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The Benefits of Yoga for Musculoskeletal Disorders: A Systematic Review of the Literature

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Abstract

The objective of this literature review is to gain insight into the effectiveness of yoga as a therapy for musculoskeletal disorders. An extensive search of databases was performed to identify studies on yoga interventions and the effectiveness of yoga in people with the disorders. This review identified intervention studies that used randomized controlled trials, as well as nonrandomized controlled trials, and summarized and synthesized evidence of effectiveness of yoga. A literature search yielded 31 intervention studies that met inclusion criteria and they were included in this review. Based on the reviewed studies, yoga intervention is moderately feasible and is likely to be equal to or superior to exercise or usual care for reducing pain and pain medication use. Methodological limitations are identified in many of the studies, such as sample size, lack of reliable sham controls, and not blinding researchers to treatment and nontreatment groups.

Keywords: Musculoskeletal disorders; Yoga; Complementary alternative medicine; Systematic review

Introduction

One in four Americans has a musculoskeletal complaint that requires medical treatment [1]. Musculoskeletal disorders and diseases are the leading cause of disability in the United States and account for more than one half of all chronic conditions in people over 50 years of age in developed countries [2,3]. Musculoskeletal disorders can be defined injuries that affect bones, muscles, tendons, nerves, and soft tissue. These types of injuries develop when there is stress or inappropriate use of a joint or surrounding structure repeatedly over time [4]. The obesity epidemic that plagues the United States and developing nations increases the risk for musculoskeletal conditions [3]. The cost of medical treatment for musculoskeletal disorders in the United States is at least $849 billion per year, or 7.7% of the U.S. gross domestic product [5]. The worldwide burden of musculoskeletal conditions has been reported by the World Health Organization [6]: 40% of people over the age of 70 suffer from osteoarthritis of the knee and 80% of these people have some degree of movement limitation, with 25% of this group unable to perform major activities of daily living. Research in the area of prevention and self-care for musculoskeletal problems is necessary to lower the health and economic burden of these diseases [7].

The most common group to experience musculoskeletal and joint disorders is people over 50 years old. Because of their association with aging, musculoskeletal disorders are likely to become more prevalent as the world's population ages. Chronic pain is the most common problem and most common reason for seeking medical care in musculoskeletal disorders [8]. The Mayo Clinic [9] studied the chronic pain cycle and posited that ineffective treatment for pain can lead to a downward spiral of frustration, decreased functioning, insomnia, stress, isolation, and worsening pain. A decrease in functional ability due to musculoskeletal and joint pain, particularly in older adults can lead to loss of independence and can require higher levels of assistance [10]. Maintaining function and mobility in persons with musculoskeletal disorders is one of the primary goals of treatment for all age groups [10].

Movement therapies such as yoga and tai chi have been shown to reduce chronic pain associated with musculoskeletal and joint diseases [4]. All types of exercise may benefit those with musculoskeletal disorders; however, exercise programs must be adjusted for persons with physical limitations and pain [11]. Studies have demonstrated the role of exercise in relieving pain, disrupting the chronic pain cycle, and increasing mobility in seniors [12]. Taylor, Dodd, Shields, and Bruder [13] compared 38 studies involving movement therapies for chronic pain and concluded that there was strong evidence that therapeutic exercise was effective in reducing chronic pain and were beneficial for patients across a variety of chronic diseases, including musculoskeletal conditions.

Yoga as an effective therapy for musculoskeletal pain and disability is the subject of this systematic review. Roughly 16 million people in the United States practice some form of yoga, with 61% reporting that yoga is important for maintaining health [14]. Only 6.1% of Americans reported that a doctor or therapist had recommended yoga to them [14].

Yoga is a philosophy and practice that connects the body, breath, and mind to energize and balance the whole person [15]. This mind-body therapy involves physical postures, breathing exercises, and meditation to improve overall well-being. Yoga is one of the strategies that can be used to meet the nationally established guidelines for muscle strengthening, flexibility, and balance activities in older adults [16].

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Yoga has been used to alleviate musculoskeletal pain and has been associated with significant improvement in range of motion and function, decreased tenderness [17,18], lower levels of depressive symptoms [19], and decreased pain during activity in patients with musculoskeletal disorders [17,18].

This systematic review provides an analysis of evidence of the effects of yoga on persons with musculoskeletal disorders. Disorders included in this review are osteoarthritis (OA), rheumatoid arthritis (RA), low back pain, osteoporosis, carpal tunnel syndrome, multiple sclerosis, and fibromyalgia (FM). The purpose of the review was to critically evaluate the evidence for and against the effectiveness of yoga as a treatment for these disorders. It is hoped that healthcare professionals will use their knowledge, as well as the existing evidence, to help people with musculoskeletal disorders to alleviate symptoms associated with the disorders.

Materials and Methods

Data sources, Search strategy, Inclusion and exclusion criteria

An extensive search of pertinent databases (Medline, OVID, Cochrane Database of Systematic Reviews, Cumulative Index to Nursing and Allied Health Literature [CINAHL], PsychINFO) was conducted to identify reports of studies of physical and psychosocial pain interventions, using the following keywords: (Yoga OR Mind-Body) AND (muscle OR muscular skeletal OR arthritis OR back pain OR carpal-tunnel syndrome OR osteoporosis). The search interval was 1937 to December 2012: Medline (1965 to June 2012), CINAHL (1937 to June 2012), and PsychINFO (1965 to June 2012). Criteria for inclusion in the review were (a) article was published in English in a peer-reviewed journal, (b) yoga as an intervention study, and (c) yoga utilized in people with musculoskeletal disorders. Exclusion criteria were (a) case studies and review articles, (b) articles that included types of disease other than musculoskeletal disorders. Selection of articles for inclusion in this review was based on the search strategy described above and completed independently by the two authors. Disagreements concerning selection were resolved in a consensus meeting. To evaluate the methodological quality of selected studies, the Downs and Black quality rating checklist was applied [20].

Data extraction

The abstract of each article retrieved for inclusion was screened and data from the included studies were extracted for synthesis and review. Data including study design, target population, setting, intervention, comparison group or condition, outcome assessment, data analysis and presentation, follow-up, key results, and the quality of each study were evaluated to describe study characteristics, confirm eligibility, and determine the effect of yoga on musculoskeletal disorders. The search strategy produced a total of 433 hits (95 CINAHL, 32 Medline, 306 PsychoINFO) and those 433 abstracts were screened. After initial screening of abstracts, 169 were excluded as duplicates. The remaining 264 articles were assessed for inclusion criteria; 233 were excluded for not meeting inclusion criteria (53 not intervention studies, 180 not muscular skeletal disorders), resulting in 31 yoga intervention studies that met the inclusion criteria and were included in this review.

Study quality

The identified studies in the current review were assessed using the Downs and Black quality rating checklist [20]. The checklist is considered to be reliable, easy to use, and appropriate for the evaluation of nonrandomized intervention studies in systematic review [21]. The 27-item checklist is composed of five subscales (with the number of items): reporting (10), external (3), internal validity—control of bias (7), internal validity—confounding (6), and power (1). Each item is positively stated and scored as yes (1), no (0), or unable to determine. Scores are summed (maximum score 27), with higher scores indicating higher quality. The two authors of this review independently extracted from the relevant articles the following: study design, sample size and characteristics, details of intervention and control group, type of musculoskeletal disorder, outcome measures, and main results.

Results

In the 31 reviewed studies the sample size ranged from 7 to 313. Average ages of participants ranged from 38.3 to 80 years. The percentages of women participants ranged from 21% to 100%. The studies were performed in a variety of countries: 18 in the United States, 4 in India, 3 in Turkey, and 1 each in the United Kingdom, Canada, Finland, United Arab Emirates, and Brazil. The focus on musculoskeletal disorders was distributed as follows: 9 studies (29%) on OA, 9 (29%) on low back pain, 3 (11%) on the effect of yoga on RA, 3 (11 %) on FM, 4 (13%) on osteoporosis and 3 (9.7%) on other musculoskeletal disorders, including muscle soreness, multiple sclerosis, and carpal tunnel syndrome.

Table 1 illustrates the study design, sample size, study samples (including mean age, standard deviation), type of musculoskeletal disorder, and interventions reported for the 31 studies comparing the effects of yoga and components of yoga interventions, other interventions, and wait-list controls. Table 2 lists the outcome measures and study results. Of the 31 articles, 48% (n=15) included randomized controlled trials (RCT) as a study design, 33% (n=10) used a pretest/posttest design, and 16% (n=5) used a time-series design; one qualitative study (3.2%) used in-depth interviews and observation. Of the 15 RCTs, 6 studies used a wait-list control group, 8 employed usual care, and 1 used both other exercise group and a wait-list control group. Length of the yoga intervention ranged from 1 week to 24 weeks. A variety of yoga style was used in the studies, most frequently Hatha yoga (16%, n=5) and Iyengar yoga (16%, n=5); the remaining studies used various types of yoga such as Viniyoga or chair yoga (16%, n=5) or did not identify the type of yoga (45%, n=14). Park et al. [22] used *Sit 'N' Fit Chair Yoga*, a gentle form of yoga, practiced sitting in a chair, consisting of a safe and secure program of stretching, muscle strengthening, breathing, and relaxation.

Osteoarthritis

Park et al. [22] measured effects of the *Sit 'N' Fit Chair Yoga* program in community-dwelling elders diagnosed with OA. Chair yoga is a gentle exercise that provides stability and safety for these older adults, reduction in OA pain, and improvement in physical function. The results for the yoga group were compared to measures for groups who completed either a pain education program or a series of Reiki treatments. The participants in the yoga group had a statistically significant decrease in mean score for pain from pretest (M=8.7, SD=3.8) to posttest (M=3.5, SD=2.3, t [5]=2.6, p=.048) and a statistically significant decrease in mean score for physical limitations from pretest (M =32.4, SD=9.0) to posttest (M =16.2, SD=5.8), t[4]=5.4, p=.006). A follow-up focus group session with the yoga participants yielded three overall themes: pain reduction and improved mobility, a feeling of security, and an improved sense of well-being.

Four studies [17,23-25] focused on OA in a specific body area. Garfinkel et al. [24] randomly assigned participants with only hand OA to either to a yoga group or a control group (no therapy). Participants in the yoga group significantly improved on measures of hand pain (p =.009) compared to those in the control group. A similar yoga-based intervention was assessed by the same author and colleagues [17] for decreasing symptoms of carpal tunnel syndrome. Participants experienced 11 yoga postures designed for strengthening, stretching, and balancing each joint in the upper body, along with relaxation, twice weekly for 8 weeks. Patients in the yoga group showed statistically significant improvements in grip strength (p=.02) and pain reduction (p=.02). Kolasinki et al. [25] examined the effects of yoga on symptoms of knee OA in older adults in eight weekly 90-minute Iyengar yoga sessions. The intervention group significantly improved on measures of pain level (p=.04) and physical function (p=.04).

Low back pain

Williams et al. [26] found that yoga significantly improved function and reduced pain in participants with chronic low back pain ($p \leq .05$). Participants who received the yoga intervention showed significant improvement in pain-related outcomes: pain intensity, functional disability, depression, and pain medication usage. A recent study [27] examined the effects of yoga for low back pain. Parallel-group RCTs were conducted. The sample of 313 persons with chronic or recurrent low back pain were randomly assigned to either a 12-week yoga program (n=156) or usual care (n=157). Outcomes were measured at baseline at 3, 6, and 12 months. The yoga group had better improvement of back function than the usual care group (p=.007), but yoga and usual care groups had similar back pain and general health scores at 3, 6, and 12 months.

Sherman et al. [18] reported on the effectiveness of 12 weeks of yoga sessions compared to conventional therapeutic exercise classes or a self-care book. The study demonstrated that 6 weeks of Viniyoga was slightly more effective than conventional exercise (mean difference in Roland-Morris Disability Questionnaire [RDQ] scores, -1.8 [CI, -3.5 to -.1]) and moderately more effective than a self-care education book (mean difference in RDQ score, -3.4 [CI, -5 to -1.6]) in terms of RDQ scores at 12 weeks, but only better than the self-care book at 26 weeks (mean difference in RDQ score, -3.6 [CI, -5.4 to -1.8]). The researchers concluded that yoga was a more effective treatment than a self-care book for improving function and reducing chronic low back pain.

Tekur, Singphow, Nagendra, and Raghuram [28] conducted a short-term (7 days) intensive residential yoga program with physical exercise to measure effects on pain and spinal flexibility in participants with chronic low back pain. They reported less pain-related disability (p=.01) and improved spinal flexibility (p=.008) in yoga participants than in those who participated in a physical exercise regimen.

Rheumatoid arthritis

In a study by Badsha et al. [29] the yoga intervention included stretches, strengthening, meditation, and deep breathing in biweekly sessions for 6 weeks. Results showed statistically significant improvement in RA (p =< .05). A case-control study by Dash and Telles [30] included poses, breathing practices, meditation, lecture, and joint loosening exercises in a 14-day yoga training camp. The study evaluated the effects of yoga practices on adults (n=37), children (n=86), and patients with RA (n=20). The study identified significant improvement in hand grip strength (p=.001); the researchers indicated that improvement may be rapid after a short-term intensive yoga program (e.g., 15 days), as compared to a longer duration (e.g., 24 weeks), less intensive administration, and lower dose. Bosch et al. [31] reported that a 10-week yoga intervention resulted in no significantly decreased Health Assessment Questionnaire (HAQ) disability index, decreased perception of pain and depression, and improved balance (p=.12). Yoga was associated with significant improvement in pain, balance, disability index, and depressive symptoms, indicating a strong positive impact of yoga on RA and underscoring the importance of physical activity in enhancing the quality of life for persons with RA.

Fibromyalgia

Carson et al. [32] studied an 8-week yoga awareness program or wait-listed standard care. Significant improvements were reported for the yoga group, compared to the control group, on scores for pain (p=.0001), fatigue (p =.0001), emotional distress (p =.0001), and vigor (p =.0001), as well as acceptance and relaxation coping strategies (p=.0001). Da Silva et al. [33] tested the effects of a relaxing yoga practice on the treatment of FM patients in an 8-week intervention. Forty women with FM were randomized into Relaxing Yoga (RY) and Relaxing Yoga plus Touch (RYT). Both RY and RYT groups had improvement on the Fibromyalgia Impact Questionnaire (FIQ) and VAS score; the RYT group showed lower verbal scores for pain. VAS and verbal scores were significantly lower on follow-up. In the study by Curtis et al. [34] 22 persons participated in 75-minute yoga class twice a week for 8 weeks. Study results suggested that a yoga intervention reduced pain and catastrophizing, increase mindfulness, and change total cortisol levels in women with FM while the intervention did not improve depression and anxiety scores over the course of the yoga program.

Osteoporosis

Tüzün et al. [35] evaluated the effect of yoga on balance and quality of life in postmenopausal women with osteoporosis and compared the results with a classic osteoporosis exercise program. Twenty-six women (55+ years) were randomly assigned to yoga or classic osteoporosis exercises; half of the women in the yoga group received 1-hour Hatha yoga sessions twice a week for 12 weeks and half performed classic osteoporosis exercises for the same period. Balance was improved in the yoga group but not in the exercise group. Pain and household activities were significantly improved (pain [p=.007], household activities [p=.003]) in both yoga group and exercise group at the end of 12 weeks. However, functional activity (p=.005), mobility (p=.002), social activities (p=.027), general health (p=.002), and mental health (p=.040) were significantly improved only in the yoga group, while the measures were not improved in the exercise group.

Fishman [36] examined long-term (2 years) effects of yoga on persons with osteoporosis, using a serial controlled repeated measure. Eleven patients continued the yoga program for 2 years and 7 patients served as controls. The mean bone mineral density (BMD) of the 11 patients in the yoga group improved more than that of the controls (.563 to .87). Those who were compliant with yoga improved spine and hip t scores by .69 and .87; the control group declined by .12 and .07, respectively. A one-tailed t test showed that differences in the dual-energy x-ray absorptiometry scans were statistically significant. Yoga appeared to be effective for patients with osteoporosis by building BMD after menopause.

Balk et al. [37] used a prospective, pretest/posttest design to compare markers of bone turnover before and after yoga training in sedentary osteopenic postmenopausal women. Seven participants

Authors	Design	*N* (% Women)	Mean Age, Years (*SD*)	Type of musculo-skeletal disorder	Interventions
Park and McCaffrey [39]	Time series design (repeated measures)	10 (86%)	77 (3.6)	Osteoarthritis	Sit 'N' Fit Chair yoga: 45 minutes twice/week
Park et al. [22]	Time series design	21 (76%)	80 (8.3)	Osteoarthritis	8 week sessions Sit 'N' Fit Chair yoga: 45 minutes twice/week, Reiki: 30 minutes, once/ week, Pain Education: 90 minutes every other week
Ebnezar et al. [23]	prospective randomized parallel active control study	235 (70 %)	59 (10)	Osteoarthritis of knee joints	Yoga Group: 40 min (per day) after 20 min of physiotherapy for 2 weeks. Components: (a)Yogic sukshmavyayamas (loosening and strengthening practices), (b) Relaxation techniques, (c) Asanas (physical postures), (d) Pranayama, (e) Meditation Control Group: 40 min of therapeutic exercises after 20 min of physiotherapy for 2 weeks
Taibi and Vitiello [47]	Pretest/ posttest	13 (100%)	65.2 (6.9)	Osteoarthritis	Gentle Hatha yoga: 75 minutes weekly for 8 weeks 20 min of nightly home practice. Components: (a) relaxation and body awareness, (b) progressed to seated poses, (c) supine poses, (d) breathing exercises, (e) deep relaxation
Ülger and Yaglı [48]	pretest/ posttest	27 (100%)	43.70 (7.35)	musculoskeletal problems	Yoga: regular yoga, 60 minutes including asansa, stretching exercise, and breathing techniques; 8 sessions (twice weekly for 4 weeks) Components: (a) Ardha Kati Chakrasana, (b) Ardhachakrasana (c) Padahastasana, (d) Trikonasana, (e) Vriks, (f) asana, (g) Veerabhadrasana, (h) Sasankasana, (i) Suptavajrasana, (j) Paschimatanasana, (k) Bhujangasana, (l) Salabhasana
Bukowski et al. [50]	Pretest/ posttest	15 (100%)	67.75	Osteoarthritis	Iyengar yoga: 61.5 minutes traditional stretching and strengthening exercise (5 minutes warm-up, stretching, 5 minutes cool-down) Component: Mountain pose-basic standing pose; Standing extended triangle pose; standing lunge pose; Supine mountain pose; Supine foot pose; Standing-bending pose; Seated restrained angle pose; Seated restrained angle pose; Seated restrained angle pose
Garfinkel et al. [24]	Randomized controlled trial	25 (56%)	52–79	Hand osteo-arthritis	Supervised yoga and relaxation techniques and patient education: 60-minute session (Sessions 1 and 10 devoted to pretest/posttest) Stretching, strengthening exercise. They raised and straightened their arms above their heads, intertwined their fingers, then turned the palms upwards and lifted from the scapulae.
Kolasinski et al. [25]	Pretest/ posttest	7 (100%)	58.6	Knee osteo-arthritis	Modified Iyengar yoga: 90 minutes once weekly for 8 weeks Posture including standing, sitting, and supine positions Components: Mountain pose and basic standing pose, standing extended triangle pose; staff pose, Supine Mountain pose; Supine foot pose
Dash and Naveen [53]	Randomized controlled trial	291 (% not reported)	31.9 (10.2) -32.8 (8.6)	Musculoskeletal dis-comfort	Yoga group: Daily 1-hour yoga sessions during a period set aside for recreation Components: asanas, exercises for the joints and back, regulated breathing, visual cleansing exercises, and guided relaxation. Wait-List Control: spent the same time in their usual recreational activities.

Tul et al. [51]	Qualitative in-depth interviews, observation	7 (% not reported)	46.6	Back pain	Hatha yoga: 8-weeks of weekly group sessions and at-home practice
Tilbrook et al. [27]	Parallel-group, randomized controlled trial	313 (100%)	46.4 (11.3)	Lower back pain	Iyengar yoga: 12 weeks, gradually progressing yoga program delivered over 3 months; Components: Pain-relieving or settling-in relaxing poses; a program of seated, standing, prone, and supine poses; educative postural advice; and 5 to 15 minutes of relaxation. Usual care:
Williams et al. [41]	Randomized controlled trial	90 (76.7%)	48.2 (1.27)	Chronic low back pain	Iyengar yoga: 90 minutes biweekly for 24 weeks Components: supine, seated, standing, forward bends, twists, and inversions. Wait-listed control group: self-directed standard medical care (SMC)
Saper et al. [52]	Pilot randomized controlled trial	30 (83%)	44 (13)	Chronic low back pain	Yoga group: weekly 75-minute Hatha yoga classes for 12 weeks Each class began and ended with svasana, a relaxation exercise. Classes included postures and berthing techniques. Usual care control group: offered the yoga intervention after 26 weeks
Groessl et al. [39]	Pretest/ posttest	33 (21%)	55.3 (13.7)	Low back pain	Hatha yoga: 8 sessions and a 10-week follow-up period. Components: Energetic breathing exercise, mindfulness/mediation and/or conceration,
Tekur et al. [28]	Randomized controlled trial	80 (46%)	49 (3.6) - 48 (4.0)	Chronic low back pain	Yoga group: 1-week intensive residential yoga program (integrated approach to yoga therapy) Components: Supine postures; Prone posture; Quick relaxation technique; Sitting postures; Standing postures; Deep relaxation technique Control group: physical exercises performed in 1-week intensive program
Sherman et al. [18]	Randomized controlled trial	101 (66%)	44 (12)	Low back pain	Yoga group: 75-minute weekly yoga sessions for 12 weeks Exercise group: 12-session conventioal therapeutic exercise class Self-care book: mailed a copy of *The Back Pain Helpbook*
Williams et al. [26]	Randomized controlled trial	60 (67.9%)	48.7 (10.6)	Low back pain	Yoga group: one 1.5-hour class weekly for 16 weeks at a community yoga studio Educational control group: two1-hour lectures on occupational/ physical therapy education
Galantino et al. [43]	Randomized controlled trial	22 (77%)	Range 30-65	Chronic low back pain	Yoga group: modified Hatha yoga protocol, 1 hour, twice a week for 6 weeks Control group: Over the same 6-week period, instructed to continue with usual daily activities Diaphragmatic breathing/relaxation postures; stretching postures; asanas/preparatory exercises; sun salutation; relaxation and meditation.
Bosch et al. [31]	Pretest/posttest design	16 (% not reported)	Yoga 56.3 (7.6) Control 66.7 (5.8)	RA	Three yoga classes: 75-minute yoga session 3 times a week for 10 weeks Supine breathing activities; traditional posture and stretches; meditation.
Badsha et al. [29]	Pretest/posttest design	47 (% not reported)	44 (10)	RA	Vishwas-Raj Yoga: 1-hour session twice a week for 6 weeks Components: Stretches, strengthening, meditation and deep breathing

Dash and Telles [30]	Pretest/posttest design	286	31 (7.4)	RA	Yoga group: 60 minutes (asanas or postures) yoga asanas or postures, pranayama or voluntarily regulated breathing, meditation, and lectures about yoga philosophy. Control group
Curtis et al. [34]	Time series design	22 (100%)	47.4 (13.7)	Fibromyalgia	75-minute yoga class twice weekly for 8 weeks Components: traditional, modified, and restorative yoga postures (asana), breathing exercises (pranayama), a brief meditation (dhyana), intention setting, mindfulness exercise and an introduction to the eight limbs of yoga.
Carson et al. [32]	Randomized controlled trial	Women 53 (100%)	53.7 (11.5)	Fibromyalgia	Yoga group: 120-minute weekly classes (7-12 patients/group) for 8 weeks Gentle stretching poses, mindfulness meditation (e.g., awareness of breath), breathing techniques, didactic presentations on the application of yogic principles to optimal coping Wait-listed control group: standard care
da Silva et al. [33]	Randomized controlled trial	40 (100%)	44 (8.0) -46 (8.9)	Fibromyalgia	Relaxing Yoga (RY): 50-minute weekly sessions for 8 weeks Relaxing Yoga plus Touch (RYT): 50-minute weekly sessions for 8 weeks
Yağlı and Ülger Ö [49]	pre/post design	12 (100%)	66.00 (3.87)	Osteoporosis	Yoga exercise program 1hour Components: breathing exercise; warm-up activities; physical poses in the supine, seated, and standing position; corpse pose
Tüzün et al. [35]	Randomized controlled trial	26 (100%)	60.62 (8.43)	Osteoporosis	Yoga education 1 hour twice/week for 12 weeks
Fishman et al. [36]	repeated measures	18 (91%)	68	Osteoporosis or osteo-penia	Yoga: 10 minutes daily for 2 years
Balk et al. [37]	Prospective, pre/post design	13 (100%)	55 (4.5)	Osteoporosis and osteo-penia	Hatha yoga: 60 minutes, once a week for 12 weeks
Boyle et al. [54]	Time-series design, repeated measures	24 (100%)	38.3	Muscle soreness in lower extremity	Kripaiustyic yoga: 90-minute gentle or moderate session (at the facility where they normally practiced yoga) at 24 and 72 hours after initial testing
Oken et al. [38]	Randomized controlled trial	57	Yoga: 49.8 (7.4)	Multiple Sclerosis	Iyengar yoga: 90 minutes once per week for 6 months Components: breathing for concentration and relaxation during the session. Each class ended with a 10-minute deep relaxation with the subject lying supine. Progressive relaxation, visualization, and mediation techniques were introduced. Exercise: Aerobic exercise (bicycling on recumbent or dual-action stationary bicycles) Waiting list
Garfinkel et al. [17]	Randomized, single-blind, controlled trial	42 (64%)	48.9	Carpal tunnel syndrome	Iyengar approach to Hatha yoga: 1 to 1.5 hours for strengthening, stretching, balancing upper body joints plus relaxation twice weekly for 8 weeks Wait-list control group

Table 1: Summary of 31 Studies of Yoga Interventions: Design and Interventions.

completed the 12-week series of 1-hour weekly yoga classes and home practice. It was concluded that yoga may have effects on bone turnover in this population.

Based on the results of the three studies on osteoporosis, it could be concluded that relaxation may decrease sympathetic activation. Yoga could improve bone mass, as sympathetic activation may mediate the skeletal effects of stress. Thus, relaxation might be a positive component in a yoga intervention aimed at reducing risk of fractures.

Other musculoskeletal disorders (Multiple sclerosis, Carpal tunnel syndrome)

Garfinkel et al. [17] conducted an RCT to measure effects of yoga for relieving symptoms associated with carpel tunnel syndrome in participant's ages 24 to 77 years. The yoga group had significant improvement in grip strength (from 162 to 187 mm HG, p=.009) and pain reduction (from 5.0 to 2.9 mm, p =.02), while the control group did not show a significant change in grip strength or pain.

Author	Outcome measures	Results
Osteoarthritis		
Park and McCaffrey (2012)	Western Ontario and McMasters Arthritis Index (WOMAC) Epidemiologic Studies Short Depression Scale (CES-D)	Although chair yoga was effective in improving physical function and reducing stiffness in older adults with osteoarthritis ($p < .05$), it was not effective in reducing pain level or improving depressive symptoms.
Park et al. (2011)	Western Ontario and McMasters Arthritis Index (WOMAC) Epidemiologic Studies Short Depression Scale (CES-D)	Statistically significant decrease in mean score for pain from pretest ($M = 8.7$) to posttest ($M = 3.5$, $t[5] = 2.6$ $p = .048$) in the chair yoga group; statistically significant decrease in physical function from pretest ($M = 32.4$) to posttest ($M = 16.2$), $t[4] = 5.4$, $p = .006$) in the chair yoga group
Ebnezar et al (2011)	Short Form 36 (SF-36)	Yoga therapy is better than therapeutic exercises as an adjunct to transcutaneous electrical stimulation and ultrasound treatment in improving knee disability and quality of life in patients with OA knees ($P < 0.001$, Mann–Whitney *U*-test).
Taibi & Vitiello (2011)	Pittsburgh Sleep Quality Index (PSQI); Insomnia Severity Index (ISI); Epworth Sleepiness Scale (ESS); Health Assessment Questionnaire (HAQ); Geriatric Depression Scale(GDS)	Pain (VAS) and disability (HAQ-DI) scores were not significantly reduced in this study. Disability scores were fairly low and may have encountered a floor effect. Severity Index and diary-reported sleep onset latency, sleep efficiency, and number of nights with insomnia were significantly improved at post-intervention versus pre-intervention ($p < .05$).
Ülger et al. (2011)	Gait cycle (sec), walking speed (m/sec), maximum walking distance (m), step length (cm), ambulation index	Yoga had a positive effect on balance and gait parameters of women with gait and balance disturbances caused by musculoskeletal problems ($p < .05$).
Bukowski, et al. (2006-07)	WOMAC	Functional changes and improvement in quality of life in a yoga and traditional exercise that should encourage further comprehensive and carefully designed studies of yoga in osteoarthritis
Garfinkel et al. (1994)	Grip strength HAQ hand function	Yoga group had significant improvement in grip strength (162 to 187 mm Hg; $p = .009$) and reduction in pain (5.0 to 2.9 mm; $p = .02$); controls had no significant change in either measure. On range of motion, the treatment group improved more than the control group. Difference was significant for right hand ($p = .002$)
Kolasinski et al. (2005)	WOMAC; Arthritis Impact Measurement Scale 2 (AIMS2), Patient Global Assessment (GA) by Visual Analog Scale	Yoga may provide a feasible treatment option for previously yoga-naïve, obese patients >50 years old with knee osteoarthritis; potential reduction in pain by 46.7% ($p = 0.04$) and stiffness by 39.0%
Telles, Dash, & Naveen (2009)	Cornell Musculoskeletal Discomfort Questionnaire; (CMDQ) Nordic Musculoskeletal Questionnaire (NMQ)	Yoga group showed significant increases in bilateral hand grip strength, right hand tapping speed, and low back and hamstring flexibility ($p < .001$). Results suggest that yoga practice is a useful addition to the routine of professional computer users.
Low Back Pain/Rheumatoid Arthritis		
Tul et al. (2011)	In-depth interviews and observations	Patients who benefit from yoga may do so in part because yoga enables changes in cognition and behaviors related to pain
Tilbrook et al. (2011)	Roland–Morris Disability Questionnaire (RMDQ)	Yoga group had better back function at 3, 6, and 12 months than usual care group. Yoga group had higher pain self-efficacy scores at 3 and 6 months but not at 12 months. The mean score of the RMDQ was 2.17 points lower in the yoga group at 3 months, 1.48 points (95% CI).
Williams et al. (2009)	Oswestry Disability Index (ODI), Visual Analogue Scale (VAS), Beck Depression Inventory-Second Edition (BDI-II)	Significantly greater reductions in functional disability and pain intensity in yoga group compared to control group at 24 weeks. Significantly greater proportion of yoga subjects also reported clinical improvements at 12 and 24 weeks.
Saper et al. (2009)	Modified Roland-Morris Disability Questionnaire; SF-36	Mean Roland scores for yoga decreased from 14.5 to 8.2 compared to usual care ($p = .28$). At 12 weeks, yoga group reported less analgesic use (13% vs. 73%, $p = .003$), less opiate use (0% vs. 33%, $p = .040$), and greater overall improvement (73% vs. 27%, $p = .03$) compared to usual care
Groessl et al. (2008)	Single visual numeric scale (range 0–10); Medical Outcomes Study, CESD-10; Health-Related Quality of Life (HRQOL)	Yoga intervention for VA patients with chronic back pain may improve the health of veterans
Tekur et al. (2008)	Oswestry Disability Index (ODI)	Significant reduction in ODI scores in yoga group compared to control group ($p = .01$); greater improvement in spinal flexibility in yoga group compared to controls: spinal flexion ($p = .008$), spinal extension ($p = .002$), right lateral flexion ($p = .059$), left lateral flexion ($p = .006$)
Sherman et al. (2005)	Modified 24-point Roland Disability Scale bothersomeness of pain	Back-related function in yoga group was superior to the book and exercise groups at 12 weeks (yoga vs. book: mean difference -3.4 [95% CI, -5.1 to -1.6], $p < .001$; yoga vs. exercise: mean difference -1.8 [CI, -3.5 to -0.1], $p = .034$); yoga was more effective than a self-care book for improving function and reducing chronic low back pain; benefits persisted for at least several months
Williams et al. (2005)	Pain Disability Index (PDI); Short Form McGill Pain Questionnaire (SF-MPQ); Tampa Scale of Kinesiophobia (TSK); Survey of Pain Attitudes (SOPA); Coping Strategies Questionnaire-Revised (CSQ-R)	Functional outcomes revealed significant reductions in pain intensity (64%), functional disability (77%), and pain medication usage (88%) in the yoga group at posttest and 3-month follow-up
Galantino et al. (2004)	Oswestry Disability Index (ODI), Beck Depression Inventory (BDI) questionnaires	Functional measures of the functional reach and sit reach improved in 64% and 90%, respectively, of the experimental group, while only 2 (20%) subjects of the control group improved.
Bosch et al. (2009)	Health Assessment Questionnaire (HAQ); Berg Balance Test; Visual Analog Pain Scale; Beck Depression Inventory	Yoga showed significantly decreased HAQ disability index, decreased perception of pain and depression, and improved balance ($p = .12$)
Badsha et al. (2009)	DAS-28; HAQ Pain Health Assessment Questionnaire (HAQ); and Quality of Life (QOL) by SF-36	Statistically significant improvements in disease activity ($p \leq .05$); some patients in yoga group decreased or discontinued rheumatoid arthritis medications

Dash & Telles (2001)	Grip strength	Yoga practice improved hand grip strength in normal persons and in patients with rheumatoid arthritis, although magnitude of improvement varied with factors such as gender and age
Fibromyalgia		
Curtis et al. (2011)	McGill Pain Questionnaire short-form 2 (MPQ-SF-2), Numeric Rating Scale (NRS) Sum of Local Areas of Pain (SLAP) Pain Catastrophizing Scale (PCS) Pain Disability Index Chronic Pain Acceptance Questionnaire (CPAQ) Salivary cortisol measurement	Yoga intervention may reduce pain (pre = 5.18 ± 1.72; post = 4.44 ± 2.03) and catastrophizing (pre = 25.33 ± 14.77; post = 20.40 ± 17.01), increase acceptance (pre = 60.47 ± 23.43; post = 65.50 ± 22.93) and mindfulness (pre = 120.21 ± 21.80; post = 130.63 ± 20.82), and alter total cortisol levels in women with FM.
Carson et al. (2010)	Fibromyalgia Impact Questionnaire Revised (FIQR); Patient Global Impression of Change (PGIC)	Yoga group had significant improvement on standardized measures of fibromyalgia symptoms and functioning, including pain (β =-1.47, t = -5.90, p < .0001), fatigue (β = -1.68, t = -6.23, p <.0001), and mood (β = -1.34, t = -4.92, p < .0001), and in pain catastrophizing, acceptance (β = 1.20, t = 5.10, p < .0001), and relaxation coping strategies (β = 1.38, t = 4.36, p < .0001)
da Silva et al. (2007)	Fibromyalgia Impact Questionnaire (FIQ); Visual Analog Scale (VAS)	Both groups showed improvement in FIQ and VAS scores, which decreased on all sessions; RYT group showed lower VAS and verbal scores for pain on the eighth session
Osteoporosis		
Yağlı & Ülger Ö (2012)	Quality of life (QoL) was evaluated using Nottingham Health Profile (NHP). Timed Up and Go Test (TUG) visual analog scale (VAS)	QoL scores after the yoga program were better than scores obtained before the yoga program (p < 0.05). After sessions, there was a statistically significant decrease in their TUG mobility scores (p < 0.05). When the initial values were compared with the after yoga program values, the severity of pain showed a diminish (p < 0.05).
Tüzün et al. (2010)	Quality of Life Questionnaire of the European Foundation for Osteoporosis	Yoga education had a positive effect on pain (pre = 11.92 ± 4.89; post = 8.62 ± 3.20, physical function (pre = 6.69 ± 1.44; post = 5.15 ± 0.90, social functions (pre = 19.38 ± 4.94 ; post = 17.62 ± 4.72), and general health perception (pre = 10.08 ± 2.06; post = 7.46 ± 1.61.
Fishman et al. (2009)	Bone Mineral Density (BMD); dual-energy x-ray absorptiometry (DEXA) scan	Five patients with osteopenia were reclassified as normal; 2 patients with osteoporosis were classified as osteopenic; no injuries reported
Balk et al. (2009)	Bone-specific alkaline phosphatase (BAP), urinary bone resorption marker, urinary N-telopeptide (uNTX),	Amount of yoga practice was significantly correlated with BAP levels (r = .68, p = .09). A weaker, nonsignificant correlation was found between the amount of yoga practice and uNTX levels (r = -.54, p = .21). Compared to yoga, other physical activities were less correlated with BAP and uNTX levels. Yoga may have beneficial effects on bone turnover in osteopenic postmenopausal women.
Boyle et al. (2004)	Aerobics Longitudinal Study Physical Activity Questionnaire (ALSPAQ); Body Awareness Questionnaire	VAS scores were higher before yoga class than after yoga class at 24 hours (21.4 |± 6.91 mm VK. 11.1 |± 4.1J mm; p = .02). SR was greater in yoga group than in control group (65.0 |± 7.9] cm vs. 33.*3* [± 7.01 cm]
Oken et al. (2004)	Profile of Mood States, State-Trait Anxiety Inventory, Multi-Dimensional Fatigue Inventory (MFI), and Short Form (SF)-36 health-related quality of life	Subjects with MS participating in either a 6-month yoga class or exercise class showed significant improvement in measures of fatigue (pre = 11.4 ± 4.7; post = 10.7 ± 4.0) compared to a wait-list control group (pre = 11.7 ± 3.5; post = 11.2 ± 3.9. There was no relative improvement of cognitive function in either of the intervention groups.
Garfinkel et al. (1998)	Visual Analog Scale (VAS), Phalen sign and Tinel sign	Yoga group improved significantly more than control group in pain (decreased from 5.0 to 2.9 mm; p = .02) during activity, tenderness, and finger range of motion; other trends also favored the yoga program; yoga was effective in providing relief for hand osteoarthritis

Table 2: Studies in Systematic Review of Yoga Interventions: Measures and Results.

Oken et al. [38] compared the effects of Iyengar yoga and exercise on attention, alertness, mood, anxiety, fatigue, and quality of life in 69 adult subjects with multiple sclerosis. Both interventions showed significant improvement in fatigue, compared with a wait-list control group (p<.01). However, there was no statistically significant improvement in cognitive function in either of the intervention groups.

Summary of Study Results

Based on the Downs and Black quality index [20], the yoga interventions yielded positive results in persons with musculoskeletal disorders. Based on the reviewed studies, yoga intervention is moderately feasible and is likely to be equal to or superior to exercise or usual care for reducing pain and pain medication use. Scores ranged from 4 to 26 (maximum possible score=27).

Types of yoga interventions included Hatha yoga, Viniyoga, Iyengar yoga, Vishwas-Raj yoga, Chair yoga, Kripaiustyic yoga, and nonspecified types of yoga. In general, the methodological quality of the RCTs was moderate to high. Sample sizes ranged from 7 to 313. Only 9 studies [17,22,26,32-34,38,39] reported specific ethnic distribution of participants. Most of the participants in these studies were Caucasian. Each study predominantly included women, and 10 studies (32%) included only women. Only 8 studies (26%) included participants with a mean age over 60 years, even though musculoskeletal disorders are the leading cause of disability among older adults [40].

Intervention protocols varied widely across studies; doses ranged substantially and were often inconsistent. Duration of yoga practice included a 1-week intensive program [27] (low back pain) twice per week for 6 weeks [41], 90 minutes biweekly for 24 weeks [26], to 90 minutes of practice twice weekly for 24 weeks [26]. The lowest dose was 45 minutes per week for 8 weeks [22,42]. While the interventions in each study were developed, adopted, and/or taught by licensed or certified yoga professionals (teachers or therapists), some studies [28,30,31] did not describe the intervention development or delivery. Although the specific yoga techniques varied across programs, elements common to all of them included specific stretching, breathing, relaxation exercise, and specific attention to alignment of body structures.

Discussion

Of the 31 identified studies, 15 used RCT methodology. Based on the outcomes of these 15 RCT trials, yoga programs were demonstrated to be safe for use and feasible to be delivered to people with musculoskeletal disorders. The reviewed studies reported duration of yoga sessions from 8 weeks to 12 weeks, each session lasting 45 to 90 minutes, once or twice a week.

Twelve studies (39%) presented precise detailed descriptions of asanas, breathing, and relaxation techniques; the remaining studies presented an outline but did not provide details that would allow replication. Although some of the studies did not provide details, yoga interventions employed included breathing activities, postures, stretches, and meditation. Specifically, yoga intervention consisted of (a) breathing and loosening practice at the beginning of each session; (b) relaxation techniques, physical posture, strengthening, and stretches during the session; and (c) meditation at the end of the session.

The investigation of yoga's efficacy as a part of a comprehensive approach to managing musculoskeletal disorders has been limited to studies that were small in size and scope. Based on the Downs and Black quality index [20], the strongest findings came from studies by Tilbrook [27], Carson et al. [32], and Williams [26,43]. The Tilbrook study [27] met all of the Downs and Black criteria with the exception of the identification of confounders in each group. The other studies met all Downs and Black criteria except for estimation of variability of outcomes and representativeness of the sample.

Methodological limitations of the reviewed studies were identified. Table 3 lists the main methodological limitations and the studies that had each limitation. One of the main limitations of many of the studies was a lack of consistency regarding content of the yoga program, dose and duration of yoga interventions, or specific poses and modifications used. Uniform consistency of teaching methods, program content, length of intervention, and dose effect would assist in measuring the efficacy of yoga in populations with musculoskeletal disorders. Given such variability in length, intensity, and frequency of the reported yoga-based interventions, it is difficult to draw conclusions regarding the best format, intensity, or duration or to measure the efficacy of yoga in relieving symptoms associated with musculoskeletal disorders. Although a recent review on yoga concluded that yoga has a positive effect on musculoskeletal disorders and function [44], the review was burdened with a high risk of bias for the above identified reasons. More studies are needed to determine the best format, intensity, duration, and content of such treatments, as well as their efficacy in this population.

In order to realize improvement of symptoms associated with musculoskeletal disorders and to obtain benefits from yoga, it is important to establish inclusion and exclusion criteria. Important inclusion criteria are (a) age range (e.g., ≥ 60 years); (b) diagnosis by a health care provider of a musculoskeletal disorder such as OA, low back pain, or related disorder; (c) pain level (e.g., at least level 4 on a scale of 0=*no pain* to 10=*excruciating pain*); (d) pain duration (e.g., ≥ 3 months). Exclusion criteria should be (a) current participation in yoga or other exercise activities to improve symptoms; (b) inability to follow directions due to cognitive or psychiatric disorder; and (c) inability to come to the research site.

Although musculoskeletal disorders are more prevalent in older adults and yoga may produce physical and psychological benefits, only four studies focused on aging populations. It is plausible that older adults may not be able to participate in regular standing yoga because they are insecure due to pain, weakness, and fear of falling due to impaired balance [26,45]. Misunderstanding about the physical demands of the practice of yoga or skepticism about the yoga philosophy may prevent this population from practicing yoga [45].

Limitations of the Review Study

Several limitations of this systematic review are recognized. First, although efforts were made to capture all relevant intervention studies, it is possible that the search strategy did not retrieve all relevant articles. Second, although two researchers independently rated the methodological quality of the reviewed studies based on the Downs and Black quality rating checklist and variances in ratings of quality were resolved by discussion, the possibility of remaining bias in the two researchers' quality assessments is recognized.

Implications

Methodological quality should be improved in future studies. First, appropriate sample calculations and sufficient sample size are required to support the effectiveness of the tested interventions. Second, future research should provide evidence of methodologically rigorous RCTs to measure the effectiveness of yoga interventions. Third, future intervention studies should report specific ethnic and racial categories

	Limitations	
1	High risk of potential bias due to lack of rigorous design based on Downs and Black quality rating checklist.	Tul et al. (2011), Bosch et al. (2009), Badsha et al. (2009), Fishman et al. (2009), Yağli & Ülger (2012)
3	Lack of standardized measurement	Yağli & Ülger (2012), Ülger & Yağli (2010), Bukowski et al. (2006-2007), Babsha et al. (2009), Dash & Telles (2001)
4	Failure to complete a power analysis to determine appropriate sample size/small sample size	Park et al. (2011), Park & McCaffrey (2012), Ülger & Yağli (2010), Bukowski et al. (2006-2007), Groessl et al. (2008), Galantino et al. (2004), Bosch et al. (2009), Badsha et al. (2009), Dash & Telles (2001), Curtis et al. (2011)
5	Lack blinding (subject and main outcomes of the intervention.)	Twenty five of the studies reviewed had no blinding to subjects or intervention. Only six met this criterion: Tilbrook et al. (2011), Williams et al. (2005), Williams et al. (2009), Saper et al. (2009), Tekur et al. (2008), Garfinkel et al. (1998)
8	Lack of sufficient follow-up to determine whether the effect was sustained (dose effect)	All of the studies demonstrated a lack of followup EXCEPT Garfinkel et al. (1998), Tilbrook et al. (2011) ,Williams et al. (2005) (2009), Tellus (2009), Saper et al. (2009), Tekur et al. (2008), Sherman et al. (2005), Carson et al. (2010), da Silva et al. (2007)
9	Potential bias of administration of treatment and assessment of outcome	Twenty-five of the studies had potential for bias due to lack of radomization. Only six met this criterion: Tilbrook et al. (2011), Williams et al. (2005), Williams et al. (2009), Saper et al. (2009), Tekur et al. (2008), Garfinkel et al. (1998)

Table 3: Summary of Main Methodological Limitations of the Reviewed Studies.

and recruit diverse groups of persons with multiple comorbidities. Closer investigation of specific types of yoga could be helpful in determining which are the most efficacious for specific conditions.

The evidence regarding the effectiveness of yoga therapy for patients with musculoskeletal disorders has implications for health and wellbeing. Safety and cost effectiveness are appealing aspects of yoga as a complementary therapy for many patients with musculoskeletal disorders. This is an important consideration as health care costs increase.

It would be useful to identify evidence of the appropriate length, intensity, and frequency of yoga therapies for various musculoskeletal diseases, including for persons with significant handicaps who are unable to participate in regular standing yoga programs and who might require adaptation, such as a chair yoga program. Creating a database of evidence regarding the effects of specific yoga programs on identified musculoskeletal disorders will increase the ability of health care providers to encourage patients to include yoga as a viable exercise and stretching program in the treatment of their condition.

Conclusion

The purpose of this literature review was to gain insight into the effectiveness of yoga as a therapy for musculoskeletal disorders. Deficiencies in the evidence for the effect of yoga for people with musculoskeletal disorders included small sample size, lack of design strength, variability in sample selection and sample size variables, and lack of precise description of the yoga therapy, including length, frequency, and intensity of programs provided. More studies are needed to provide an evidence base for yoga as a therapy for musculoskeletal disorders. Future research should include (a) a sufficient sample size to produce validated findings; (b) sufficient follow-up to determine the extent to which the effect was sustained; (c) power analysis to determine appropriate sample size; (d) rigorous design, such as RCTs, with double blinding; (e) standardized measurement tools; (f) uniform length of sessions and identification of asanas, breathing, relaxation, and meditation techniques.

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