

Research Review

Is Yoga an Effective Treatment for Low Back Pain: A Research Review

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Abstract: *Low back pain is a significant health problem. Current conventional medical interventions seem largely ineffective and do not address the contributing issues of low back pain in a comprehensive or holistic manner. The holistic approach of Yoga makes it an ideal intervention for low back pain, as it addresses the multifactorial physical, psychological, and social factors associated with low back pain. The objectives of this research review were to (1) identify all relevant published studies that identify Yoga as an intervention for low back pain; (2) draw conclusions about whether Yoga is an effective treatment for low back pain and comparable to other interventions; and (3) summarize interventions used in studies to better inform practitioners, healthcare providers, and researchers about how Yoga may be used to treat low back pain. Seven studies were identified: five moderate- to high-quality randomized controlled trials (RCTs) and two case series. Participants of six out of the seven studies had chronic low back pain with a duration of greater than three months. The main outcome measures were disability questionnaires and pain. Styles of Yoga included Anusara, Iyengar, Viniyoga, a combined intervention of Yoga and Pilates, and Hatha Yoga, not further specified. The findings of this review suggest that Yoga has a positive effect on low back pain and function, with effects comparable to education combined with aerobic and strengthening exercise and more effective than education alone or no treatment. Yoga may provide an inexpensive and easily accessible way for those with low back pain to manage their symptoms. However, the small number of studies prevents definite conclusions from being drawn. This demonstrates a need to increase the evidence base through larger, well-designed RCTs in this area.*

Keywords: *Yoga, back pain, meditation, relaxation, exercise, review*

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Introduction

Low back pain is a significant health problem. In the U.K., 15% to 30% of the population seeks medical intervention for low back pain each year.¹ Sixty percent of these will have reoccurring low back pain episodes and 25% will be substantially disabled in carrying out activities of daily

living. In the U.S., 27% of adults report experiencing chronic low back pain,² and back pain is the leading cause of disability among adults age 45 and under.³ These statistics represent a growing problem worldwide.

Recent literature suggests that low back pain may be caused by a combination of physical factors, such as instability of the spine and faulty biomechanics, as well as

psychosocial and behavioral factors that cause further impairment and disability.⁴⁻⁵ Current conventional medical interventions seem largely ineffective and do not address the contributing issues of low back pain in a consistent or holistic manner.¹ Consequently, a growing number of people with back pain are seeking complementary or alternative treatments. Yoga is among the most commonly used intervention.⁶

The holistic approach of Yoga makes it an ideal intervention for low back pain. There is growing evidence from clinical trials suggesting that Yoga improves a range of physical⁷⁻⁹ and psychological¹⁰⁻¹¹ parameters. Yoga is also growing in popularity and is now easily accessible in many communities.¹² Therefore, Yoga may provide an inexpensive and easily accessible way to manage and treat low back pain.

A systematic review of evidence for Yoga as a treatment for low back pain has not previously been published. The objectives of this review were to identify all relevant published studies that identify Yoga as an intervention for low back pain and to draw conclusions as to whether Yoga is an effective treatment for low back pain.

Methodology

A systematic review of recent randomized clinical trials, pilot studies, and case series was conducted to identify the most relevant evidence for Yoga as a treatment for low back pain.

Criteria for Selection of Studies

Types of studies. Evidence-based medicine requires the informed use of all types of evidence, from meta-analysis to individual case series and reports.¹³ For this reason, all types of quantitative study designs were included in the review. This decision was made in order to capture the largest amount of studies possible.

Types of participants. Studies were considered for inclusion if they used adult participants who had acute, sub-acute, chronic, specific, or nonspecific low back pain. The definition of low back pain used in this review was pain involving the lumbar spine/lower back region, with or without extremity radiation.

Types of interventions. Although there are many different types of Hatha Yoga, all combine movement, mental focus through breathing and meditation, and relaxation. Any form of Hatha Yoga as an intervention for low back pain was considered for inclusion.

Types of outcome measures. Disability and pain were chosen as the main outcome measures, as they are the most commonly used and reflect clinically relevant measures. Studies were considered as having relevant outcome measures if they included measures of disability or measures of pain/pain medication usage. These outcomes most directly reflect the effect that the treatment had on a participant's health and quality of life.

| Inclusion criteria | Exclusion criteria |
|--|--|
| <ul style="list-style-type: none"> • Printed in English language • Peer-reviewed published study • Participants had chronic, acute, specific or nonspecific low back pain • Intervention: Hatha Yoga (any variety) • Outcome measures: disability and/or pain | <ul style="list-style-type: none"> • Printed in foreign language • Unpublished literature • Neck or thoracic pain |

Table 1. Inclusion/exclusion criteria

Search Strategy for Identification of Studies

Studies were identified by searching four sources of research evidence. The first round involved searching the following electronic databases: Cochrane Library, Medline/Pubmed and Embase, CINAHL (literature on nursing and allied health disciplines), Psycinfo (research in psychology and related behavioural science), and AMED (Allied and complementary medicine). There is no single electronic database that records all publications from all medical journals.¹⁴ The electronic databases were originally searched between the years 1987 and 2007 to capture as many relevant studies as possible while reflecting contemporary practices. The second round involved searching the reference lists of identified studies and systematic reviews to identify further relevant studies. The third round involved hand-searching the 2000–2007 issues of the following publications: *Spine*, *Alternative and Complementary Therapies*, *Focus on Alternative and Complementary Therapies*, and *Complementary Therapies in Medicine*. These relevant publications may be overlooked in electronic searching due to inaccurate or incomplete indexing.¹⁴ In the fourth round, Google scholar was used to search the Internet for any previously unidentified relevant studies.

Repeated searches between 2007 and 2009 were conducted to identify any new relevant studies.

Results

The search and inclusion criteria yielded eight potential studies for review. One study, Vidyasagar et al. (1989),¹⁵ was available only through an expensive international interlibrary loan, which unfortunately could not be obtained by the author due to a lack of resources. Therefore, seven studies of a possible eight were included in the review. Table 2 lists the details of these seven studies, including number of participants, type of low back pain studied, intervention and control, outcomes measured, and significant results.

| | |
|-----------------------------|--|
| Reference | Ananthanarayanan & Srinivasan (1994) ¹⁶ |
| Number of subjects | 16, 5 with chronic low back pain > 5 years; duration not reported for other participants |
| Description of intervention | Viniyoga, 60-min session, 4–6 x week, duration of 6 months |
| Control | None |
| Outcome measures | Pain and mobility |
| Effect | No statistical analysis conducted. A questionnaire at 6 months found 70% of the patients reported near normal mobility and an absence of pain. |
| Reference | Galantino et al. (2004) ¹⁷ |
| Number of subjects | 22 chronic low back pain |
| Description of intervention | 60-min Hatha Yoga sessions, 2 x week, duration of 6 weeks |
| Control | No treatment received; intervention at a later date |
| Outcome measures | Oswestry disability index, Beck depression inventory, forward reach, sit and reach, journal of Yoga practice |
| Effect | No statistically significant effects, trends towards improved depression and sit and reach test in Yoga group, $p = 0.170$ |

| | |
|-----------------------------|---|
| Reference | Sherman et al. (2005) ¹⁸ |
| Number of subjects | 101 chronic low back pain |
| Description of intervention | Viniyoga 75 min, 1 x week, duration of 12 weeks |
| Control | Exercise/ self-care book |
| Outcome measures | Roland disability scale, SF-36 health survey, bothersomeness of pain (11-point numerical scale), pain medication usage, adherence |
| Effect | Significant reduction in disability in Yoga group compared to controls, $p = 0.001$ (book), $p = 0.092$ (exercise). Significant reduction in pain medication usage was also found, with only 21% of participants in the Yoga group using medications at 26 weeks compared to 50% in the exercise group. |
| Reference | Williams et al. (2005) ¹⁹ |
| Number of subjects | 42 chronic low back pain |
| Description of intervention | 90-min Iyengar Yoga, 1 x week, duration of 16 weeks |
| Control | Educational program |
| Outcome measures | Pain disability index, SF-McGill questionnaire, Tampa scale of kinesiophobia, survey of pain attitudes, coping strategies questionnaire, pain self-efficacy scale, Saunders digital inclinometer, pain medication usage, adherence |
| Effect | Significant reduction in pain intensity, functional disability, and pain medication usage in Yoga group compared to control, $p = 0.005$ disability, $p = 0.04$, pain, $p = 0.004$ pain medication |

Table 2. Details of included studies.

| | |
|-----------------------------|---|
| Reference | Vad et al. (2007) ²⁰ |
| Number of subjects | 50 chronic low back pain |
| Description of intervention | Combined Yoga, Pilates, Cryobrace, and oral medication, 15mins, 3 x week, duration of 12 months |
| Control | Cryobrace and oral medication only |
| Outcome measures | Roland disability scale, numeric pain rating scale, oral medication usage, patient satisfaction score, forward flexion, time off work, rate of symptom recurrence |
| Effect | Significant reduction in medication usage time, time off work, symptom recurrence, disability and greater patient satisfaction in Yoga group compared to control, $p = 0.001$ disability, $p < 0.05$ medication usage |
| Reference | Groessler et al. (2008) ²¹ |
| Number of subjects | 33 chronic low back pain |
| Description of intervention | Viniyoga, 60 mins, 4-6 x week, duration of 2.5 months |
| Control | None |
| Outcome measures | Pain VAS scale, fatigue/energy, depression (CESD-10), health related quality of life (SF-12) |
| Effect | Significant reduction in pain $p = 0.001$, depression $p = 0.001$, and fatigue $p = 0.001$ |
| Reference | Tekur et al. (2008) ²² |
| Number of subjects | 80 low back pain |
| Description of intervention | 120 mins every day for 1 week |
| Control | Walking, counseling, breathing exercises, education |

| | |
|------------------|---|
| Outcome measures | Oswestry disability index (ODI), spinal flexibility |
| Effect | $p = 0.01$ ODI, $p = 0.008$ flexion, $p = 0.002$ extension, $p = 0.059$ right lateral flexion, $p = 0.006$ left lateral flexion |

Table 2. Details of included studies. (continued)

Description of Included Studies

For quick overviews of each study identified, see Table 2. The following sections provide an integrated look at the participants, designs, methods, and results of all seven studies.

Participants

The sample sizes ranged from between 16 and 101 participants ($M = 49$). Participant age ranged from 30 to 65 years. The percentage of female participants ranged from 21% to 77% ($M = 65\%$).

Six of the seven studies specified that participants had chronic low back pain over three months' duration. The seventh study (Ananthanarayanan & Srinivasan 1994) reported that 5 out of 16 participants had chronic low back pain with duration of over five years, but did not state the duration of back pain reported by the remaining participants. Two studies looked at participants with various forms of specific low back pain, including post-natal, retroverted uterus, age-related degeneration, myocytis, muscular, and gait related (Ananthanarayanan & Srinivasan 1994); and discogenic low back pain (Vad et al. 2007). Two studies (Sherman et al. 2005, Williams et al. 2005) included participants with nonspecific low back pain, and the three remaining studies (Galantino et al. 2004, Groessler et al. 2008, Tekur et al. 2008) included participants with both specific and nonspecific low back pain. Recruitment of participants involved both advertising for participant self-referral and physician referral.

Interventions

Five different styles of Yoga were used in the seven studies. Two studies used Viniyoga (Sherman et al. 2005, Ananthanarayanan & Srinivasan 1994). One study each used Iyengar (Williams et al. 2005), Anusara (Groessler et al. 2008), and Hatha not further specified (Galantino et al. 2004). Vad et al. (2007) combined Yoga and Pilates and did not state which style of Yoga was used. Tekur et al. (2008) stated that the Yoga therapy was developed using traditional Yoga scriptures, including Patanjali's *Yoga Sutras*, the *Upanishads*, and the *Yoga Vasishtha*.

Only five of the seven studies described the Yoga intervention in detail. See Appendix 1 for detailed descriptions of the interventions used in these studies. Each study used a different combination of poses and other practices. Only one category of pose, the forward-bending pose and its variations (seated, standing, standing with legs apart with twist), was consistently used in all the interventions that were described.

Information about posture repetition and length of hold was only reported in two studies (Sherman et al. 2005, Ananthanarayanan & Srinivasan 1994). In Sherman et al. (2005), poses were not held but repeated three to six times, moving in and out with the breath. A similar approach was taken in Ananthanarayanan and Srinivasan (1994), which reports that *asanas* were dynamic and combined with their counterpose using slow repetition. None of the remaining studies gave details of repetitions or length of hold for poses. However, most studies stated that modifications and progressions of various postures were made based on participant abilities and tolerance.

Four studies reported using breathing exercises, although these were not reported in detail. The following descriptions were provided: diaphragmatic breathing (Galantino et al. 2004), breathing exercises at the beginning and end of the class (Sherman et al. 2005), breathing exercises in a chair while resting after sequences (Ananthanarayanan & Srinivasan 1994), and *pranayama*, not further specified (Tekur et al. 2008). Two studies (Tekur et al. 2008, Galantino et al. 2004) mentioned using meditation, but the techniques were not reported in detail. One study reported including Yogic chants (Tekur et al. 2008).

Only three studies (Galantino et al. 2004, Sherman et al. 2005, & Tekur et al. 2008) specifically mentioned relaxation techniques (e.g., *savasana*, guided relaxation, and/or restorative poses) as part of the intervention. However, relaxation is standard in any Hatha Yoga practice, and it may be assumed that it was likely included in other interventions.

Intervention duration ranged widely, from a one-week intensive residential program (Tekur et al. 2008) to 12 months of sessions three times a week (Vad et al. 2007). The mean intervention length was 17 weeks. The frequency of Yoga sessions ranged from two per day to one to three times per week, with an average of three sessions per week. Session time ranged between 15 and 90 minutes, with an average of 68 minutes per session. All of the studies encouraged home Yoga practice except for Ananthanarayanan and Srinivasan (1994). Where mentioned, interventions were developed and taught by experienced Yoga instructors. Galantino et al. (2004) also included the input of a physical therapist.

Co-interventions

Most studies did not mention controlling for or excluding co-interventions. Only one study explicitly used a co-intervention (Vad et al. 2005, cyrobrace and oral medication), and only one study attempted to control for co-interventions (Sherman et al. 2005).

Outcome measures

Six of the seven studies used measures of disability, five of the studies used measures of pain, three studies used pain medication usage, three studies used measures of flexibility, and two studies used depression as an outcome measure. See Table 2 for specific outcome measures used in each study.

Statistical analysis of outcome measures

Five studies tested the hypothesis that Yoga would improve low back pain-related disability. Four studies (Williams et al. 2005, Vad et al. 2007, Sherman et al. 2005, & Tekur et al. 2008) reported statistically significant improvements in disability compared to the control groups; the fifth (Galantino et al. 2004) was not powered to reach statistical significance.

Four studies tested the hypothesis that Yoga would reduce pain or use of pain medication. All of these studies (Sherman et al. 2005, Williams et al. 2005, Vad et al. 2007, Groessl et al. 2008) found a significant decrease in pain/medication usage in the Yoga groups compared to controls.

Two studies tested the hypothesis that Yoga would reduce depression. Galantino et al. (2004) was not powered to reach statistical significance, but identified a trend towards decreased depression among participants in the Yoga group compared to control group. Groessl et al. (2008) found significant reductions in depression in a within-subject comparison from baseline to 10-week follow up.

Of the three studies that used flexibility as an outcome measure, only one conducted statistical hypothesis testing. Tekur et al. (2008) found significant improvements in spinal flexibility (flexion, extension, and lateral flexion) compared to controls. Galantino et al. (2004) reported a 90% improvement in the functional sit and reach in the Yoga group, compared to only 20% in the control group.

Although all of the studies used similar outcome measures, not all conducted comparable statistical analyses. Therefore a meta-analysis of reported effects would not be appropriate in this review.

Method Quality Assessment

Studies that met the inclusion criteria were critically appraised using The Van Tulder tool,²³ which was developed to evaluate RCTs with the low back pain population. The tool uses 19 criteria, which are used to assign a rating of method-

ological quality. Sample criteria include: groups were similar at baseline regarding most important prognostic indicators; outcome measures were relevant; index and control interventions were explicitly described. The criteria can be answered with yes, no, or don't know, based on the presence of sufficient information within the article. One point was awarded to each item if the specific criteria were met.

Using the Van Tulder quality assessment tool, two studies were low quality, scoring less than 50% (Ananthanarayanan & Srinivasan 1994, Groessl et al. 2008), four were moderate quality, scoring between 50% and 75% (Vad et al. 2005, Galantino et al. 2004, Williams et al. 2005, & Tekur et al. 2008), and one was high quality, scoring higher than 75% (Sherman et al. 2005). However, it is important to keep in mind that some of the Van Tulder criteria—such as blinding of care provider and patient blinding—are not as feasible for a Yoga intervention. For this reason, a score of 100% would not be expected even for a well-designed clinical trial examining the benefits of Yoga. Also, the Van Tulder tool was designed to rate clinical trials. The two lowest-scoring studies in this review were case series, not clinical trials.

Although a case series is considered to be at the bottom of the hierarchy of evidence, both of the case series in this review provided information not available in the controlled trials. For example, Ananthanarayanan and Srinivasan (1994) found that participants had a reoccurrence of low back pain if Yoga practice was discontinued. Reoccurrence of pain associated with discontinued Yoga was not a factor that was recorded in any of the RCTs. Groessl et al. (2008) found a dose-response effect for the positive changes in health outcomes associated with self-reported practice and number of Yoga sessions attended. This was also not a factor recorded in any of the RCTs.

Discussion

The purpose of this review was to examine the evidence that Yoga is an effective treatment for low back pain. The findings of the seven studies reviewed suggest that Yoga can be a safe treatment for low back pain. There is also preliminary evidence that Yoga is as effective as several other interventions, including an educational program and other forms of exercise.

All of the studies showed positive results regardless of differences in type of low back pain, duration and frequency of intervention, type of Yoga used, and the poses and practices used. These findings suggest that Hatha Yoga programs designed specifically for individuals with back pain may be generally effective; there is no evidence in these studies to support specific prescriptions, required practices, or mini-

mum length of intervention. It may be reasonable to assume that elements common to all of the Yoga interventions, such as controlled breathing and *asanas* adapted to the individual, may be factors associated with improvements of disability and low back pain.

Limitations

The findings of this review must be interpreted with caution for a number of reasons. First, the generalizability of the review is limited by the relatively small number of studies conducted and the limitations of those studies. For example, the vast majority of participants had chronic low back pain, and the results may not apply to those with acute low back pain. Most studies also did not control for factors that can influence back pain outcomes, such as time of first episode of low back pain, comorbid mental health issues, smoking, or whether a person is receiving disability pay. It is not possible to know whether a Yoga intervention would be more or less helpful depending on these factors.

Finally, long-term follow up was only carried out in two studies. Therefore, long-term benefits of a Yoga intervention cannot be assumed. In most of the reviewed studies, it is unknown whether participants continued to improve over time, whether their symptoms worsened, or whether spontaneous recovery would have occurred without intervention.

Due to the exclusion criteria of non-English language studies, bias may also have been introduced in the search process, as not all available studies may have been identified. This review does not include unpublished articles, which may also bias results, as articles with negative results are less likely to be published.²⁴

Clinical Implications

The following clinical implications are derived from a small number of studies, with further empirical studies recommended:

- Yoga may be recommended as an intervention for chronic low back pain.
- Yoga is as effective as other common forms of intervention for low back pain, including trunk strengthening, aerobics, and education about back pain.
- There are no uniform, evidence-based guidelines for the duration and content of a Yoga intervention for low back pain. However, all poses and practices should be adapted for individuals for back pain and modified based on participants' abilities and tolerance.
- Regular self-practice and class attendance should be encouraged to increase positive health benefits for people with chronic low back pain.

References

1. Quinn F, Hughes C, Baxter GD. Complementary and alternative medicine in the treatment of low back pain: a systematic review. *Physical Therapy Reviews*. 2006;11/2:107-116.
2. National Center for Health Statistics. *Health*, United States 2006, with chartbook on trends in the health of Americans. Hyattsville, MD: 72. Cited by American Pain Foundation, www.painfoundation.org.
3. Edwards RR, Doleys DM, Fillingim RM, Lowery D. Ethnic differences in pain tolerance: Clinical implications in a chronic pain population. *Psychosomatic Medicine*. 2001; 63: 316-323.
4. Cailliet, R. *Low Back Disorders: A Medical Enigma*. Philadelphia: Lippincott Williams & Williams; 2003.
5. Keeley P, Creed F, Tomenson B, Todd C, Borglin G, Dickens C. Psychosocial predictors of health-related quality of life and health service utilisation in people with chronic low back pain. *Pain*. 2008;135:142-150.
6. Long L, Huntley A, Ernst E. Which complementary and alternative therapies benefit which conditions? A survey of the opinions of 223 professional organizations. *Complementary Therapies in Medicine*. 2001; 9:178-185.
7. Tran MD, Holly RG, Lashbrook J, Amsterdam EA. Effects of hatha yoga practice on the health-related aspects of physical fitness. *Preventive Cardiology*. 2001;4(4):165-170.
8. Boehde DD, Porcari JP, Greany J, Udermann B, Johanson D, Foster C. The physiological effects of 8 weeks of yoga training. *Journal of Cardiopulmonary Rehabilitation*. 2005;25:290.
9. Cowen VS, Adams TB. Heart rate in yoga asana practice: A comparison of styles. *Journal of Bodywork and Movement Therapies*. 2007;11:91-95.
10. Pilkington K, Kirkwood G, Rampes H, Richardson J. Yoga for depression: the research evidence. *Journal of Affective Disorders*. 2005;89:13-24.
11. Kirkwood G, Rampes H, Tuffrey V, Richardson J, Pilkington K. Yoga for anxiety: a systematic review of the research evidence. *British Journal of Sports Medicine*. 2005;39(12):884-891.
12. Mees PD. Yoga participation surges: exploring the clinical implications. *The Physician and Sports Medicine*. 2005;33(5) 12-5.
13. Bhandari M, Giannoudis PV. Evidence-based medicine: what it is and what it is not. *Injury*. 2006;37:302-306
14. Khan KS, Riet GT, Glanville, Sowden JA, Kleijnen, J. *Undertaking systematic reviews of research on effectiveness CRD's guidance for those carrying out or commissioning reviews*. NHS centre for reviews and Dissemination Report number. York: University of York. York Publishing; 2001.
15. Vidyasagar BN, Prasad M, Venkat Reddy PS, Raju Madhavi, Jai Shankar, Kalyani Sampath. Effect of yogic practices in non-specific low back pain. *Clinical Proceedings of NIMS*. 1989;4(4):160-164.
16. Ananthanarayanan TV, Srinivasan TM. Asana-based exercises for the management of low back pain. *The International Journal of Yoga Therapists*. 1994;4:6-15.
17. Galantino ML, Bzdewka TM, Eissler-Russo JL, Holbrook KL, Mogck EP, Geigle P, Farrar JT. The impact of modified Hatha yoga on chronic low back pain: A pilot study. *Alternative Therapies in Health and Medicine*. 2004;10(2):56-9.
18. Sherman K, Cherkin DC, Erro J, Miglioretti DL, Deyo RA. Comparing yoga, exercise, and a self-care book for chronic low back pain. *Annals of Internal Medicine*. 2005;14(12):849-856.
19. Williams KA, Petronis J, Smith D, Goodrich D, Wu J, Ravi N, Doyle EJ Jr, Gregory Juckett R, Munoz Kolar M, Gross R, Steinberg L. Effect of Iyengar yoga therapy for chronic low back pain. *Pain*. 2005;115(1-2):107-17.
20. Vad V, Bhat A, Tarabichi Y. The role of the Back Rx exercise program in discogenic low back pain: A prospective randomized trial. *Archives of Physical Medicine and Rehabilitation*. 2007;88:577-582.
21. Groessl EJ, Weingart KR, Aschbacher K, Pada L, Baxi S. Yoga for veterans with chronic low-back pain. *Journal of Alternative and Complementary Medicine*. 2008;14(9):1123-1129.
22. Tekur P, Singphow C, Nagendra HR, Raghuram N. Effect of short-term intensive yoga program on pain, functional disability and spinal flexibility in chronic low back pain: a randomised control study. *The Journal of Complementary and Alternative Medicine*. 2008;14(6):637-644.
23. Van Tulder MW, Assendelft WJJ, Koes BW, Boutler LM. Method guidelines for systematic reviews in the Cochrane Collaboration back review group for spinal disorders. *Spine*. 1997;22:2323-30.
24. Greenhalgh T. *How to read a paper: the basics of evidenced-based medicine*. 3rd Edition. Oxford: Blackwell Publishing; 2001.

Appendix 1: Detailed Descriptions of Yoga Interventions

| Poses | Breathing | Relaxation | Meditation |
|---|---|----------------|----------------|
| <ol style="list-style-type: none"> 1. <i>Dvipadapittam</i> bridge, arms over head 2. <i>Shalabhasana</i> locust pose 3. <i>Apanasana</i> knees to chest 4. Supine bent-leg flexion-knee to chest 5. <i>Vajrasana</i> kneeling 6. <i>Uttanasana</i> standing forward bend 7. <i>Pachimatanasana</i> sitting forward bend 8. <i>Chakravakasana</i> sun bird 9. <i>Bhujangasana</i> cobra 10. Supine trunk flexion | Rest after sequences breathing exercises in sitting | None described | None described |

1. Yoga intervention described by Ananthanarayanan Srinivasan (1994)

10 poses made progressively more difficult to improve strength.

| Poses | Breathing | Relaxation | Meditation |
|--|-------------------------|---------------------|------------|
| <ol style="list-style-type: none"> 1. Simple standing 2. Corpse 3. Knees to chest in prone 4. Cat 5. Standing horizontal stretch 6. Overhead stretch 7. Side stretch 8. Simple back stretch 9. Standing tree 10. Triangle 11. Preparation for hand to foot posture 12. Sitting, easy posture 13. Kneeling postures 14. Cobra-backward bending 15. Forward bending 16. Preparation head to knee posterior stretch, 17. Twisting, half spinal twist 18. Sun salutation | Diaphragmatic breathing | Relaxation postures | Meditation |

2. Yoga intervention described by Galantino et al. (2004)

Poses modified to adapt to participants' abilities and tolerance.

| Poses | Breathing | Relaxation | Meditation |
|---|--|------------------------|----------------|
| <ol style="list-style-type: none"> 1. Cobra and variations, 2. Knees to chest 3. Wheel 4. Bridge 5. Supine butterfly 6. Extended leg posture 7. Warrior 8. Standing forward bend 9. Kneeling forward bend 10. Chair posture 11. Lying twist 12. Swimmer's posture 13. Extended side stretch 14. Lunge 15. Lying side hip strengtheners 16. Kneeling lateral posture 17. Standing lateral posture | Each class had initial and final breathing exercises | Guided deep relaxation | None described |

3. Yoga intervention described by Sherman et al. (2005)

Postures not held but repeated 3–6 times with the breath. 5–12 out of 17 poses listed above used in each thematic class.

| 1. Poses | Breathing | Relaxation | Meditation |
|---|----------------|----------------|----------------|
| <ol style="list-style-type: none"> 1. <i>Savasana</i> II with bolster and sandbag; with sacral traction 2. Prone <i>savasana</i> with 25 lb weight on buttocks, two 15 lb plate weights, and three 10 lb sandbags between plate weights 3. Prone <i>supta padangusthasana</i> with raised knee bent and supported 4. <i>Supta pavanmuktasana</i>—One knee to chest, both knees to chest 5. <i>Supta padangusthasana</i> I and II—bent knee and straight leg with support of the wall; with assisted traction; traction with two straps 6. <i>Pavanmuktasana</i> on the bench 7. <i>Uttanasana</i> on the stool 8. <i>Ardha uttanasana</i> onto <i>halasana</i> box with double traction 9. <i>Adho mukha svanasana</i> using <i>simbasana</i> box and upper wall ropes; with lower wall ropes and heels on wall 10. Lumbar traction with straight legs and bent legs 11. <i>Adho mukha virasana</i> over bolster 12. <i>Parsva pavanmuktasana</i> on the bench 13. <i>Prasarita padottanasana</i> on bench with traction on the upper thighs (concave back) 14. <i>Parsvottanasana</i> (concave back) 15. <i>Maricyasana</i> III at trestler 16. <i>Tadasana</i> with block between the legs 17. <i>Utthita hasta padangusthasana</i> I and II with bent knee and straight leg 18. <i>Parivritta hasta padangusthasana</i> III straight leg supported on stool at trestler 19. <i>Utthita padmasana</i> 20. Forward bend (<i>adho mukha</i>) and lateral stretch (<i>parsva</i>) 21. <i>Adho mukha sukasana</i> 22. <i>Parsva sukasana</i> 23. <i>Trikonasana</i> (at trestler with traction) 24. <i>Virabdrasana</i> II (at trestler with traction) 25. <i>Parsvakonasana</i> (at trestler) 26. <i>Parivritta trikonasana</i> (trestler) 27. <i>Bharadvajasana</i> (chair) 28. Supported <i>urdhva prasarita padasana</i> 29. Supported <i>baddha konasana</i> 30. Supported <i>halasana</i> | None described | None described | None described |

4. Yoga intervention described by Williams et al. et al. (2005)

| Series A | Series B | Series C |
|---|--|---------------|
| (First 6 months): lying supine isometric exercises derived from physical therapy to lay a foundation of core muscle flexibility | (Second 6 months): more dynamic muscle movements Yoga based exercises that intensify isometric loading of the core muscles of the back, build strength through concentric, eccentric, and plyometric contractions; patients asked to focus on their breathing; other targeted areas chest, shoulder, abdominal, thigh, and hip musculature | Not described |

5. Yoga/Pilates intervention described by Vad et al. (2007)

Yoga and Pilates exercises were modified to exclude exercises that may easily injure a weak back.

| Poses | Breathing | Relaxation | Meditation |
|--|------------------|---|--|
| <ol style="list-style-type: none"> 1. <i>Pavanamuktasana</i> wind releasing posture 2. <i>Supta pavanmuktasana</i> leg rock pose 3. <i>Jhulana lurkhanasana</i> rocking and rolling 4. <i>Ardha navasana</i> half boat 5. <i>Uttanapadasana</i> straight leg pose 6. <i>Sethubandhasana</i> breathing bridge pose lumbar stretch 7. <i>Bhujangasana</i> cobra 8. <i>Shalabhasana</i> locust pose 9. <i>Vyaghra</i>-tiger breathing 10. <i>Shashankasana</i> breathing –moon pose 11. <i>Ardha chakrasana</i> half wheel pose 12. <i>Prasarita pada hastasana</i> forward bend with legs apart 13. <i>Ardha kati chakrasana</i> lateral arc pose | <i>Pranayama</i> | Quick relaxation in <i>savasana</i> , corpse pose | <p>Meditation with Yogic chants</p> <p>Cyclic meditation</p> |

6. Yoga intervention described by Tekur et al. (2008)