International Journal of Yoga and Allied Sciences
Vol 13, No: 1, Jan-June 2024 pp: 65-83

# Systematic review of systematic reviews of yoga compared to active interventions for chronic low back pain

**Dipak Chetry,[1,2] MA,Shirley Telles,[1,2] MBBS, PhD, Sachin Kumar Sharma,[1] PhD Acharya Balkrishna[1,2] DLitt**

1. Patanjali Research Foundation, Haridwar, Uttarakhand, India, 249405;
2.University of Patanjali, Haridwar, Uttarakhand, India, 249405.

**Abstract**

Background: Chronic low back pain (CLBP) is often associated with pain, disability and reduced quality of life. Conventional care may be integrated with other therapies, though none is clearly the most effective. A systematic review (SR) of systematic reviews (SRs) was performed to appraise the evidence for yoga compared with exercise or physical therapy addressing pain, disability and quality of life in CLBP. Methods: PubMed/ Medline, Cochrane Database of Systematic Reviews and Google Scholar were searched from their inception up to July, 2021. Seven SRs of randomized controlled trials on patients with CLBP investigating yoga compared to exercise or physical therapy were included in the review. Two reviewers performed the AMSTAR 2 assessment. Overall confidence in the results of the SRs was rated as 'high', 'moderate', 'low' or 'critically low'. Results: The 7 included SRs had a median of 8 randomized controlled trials and the total sample size of participants was 743 per review. One of the systematic reviews (14.29%) was a Cochrane review, and 2 (28.57%) SRs had a protocol published or registered prospectively. The overall confidence in the results of 7 systematic reviews was rated: as 'critically low' 1 (14.29%), as 'low' 4 (57.14%), as 'moderate' 1 (14.29%), while 1 of 7 systematic reviews (14.29%) was rated as 'high'. Systematic reviews rated as 'high' or 'moderate' were included in the descriptive analysis. Conclusion: Low certainty of evidence indicated that patients with CLBP showed no clear difference between yoga and exercise or physical therapy for pain, disability or quality of life, at short term or intermediate term, with no long term information available. The findings of this SR review are limited to two included systematic reviews. To integrate yoga in healthcare settings higher quality evidence is required with comparisons of yoga to other active therapies.

**Keywords:** Chronic low back pain, Yoga, Active therapies, Randomized controlled trials, AMSTAR 2, Systematic reviews.

## Introduction

Low back pain persists in 5-10% of patients as chronic low back pain (CLBP), which has high treatment costs, requires medical leave, causes individual suffering and is one of the chief reasons people seek medical services [1, 2]. CLBP is managed with several treatments, viz., medication, physiotherapy, surgery, multidisciplinary

therapy, complementary and alternative medicine [3]. These treatments provide varying degrees of pain relief and satisfaction with the treatment [4]. However, according to a Global Burden of Disease (GBD) 2015 study, CLBP is the main cause of disability worldwide, accounting for 815 Years Lived with Disability per 100,000 persons and hence negatively impacting patients' quality of life [5, 6].

Yoga offers a holistic approach to therapy compatible with the biospsychosocial approach considered the gold standard to treat chronic pain [7]. Research has indicated that yoga practice may be beneficial in CLBP with better pain management and reduced functional disability [8-14].

Apart from yoga, active interventions such as exercise therapy and physical therapy have been evaluated for CLBP with varied benefits for clinical outcomes and quality of life [15-19]. In an integrative healthcare setting, an informed physician may be required to select one integrative therapy over another when faced with concerns about time, resources, patients' abilities or preferences [20, 21]. Hence an understanding of the comparative benefits of each therapy for the clinical outcomes and the patient's quality of life would assist such choices.

With this background the present review was conducted to appraise relevant systematic reviews on yoga compared to exercise or physical therapy for pain, disability and quality of life in CLBP.

## 2. Methods

### 2.1. Literature search and systematic reviews selection

The literature search comprised the following electronic bibliographic databases from their inception through July, 2021: PubMed/Medline, the Cochrane Library, and Google Scholar. The search strategy was adapted for each database including terms relating to or describing yoga and chronic low back pain (CLBP). Boolean search techniques were used to identify the studies and a filter was used to restrict searches to systematic reviews and meta-analyses. No language restrictions were applied. In addition, reference lists of included systematic reviews and meta-analyses were searched manually to identify if any other systematic reviews and meta-analyses were available for the same topic. The titles and abstracts of all retrieved studies were read to determine the eligibility of the study. Databases search were conducted in successive steps using search words 'Yoga', 'Physical therapy', 'Exercise therapy', 'Low back pain', 'Chronic low back pain' and 'Pain' as search words in the title, abstract or keywords using Boolean search techniques. The complete search strategy for each of the databases is mentioned in **Table 1**.

**Table 1:** Search strategy of systematic reviews identified through different databases.

| PubMed/Medline |
|---|
| #1 ("Yoga"[Title/Abstract] AND "Low back pain"[Title/Abstract]) AND (systematicreview[Filter]) |
| #2 ("Yoga"[Title/Abstract] AND " Chronic low back pain "[Title/Abstract]) AND (systematicreview[Filter]) |
| #3 ("Yoga"[Title/Abstract] AND "Pain"[Title/Abstract]) AND (systematicreview[Filter]) |
| #4 ("Yoga"[Title/Abstract] AND "Physical therapy "[Title/Abstract] AND "Low back pain"[Title/Abstract] AND (systematicreview[Filter]) |
| #5 ("Yoga"[Title/Abstract] AND "Exercise therapy "[Title/Abstract] AND "Low back pain"[Title/Abstract] AND (systematicreview[Filter]) |
| #6 ("Yoga"[Title/Abstract] AND "Exercise therapy "[Title/Abstract] AND "Chronic low back pain"[Title/Abstract] AND (systematicreview[Filter]) |
| Cochrane Library (Cochrane Reviews) (Word |

| variations have been searched) |
|---|
| #1 Yoga in Title Abstract Keyword AND Low back pain in Title Abstract Keyword<br><br>#2 Yoga in Title Abstract Keyword AND Chronic low back pain in Title Abstract Keyword<br><br>#3 Yoga in Title Abstract Keyword AND Pain in Title Abstract Keyword<br><br>#4 Yoga in Title Abstract Keyword AND Physical therapy in Title Abstract Keyword AND Low back pain in Title Abstract Keyword<br><br>#5 Yoga in Title Abstract Keyword AND Exercise therapy in Title Abstract Keyword AND Low back pain in Title Abstract Keyword<br><br>#6 Yoga in Title Abstract Keyword AND Exercise therapy in Title Abstract Keyword AND Chronic low back pain in Title Abstract Keyword |
| Google Scholar |
| "Yoga" AND "Chronic low back pain" AND "Systematic review", which was sorted by relevance and the first 100 results were listed and screened for eligibility. |

### 2.2. Inclusion and exclusion criteria of systematic reviews

Systematic reviews and meta-analyses were included in this review if they met the following criteria: (i) a focus on yoga compared to active interventions such as exercise or physical therapy and chronic low back pain and (ii) review of randomized controlled trials exclusively.

The systematic reviews and meta-analyses were excluded if the articles reported reviews of: (i) non-chronic low back pain, CLBP due to malignancy, pregnancy-related low back pain and low back pain associated with pelvic pain; (ii) non-randomized controlled trials and (iii) a comparison of yoga with any other complementary or integrative therapy.

### 2.3. Quality assessment of included systematic reviews

The methodological quality and risk of bias of all systematic reviews which met the inclusion criteria was evaluated using AMSTAR 2 (A MeaSurement Tool to Assess Systematic Reviews) [22], a tool used to evaluate systematic reviews critically. The tool consists of 16 items. Quality of the included systematic reviews was rated as 'high', 'moderate', 'low' or 'critically low' according to the quality rating confidence levels [23]. Based on the quality rating, the results of moderate to high quality meta-analysis alone were presented and discussed in this systematic review of systematic reviews.

AMSTAR 2 is the newly modified version of the original AMSTAR tool. AMSTAR was widely used to assess the methodological quality of SRs before developing AMSTAR 2. AMSTAR 2 is comprised of 16 items of which seven are considered as critical items. These include: (i) prior protocol, (ii) comprehensive literature search, (iii) justification of excluding studies, (iv) assessment of risk of bias for individual studies, (v) appropriate meta-analytic methods, (vi) consideration of risk of bias in results and (vii) impact of publication bias [24-26]. According to AMSTAR 2, multiple non-critical weaknesses may diminish confidence in the review, therefore we chose to move the overall appraisal down from moderate to low confidence if seven or more non-critical weaknesses were found [23].

To ensure interrater reliability, the included systematic reviews were evaluated by two authors (DC and SKS) using predefined AMSTAR 2 tool criteria and discrepancies were discussed with author (ST) until a consensus was reached. This was required for one of the seven articles (i.e. item 9 of AMSTAR 2, corresponding to risk of bias). The kappa coefficient (κ) was calculated for each of the 16 items of the seven systematic reviews rated by the two reviewers to determine interrater agreement (using SPSS Version 24.0). The kappa coefficient (κ) can range from -1 to +1. Value of the kappa coefficient (κ) was interpreted as: no level of agreement (κ = 0 to 0.20), minimal level of agreement (κ = 0.21 to 0.39), weak level of agreement (κ = 0.40 to

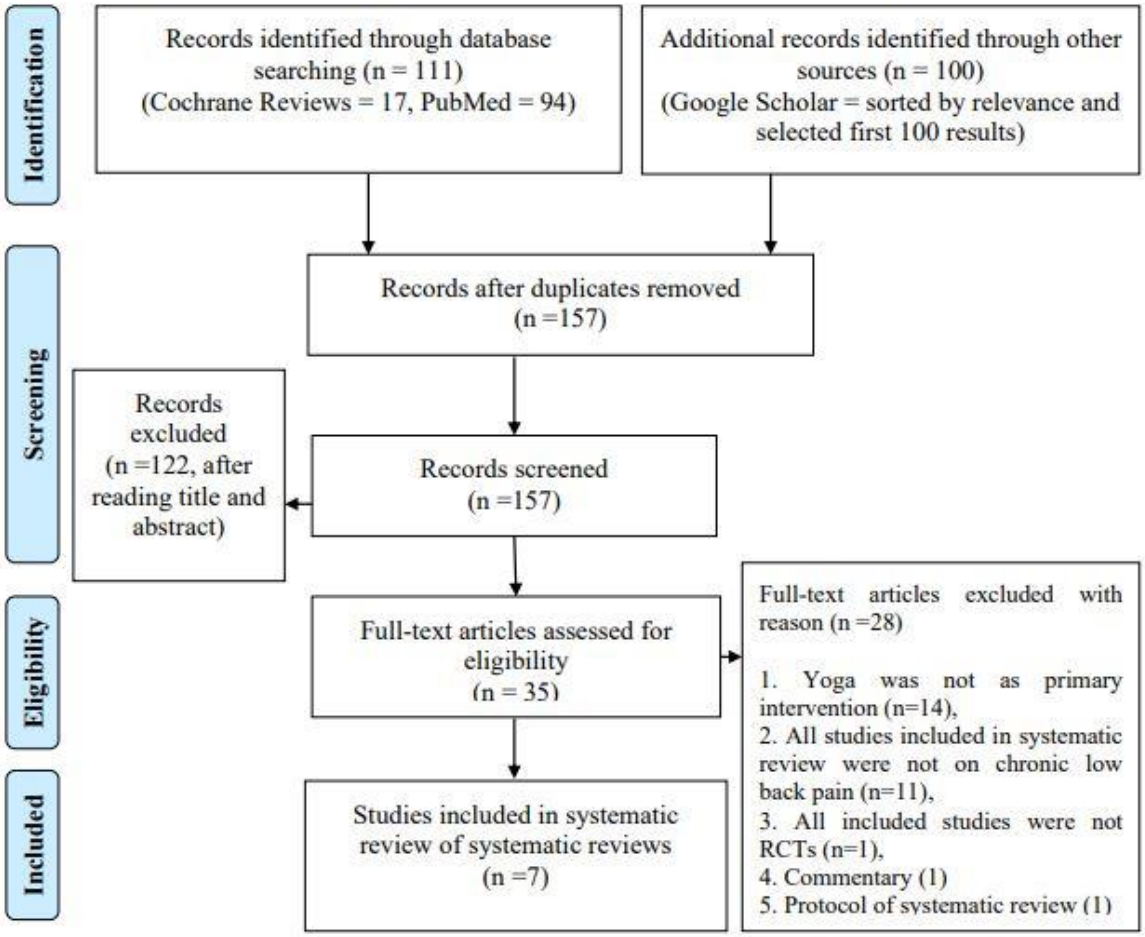
0.59), moderate level of agreement (κ = 0.60 to 0.79), strong level of agreement (κ = 0.80 to 0.90), and almost perfect level of agreement (κ = above 0.90) [27].

### 2.4. Data extraction

Studies which were searched from the databases were (i) screened, (ii) reviewed to meet the inclusion criteria and (iii) verified by the authors (DC, SKS and ST). The full text versions of potentially eligible studies were retrieved and assessed for eligibility. MS Excel 2019 was used for data extraction from each study including: study population, interventions, comparators, outcomes, included study designs, number of participants, year of publication, journal of publication, study design and assessment method used for outcomes of interest to the present review (i.e. pain, disability, functionality and quality of life).

## 3. Results

Two hundred and eleven potentially relevant studies were found from the database search, leaving one hundred and fifty-seven studies after removing duplicates. In total, one hundred and twenty-two studies were removed following the review of study titles and abstracts. Of the thirty-five potentially eligible systematic reviews, twenty-eight systematic reviews were excluded, leaving seven systematic reviews for inclusion in this systematic review. For details of the identification and inclusion/exclusion of systematic reviews, see flow chart (see Figure 1).



The reasons for exclusion of twenty-eight studies were: (i) yoga was not as primary intervention in fourteen reviews [28-41], (ii) included studies in the review were not on chronic low back pain in eleven reviews [42-52], (iii) all included studies in the review were not RCTs [53], (iv) commentary on Cochrane review [54] and (v) protocol of systematic review [55]. Seven studies were included for this ystematic review of systematic reviews based on inclusion/exclusion criteria [56-62].

All seven systematic reviews evaluated pain and disability as the outcomes, and two (28.57%) systematic reviews evaluated quality of life as the outcome. A detailed characteristic of each included systematic review is presented in Table 2.

| Study | Country | Cochrane review | Funding | Protocol | Included RCTs | N | MA | Intervention | Comparison |
|---|---|---|---|---|---|---|---|---|---|
| Posadzki and Ernst, 2011 [56] | UK | No | Yes | No | 7 | 403 | No | Hatha yoga, Iyengar yoga, Yoga asanas, Pranayamas, Meditation, Viniyoga | Usual care, Physical exercises, Conventional therapeutic exercise classes or a self-care book, Educational control group+usual care, No treatment, Usual care+written advice |
| Sawyer et al., 2012 [57] | USA | No | No | No | 7 | 403 | Yes | Hatha yoga, Iyengar yoga, Yoga asanas, Pranayamas, Meditation, Viniyoga | Control intervention (Conventional exercise, Written advice on back care and/or Standard medical care) |
| Holtzman and Beggs, 2013 [58] | Canada | No | No | No | 8 | 743 | Yes | Hatha yoga, Viniyoga, Iyengar yoga, Yoga | No treatment, Exercise, Self-care book, Education, Waitlist, Stretching, Usual care |
| Diaz et al., 2013 [59] | USA | No | No | No | 10 | 1024 | No | Meditation, Yogic hymns, Lectures on yogic lifestyle, Pranayama, Deep relaxation technique, Cyclic meditation, Counseling, Mind sound resonance technique, and Yoga-based special techniques consisting of yoga postures to relax, stretch, and strengthen | Usual care, Self-care book, or Exercises |
| Hill, 2013 [60] | UK | No | No | No | 4 | 711 | No | Iyengar yoga, Viniyoga, Hatha yoga and related practices | Usual care, Standard medical care, Self-care book, Physical therapy programme |
| Wieland et al., 2017 [61] | USA | Yes | Yes | Yes | 12 | 1080 | Yes | Hatha yoga, Iyengar yoga, Viniyoga, Residential yoga programme | No specific treatment, A minimal intervention (e.g. education), or Another active treatment (author's note, this includes physical therapy, exercise therapy) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Zhu et al., 2020 [62] | China | No | Yes | Yes | 18 | 1943 | Yes | Iyengar yoga, Hatha yoga, Viniyoga, Yoga and related practices | Non-exercise (e.g., usual care, education), Physical therapy exercise |
| | | | | | | | | | |

**Table 2:** Characteristics detailed of each included systematic review.

### 3.1. Overall confidence in the results of the systematic reviews

The assessment of the 16 items of AMSTAR 2 for each included systematic review and the interrater agreement showed 12 items as almost perfect agreement and 4 items as substantial agreement between the two raters. The assessment of the 16 items of AMSTAR 2 from each included systematic review and interrater agreement are presented in **Table 3**.

**Table 3:** AMSTAR 2 assessment of each included systematic reviews.

| **Author, Year** | **AMSTAR 2 Items** | | | | | | | | | | | | | | | | | **Overall rating** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **Study (κ)** | |
| Posadzki and Ernst, 2011 [56] | Y | N | N | Y | Y | Y | N | PY | PY | N | NMC | NMC | Y | N | NMC | Y | 1 | Low |
| Sawyer et al., 2012 [57] | Y | N | N | PY | N | N | N | PY | PY | N | N | N | N | N | N | N | 0.86 | Critically low |
| Holtzman and Beggs, 2013 [58] | Y | N | Y | Y | N | N | Y | PY | PY | N | Y | N | N | N | N | N | 0.89 | Low |
| Diaz et | Y | N | N | PY | Y | N | N | P | Y | N | N | N | N | N | N | N | 1 | Low |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| al., 2013 [59] | | | | | | | | Y | | | MC | MC | | | MC | | | | |
| Hill, 2013 [60] | Y | N | Y | PY | N | N | Y | PY | N | N | NMC | NMC | N | N | NMC | N | 1 | | Low |
| Wieland et al., 2017 [61] | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y | N | Y | 0.64 | | High |
| Zhu et al., 2020 [62] | Y | PY | Y | PY | Y | Y | N | Y | Y | N | Y | Y | Y | Y | Y | Y | 0.85 | | Moderate |
| **Items (κ)** | 1 | 0.68 | 1 | 0.70 | 1 | 1 | 0.75 | 1 | 1 | 1 | 0.75 | 1 | 1 | 1 | 1 | 1 | | | |

**Abbreviations:** Y=Yes, N=No, PY= Partially yes, NMC= No meta-analysis conducted, κ = Kappa coefficient, AMSTAR= Assessing the Methodological Quality of Systematic Reviews. **Items: (**1) Did the research questions and inclusion criteria for the review include the components of PICO?; (2) Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?; (3) Did the review authors explain their selection of the study designs for inclusion in the review?; (4) Did the review authors use a comprehensive literature search strategy?; (5) Did the review authors perform study selection in duplicate?; (6) Did the review authors perform data extraction in duplicate?; (7) Did the review authors provide a list of excluded studies and justify the exclusions?; (8) Did the review authors describe the included studies in adequate detail?; (9) Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review?; (10) Did the review authors report on the sources of funding for the studies included in the review?; (11) If meta-analysis was performed did the review authors use appropriate methods for statistical combination of results?; (12) If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?; (13) Did the review authors account for RoB in individual studies when interpreting/ discussing the results of the review?; (14) Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review?; (15) If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?; (16) Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?

Most of the reviews were conducted in North America (57.14 %), included a median of 8 RCTs and a total sample size of 743 per review. One of seven (14.29 %) reviews was a Cochrane review and 2 (28.57 %) systematic reviews had a protocol published or registered prospectively. The assessment of the 16 items of AMSTAR 2 from each included systematic review showed overall confidence in the results of seven reviews, one (14.29%) was rated as 'Critically low', four (57.14%) reviews were rated as 'Low', one (14.29%) review was rated as 'Moderate', and one (14.29%) review was rated as 'High'. The one SR rated as 'High' is a Cochrane review while the other SR rated as 'Moderate' is published in PLoS One and both had a registered protocol prospectively. The mean journal impact factor of the SRs rated as 'Critically low' was not available and also the journal was not indexed in internationally recognised databases. The mean journal impact factor of the systematic reviews rated as 'Low' (1.93) was the lowest compared to the other SRs rated as 'Moderate' (3.04) and 'High' (3.22). Rating of the 7 included reviews based on the 16 items of AMSTAR 2 assessment is presented in **Table 4**. Overall confidence assessment based on the AMSTAR 2 assessment of the 7 included systematic reviews is presented in **Table 5.**

**Table 4**: Summary of the characteristics of the seven included systematic reviews.

| | | **AMSTAR rating** | | | |
|---|---|---|---|---|---|
| | **Total** | **High** | **Moderate** | **Low** | **Critically Low** |
| Number of reviews (%) | 7 | 1 (14.29) | 1 (14.29) | 4 (57.14) | 1 (14.29) |
| Location, n (%) | | | | | |
| North America | 4 (57.14) | 1 (25) | - | 2 (50) | 1 (25) |
| South America | - | - | - | - | - |
| Europe | 2 (28.57) | - | - | 2 (100) | - |
| Asia | 1 (14.29) | - | 1 (100) | - | - |
| Oceania | - | - | - | - | - |
| Impact factor of the journal, mean (SD) | 2.33 (0.82) | 3.22 | 3.04 | 1.93 (0.68) | - |
| Cochrane review, n (%) | 1 (14.29) | 1 (100) | - | - | - |
| Funding, n (%) | 3 (42.86) | 1 (33.33) | 1 (33.33) | 1 (33.33) | - |
| Protocol published, n (%) | 2 (28.57) | 1 (50) | 1 (50) | - | - |
| Number of included RCTs in the review, median (IQR) | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| | 8 (7-11) | 12 | 18 | 7.5 (6.25-8.5) | 7 |
| Total sample size, median (IQR) | 743 (557-1052) | 1080 | 1943 | 727 (634-813.25) | 403 |

Abbreviations: IQR= Interquartile range

**Table 5: Overall confidence assessment (AMSTAR 2 tool) of the seven included systematic reviews.**

| AMSTAR 2 Items | Yes n (%) | Partial yes n (%) | No n (%) | No MA n (%) |
|---|---|---|---|---|
| 1. Did the research questions and inclusion criteria for the review include the components of PICO? | 7 (100) | - | - | - |
| 2. Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol? | 1 (14.29) | 1 (14.29) | 5 (71.43) | - |
| 3. Did the review authors explain their selection of the study designs for inclusion in the review? | 4 (57.14) | - | 3 (42.86) | - |
| 4. Did the review authors use a comprehensive literature search strategy? | - | 4 (57.14) | 3 (42.86) | - |
| 5. Did the review authors perform study selection in duplicate? | 4 (57.14) | - | 3 (42.86) | - |
| 6. Did the review authors perform data extraction in duplicate? | 3 (42.86) | - | 4 (57.14) | - |
| 7. Did the review authors provide a list of excluded studies and justify the exclusions? | 3 (42.86) | - | 4 (57.14) | - |
| 8. Did the review authors describe the included studies in adequate detail? | 2 (28.57) | 5 (71.43) | - | - |

| | | | | |
|---|---|---|---|---|
| 9. Did the review authors use a satisfactory technique for assessing the risk of bias (RoB) in individual studies that were included in the review? | 3 (42.86) | 3 (42.86) | 1 (14.29) | - |
| 10. Did the review authors report on the sources of funding for the studies included in the review? | 1 (14.29) | - | 6 (85.71) | - |
| 11. If meta-analysis was performed did the review authors use appropriate methods for statistical combination of results? | 3 (42.86) | - | 1 (14.29) | 3 (42.86) |
| 12. If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis? | 2 (28.57) | - | 2 (28.57) | 3 (42.86) |
| 13. Did the review authors account for RoB in individual studies when interpreting/ discussing the results of the review? | 3 (42.86) | - | 4 (57.14) | - |
| 14. Did the review authors provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review? | 2 (28.57) | - | 5 (71.43) | - |
| 15. If they performed quantitative synthesis did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review? | 1 (14.29) | - | 3 (42.86) | 3 (42.86) |
| 16. Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review? | 3 (42.86) | - | 4 (57.14) | - |

The reviews performed poorly (i.e., lack of compliance with 50 % of AMSTAR 2 items) on eight of the 16 items of the AMSTAR 2. The details for these items and number of the systematic reviews under each item are presented here in order of most to least poorly items: (i) Item 10 (authors of the six of the seven reviews did not report on the sources of funding for the studies included in the reviews); (ii) Item 2 (authors of the five of the seven reviews did not contain an explicit statement that the review methods were established prior to the conduct of the review and whether the report justified any significant deviations from the protocol); (iii) Item 14 (authors of the five of the seven reviews did not provide a satisfactory explanation for, and discussion of, any heterogeneity observed in the results of the review); (iv) Item 6 (authors of the four of the seven reviews did not perform data extraction in duplicate; (v) Item 7 (authors of the four of the seven reviews did not provide a list of excluded studies and justify the exclusions; (vi) Item 13 (authors of the four of the seven

reviews did not account for risk of bias (RoB) in individual studies when interpreting/ discussing the results of the review; (vii) Item 15 (authors of the four of the seven reviews did not perform quantitative synthesis and carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review) and (viii) Item 16 (authors of the four of the seven reviews did not report any potential sources of conflict of interest, including any funding they received for conducting the review).

### 3.2. Risk of bias in the included systematic reviews

The quality assessment tools used in the included systematic reviews were Cochrane risk of bias tool (n=2) followed by PEDro scale (n=2), Jadad scale (n=1), a checklist to evaluate a report of a nonpharmacological trial (CLEAR NPT) (n=1) while one study did not use any scale for assessing risk of bias tool.

Based on the Cochrane risk of bias tool we tried to evaluate the seven domains from each systematic review based on the tool authors used for assessing risk of bias in their review. The risk of bias tool used in the three reviews did not cover the seven domains mentioned in Cochrane risk of bias tool [57, 59, 60], the two reviews partially covered some domains [56, 58] and only two reviews covered all the seven domains mentioned in Cochrane risk of bias (RoB) tool [61, 62]. The high risk of bias is related to blinding (performance bias and detection bias), which is very difficult or not feasible in yoga research [63]. The results are presented in the **Table 6**.

**Table 6 :** Risk of bias (RoB) in the included systematic reviews (based on Cochrane RoB tool).

| RoB domains | | | Studies | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Posadzki and Ernst, 2011 [56] | Sawyer et al., 2012 [57] | Holtzman and Beggs, 2013 [58] | Diaz et al., 2013 [59] | Hill, 2013 [60] | Wieland et al., 2017 [61] | Zhu et al., 2020 [62] |
| **Selection bias** | Random sequence generation | High | - | - | - | - | - | - | - |
| | | Low | 7 (100) | - | 8 (100) | - | - | 10 (83.33) | 16 (88.89) |
| | | Unclear | - | - | - | - | - | 2 (16.67) | 2 (11.11) |
| | Allocation concealment | High | 2 (28.57) | - | - | - | - | - | 1 (5.56) |
| | | Low | 5 (71.43) | - | 5 (62.5) | - | - | 7 (58.33) | 10 (55.56) |
| | | Unclear | - | - | 3 (37.5) | - | - | 5 (41.67) | 7 (38.89) |
| **Reporting bias** | Selective reporting | High | - | - | - | - | - | 3 (25) | 2 (11.11) |
| | | Low | - | - | - | - | - | 2 (16.67) | 10 (55.56) |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Unclear | - | - | - | - | - | 7 (58.33) | 6 (33.33) |
| **Other bias** | Other sources of bias | High | - | - | - | - | - | 1 (8.33) | - |
| | | Low | - | - | - | - | - | 8 (66.67) | 15 (83.33) |
| | | Unclear | - | - | - | - | - | 3 (25) | 3 (16.67) |
| **Performance bias** | Blinding (participants and personnel) | High | 7 (100) | - | 7 (87.5) | - | - | 12 (100) | 15 (83.33) |
| | | Low | - | - | - | - | - | - | - |
| | | Unclear | - | - | - | - | - | - | 3 (16.67) |
| **Detection bias** | Blinding (outcome assessment) | High | 6 (85.71) | - | 7 (87.5) | - | - | 12 (100) | 11 (61.11) |
| | | Low | 1 (14.29) | - | - | - | - | - | 4 (22.22) |
| | | Unclear | - | - | - | - | - | - | 3 (16.67) |
| **Attrition bias** | Incomplete outcome data | High | - | - | - | - | - | 4 (33.33) | 3 (16.67) |
| | | Low | - | - | - | - | - | 5 (41.67) | 14 (77.78) |
| | | Unclear | - | - | - | - | - | 3 (25) | 1 (5.56) |

### 3.3. Evidence on yoga for pain, disability and quality of life

The most used tools for assessing pain outcomes in RCTs were Visual Analogue Scale (VAS) (n=8) followed by Aberdeen Back Pain Scale (n=2), Bothersomeness of Pain 0–10 Point (n=2), Numerical Pain Rating Scale (NPRS) (n=2), Oswestry Back Pain Index (n=2) and Brief Pain Inventory (n=1). The most used tools for assessing disability outcomes in RCTs were Roland Morris Disability Questionnaire (RMDQ) (n=8) followed by Oswestry Disability Index (ODI) (n=5). The most used tool for assessing quality of life outcomes in RCTs were Medical Outcomes Study Questionnaire Short Form 36 Health Survey (SF-36) (n=4) followed by Medical Outcomes Study Questionnaire Short Form 12 Health Survey (SF-12) (n=2) and WHOQOL-BREF (26 items) (n=1).

Following dual independent rating one review was rated high ('Yes' for 15 out of 16 AMSTAR 2 items, referred to as Review 1 (Wieland et al., 2017) [61] in this paragraph, whereas one review was rated moderate ('Yes' for 12 out of 16 AMSTAR 2 items, referred to as Review 2 (Zhu et al., 2020) [62] in this paragraph.

3.3.1. Yoga versus physical therapy exercise on pain

Review 1 reported that authors did not conduct any meta-analyses to compare yoga versus exercise for any time period because there was only one RCT for short and intermediate terms, and no RCTs for long term comparing yoga versus exercise, which evaluated pain as an outcome [61].

Review 2 reported (i) very short term/ close to 4-10 weeks, based on five RCTs: no significant effect in favour of both yoga and physical therapy/ exercise (MD, 95% CI -0.37 [-1.16 to 0.42], df =4, $I^2$ = 81%),

(ii) short term/ close to 3 months based on four RCTs: no significant effect in favour of both yoga and physical therapy/ exercise (MD, 95% CI 0.19 [-0.63 to 1.01], df =3, $I^2$ = 64%), (iii) intermediate term/ close to 6 months with four RCTs: no significant effect of both yoga and physical therapy/exercise (MD, 95% CI -0.73 [-2.13 to 0.67], df =3, $I^2$ = 85%), and (iv) no meta analysis was conducted for long term comparing yoga versus physical therapy exercise on pain [62].

### 3.3.2. Yoga versus physical therapy exercise on disability

Review 1 reported (i) very short term/ close to 4-10 weeks with two RCTs: no significant effect of both yoga and physical therapy/ exercise (MD, 95% CI –0.02 [-0.41 to 0.37], df =1, $I^2$ = 50%), (ii) short term/ close to 3 months with two RCTs: no significant effect of both yoga and physical therapy/exercise (MD, 95% CI -0.22 [-0.65 to 0.20], df =1, $I^2$ = 57%), (iii) intermediate term/ close to 6 months with two RCTs: no significant effect of both yoga and physical therapy/ exercise (MD, 95% CI -0.20 [-0.59 to 0.19], df =1, $I^2$ = 50%), and (iv) there were no RCTs available for long term comparison between yoga versus physical therapy/ exercise on disability [61].

Review 2 reported (i) very short term/ close to 4-10 weeks with five RCTs: no significant effect of both yoga and physical therapy/ exercise (MD, 95% CI -0.33 [-0.76 to 0.09], df =4, $I^2$ = 72%) (ii) no meta analyses were conducted for short term/ close to 3 months, intermediate term/ close to 6 months and long term /close to 1 year comparing yoga versus physical therapy/ exercise on disability [62].

### 3.3.3. Yoga versus physical therapy exercise on quality of life

Review 1 reported that authors did not conduct any meta-analyses to compare yoga versus exercise for any time period because there was only one RCT available for short and intermediate terms comparing yoga versus exercise on physical and mental quality of life [61].

Review 2 reported (i) short term/ close to 3 months with two RCTs: no significant effect of both yoga and physical therapy exercise group on quality of life (for physical quality of life MD, 95% CI 0.18 [-1.97 to 2.32], df =1, $I^2$ = 0%, and for mental quality of life MD, 95% CI 0.07 [-2.74 to 2.89], df =1, $I^2$ = 0%) and (ii) there was only one RCT available for intermediate term and no RCTs for long term comparison of yoga versus exercise/physical therapy on physical and mental quality of life [62].

## 4. Discussion

The present systematic review appraised the evidence in seven systematic reviews which reported on yoga versus physical therapy or exercise for chronic low back pain, with an emphasis on the effects on (i) pain, (ii) disability and (iii) quality of life. The overall confidence in the results of the systematic reviews proposed by the AMSTAR 2 tool [23] was high for one review (14.29 % of reviews) [61], moderate for one review (14.29 % of reviews) [62], low for four reviews (57.14% of reviews) [54, 58-60] and critically low for one review (14.29 % of reviews) [57]. The confidence in results of systemic reviews reporting effects of yoga on pain and disability in chronic low back pain was low in 71.43 % of reviews (i.e., 5 of 7 systematic reviews). For the two reviews rated as ‘high’/’moderate’ confidence in the results, the following were noted: (i) the authors had a written/ registered protocol or guide that included review question(s), a search strategy, inclusion/exclusion criteria, a risk of bias assessment, a meta-analysis/synthesis plan and a plan for investigating causes of heterogeneity; (ii) the authors reported the sources of funding for the studies included in the review; and (iii) the authors reported no competing interests or described their funding sources and how they managed potential conflicts of interest. Hence the certainty of evidence regarding yoga for pain, disability and quality of life obtained from two reviews which had either high

[61] or moderate [62] confidence in the results are presented here.

Twelve RCTs were reviewed in the first systematic review and meta-analysis (AMSTAR 2 dual independent rating 'high', κ=0.64) [61]. Very low certainty evidence supported the comparison between yoga and exercise or physical therapy (included under 'active interventions'), with no difference in pain between therapies at short term (i.e., three months), intermediate term (i.e., six months) or long term, after six months. Also, there was very low certainty evidence to support little or no difference between yoga and exercise or physical therapy (i.e., active interventions) for back related functions. Here, 'back related functions' included assessments of disability and of pain. Wieland et al (2017) report no certainty of evidence to report differences between yoga and other active interventions for quality of life [61].

The second systematic review (AMSTAR 2 dual independent rating 'moderate', κ=0.85) [62] reviewed eighteen RCTs (11 RCTs were in common with Review 1 [61]). This meta-analysis cited very low certainty to moderate certainty evidence to support no difference between yoga and exercise/ physical therapy at very short term (i.e., four to ten weeks), short term (i.e., three months) or intermediate term (i.e., six months) for pain, disability and quality of life, with no information for the long term comparison [62].

The two reviews in question were published within the last five years [61, 62]. Hence it is possible that systematic reviews on yoga are evolving to more closely conform to the standards of Cochrane reviews [64]. The remaining five systematic reviews which were examined all had information about components of PICO (Population, Intervention, Comparator group, Outcome) and partial information about comprehensive literature search strategy as well as description of the included studies in adequate detail [56-60].

The results of this review hence suggest that though the number of systematic reviews on yoga have increased between 2001 to 2021 and the present [65], the systematic reviews require more attention with regard to (i) a written/ registered protocol, a search strategy, more stringent inclusion/exclusion criteria, details about risk of bias assessment using accepted tools, a meta-analysis/synthesis plan and a plan for investigating causes of heterogeneity.

## 5. Limitations

5.1. This systematic review was limited to two systematic reviews which met all criteria and examined different numbers of RCTs individually (i.e., 12 and 18), with 11 RCTs being common between the reviews.

5.2. Databases including reports of psychological outcomes were not searched, which could result in exclusion of studies reporting on attitude towards pain or psychological aspects influencing quality of life.

5.3. The purpose of reviews of this kind are to enhance the evidence available regarding yoga as a therapy compared to other active interventions, to translate to implementation and integration of yoga as therapy in a conventional health setting. The difference in descriptions of the yoga therapy program hence have not permitted adequate detail for clinical application.

## 6. Conclusions

In summary the results of the present systematic review of systematic reviews demonstrates with low certainty evidence that (i) yoga and (ii) physical therapy or any exercise used as therapy, are not different with respect to effects on pain, disability and quality of life in the short (3 months), intermediate (6 months) or long term (1 year) of CLBP.

**Conflicts of Interest**: None of the authors have any conflict of interests regarding the publication of this paper.

**Acknowledgments:** The authors acknowledge the support of Patanjali Research Foundation, Haridwar, India
.

## References

[1] Esteban-Vasallo, Maria D., M. Felicitas Domínguez-Berjón, Jenaro Astray-Mochales, Ricard Genova-Maleras, Aurelio Perez-Sania, Luis Sanchez-Perruca, Marta Aguilera-Guzman, and Francisco J. Gonzalez-Sanz. "Prevalence of diagnosed chronic disorders in the immigrant and native population." Gaceta sanitaria 23, no. 6 (2009): 548-552.
[2] Melloh, Markus, Christoph Röder, Achim Elfering, Jean-Claude Theis, Urs Müller, Lukas P. Staub, Emin Aghayev et al. "Differences across health care systems in outcome and cost-utility of surgical and conservative treatment of chronic low back pain: a study protocol." BMC musculoskeletal disorders 9, no. 1 (2008): 1-9.
[3] Ehrlich, George E. "Low back pain." Bulletin of the World Health Organization vol. 81, 9 (2003): 671-6.
[4] Rofail, D., L. Myers, and D. Froggatt. "Treatment satisfaction and Dissatisfaction in chronic low back pain: a systematic review." J Psychol Psychother 6, no. 260 (2016): 2161-0487.
[5] Husky, Mathilde M., Farina Ferdous Farin, Philippe Compagnone, Christophe Fermanian, and Viviane Kovess-Masfety. "Chronic back pain and its association with quality of life in a large French population survey." Health and quality of life outcomes 16, no. 1 (2018): 1-9.
[6] Doualla, Marie, Jeannine Aminde, Leopold Ndemnge Aminde, Fernando Kemta Lekpa, Felix Mangan Kwedi, Emmanuel Vubo Yenshu, and Alain Mefire Chichom. "Factors influencing disability in patients with chronic low back pain attending a tertiary hospital in sub-Saharan Africa." BMC musculoskeletal disorders 20, no. 1 (2019): 1-11.
[7] Gatchel, Robert J., Yuan Bo Peng, Madelon L. Peters, Perry N. Fuchs, and Dennis C. Turk. "The biopsychosocial approach to chronic pain: scientific advances and future directions." Psychological bulletin 133, no. 4 (2007): 581.
[8] Garfinkel, Marian S., Atul Singhal, Warren A. Katz, David A. Allan, Rosemary Reshetar, and H. Ralph Schumacher Jr. "Yoga-based intervention for carpal tunnel syndrome: a randomized trial." Jama 280, no. 18 (1998): 1601-1603.
[9] Guzman, Jaime, Rosmin Esmail, Kaija A. Karjalainen, Antti Malmivaara, Emma Irvin, and Claire Bombardier. "Multidisciplinary bio-psycho-social rehabilitation for chronic low-back pain." Cochrane database of systematic reviews 1 (2002).
[10] Gatantino, Mary Lou, Todd M. Bzdewka, Jamie L. Eissler-Rnsso, Matthew L. Holbrook, Eric P. Mogck, Paula Geigle, and John T. Farrar. "The impact of modified Hatha yoga on chronic low back pain: a pilot study." Alternative Therapies in Health & Medicine 10, no. 2 (2004).
[11] Hayden, Jill A., Maurits W. Van Tulder, Antti V. Malmivaara, and Bart W. Koes. "Meta-analysis: exercise therapy for nonspecific low back pain." Annals of internal medicine 142, no. 9 (2005): 765-775.
[12] Manheimer, Eric, Adrian White, Brian Berman, Kelly Forys, and Edzard Ernst. "Meta-analysis: acupuncture for low back pain." Annals of internal medicine 142, no. 8 (2005): 651-663.
[13] Hoffman, Benson M., Rebecca K. Papas, David K. Chatkoff, and Robert D. Kerns. "Meta-analysis of psychological interventions for chronic low back pain." Health psychology 26, no. 1 (2007): 1.
[14] Haaz, Steffany, and Susan J. Bartlett. "Yoga for arthritis: a scoping review." Rheumatic Disease Clinics 37, no. 1 (2011): 33-46.
[15] Van Middelkoop, Marienke, Sidney M. Rubinstein, Arianne P. Verhagen, Raymond W. Ostelo, Bart W. Koes, and Maurits W. van Tulder. "Exercise therapy for chronic nonspecific low-back pain." Best practice & research Clinical rheumatology 24, no. 2 (2010): 193-204.
[16] Lötzke, Désirée, Florian Wiedemann, Daniela Rodrigues Recchia, Thomas Ostermann, Daniel Sattler, Johannes Ettl, Marion Kiechle, and Arndt Büssing. "Iyengar-yoga compared to exercise as a therapeutic intervention during (neo) adjuvant therapy in women with stage I–III breast

cancer: health-related quality of life, mindfulness, spirituality, life satisfaction, and cancer-related fatigue." Evidence-based complementary and alternative medicine 2016 (2016).
[17] Alphonsus, Khrisha B., Yingying Su, and Carl D'Arcy. "The effect of exercise, yoga and physiotherapy on the quality of life of people with multiple sclerosis: systematic review and meta-analysis." Complementary therapies in medicine 43 (2019): 188-195.
[18] Joyce, Christopher, Eric J. Roseen, Julie J. Keysor, K. Douglas Gross, Larry Culpepper, and Robert B. Saper. "Can Yoga or Physical Therapy for Chronic Low Back Pain Improve Depression and Anxiety Among Adults From a Racially Diverse, Low-Income Community? A Secondary Analysis of a Randomized Controlled Trial." Archives of Physical Medicine and Rehabilitation 102, no. 6 (2021): 1049-1058.
[19] Jette, Alan M., Kevin Smith, Stephen M. Haley, and Kenneth D. Davis. "Physical therapy episodes of care for patients with low back pain." Physical therapy 74, no. 2 (1994): 101-110.
[20] Winslow, Lisa Corbin, and Howard Shapiro. "Physicians want education about complementary and alternative medicine to enhance communication with their patients." Archives of Internal Medicine 162, no. 10 (2002): 1176-1181.
[21] Brownson, Ross C., Julie A. Jacobs, Rachel G. Tabak, Christine M. Hoehner, and Katherine A. Stamatakis. "Designing for dissemination among public health researchers: findings from a national survey in the United States." American journal of public health 103, no. 9 (2013): 1693-1699.
[22] AMSTAR. What is AMSTAR. (2021). https://amstar.ca/About_Amstar.php
[23] Shea, Beverley J., Barnaby C. Reeves, George Wells, Micere Thuku, Candyce Hamel, Julian Moran, David Moher et al. "AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both." bmj 358 (2017).
[24] Pieper, Dawid, Nadja Koensgen, Jessica Breuing, Long Ge, and Uta Wegewitz. "How is AMSTAR applied by authors–a call for better reporting." BMC medical research methodology 18, no. 1 (2018): 1-7.
[25] Lu, Cuncun, Tingting Lu, Long Ge, Nan Yang, Peijing Yan, and Kehu Yang. "Use of AMSTAR-2 in the methodological assessment of systematic reviews: protocol for a methodological study." Annals of translational medicine 8, no. 10 (2020).
[26] Shea, Beverley J., Jeremy M. Grimshaw, George A. Wells, Maarten Boers, Neil Andersson, Candyce Hamel, Ashley C. Porter, Peter Tugwell, David Moher, and Lex M. Bouter. "Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews." BMC medical research methodology 7, no. 1 (2007): 1-7.
[27] McHugh, Mary L. "Interrater reliability: the kappa statistic." Biochemia medica 22, no. 3 (2012): 276-282.
[28] Donahue, Marissa L., Eugene M. Dunne, Emily C. Gathright, Julie DeCosta, Brittany L. Balletto, Robert N. Jamison, Michael P. Carey, and Lori AJ Scott-Sheldon. "Complementary and integrative health approaches to manage chronic pain in US military populations: Results from a systematic review and meta-analysis, 1985–2019." Psychological services 18, no. 3 (2021): 295.
[29] Rothberg, Samantha, and Benjamin W. Friedman. "Complementary therapies in addition to medication for patients with nonchronic, nonradicular low back pain: a systematic review." The American journal of emergency medicine 35, no. 1 (2017): 55-61.
[30] Zou, Liye, Yanjie Zhang, Lin Yang, Paul D. Loprinzi, Albert S. Yeung, Jian Kong, Kevin W. Chen, Wook Song, Tao Xiao, and Hong Li. "Are mindful exercises safe and beneficial for treating chronic lower back pain? A systematic review and meta-analysis of randomized controlled trials." Journal of clinical medicine 8, no. 5 (2019): 628.
[31] Smith, Stefanie L., and Wendy Hoon Langen. "A systematic review of mindfulness practices for improving outcomes in chronic low back pain." International Journal of Yoga 13, no. 3 (2020): 177.
[32] Sun, Weige, Haijiao Zhang, Chenxu Lv, Limei Tang, and Suzhai Tian. "Comparative efficacy of 12 non-drug interventions on non-specific chronic low back pain in nurses: A systematic review and network meta-analysis." Journal of Back and Musculoskeletal Rehabilitation Preprint (2021): 1-12.
[33] Cramer, Holger, Heidemarie Haller, Romy Lauche, and Gustav Dobos. "Mindfulness-based stress reduction for low back pain. A systematic review." BMC complementary and alternative medicine 12, no. 1 (2012): 1-8.

[34] Anheyer, Dennis, Heidemarie Haller, Jürgen Barth, Romy Lauche, Gustav Dobos, and Holger Cramer. "Mindfulness-based stress reduction for treating low back pain: a systematic review and meta-analysis." Annals of internal medicine 166, no. 11 (2017): 799-807.
[35] Chou, R., Deyo, R., Friedly, J., Skelly, A., Hashimoto, R., Weimer, M., ... & Brodt, E. D. (2017). Nonpharmacologic therapies for low back pain: a systematic review for an American College of Physicians clinical practice guideline. Annals of internal medicine, 166(7), 493-505.
[36] do Nascimento, Paulo RC, Leonardo OP Costa, Amanda C. Araujo, Stéphane Poitras, and Martin Bilodeau. "Effectiveness of interventions for non-specific low back pain in older adults. A systematic review and meta-analysis." Physiotherapy 105, no. 2 (2019): 147-162.
[37] Slade, Susan C., and Jennifer L. Keating. "Unloaded movement facilitation exercise compared to no exercise or alternative therapy on outcomes for people with nonspecific chronic low back pain: a systematic review." Journal of manipulative and physiological therapeutics 30, no. 4 (2007): 301-311.
[38] Nduwimana, Ildephonse, Félix Nindorera, Jean Louis Thonnard, and Oyene Kossi. "Effectiveness of walking versus mind-body therapies in chronic low back pain: A systematic review and meta-analysis of recent randomized controlled trials." Medicine 99, no. 35 (2020).
[39] Skelly, Andrea Clare, Roger Chou, Joseph R. Dettori, Judith A. Turner, Janna L. Friedly, Sean D. Rundell, Rongwei Fu et al. "Noninvasive nonpharmacological treatment for chronic pain: a systematic review." (2018).
[40] Skelly, Andrea C., Roger Chou, Joseph R. Dettori, Judith A. Turner, Janna L. Friedly, Sean D. Rundell, Rongwei Fu et al. "Noninvasive nonpharmacological treatment for chronic pain: A systematic review update." (2020).
[41] Brox, J. I., K. Storheim, M. Grotle, T. H. Tveito, A. Indahl, and H. R. Eriksen. "Systematic review of back schools, brief education, and fear-avoidance training for chronic low back pain." The spine journal 8, no. 6 (2008): 948-958.
[42] Sharma, Manoj, and Taj Haider. "Yoga as an alternative and complementary treatment for patients with low back pain: a systematic review." Journal of Evidence-Based Complementary & Alternative Medicine 18, no. 1 (2013): 23-28.
[43] Cramer, Holger, Romy Lauche, Heidemarie Haller, and Gustav Dobos. "A systematic review and meta-analysis of yoga for low back pain." The Clinical journal of pain 29, no. 5 (2013): 450-460.
[44] Saragiotto, Bruno T., Tiê P. Yamato, and Chris Maher. "Yoga for low back pain: PEDro systematic review update." British journal of sports medicine 49, no. 20 (2015): 1351-1351.
[45] Crow, Edith Meszaros, Emilien Jeannot, and Alison Trewhela. "Effectiveness of Iyengar yoga in treating spinal (back and neck) pain: A systematic review." International Journal of Yoga 8, no. 1 (2015): 3.
[46] Russell, Natalie, Bevin Daniels, Betty Smoot, and Diane D. Allen. "Effects of yoga on quality of life and pain in women with chronic pelvic pain: systematic review and meta-analysis." Journal of Women's Health Physical Therapy 43, no. 3 (2019): 144-154.
[47] Denham-Jones, Laura, Lynne Gaskell, Nicola Spence, and Tim Pigott. "A systematic review of the effectiveness of yoga on pain, physical function, and quality of life in older adults with chronic musculoskeletal conditions." Musculoskeletal care (2021).

[48] Ward, Lesley, Simon Stebbings, Daniel Cherkin, and G. David Baxter. "Yoga for functional ability, pain and psychosocial outcomes in musculoskeletal conditions: A systematic review and meta-analysis." Musculoskeletal care 11, no. 4 (2013): 203-217.
[49] Posadzki, Paul, Edzard Ernst, Rohini Terry, and Myeong Soo Lee. "Is yoga effective for pain? A systematic review of randomized clinical trials." Complementary therapies in medicine 19, no. 5 (2011): 281-287.
[50] Goode, Adam P., Remy R. Coeytaux, Jennifer McDuffie, Wei Duan-Porter, Poonam Sharma, Hillary Mennella, Avishek Nagi, and John W. Williams Jr. "An evidence map of yoga for low back pain." Complementary therapies in medicine 25 (2016): 170-177.
[51] Kelly, Zena. "Is yoga an effective treatment for low back pain: a research review." International Journal of Yoga Therapy 19, no. 1 (2009): 103-112.
[52] Anheyer, Dennis, Heidemarie Haller, Romy Lauche, Gustav Dobos, and Holger Cramer. "Yoga for treating low back pain: a systematic review and meta-analysis." Pain (2021).

[53] Chang, Douglas G., Jacquelyn A. Holt, Marisa Sklar, and Erik J. Groessl. "Yoga as a treatment for chronic low back pain: A systematic review of the literature." Journal of orthopedics & rheumatology 3, no. 1 (2016): 1.
[54] Whitehead, Alison, and Susan Gould Fogerite. "Yoga Treatment for Chronic Non-Specific Low Back Pain (2017)." Explore 13, no. 4 (2017): 281-284.
[55] Brinzo, Julie A., Jeannette T. Crenshaw, Laura Thomas, and Alysha Sapp. "The effect of yoga on depression and pain in adult patients with chronic low back pain: a systematic review protocol." JBI Evidence Synthesis 14, no. 1 (2016): 56-66.
[56] Posadzki, Paul, and Edzard Ernst. "Yoga for low back pain: a systematic review of randomized clinical trials." Clinical rheumatology 30, no. 9 (2011): 1257.
[57] Sawyer, Amy, Sarah K. Martinez, and Gordon L. Warren. "Impact of yoga on low back pain and function: a systematic review and meta-analysis." (2012).
[58] Holtzman, Susan, and R. Thomas Beggs. "Yoga for chronic low back pain: a meta-analysis of randomized controlled trials." Pain Research and Management 18, no. 5 (2013): 267-272.
[59] Diaz, Alison M., Morey J. Kolber, Chetan K. Patel, Patrick S. Pabian, Carey E. Rothschild, and William J. Hanney. "The efficacy of yoga as an intervention for chronic low back pain: a systematic review of randomized controlled trials." American Journal of Lifestyle Medicine 7, no. 6 (2013): 418-430.
[60] Hill, Christopher. "Is yoga an effective treatment in the management of patients with chronic low back pain compared with other care modalities–a systematic review." Journal of Complementary and Integrative Medicine 10, no. 1 (2013): 211-219.
[61] Wieland, L. Susan, Nicole Skoetz, Karen Pilkington, Ramaprabhu Vempati, Christopher R. D'Adamo, and Brian M. Berman. "Yoga treatment for chronic non-specific low back pain." Cochrane Database of Systematic Reviews 1 (2017).
[62] Zhu, Feilong, Ming Zhang, Dan Wang, Qianqin Hong, Cheng Zeng, and Wei Chen. "Yoga compared to non-exercise or physical therapy exercise on pain, disability, and quality of life for patients with chronic low back pain: A systematic review and meta-analysis of randomized controlled trials." PloS one 15, no. 9 (2020): e0238544.
[63] Gangadhar, B. N. "Toward building evidence for yoga." International journal of yoga 7, no. 2 (2014): 87.
[64] Higgins, Julian PT, Douglas G. Altman, Peter C. Gøtzsche, Peter Jüni, David Moher, Andrew D. Oxman, Jelena Savović, Kenneth F. Schulz, Laura Weeks, and Jonathan AC Sterne. "The Cochrane Collaboration's tool for assessing risk of bias in randomised trials." Bmj 343 (2011).
[65] Chetry, Dipak, Shirley Telles, and Acharya Balkrishna.. "A PubMed-Based Exploration of the Course of Yoga Research from 1948 to 2020." International journal of yoga therapy vol. 31,1 (2021): Article_22.