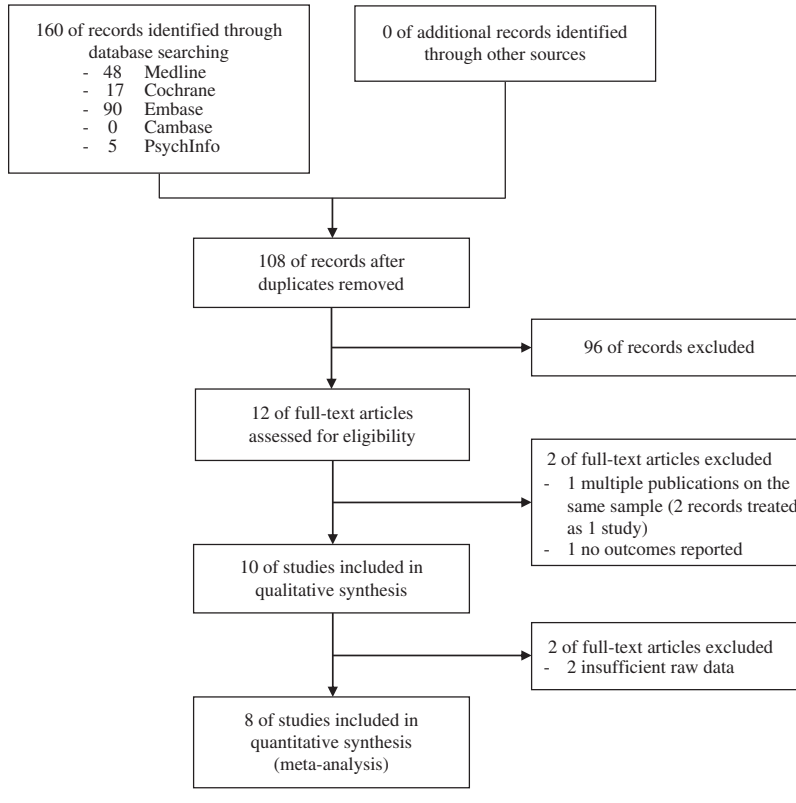


FIGURE 1. Flowchart of the results of the literature search.

TABLE 1. Characteristics of the Included Studies

References	Sample Size, No. of Groups	Mean Age (± SD)	Inclusion Criteria	Treatment Group: Intervention Program Length, Frequency, Duration	Control Group: Intervention Program Length, Duration, Frequency	Outcome Assessment (a) Short-term Follow-up (b) Long-term Follow-up	Outcome Measures (1) Pain (2) Back-specific Disability (3) Quality of Life (4) Generic Disability (5) Global Improvement (6) Safety	Results (a) Short-term Follow-up (b) Long-term Follow-up (1) Pain (2) Back-specific Disability (3) Quality of Life (4) Generic Disability (5) Global Improvement (6) Safety
Attanayake et al[21]	12 2 groups	Range, 30-49 y	LBP at least 3 wk No specific causes No neurological symptoms No major concomitant illness	Yoga (asanas, prayer, chanting, pranayama) 3 wk, 60 min weekly + LS	LS (EXs, prayer, chanting) 3 wk	(a) 3 wk (b) NA	(1) Pain intensity; frequency of pain (2) NA (3) NA (4) Sleep, personal care, travel, work, recreation, lifting, walking, standing (5) NA (6) NA	(a) (1) Yoga > LS (2) NA (3) NA (4) Sleep: NS; personal care: Yoga > LS; travel: Yoga > LS; work: NS; recreation: Yoga > LS; lifting: Yoga > LS; walking: NS; standing: Yoga > LS (5) NA (b) NA (6) NA
Cox et al[22]	20 2 groups	45	LBP at least 3 mo RMDQ > 4 No spinal surgery	Specialized Iyengar yoga for back pain (relaxation, postures) 12 wk, 75 min weekly Homework: regular practice + Booklet "The back book" + Usual care	WLC + Booklet "The back book" + Usual care 12 wk	(a) 12 wk (b) NA	(1) Pain intensity (ABPS) (2) Disability (RMDQ) (3) Quality of life (SF-12); quality of life (EQ5D) (4) No. of days in bed; no. of days with restricted activities (5) NA (6) NA	(a) (1) NS (2) NS (3) NS (4) NS (5) NA (b) NA (6) NA
Galantino et al[23]	22 2 groups	Range, 30-65	LBP at least 6 mo Minimum of 2 conservative treatments without long-term relief	Hatha yoga (stretching postures, asanas, breathing, relaxation, meditation) 6 wk, 60 min twice weekly Usual care allowed	WLC Usual care allowed 6 wk	(a) 6 wk (b) NA	(1) NA (2) Disability (ODI) (3) NA (4) NA (5) NA (6) NA	(a) (1) NA (2) NS (3) NA (4) NA (5) NA (b) NA (6) NA
Saper et al[24]	30 2 groups	Yoga: 44 ± 13, WLC: 44 ± 11	Muscular LBP at least 12 wk Pain intensity 2 wk before > 4 (0-10 NRS) No back surgery within the last 3 y	Hatha yoga (breathing, asanas, relaxation) 12 wk, 75 min weekly Homework: 30 min. daily using CD and a manual Routine care allowed	WLC Routine care allowed + BOOK 12 wk	(a) 12 wk (b) NA	(1) Pain score (0-10 NRS) (2) Disability (RMDQ) (3) Quality of life (SF-36) (4) NA (5) Global Improvement (6) Safety	(a) (1) Yoga > WLC (2) NS (3) NS (4) NA (5) Yoga > WLC (b) NA (6) no major adverse events

(*Continued*)

TABLE 1. (*continued*)

References	Sample Size, No. of Groups	Mean Age (± SD)	Inclusion Criteria	Treatment Group: Intervention Program Length, Frequency, Duration	Control Group: Intervention Program Length, Duration, Frequency	Outcome Assessment (a) Short-term Follow-up (b) Long-term Follow-up	Outcome Measures (1) Pain (2) Back-specific Disability (3) Quality of Life (4) Generic Disability (5) Global Improvement (6) Safety	Results (a) Short-term Follow-up (b) Long-term Follow-up (1) Pain (2) Back-specific Disability (3) Quality of Life (4) Generic Disability (5) Global Improvement (6) Safety
Sherman et al[25]	101 3 groups	Yoga: 44 ± 12, EX: 42 ± 15, BOOK: 45 ± 11	Muscular LBP at least 12 wk Pain intensity >4 (0-10 NRS)	Viniyoga (breathing, postures, relaxation) 12 wk, 75 min weekly Homework: daily practice	1. EX (education, aerobic, and strengthening EXs, 12 wk, 75 min weekly 2. BOOK (with EXs, fitness, lifestyle advices) for home use, 12 wk	(a) 12 wk (b) 26 wk	(1) Bothersomeness (2) Disability (RMDQ) (3) Quality of life (SF-36) (4) Restricted activity (5) NA (6) NA	(a) (1) NS (2) Yoga > EX, BOOK (3) NS (4) NS (5) NA (b) (1) Yoga > EX, BOOK (2) Yoga > BOOK (3) NS (4) NS (5) NA (6) NA
Sherman et al[26]	228 3 groups	48.1 ± 9.8	Muscular LBP at least 3 mo Bothersomeness >3 (0-10 NRS)	Viniyoga (breathing, postures, relaxation) 12 wk, 75 min course weekly Homework: daily practice	1. Stretching EX (education, aerobic, and strengthening EXs), 12 wk, 75 min weekly 2. BOOK (with EXs, fitness, lifestyle advices) for home use, 12 wk	(a) 12 wk (b) 26 wk	(1) Bothersomeness (2) Disability (RMDQ) (3) NA (4) Restricted activity (5) Global improvement; satisfaction (6) Adverse events	(a) (1) Yoga > BOOK (2) Yoga > BOOK (3) NA (4) NS (5) Yoga > BOOK (b) (1) NS (2) Yoga > BOOK (3) NA (4) NS (5) Yoga > BOOK (6) 13 mild to moderate adverse events, 1 herniated disk in yoga
Tekur et al[27,28]	91 2 groups	Yoga: 49 ± 3.6, EX: 48 ± 4	LBP at least 3 mo Inpatients in a health care center No radiating pain to the legs, no organic pathology	Yoga (meditation, chanting, physical practice, lectures) 1 wk, daily practice + vegetarian diet	Physical therapy EXs 1 wk, daily practice + vegetarian diet	(a) 1 wk (b) NA	(1) NA (2) Disability (ODI) (3) Quality of life (WHO-QOL-BREF) (4) NA (5) NA (6) NA	(a) (1) NA (2) Yoga > EX (3) Yoga > EX (4) NA (5) NA (b) NA (6) NA

Tilbrook et al[29]	313 2 groups	Yoga: 46.3 ± 11.5 WLC: 46.4 ± 11.3	LBP at least 3 mo RMDQ > 4 No spinal surgery	Yoga (asanas, pranayamas, relaxation, mental focus, philosophy) 12 wk, 75 min course weekly Homework: daily practice + back pain education booklet	WLC + back pain education booklet 12 wk	(a) 12 wk (b) 12 mo	(1) Pain intensity (ABPS) (2) Disability (RMDQ) (3) Physical and mental quality of life (SF-12); Health index (EQ5D) (4) No. of days in bed; no. of days with restricted activities (5) NA (6) Adverse events	(a) (1) NS (2) Yoga > WLC (3) SF-12: NS; EQ5D: NR (4) NR (5) NA (b) (1) NS (2) Yoga > WLC (3) SF-12: NS; EQ5D: NR (4) NR (5) NA (6) 11 adverse events (mainly pain), 1 serious adverse event in yoga
Williams et al[30]	60 2 groups	Yoga: 48 ± 2, EDU: 48.7 ± 10.6	LBP at least 3 mo No organic origin	Iyengar Yoga 16 wk, 90 min weekly Homework: 30 min practice at least 5 d a week + Weekly newsletters on back care, two 60 min lectures, handouts on physical therapy	EDU control group Weekly newsletters on back care, two 60 min lectures, handouts on physical therapy 16 wk	(a) 16 wk (b) 28 wk	(1) Pain intensity (MPQ: VAS; PPI) (2) Disability (PDI) (3) NA (4) NA (5) NA (6) NA	(a) (1) VAS: NS; PPI: Yoga > EDU (2) NS (3) NA (4) NA (5) NA (b) (1) VAS, PPI: Yoga > EDU (2) Yoga > EDU (3) NA (4) NA (5) NA (6) NA
Williams et al[31]	90 2 groups	48 ± 11.1	LBP at least 3 mo No organic origin	Iyengar Yoga 24 wk, 90 min twice weekly Homework: 30 min daily	Self-directed SMC 24 wk	(a) 24 wk (b) 48 wk	(1) Pain intensity (VAS) (2) Disability (ODI) (3) NA (4) NA (5) NA (6) NA	(a) (1) NS (2) NS (3) NA (4) NA (5) NA (b) (1) Yoga > SMC (2) Yoga > SMC (3) NA (4) NA (5) NA (6) NA

> indicates "significantly better than"; ABPS, Aberdeen Back Pain Scale; BOOK, Back pain self-care book; EQ-5D, EuroQol 5 Digit Questionnaire; EDU, educational; EX, exercise; LBP, low back pain; LS, lifestyle and dietary advices; MPQ, McGill Pain Questionnaire; NA, not assessed; NR, not reported; NRS, Numeric Rating Scale; NS, not significant; ODI, Oswestry Disability Index; PDI, Pain Disability Index; PPI, Present Pain Intensity; RMDQ, Roland and Morris Disability Questionnaire; SF-12/SF-36, Short Form Health Survey; SMC, standard medical care; VAS, visual analogue scale; WHO-QOL-BREF, World Health Organization Quality of Life Questionnaire (abbreviated version); WLC, wait list control.

TABLE 2. Risk of Bias Assessment of the Included Studies Using the Cochrane Risk of Bias Tool

Bias	Selection Bias			Performance Bias				Attrition Bias		Reporting Bias	Detection Bias		
References	Adequate Random Sequence Generation	Adequate Allocation Concealment	Similar Baseline Characteristics	Adequate Participant Blinding	Adequate Provider Blinding	Similar or no cointerventions	Acceptable Compliance	Acceptable and Described Dropout Rate	Inclusion of an Intention-to-Treat Analysis	No Selective Outcome Reporting	Adequate Outcome Assessor Blinding	Similar Timing of Outcome Assessment	Total: (max. 12)†
Attanayake et al[21]	Unclear	Unclear	Unclear	Unclear	No	Unclear	Unclear	Yes	Unclear	No	Unclear	Unclear	1
Cox et al[22]	Yes	Yes	No	No	No	Yes	No	No	Yes	Yes	Yes	Yes	7
Galantino et al[23]	Yes*	Yes*	No	No*	No	Yes*	Yes*	No	Yes	Yes	Yes*	Yes	8
Saper et al[24]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes	9
Sherman et al[25]	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	10
Sherman et al[26]	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	No	Yes	Yes	8
Tekur et al[27,28]	Yes	Yes	Yes	No	No	Yes	Unclear	Yes	No	No	Yes	Yes	7
Tilbrook et al[29]	Yes	Yes	Yes	No	No	Unclear	No	Yes	Yes	Yes	Yes	Yes	8
Williams et al[30]	Yes	Unclear	No	No	No	No	Yes	No	Unclear	Yes	Yes	Yes	5
Williams et al[31]	Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	Yes	Yes	9

*Additional details provided upon request.
†Higher scores indicate lower risk of bias.

cointerventions[22–28,30,31] and cointerventions were comparable between groups in 6 of these.[22–25,27,28,31]

Outcome Measures

Pain was assessed in 7 studies. Five of them assessed pain intensity using the Aberdeen Back Pain Scale,[22,29] the McGill Pain Questionnaire,[30] a visual analog scale,[30,31] or a numerical rating scale.[21] The other 2 studies assessed pain bothersomeness using numerical rating scales.[25,26] Back-specific disability was assessed in 8 studies by means of the Roland and Morris Disability Questionnaire,[22,25,26,29] the Oswestry Disability Index,[23,27,28,31] or the Pain Disability Index.[30] Five studies assessed quality of life using the 12-item[22,29] or 36-item Short Form Health Survey,[24,25] or the World Health Organization Quality of Life Questionnaire.[27,28] Generic disability was operationalized as number of days with restricted activities in 4 studies[22,25,26,29] but available data were insufficient for meta-analysis. Global improvement was assessed in 2 studies.[24,26] Safety data were reported in 3 studies.[24,26,29]

Risk of Bias in Individual Studies

Eight studies had low risk of bias[22–29,31] and 2 studies had high risk of bias[21,30] (Table 2). Overall, risk of selection bias mainly was low; all but 2 studies[21,30] reported adequate randomization and allocation concealment. Risk of performance bias mainly was high, mostly due to lack of blinding of patients and care providers. Risk of attrition bias was mixed; intention-to-treat analysis was included in 7 studies.[22–26,29,31] Risk of reporting bias and detection bias mainly were low; all but 2 studies[21,24] reported adequate blinding of outcome assessors.

Analyses of Overall Effects

Meta-analyses revealed strong evidence for short-term effects of yoga on pain (SMD = -0.48; 95% CI, -0.65 to -0.31; $P < 0.01$; heterogeneity: $I^2 = 0\%$; $\chi^2 = 3.21$; $P = 0.67$) and back-specific disability (SMD = -0.59; 95% CI, -0.87 to -0.30; $P < 0.01$; heterogeneity: $I^2 = 59\%$; $\chi^2 = 17.02$; $P = 0.02$) compared with controls (Fig. 2). There was no evidence for improved quality of life at the short term (SMD = 0.41; 95% CI, -0.11 to 0.93; $P = 0.12$; heterogeneity: $I^2 = 72\%$; $\chi^2 = 10.71$; $P = 0.01$) (Fig. 2). There was strong evidence for higher short-term global improvement in the yoga groups compared with controls (RR = 3.27; 95% CI, 1.89-5.66; $P < 0.01$; heterogeneity: $I^2 = 0\%$; $\chi^2 = 0.47$; $P = 0.49$).

At long-term follow-up, there was moderate evidence for reduction of pain (SMD = -0.33; 95% CI, -0.59 to -0.07; $P = 0.01$; heterogeneity: $I^2 = 48\%$; $\chi^2 = 7.65$; $P = 0.11$) and disability (SMD = -0.35; 95% CI, -0.55 to -0.15; $P < 0.01$; heterogeneity: $I^2 = 20\%$; $\chi^2 = 4.98$; $P = 0.29$) (Fig. 2). No evidence was found for improved quality of life at the long term (SMD = 0.18; 95% CI, -0.05 to 0.41; $P = 0.13$; heterogeneity: $I^2 = 0\%$; $\chi^2 = 0.10$; $P = 0.76$) (Fig. 2).

On the basis of Cohen categories, the short-term effect on back-specific disability was of moderate size; all other significant short or long-term effects were small. Three studies reported adverse events (n = 26 of 248).[24,26,29] Most adverse events were mild to moderate. More severe adverse events were a herniated disk (n = 1) and severe pain (n = 1). One study reported dropouts due to respiratory tract infections (n = 2).[27,28]

Subgroup Analyses

When comparing yoga to usual care, there was no evidence for a short-term effect on back-specific disability (Table 3).

When comparing yoga to education, there was strong evidence for small short-term effects on pain and back-specific disability and moderate evidence for a small short-term effect on quality of life (Table 3). Strong evidence was found for a short-term effect on global improvement (RR = 3.27; 95% CI, 1.89-5.66; $P < 0.01$; heterogeneity: $I^2 = 0\%$; $\chi^2 = 0.47$; $P = 0.49$). There was no evidence for a long-term effect on pain or quality of life but limited evidence for a small long-term effect on back-specific disability (Table 3). There was no evidence for a short-term effect of yoga compared with exercise on back-specific disability (Table 3).

Sensitivity Analyses

Results did not change when the low-quality study[30] was excluded from analyses.

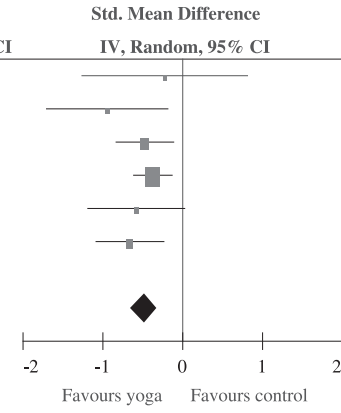
A Short-term effects

Pain

Study	Yoga Mean	Yoga SD	Yoga Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Cox et al., 2010[a]	-7.72	11.15	6	-5.16	10.45	9	2.6%	-0.22 [-1.26, 0.81]
Saper et al., 2009	-2.3	2.1	15	-0.4	1.8	15	4.8%	-0.95 [-1.71, -0.18]
Sherman et al., 2011	3.26	1.98	92	4.2	1.96	45	21.5%	-0.47 [-0.83, -0.11]
Tilbrook et al., 2011[a]	20.83	11.26	130	25.24	12.23	138	48.0%	-0.37 [-0.62, -0.13]
Williams et al., 2005	1	1.1	20	2.1	2.3	24	7.6%	-0.58 [-1.19, 0.02]
Williams et al., 2009	24.3	17.9	43	36.9	19.81	47	15.5%	-0.66 [-1.09, -0.23]
Total (95% CI)			**306**			**278**	**100.0%**	**-0.48 [-0.65, -0.31]**

Heterogeneity: Chi² = 3.21, df = 5 (P = 0.67); I² = 0%

Test for overall effect: Z = 5.61 (P < 0.00001)

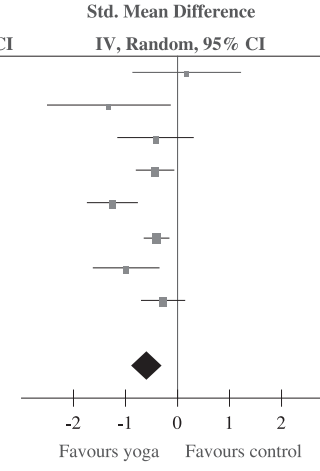


Back-specific disability

Study	Yoga Mean	Yoga SD	Yoga Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Cox et al., 2010[a]	-1.76	8.49	6	-2.94	4.33	9	5.7%	0.18 [-0.86, 1.21]
Galantino et al., 2004	21.15	10.18	11	38.91	17.56	5	4.6%	-1.32 [-2.50, -0.14]
Saper et al., 2009	-6.3	6.9	15	-3.7	4.9	15	9.4%	-0.42 [-1.15, 0.30]
Sherman et al., 2011	4.59	4.49	92	6.56	4.63	45	17.6%	-0.43 [-0.79, -0.07]
Tekur et al., 2008, 2010	18.7	11.55	40	35.75	15.19	40	14.4%	-1.25 [-1.73, -0.77]
Tilbrook et al., 2011[a]	5.15	4.88	136	7.24	5.45	141	21.0%	-0.40 [-0.64, -0.16]
Williams et al., 2005	3.3	5.1	20	12.8	11.9	24	11.1%	-0.99 [-1.62, -0.36]
Williams et al., 2009	17.9	10.49	43	20.8	10.28	47	16.1%	-0.28 [-0.69, 0.14]
Total (95% CI)			**363**			**326**	**100.0%**	**-0.59 [-0.87, -0.30]**

Heterogeneity: Chi² = 17.02, df = 7 (P = 0.02); I² = 59%

Test for overall effect: Z = 4.06 (P < 0.0001)



Health-related quality of life

Study	Yoga Mean	Yoga SD	Yoga Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Cox et al., 2010[a]	1.2	14.41	4	6.88	11.95	9	12.8%	-0.42 [-1.61, 0.78]
Saper et al., 2009[a]	41.49	9.06	14	39.41	9.2	14	21.7%	0.22 [-0.52, 0.96]
Tekur et al., 2008, 2010	15.14	1.56	40	13.11	2.17	40	29.6%	1.06 [0.59, 1.53]
Tilbrook et al., 2011[a]	47.66	9.56	129	45.05	9.3	138	35.9%	0.28 [0.03, 0.52]
Total (95% CI)			**187**			**201**	**100.0%**	**0.41 [-0.11, 0.93]**

Heterogeneity: Chi² = 10.71, df = 3 (P = 0.01); I² = 72%

Test for overall effect: Z = 1.54 (P = 0.12)

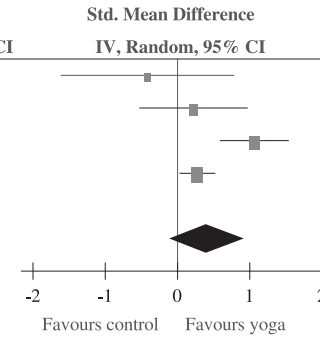


FIGURE 2. (*Continued*)

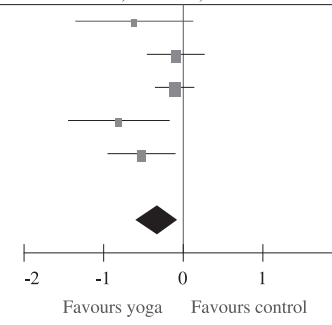
B Long-term effects

Pain

Study	Yoga Mean	Yoga SD	Yoga Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Saper et al., 2009[a]	3.9	0.6	15	4.5	1.2	15	9.9%	-0.62 [-1.35, 0.12]
Sherman et al., 2011	3.59	2.27	92	3.8	2.2	45	24.5%	-0.09 [-0.45, 0.26]
Tilbrook et al., 2011[a]	21.75	13.89	127	23.16	12.28	138	32.4%	-0.11 [-0.35, 0.13]
Williams et al., 2005	0.6	1.1	20	2	2.1	22	12.4%	-0.81 [-1.44, -0.18]
Williams et al., 2009	27.7	22.56	43	38.5	18.3	47	20.8%	-0.52 [-0.94, -0.10]
Total (95% CI)			**297**			**267**	**100.0%**	**-0.33 [-0.59, -0.07]**

Heterogeneity: Chi² = 7.65, df = 4 (P = 0.11); I² = 48%

Test for overall effect: Z = 2.45 (P = 0.01)

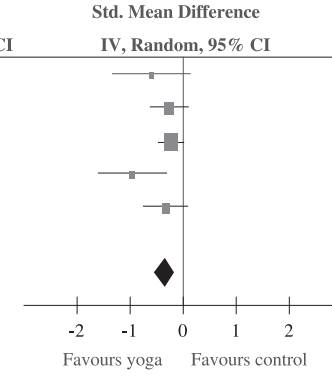


Back-specific disability

Study	Yoga Mean	Yoga SD	Yoga Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Saper et al., 2009	6.6	2.6	15	8.3	2.9	15	7.0%	-0.60 [-1.33, 0.13]
Sherman et al., 2011	4.49	4.73	92	5.73	4.66	45	23.9%	-0.26 [-0.62, 0.10]
Tilbrook et al., 2011[a]	5.22	5.27	135	6.43	5.23	140	41.4%	-0.23 [-0.47, 0.01]
Williams et al., 2005	3.9	5.3	20	12.7	11.4	22	8.9%	-0.96 [-1.60, -0.31]
Williams et al., 2009	19.3	12.72	43	23.5	12.34	47	18.8%	-0.33 [-0.75, 0.08]
Total (95% CI)			**305**			**269**	**100.0%**	**-0.35 [-0.55, -0.15]**

Heterogeneity: Chi² = 4.98, df = 4 (P = 0.29); I² = 20%

Test for overall effect: Z = 3.39 (P = 0.0007)



Health-related quality of life

Study	Yoga Mean	Yoga SD	Yoga Total	Control Mean	Control SD	Control Total	Weight	Std. Mean Difference IV, Random, 95% CI
Saper et al., 2009[a]	44.33	2.17	8	43.14	4.23	15	7.3%	0.31 [-0.55, 1.18]
Tilbrook et al., 2011[a]	48.01	10.39	125	46.34	9.12	139	92.7%	0.17 [-0.07, 0.41]
Total (95% CI)			**133**			**154**	**100.0%**	**0.18 [-0.05, 0.41]**

Heterogeneity: Chi² = 0.10, df = 1 (P = 0.76); I² = 0%

Test for overall effect: Z = 1.52 (P = 0.13)

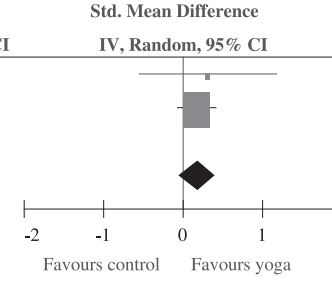


FIGURE 2. Forest plots of overall short-term effects (A) and long-term effects (B). [a]Additional data provided upon request.

Risk of Bias Across Studies

As less than 10 studies were included in each meta-analysis, funnel plots were not analyzed.

DISCUSSION

This systematic review found strong evidence for short-term and moderate evidence for long-term reduction of LBP and back-specific disability after yoga interventions. There was strong evidence for higher global improvement but not for improved quality of life. Although the limited available data preclude definite judgment on superiority or inferiority of yoga to usual care or exercise, yoga was found to be more effective than education. The available safety data suggest that yoga is not associated with serious adverse events. However, future RCTs should ensure more rigorous reporting of adverse events and reasons for dropouts.

The results of this review are in line with a previous qualitative systematic review, which concluded that the evidence for treating LBP with yoga was encouraging.[10] Although this review also concluded that this evidence was

TABLE 3. Effect Sizes of Yoga Versus Controls

Outcome*	No. of Studies	No. of Patients (Yoga)	No. of Patients (Control)	Standardized Mean Difference (95% Confidence Interval)	*P* (Overall Effect)	Heterogeneity I^2; χ^2; *P*
Yoga versus usual care						
Short term						
Back-specific disability	2	54	52	−0.65 (−1.62 to 0.33)	0.20	62%; 2.66; 0.10
Yoga versus education						
Short term						
Pain†	5	263	231	−0.45 (−0.63 to −0.26)	< 0.01	0%; 2.39; 0.66
Back-specific disability†	5	269	234	−0.45 (−0.65 to −0.25)	< 0.01	8%; 4.35; 0.36
Quality of life	3	147	161	0.25 (0.02 to 0.47)	0.03	0%; 1.25; 0.54
Long term						
Pain†	4	262	219	−0.28 (−0.58 to 0.02)	0.07	47%; 5.69; 0.13
Back-specific disability†	4	262	219	−0.39 (−0.66 to −0.11)	< 0.01	40%; 4.98; 0.17
Quality of life	2	133	154	0.18 (−0.05 to 0.41)	0.13	0%; 0.10; 0.76
Yoga versus exercise						
Short term						
Back-specific disability†	2	132	131	−0.59 (−1.85 to 0.67)	0.36	95%; 20.22; < 0.01

*Outcomes are only shown if sufficient data for meta-analysis were available.
†Sherman et al[26] with 1 control arm each.

inconclusive due to the small number and methodological weaknesses of the included studies, data from 2 new large-scale RCTs with low risk of bias were now available.[26,29] Results were also in line with a recent meta-analysis on yoga for pain.[9] This meta-analysis found evidence for effects of yoga on pain and pain-specific disability. Although this study did not separately meta-analyze studies on yoga for LBP, a subgroup analysis of studies on yoga for chronic LBP or rheumatoid arthritis found moderate effects on pain and disability.

External and Internal Validity

The included studies were conducted in primary, secondary, and tertiary care settings in North America, Europe, or Asia. Patients were mainly adult female Caucasians, but studies that included only Asians[27,28] or put special emphasis on including members of ethnic minorities[24] were also included in the review. The results of this review are therefore applicable to the vast majority of LBP patients in clinical practice.

All but 2 of the included studies[21,30] had low risk of bias. Especially randomization and allocation concealment were adequate in all but 2 studies[21,30]; most studies performed intention-to-treat analyses and were single blind. Blinding patients or care providers in yoga studies might not be possible at all.[9] Results of the meta-analyses did not change when studies with high risk of bias were excluded from the analyses. Therefore, the effects of yoga on low back pain seem to be robust against bias.

Strengths and Weaknesses

This is the first available meta-analysis on yoga for low back pain. Moreover, patient-centered outcomes were used for meta-analyses as recommended by the Cochrane Back Review Group.[13] Overall risk of bias was low; 8 of 10 included studies had low risk of bias.

The primary limitation of this review is the small total number of eligible RCTs. Therefore, meta-analyses were not possible for all prespecified outcome measures. Moreover, subgroup analyses are hardly interpretable as only 1 meta-analysis each was possible for yoga versus usual care and yoga versus exercise. More studies that compare yoga to guideline-endorsed therapies, such as exercise,[8] are urgently needed. Heterogeneity of yoga interventions regarding yoga tradition, length of the program, and frequency of the intervention might limit the interpretation of the results. At the moment, it is impossible to make claims on whether the yoga style or other characteristics of the intervention have any impact on the effectiveness of the program. Statistical heterogeneity was acceptable in most meta-analysis; 9 of 16 comparisons were free of statistical heterogeneity. However, due to the low number of included studies, sensitivity analyses could not provide reasons for heterogeneity in the remaining meta-analyses.

Implications for Further Research

As yoga is popular among patients with LBP, further studies are warranted. These studies should ensure rigorous methodology and reporting, mainly adequate randomization, allocation concealment, and blinding of at least outcome assessors.[32] Comparisons of yoga to adequately matched guideline-endorsed therapies[8] are equally needed as comparisons of different yoga styles. Dismantling studies that separately evaluate the effects of different components of yoga such as physical postures, breathing techniques, or meditation would further improve knowledge of the underlying mechanisms of yoga in LBP treatment.

CONCLUSIONS

This systematic review found strong evidence for short-term effectiveness and moderate evidence for long-term effectiveness of yoga for chronic LBP in the most important patient-centered outcomes. Given the low number of adverse events, yoga can be recommended as an additional therapy to patients who do not improve with education on self-care options.

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